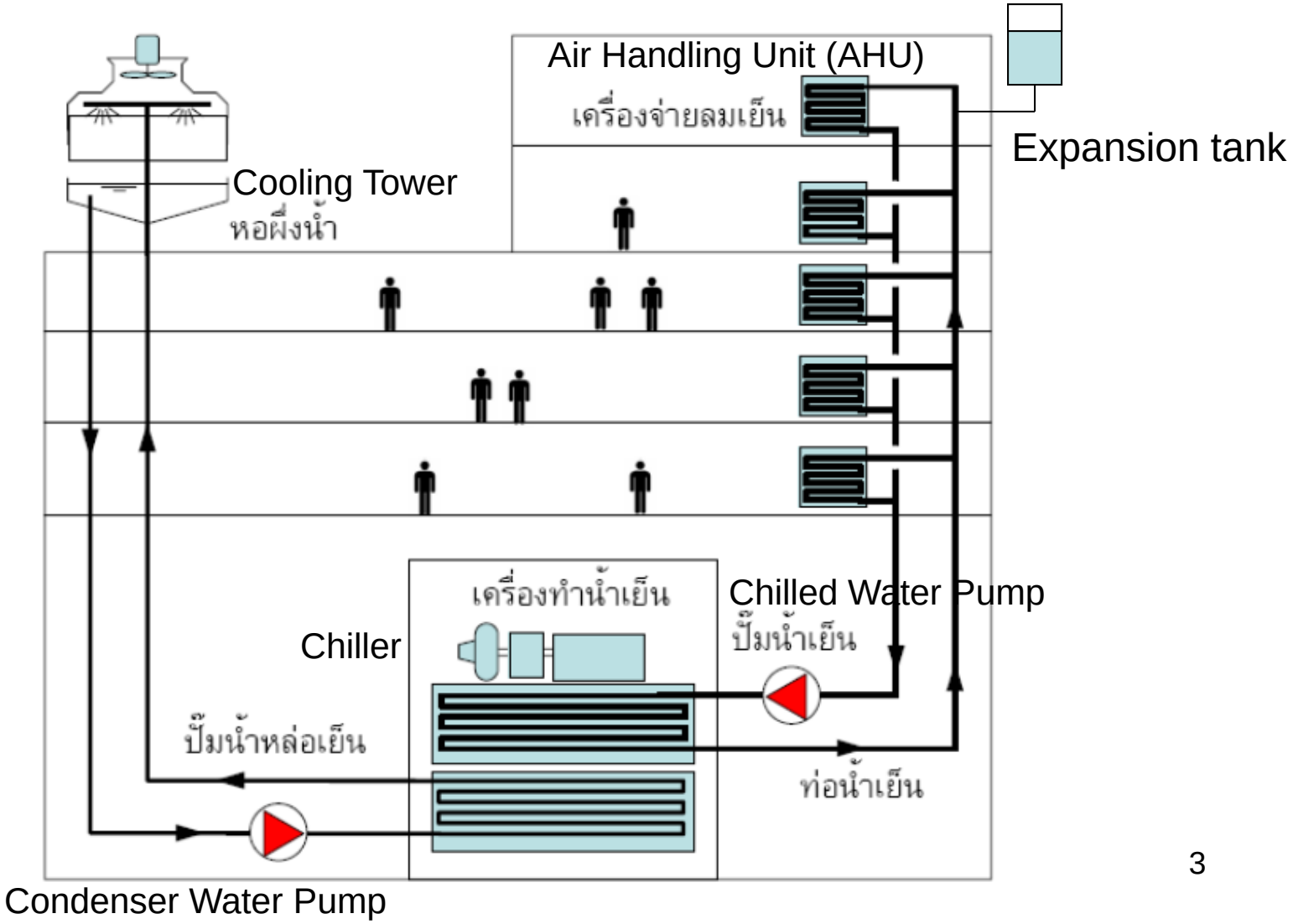
ME444 ENGINEERING PIPING SYSTEM DESIGN

CHAPTER 10 : CONTROL VALVES IN CLOSED LOOP SYSTEMS

CONTENT

1. CIRCULATION SYSTEM
2. CONTROL VALVES
3. SELECTION PROCESS

1. CIRCULATION SYSTEM

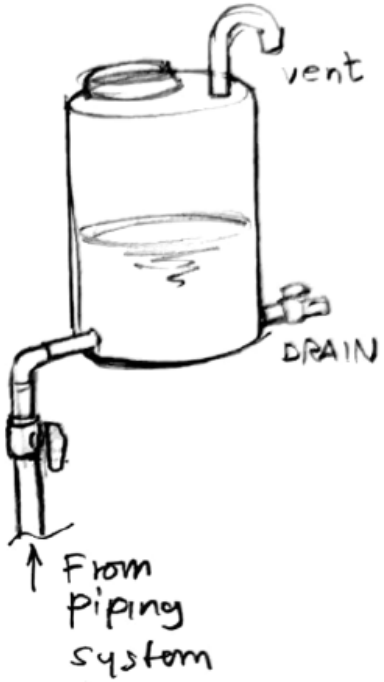


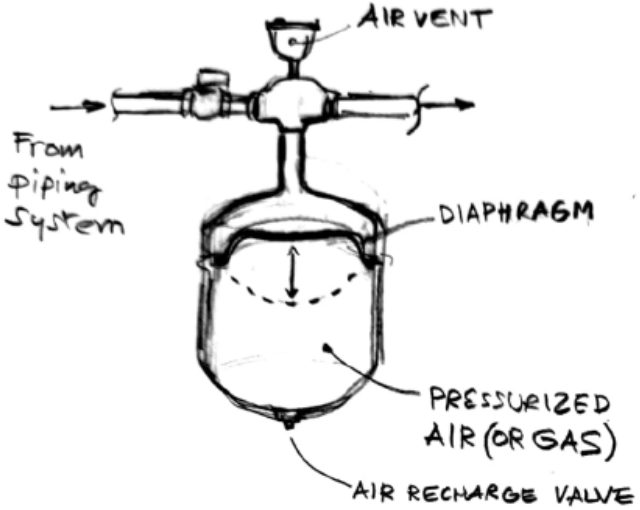
CHILLED WATER/CONDENSER WATER PUMPS

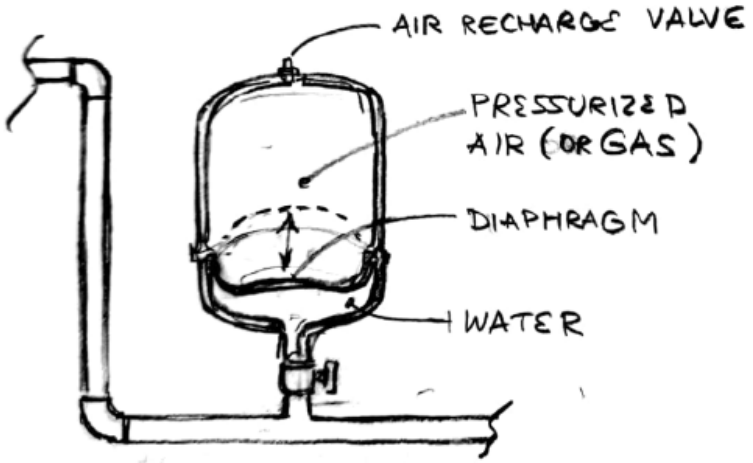
CHILLERS/ COOLING TOWERS

AIR HANDLING/ FANCOIL UNITS

EXPANSION TANKS



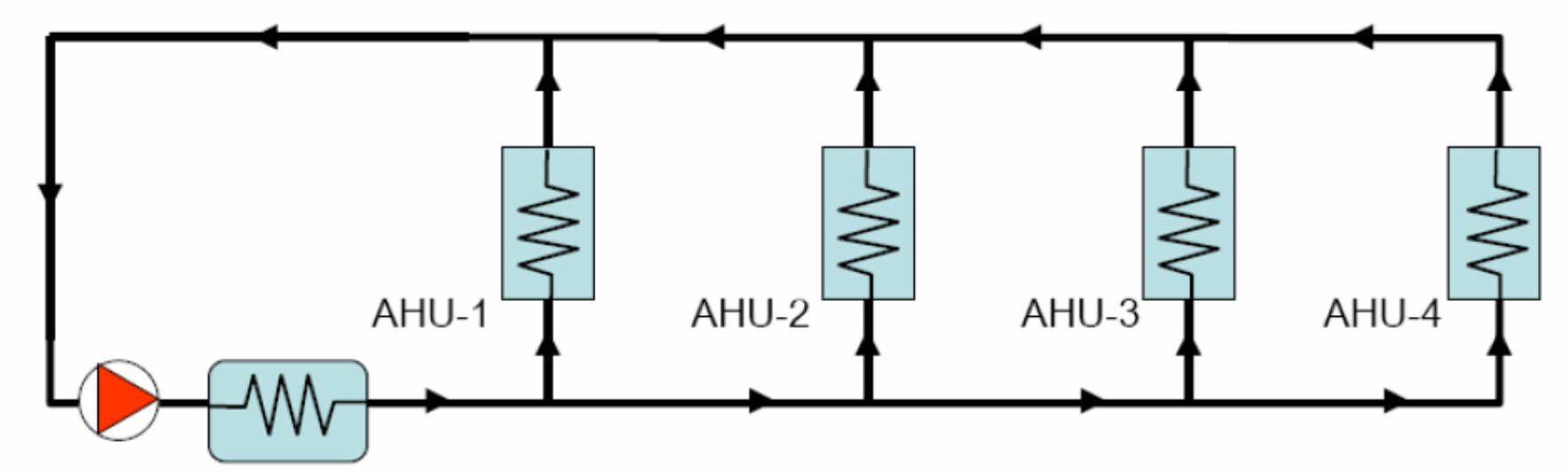




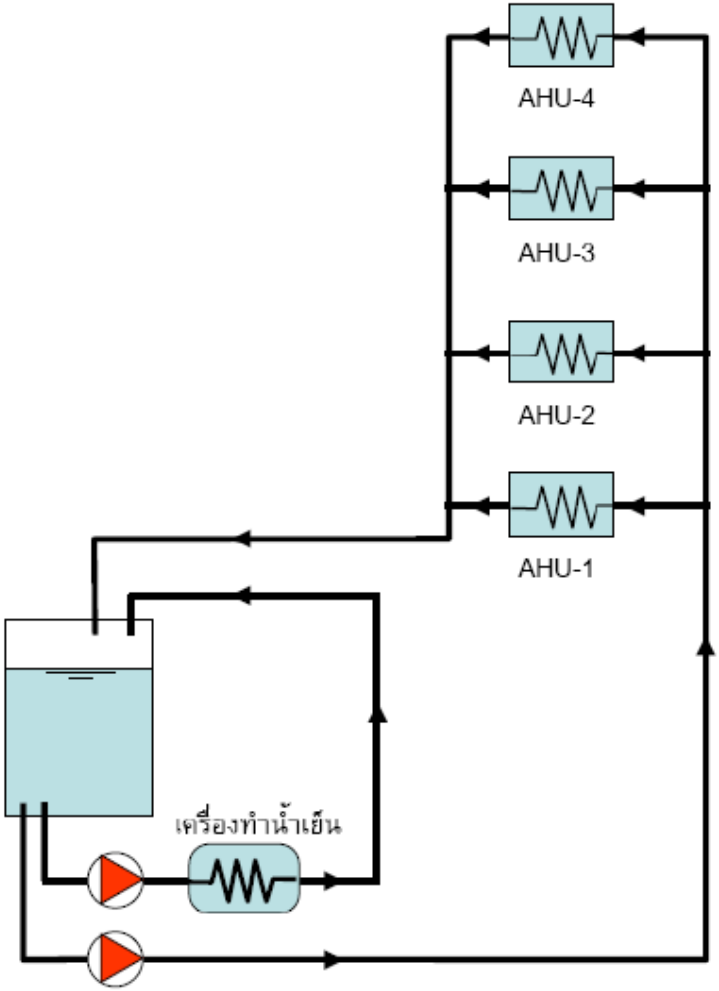
REQUIRED FLOW

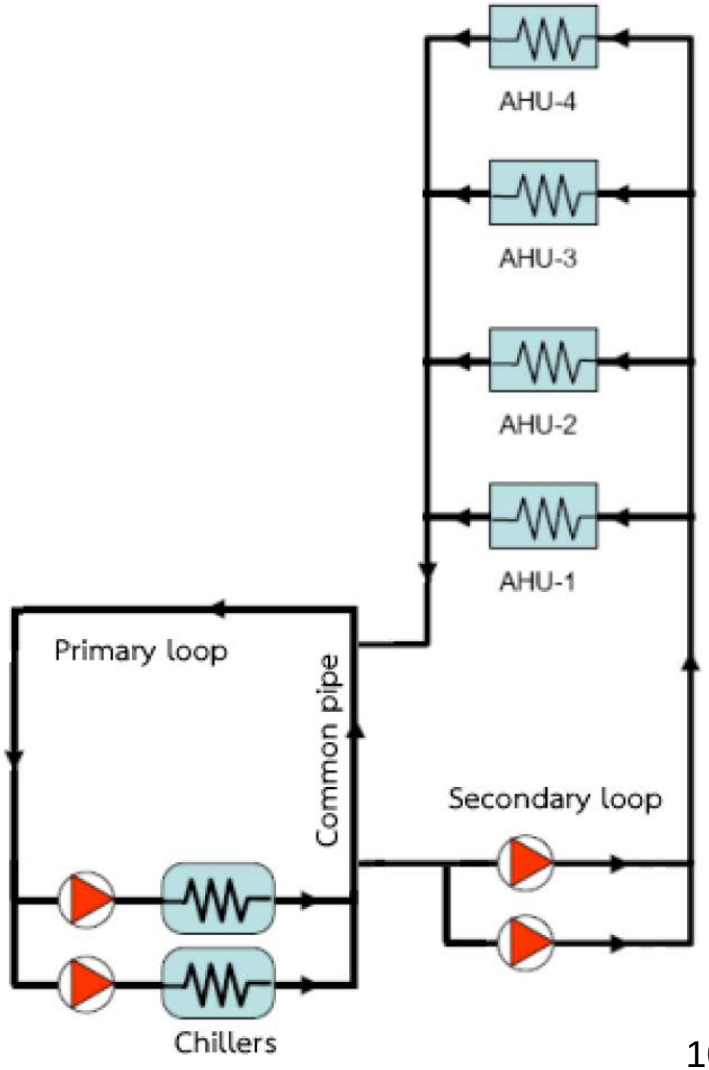
System	Flowrate (lpm/tonR)	
	At diff. temp	
	5.5 °C	11°C
Chilled Water	9.0 (2.4GPM)	4.5
Condenser Water	11.3 (3 GPM)	5.7

CHILLED WATER CIRCULATION



PRIMARY/SECONDARY SYSTEM





BASIC EQUATION

BERNOULLI EQUATION

$$\frac{p_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{V_2^2}{2g} + z_2 + LOSS$$

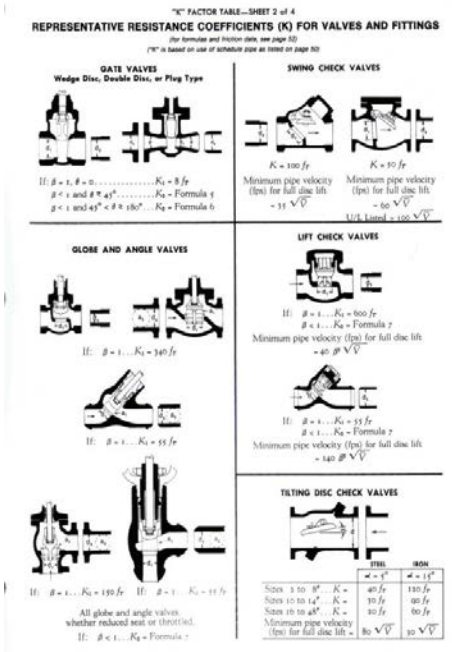
TOTAL PRESSURE = VELOCITY PRESSURE + STATIC PRESSURE

ENERGY GRADE LINE = VELOCITY PRESSURE + STATIC PRESSURE + ELV
HYRRAULIC GRADE LINE = STATIC PRESSURE + ELEVATION

LOSS

MAJOR LOSS: PRESSURE DROP IN PIPE

MINOR LOSS: PRESSURE DROP IN FITTINGS AND VALVES


"K" FACTOR TABLE—SHEET 2 of 4

REPRESENTATIVE RESISTANCE COEFFICIENTS (K) FOR VALVES AND FITTINGS

GATE VALVES
Wedge Disc, Double Disc, or Plug Type

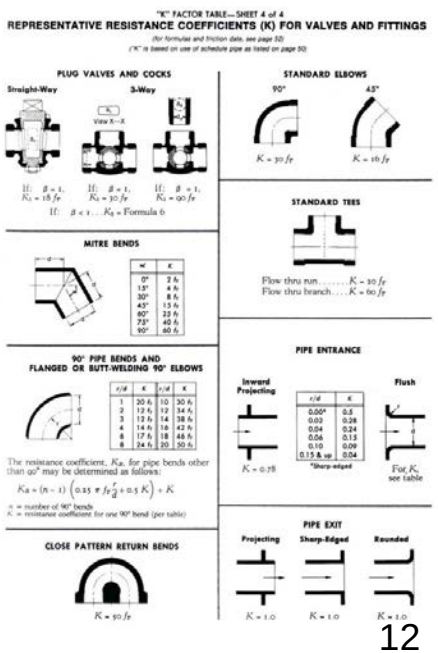
SWING CHECK VALVES

GLOBE AND ANGLE VALVES

LIFT CHECK VALVES

TILTING DISC CHECK VALVES

All globe and angle valves, whether reduced seat or throttled.


"K" FACTOR TABLE—SHEET 4 of 4

REPRESENTATIVE RESISTANCE COEFFICIENTS (K) FOR VALVES AND FITTINGS

PLUG VALVES AND COCKS

STANDARD ELBOWS

STANDARD TEES

MITRE BENDS

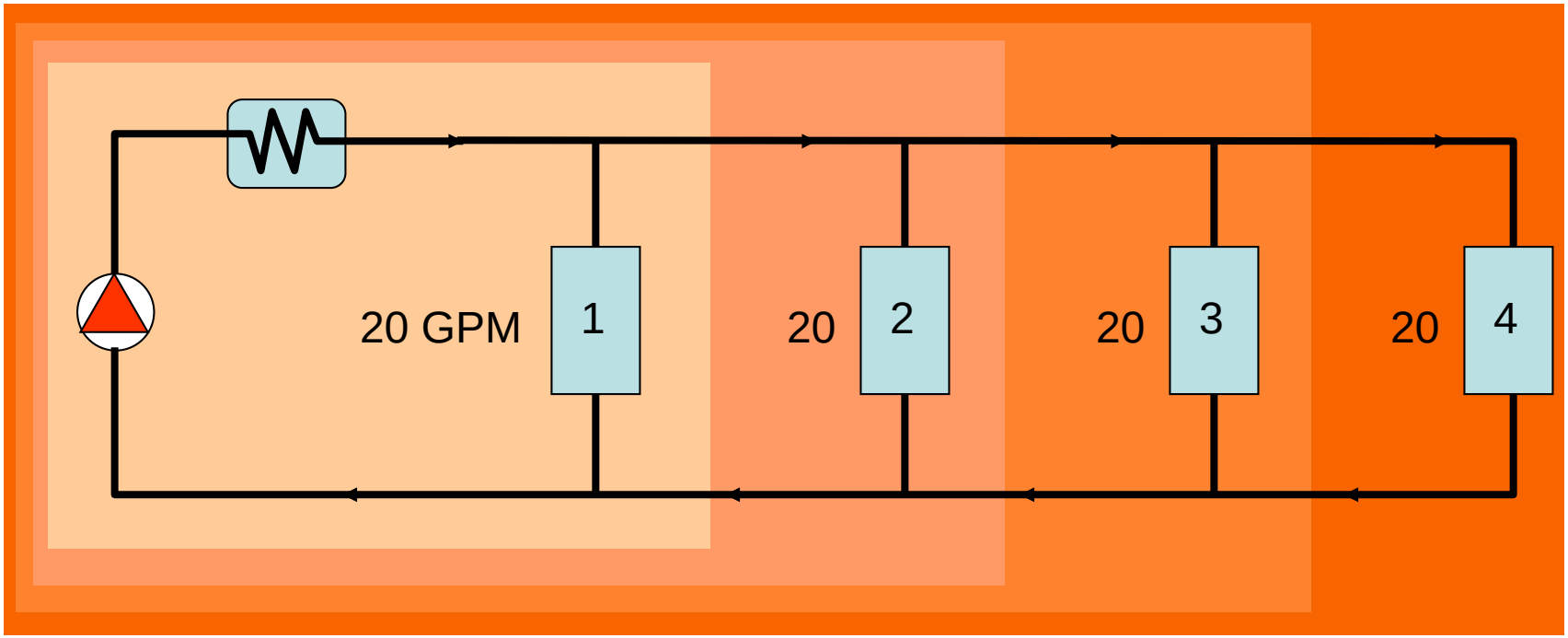
90° PIPE BENDS AND FLANGED OR BUTT-WELDING 90° ELBOWS

PIPE ENTRANCE

CLOSE PATTERN RETURN BENDS

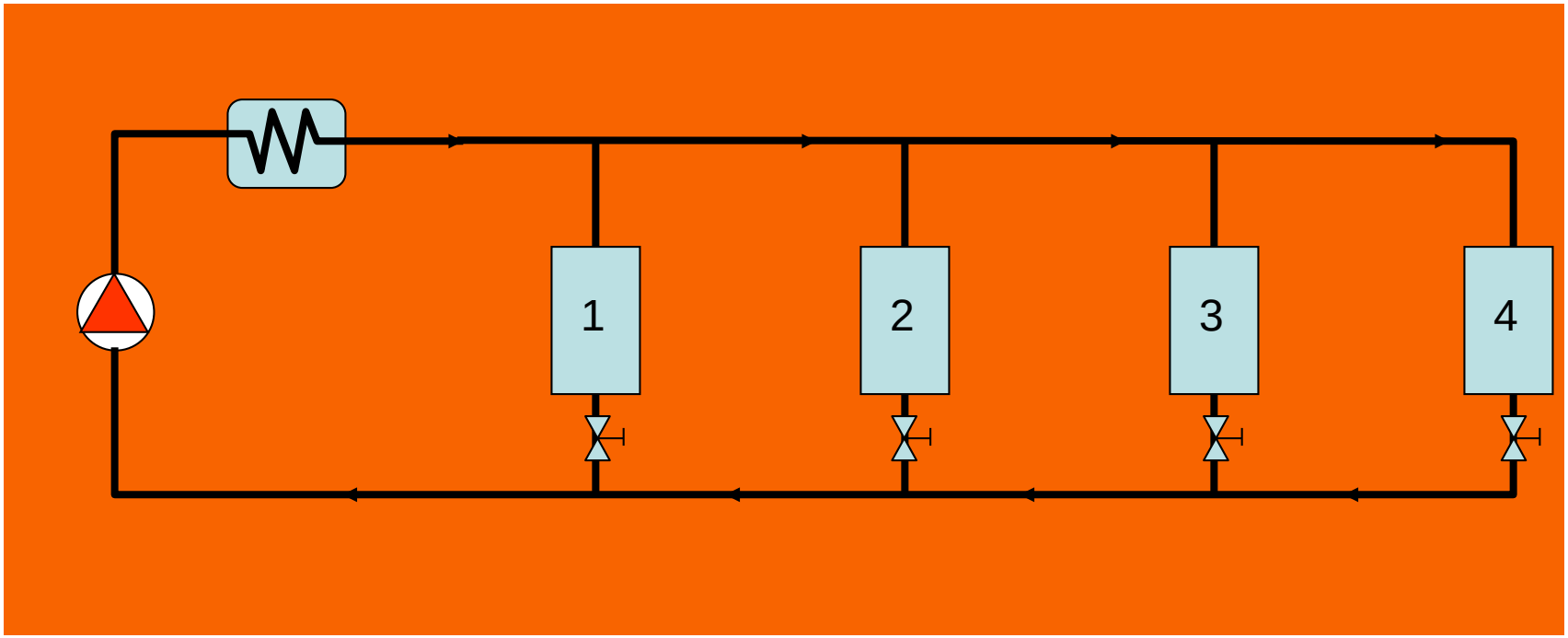
PIPE EXIT

CLOSED LOOP SYSTEM



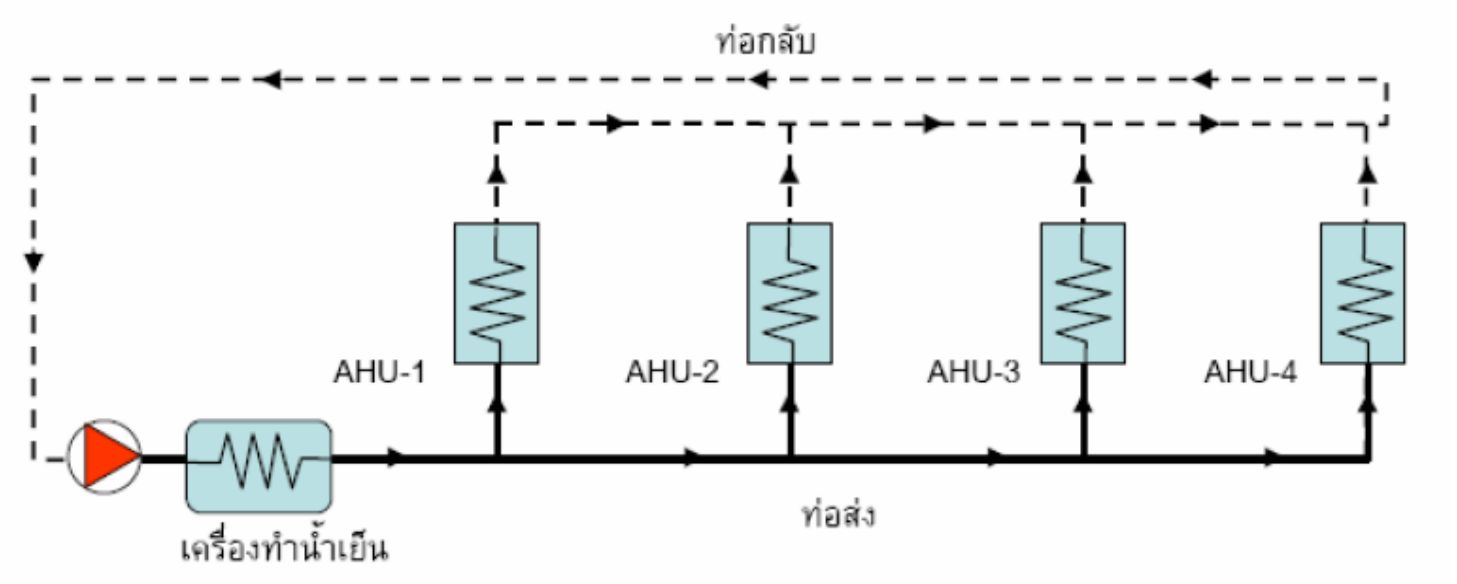
UNBALANCED PRESSURE DROP FOR EACH CIRCUIT

BALANCE THE PRESSURE DROP



BALANCING VALVE, CONTROL VALVE OR REGULATOR

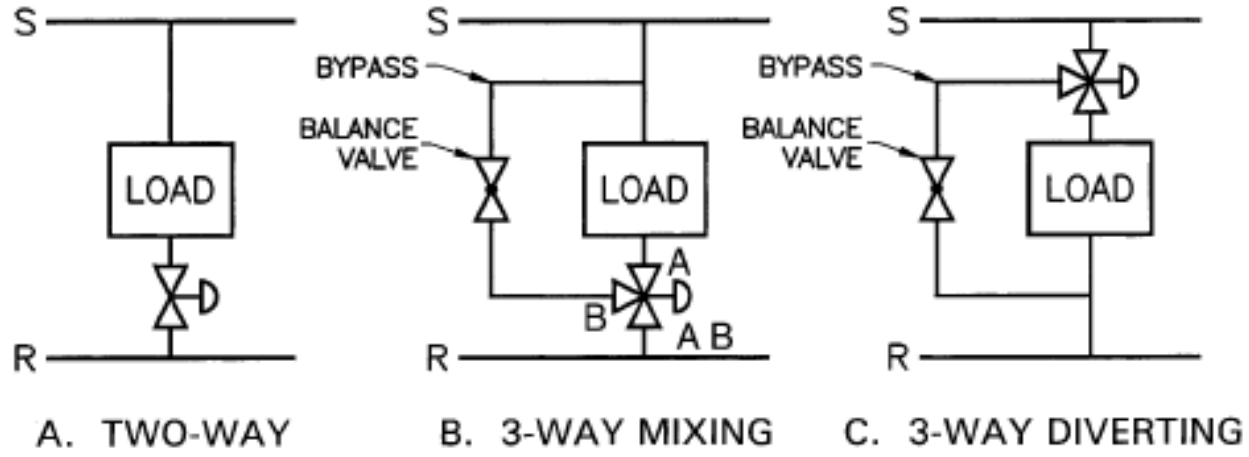
REVERSE RETURN DESIGN



TWO WAY VS. THREE WAY VALVE

variable flow rate

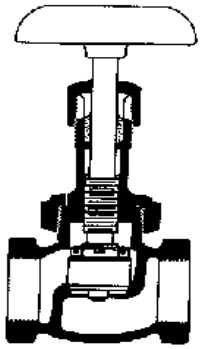
constant flow rate



2. VALVES

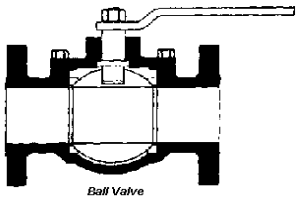
(A) PROCESS CONTROLLING

(B) REGULATING, FLOW BALANCING

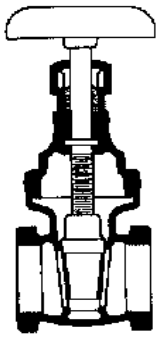


Globe Valve

Butterfly Valve



Ball Valve

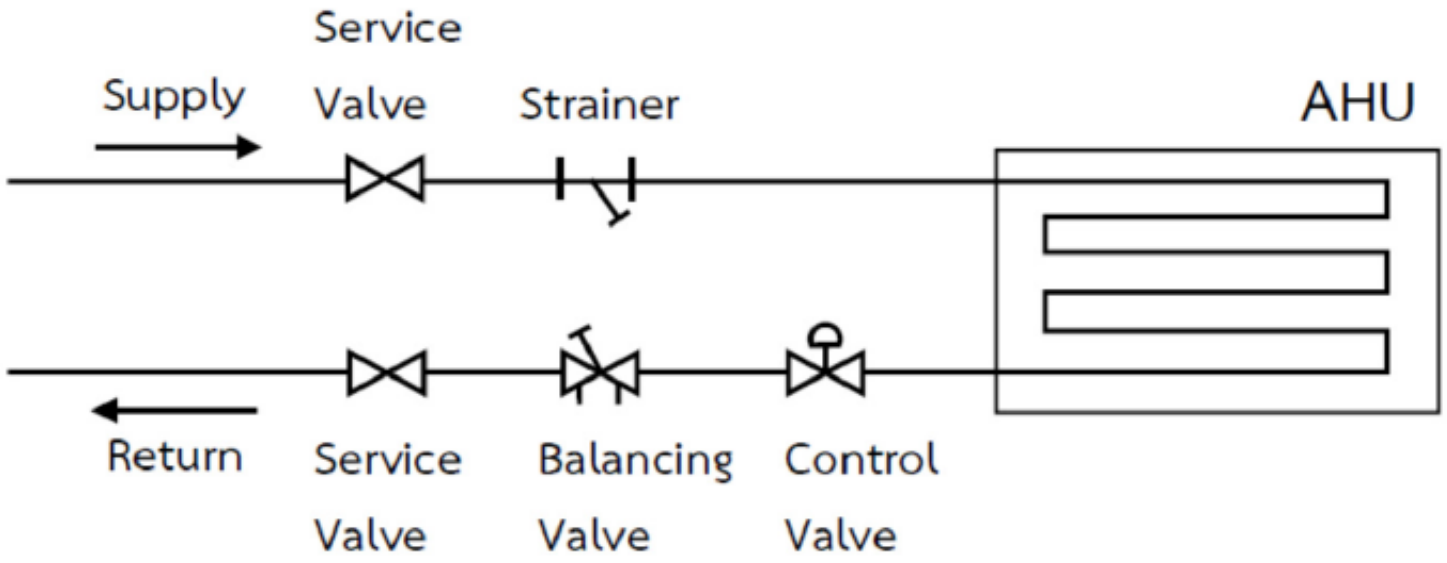


Gate Valve

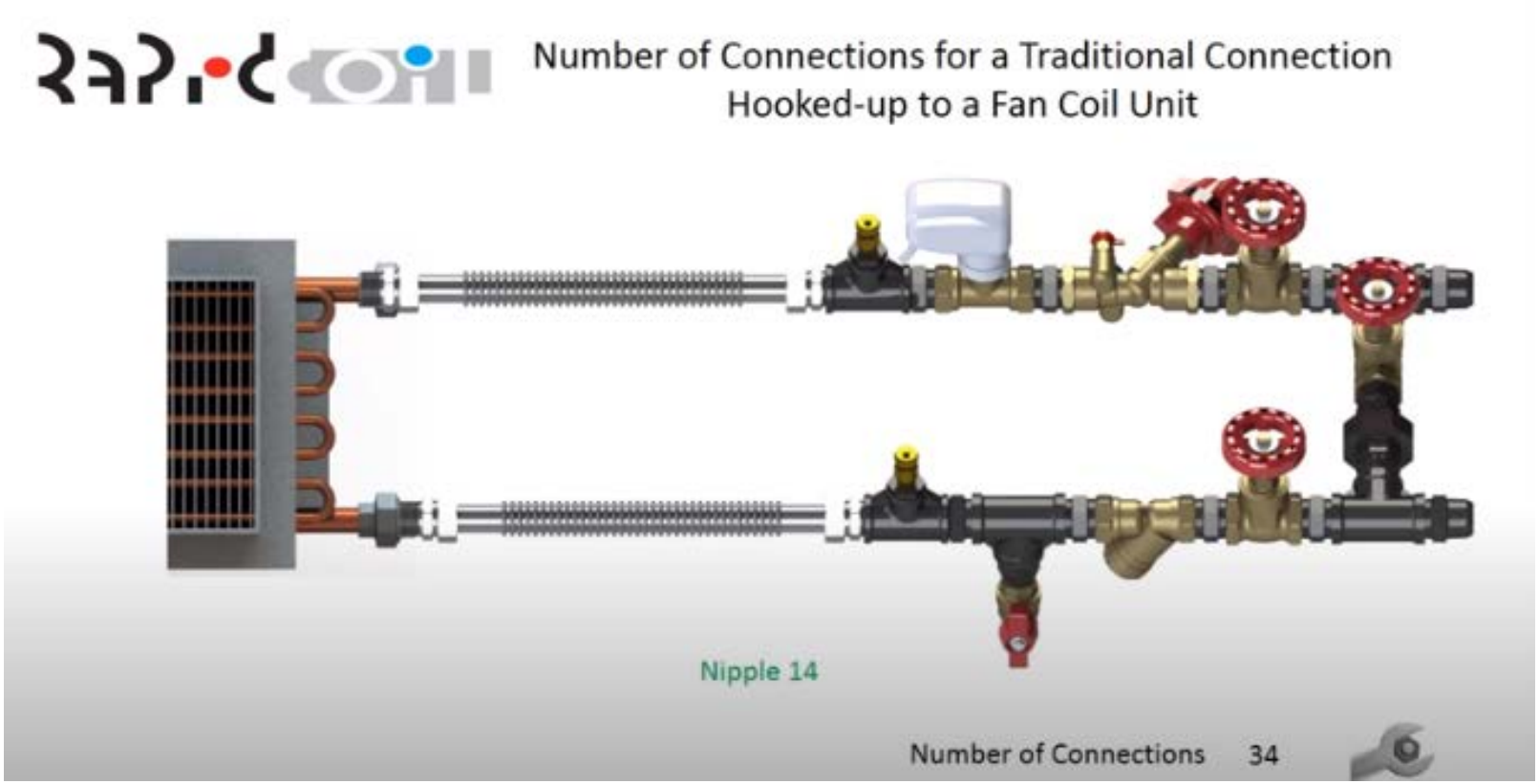
SUITABLE

DO NOT USE

VALVE INSTALLATION AT AHU

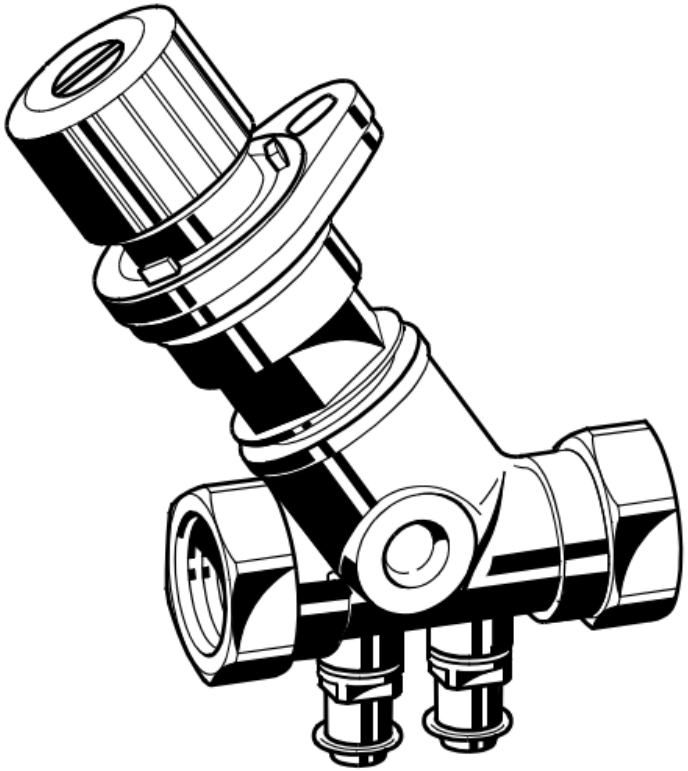


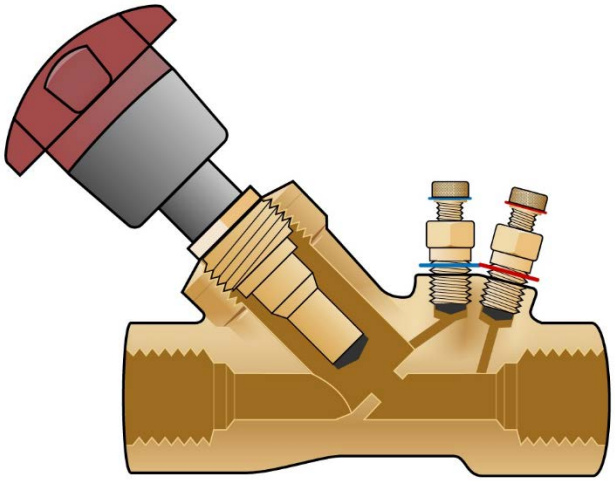
VALVE INSTALLATION AT AHU



https://www.youtube.com/watch?v=QWh_oeF8y3w

BALANCING VALVE





Hydro monometer

VALVE Cv AND Kv

$$C_v = Q\sqrt{\frac{S.G.}{\Delta P}}$$

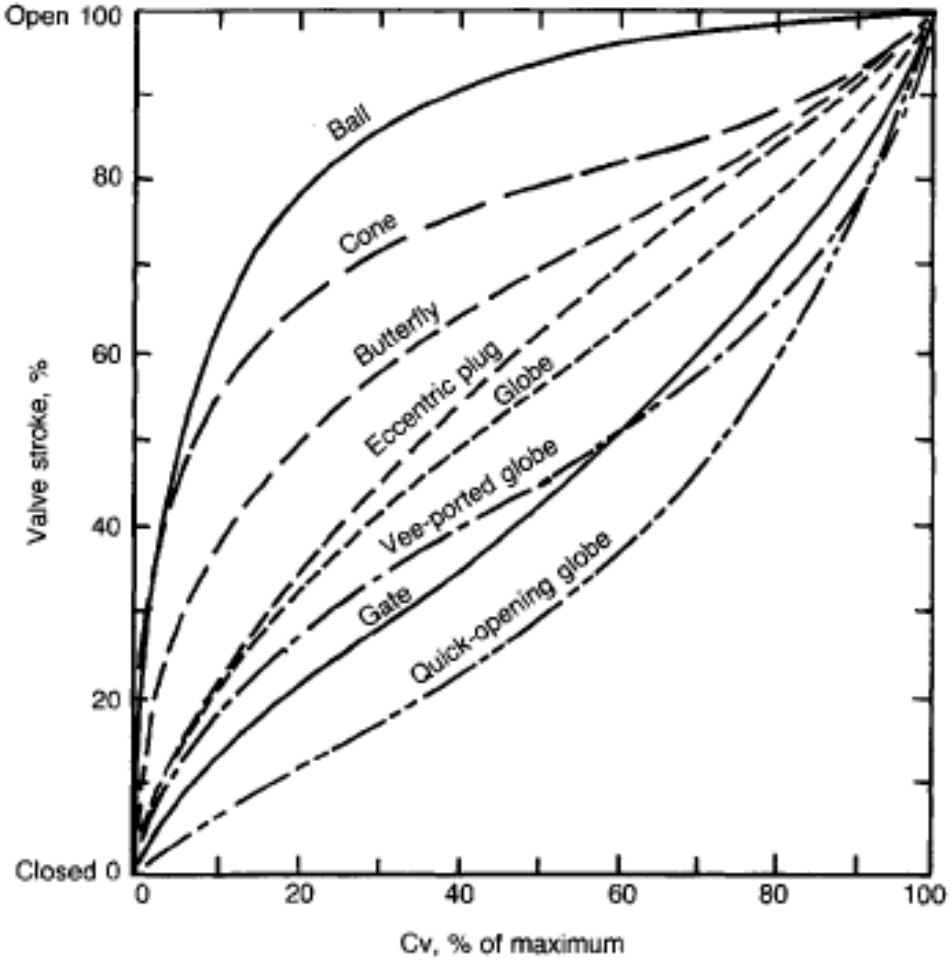
Q IN GPM
ΔP IN PSI
S.G. = SPECIFIC GRAVITY

$$K_v = Q\sqrt{\frac{S.G.}{\Delta P}}$$

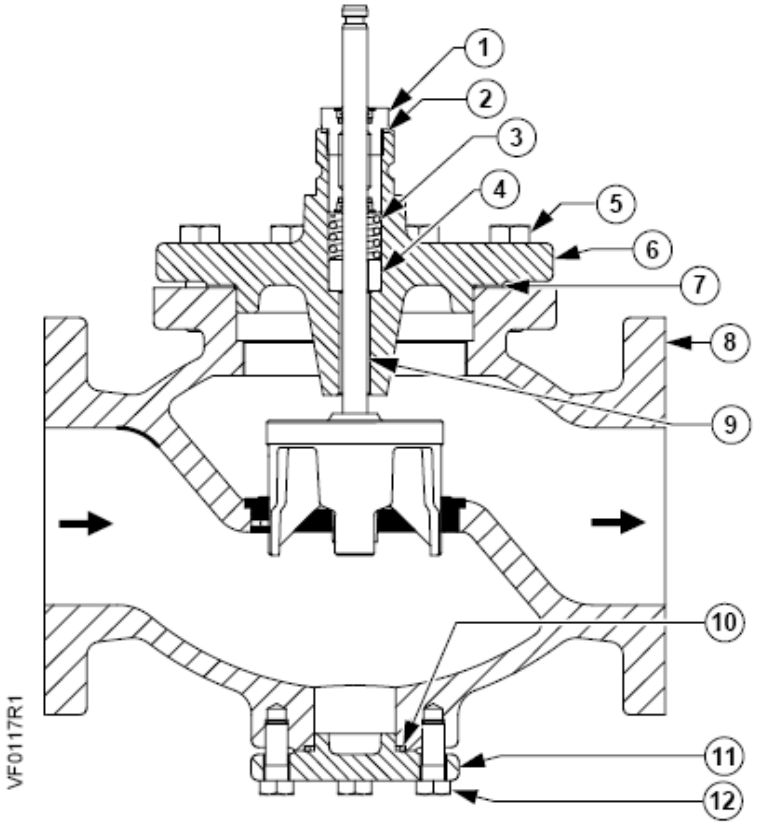
Q IN CU.M./HR
ΔP IN BAR
S.G. = SPECIFIC GRAVITY

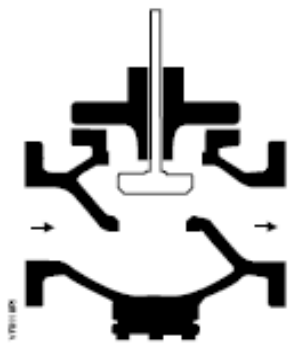
Kv = 0.86 x Cv

VALVE CHARACTERISTIC

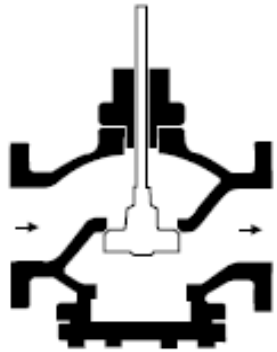


CONTROL VALVE CONSTRUCTION

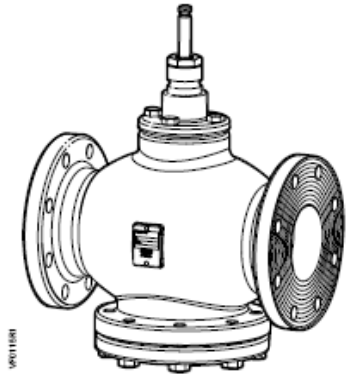




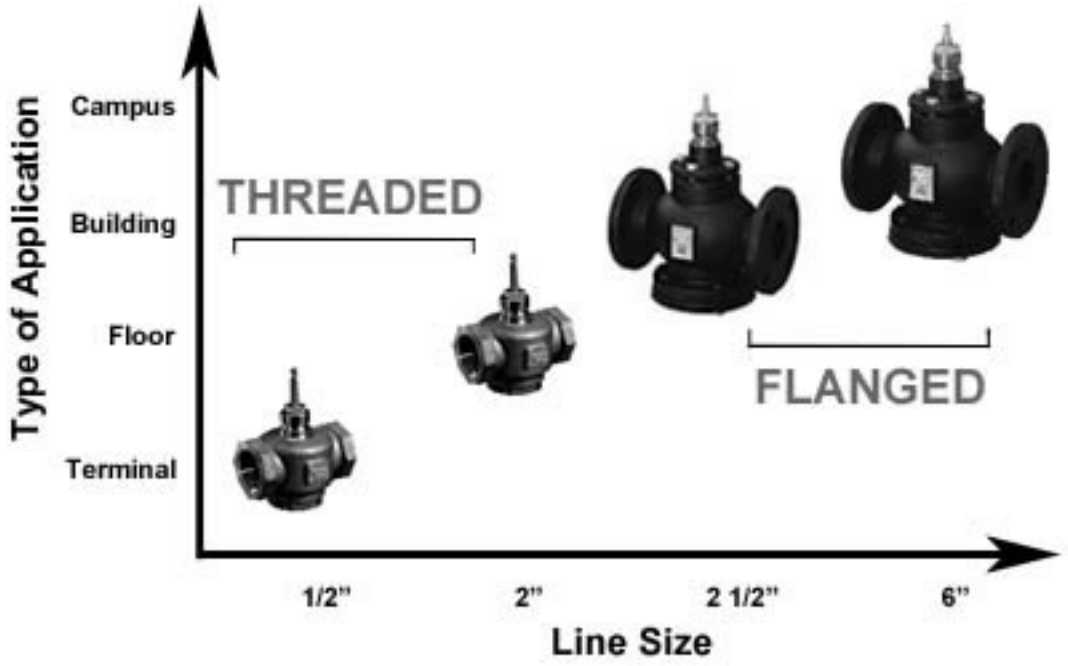
Normally Open



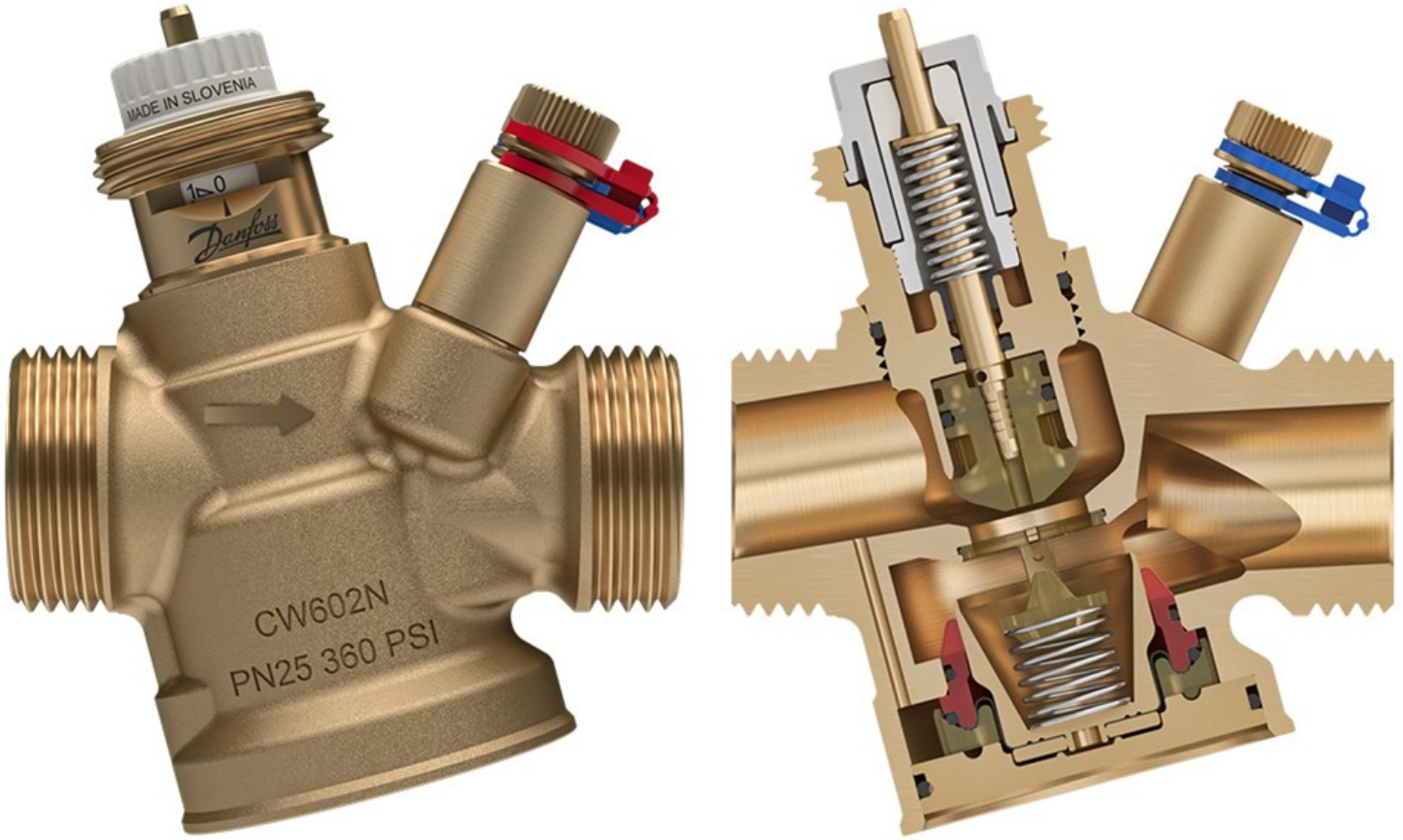
Normally Closed



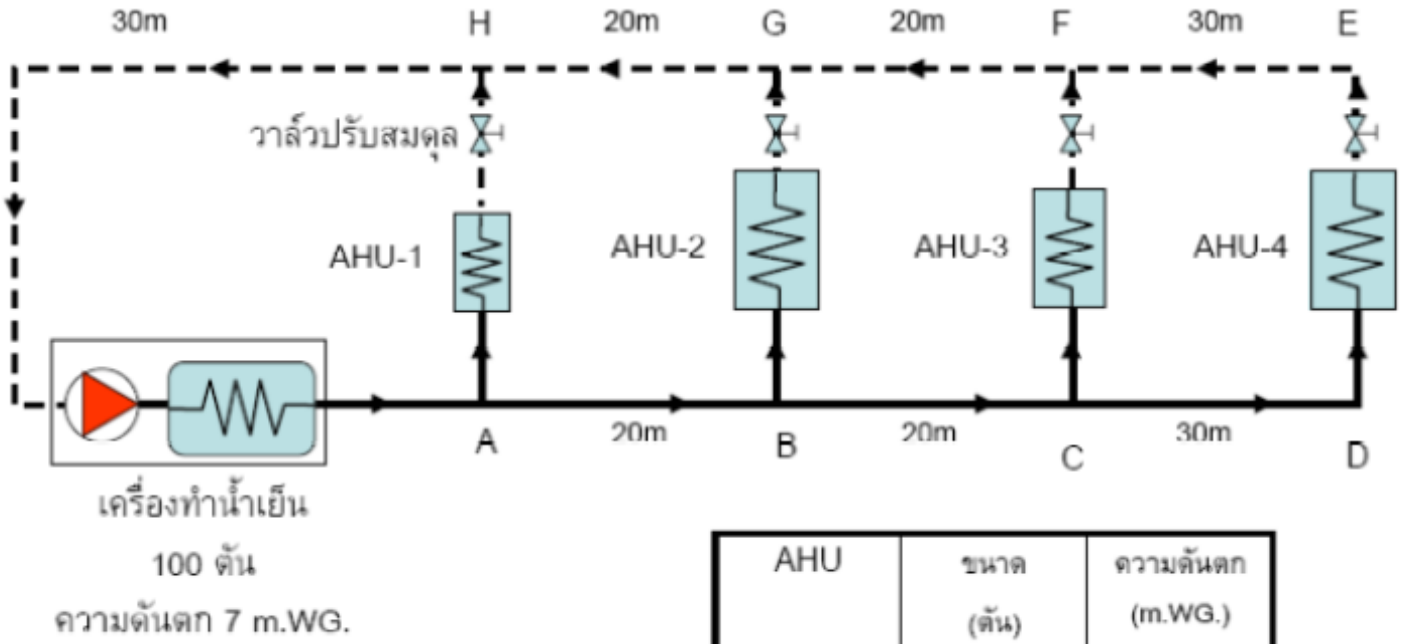
CONTROL VALVE RANGE



PRESSURE INDEPENDENT CONTROL VALVE (PICV)



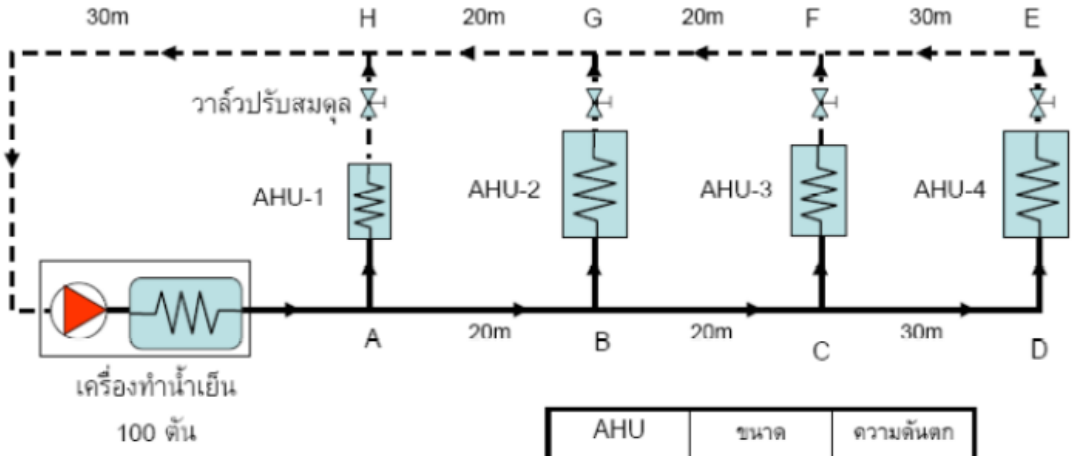
3. VALVE SELECTION PROCESS



AHU	ขนาด (ตัน)	ความดันตก (m.WG.)
1	10	3
2	30	3.5
3	20	3
4	40	4

Pump capacity: 900lpm@30m.WG.

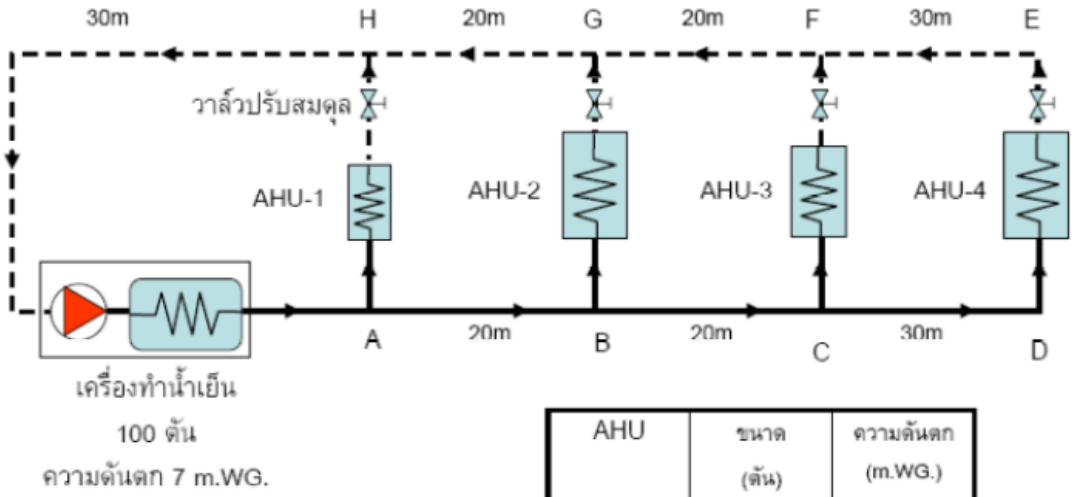
Size the Pipes



AHU	ขนาด (ตัน)	ความดันตก (m.WG.)
1	10	3
2	30	3.5
3	20	3
4	40	4

Section	Flow (lpm)	DN (mm)	Length (m)	Velocity (m/s)	P-drop	
					(m/100m)	(m)
AB	810	100	20	1.643	2.50	0.50
BC	540	80	20	1.886	4.55	0.91
CD	360	65	30	1.894	5.90	1.77
EF	360	65	30	1.894	5.90	1.77
FG	540	80	20	1.886	4.55	0.91
GH	810	100	20	1.643	2.50	0.50
HA	900	100	30	1.826	3.06	0.92

Compute Pressure Drops



AHU	ขนาด (ตัน)	ความดันตก (m.WG.)
1	10	3
2	30	3.5
3	20	3
4	40	4

AHU	(1) FLOW (m^3/h)	(2) Pump head (bar)	(3) Pipe PD (bar)	(4) Chiller PD (bar)	(5) Coil PD (bar)	(6) Total PD (bar)	(7) Req. PD (bar)	(8) Required K_v
1	5.40	2.94	0.138	0.686	0.294	1.12	1.64	4.22
2	16.2	2.94	0.288	0.686	0.343	1.32	1.46	13.4
3	10.8	2.94	0.560	0.686	0.294	1.54	1.26	9.62
4	21.6	2.94	1.091	0.686	0.392	2.17	0.694	25.9

Valve Selection

Table 1. Normally Closed Valves.

Flow Rate		Nominal Line Size		Connection	Equal Percentage		Linear	
					Stl. Steel Trim	Brass Trim	Stainless Steel Trim	
Cv	(Kvs)	Inch	(mm)		Normal Duty Packing		Normal Duty Packing	Steam Packing
1	(0.85)	1/2	(15)	FxF	599-03126	599-03180	599-03018	599-03072
				FxUF	599-03135	599-03189	599-03027	599-03081
				FxUM	599-03261	599-03279	599-03225	599-03243
1.6	(1.37)	1/2	(15)	FxF	599-03127	599-03181	599-03019	599-03073
				FxUF	599-03136	599-03190	599-03028	599-03082
				FxUM	599-03262	599-03280	599-03226	599-03244
2.5	(2.15)	1/2	(15)	FxF	599-03128	599-03182	599-03020	599-03074
				FxUF	599-03137	599-03191	599-03029	599-03083
				FxUM	599-03263	599-03281	599-03227	599-03245
4	(3.44)	1/2	(15)	FxF	599-03129	599-03183	599-03021	599-03075
				FxUF	599-03138	599-03192	599-03030	599-03084
				FxUM	599-03264	599-03282	599-03228	599-03246
								599-03076
								599-03085
								599-03247

AHU	(1) FLOW (m^3/h)	(2) Pump head (bar)	(7) Req. PD	(8) Required K_v	(9) Valve model	(10) Selected K_v	(11) Actual Valve PD (bar)	(12) Valve Authority
1	5.40	2.94	1.64	4.22	DN20	5.09	1.13	39%
2	16.2	2.94	1.46	13.4	DN40	19.4	0.70	24%
3	10.8	2.94	1.26	9.62	DN32	13.1	0.68	23%
4	21.6	2.94	0.694	25.9	DN50	31.4	0.47	16%

VALVE AUTHORITY

Table 1. Normally Closed Valves.

Flow Rate		Nominal Line Size		Connection	Equal Percentage		Linear	
					Stl. Steel Trim	Brass Trim	Stainless Steel Trim	
Cv	(Kvs)	Inch	(mm)		Normal Duty Packing		Normal Duty Packing	Steam Packing
1	(0.85)	1/2	(15)	FxF	599-03126	599-03180	599-03018	599-03072
				FxUF	599-03135	599-03189	599-03027	599-03081
				FxUM	599-03261	599-03279	599-03225	599-03243
1.6	(1.37)	1/2	(15)	FxF	599-03127	599-03181	599-03019	599-03073
				FxUF	599-03136	599-03190	599-03028	599-03082
				FxUM	599-03262	599-03280	599-03226	599-03244
2.5	(2.15)	1/2	(15)	FxF	599-03128	599-03182	599-03020	599-03074
				FxUF	599-03137	599-03191	599-03029	599-03083
				FxUM	599-03263	599-03281	599-03227	599-03245
4	(3.44)	1/2	(15)	FxF	599-03129	599-03183	599-03021	599-03075
				FxUF	599-03138	599-03192	599-03030	599-03084
				FxUM	599-03264	599-03282	599-03228	599-03246
6.3	(5.43)	3/4	(20)	FxF	599-03130	599-03184	599-03022	599-03076
				FxUF	599-03139	599-03193	599-03031	599-03085
				FxUM	599-03265	599-03283	599-03229	599-03247

$$\text{VALVE AUTHORITY} = \frac{\text{PRESSURE DROP AT VALVE}}{\text{OVERALL PRESSURE DROP}}$$

EXPECT 30%-40% AUTHORITY

LARGE PIPES + HIGH HEAD PUMP LEAD TO HIGH AUTHORITY