ASHRAE Hong Kong Chapter Technical Workshop

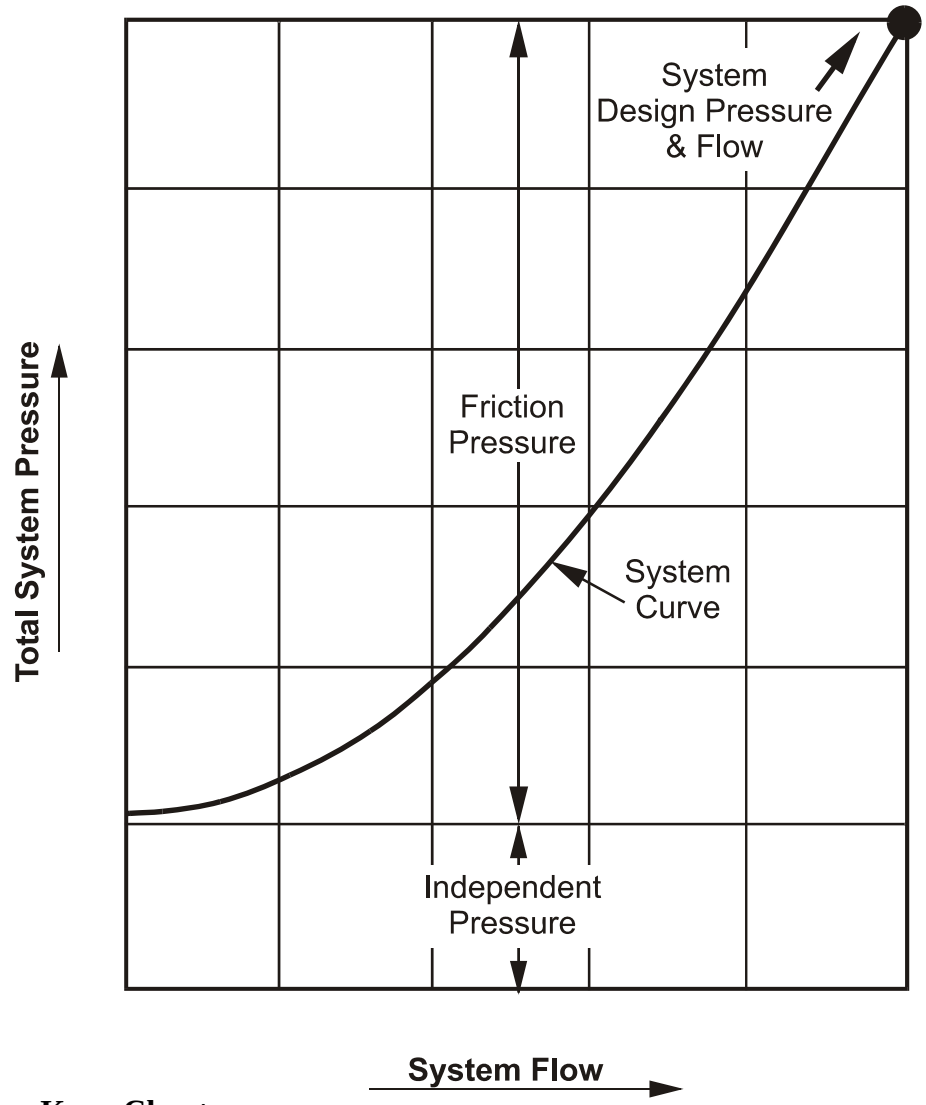
Fundamentals of Water System Design

17, 18, 24, 25 January 2007

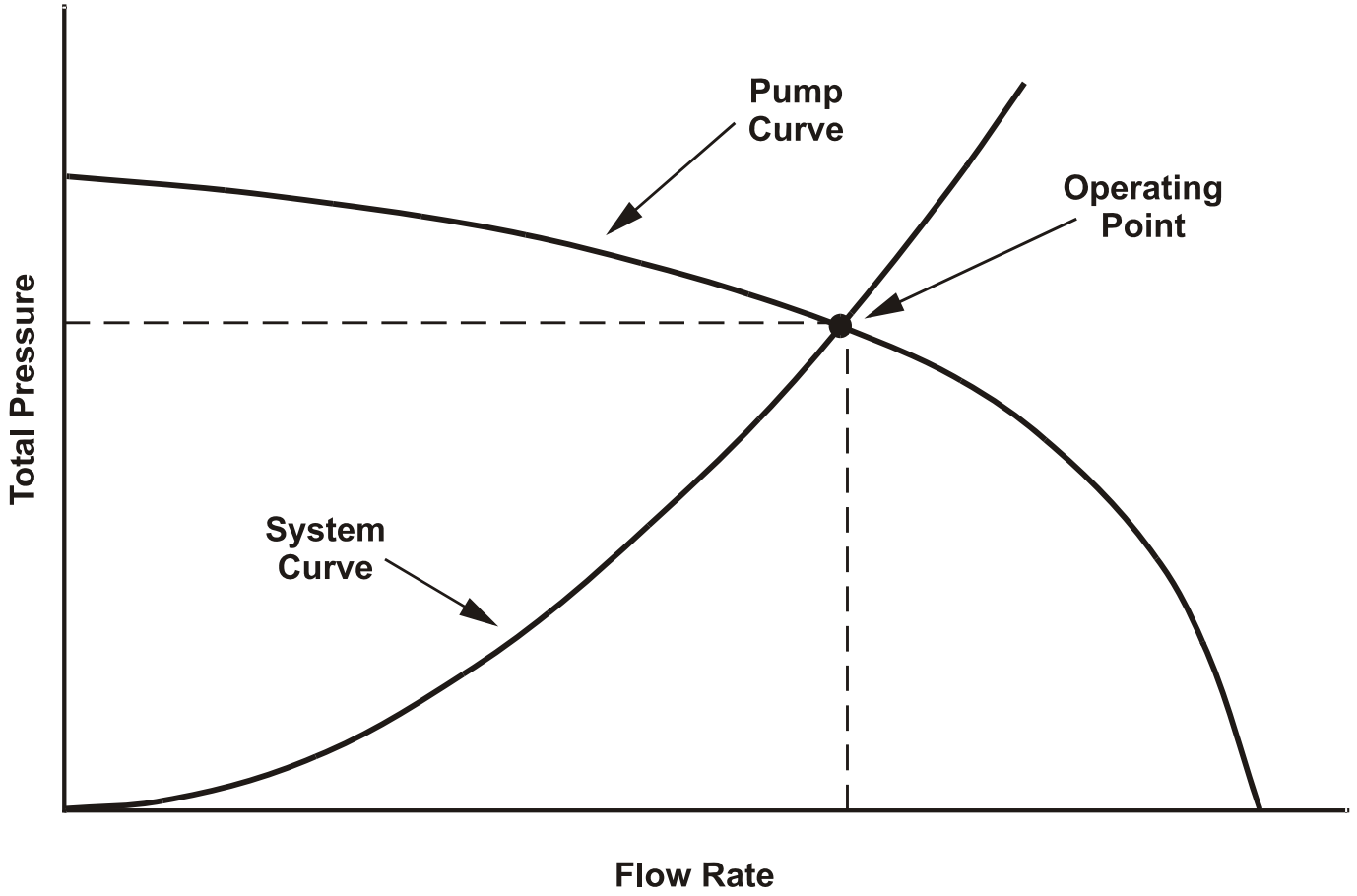
Chapter 8:
Matching Pumps to Systems

1. **Matching the Pump to the System**
2. **Parallel Pumping**
3. **Series Pumping**
4. **Standby Pumps**
5. **Trimming Pump Impellers**
6. **Two-speed Pumping**
7. **Variable-speed Pumping**
8. **Source Distribution Pumping**

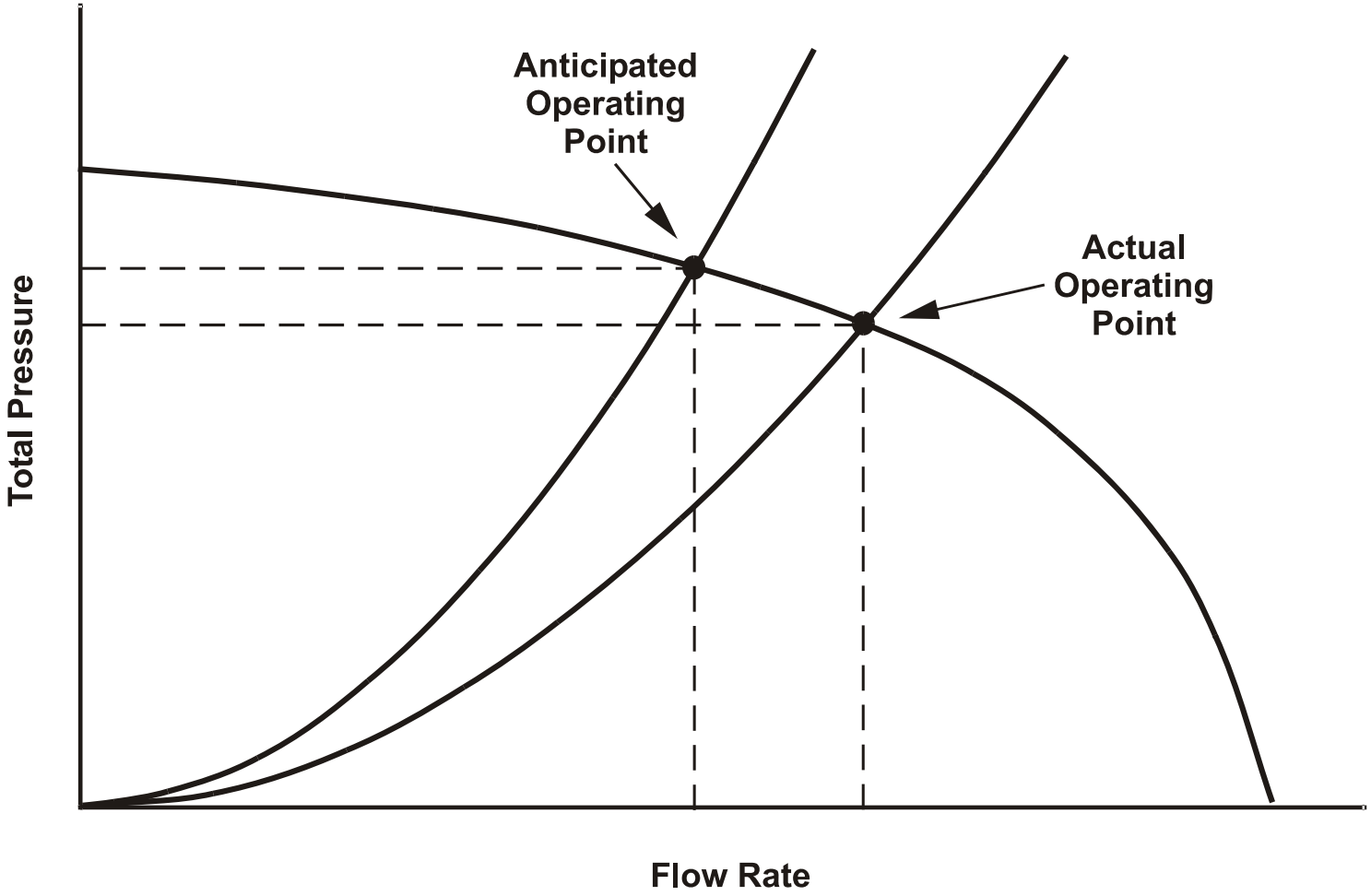
Typical System Curve



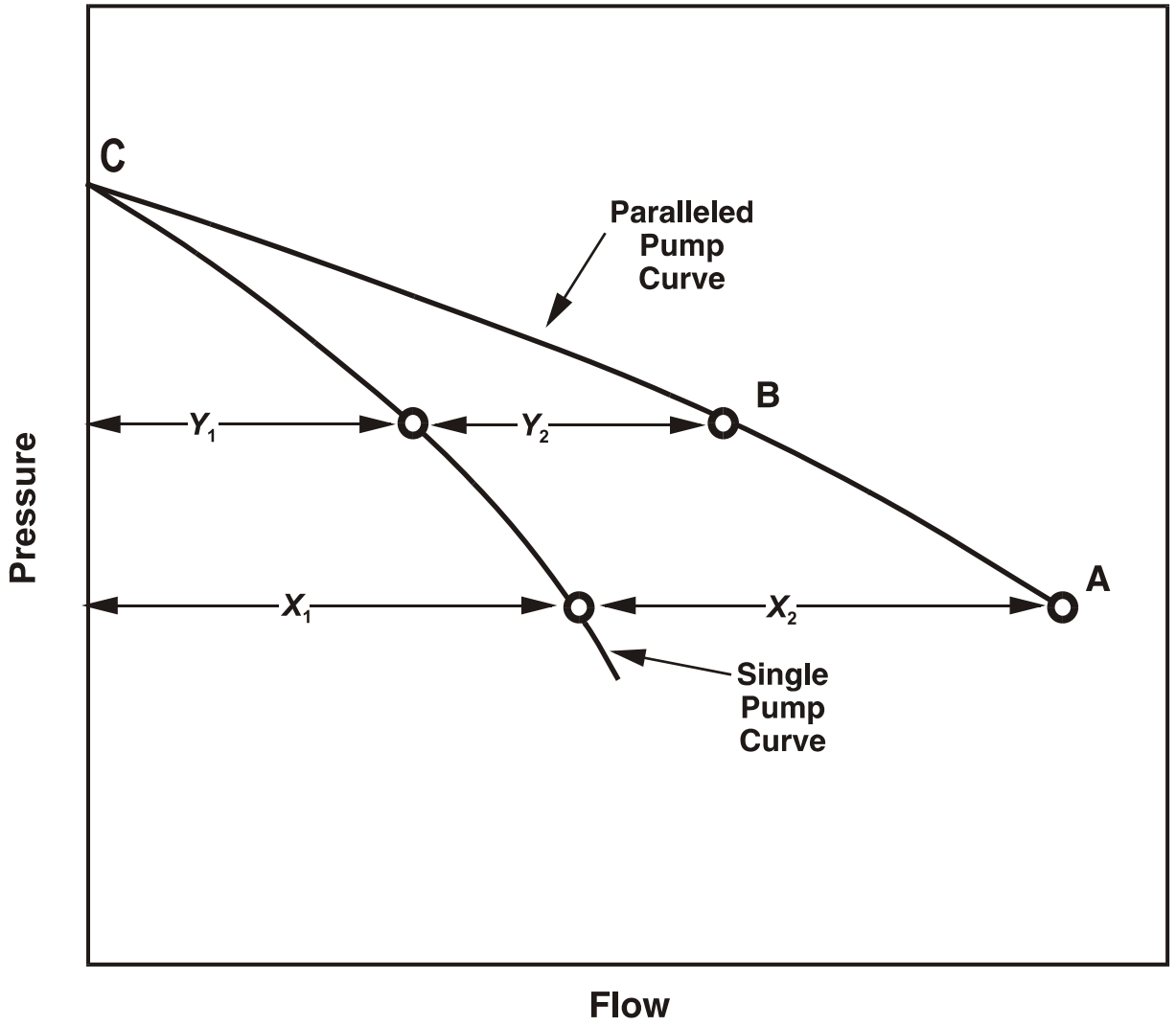
Pump Curve and System Curve



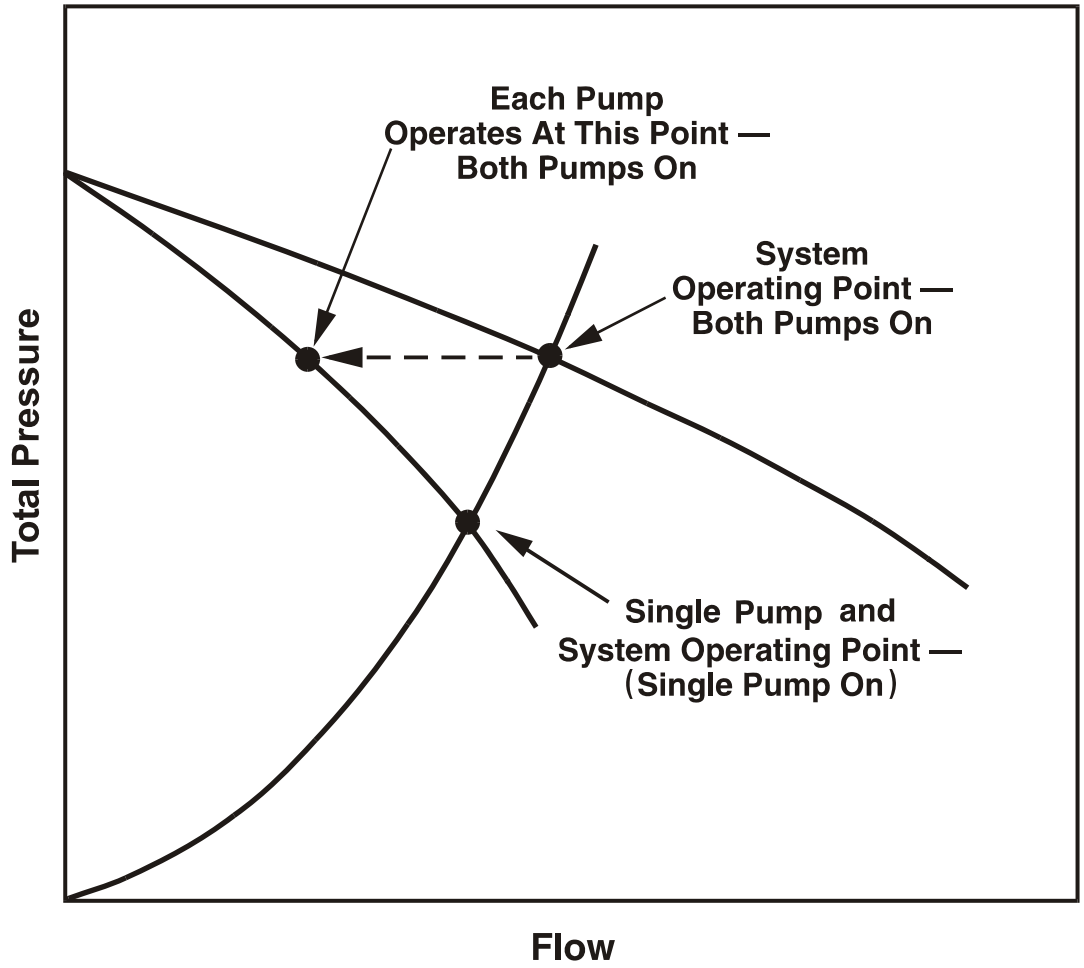
Shift of System Curve



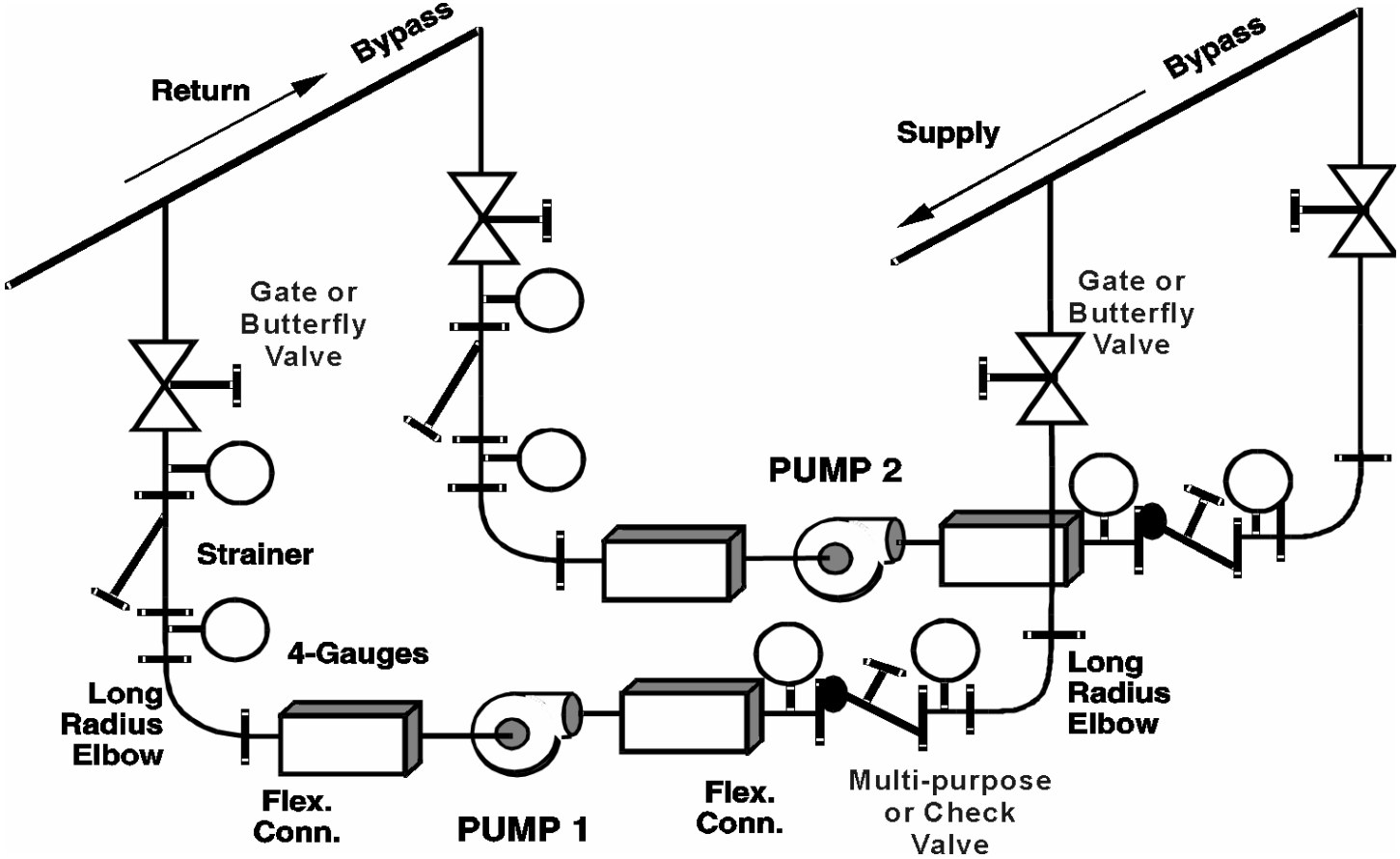
Pump Curve for Parallel Operation



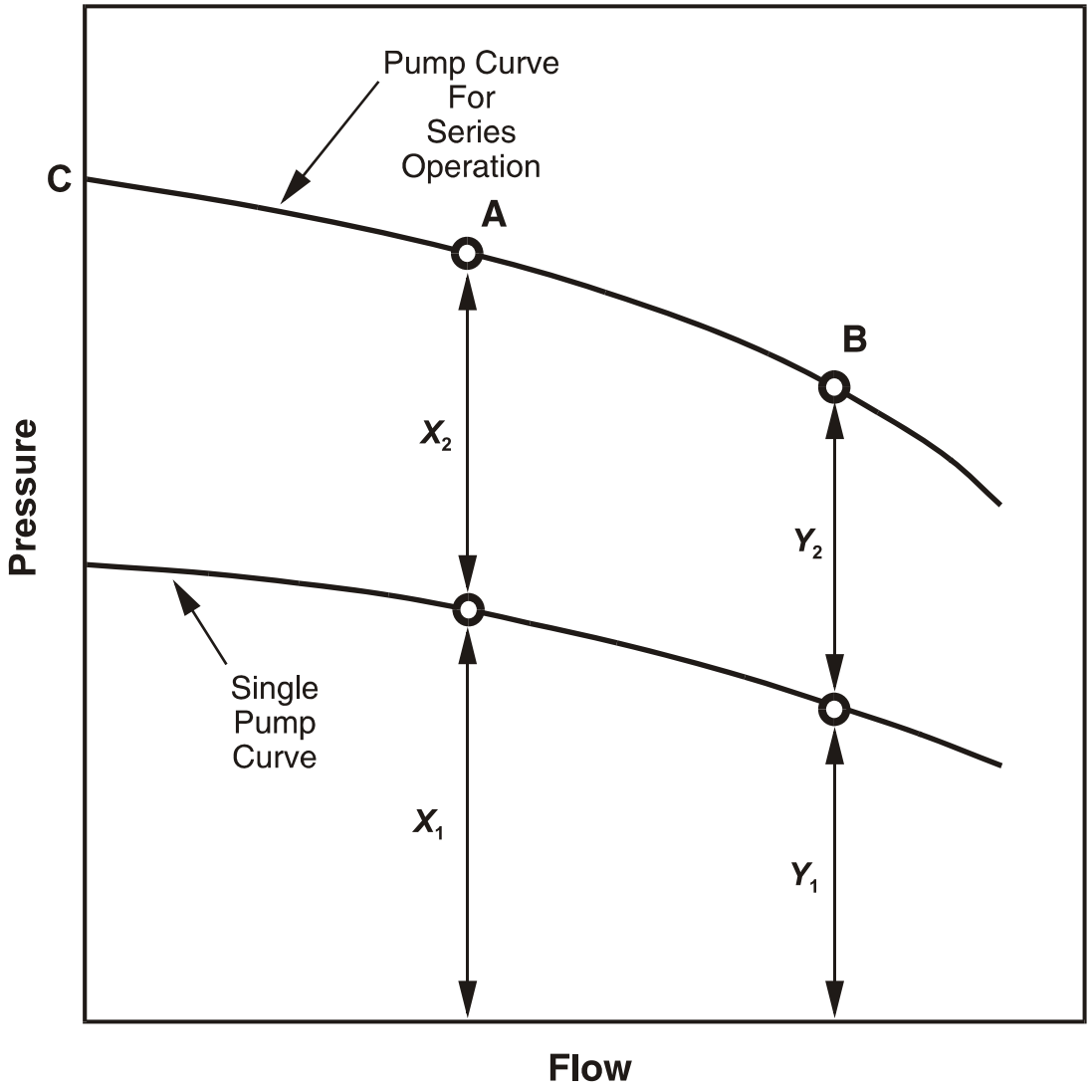
Operating Conditions for Parallel Pump Installation



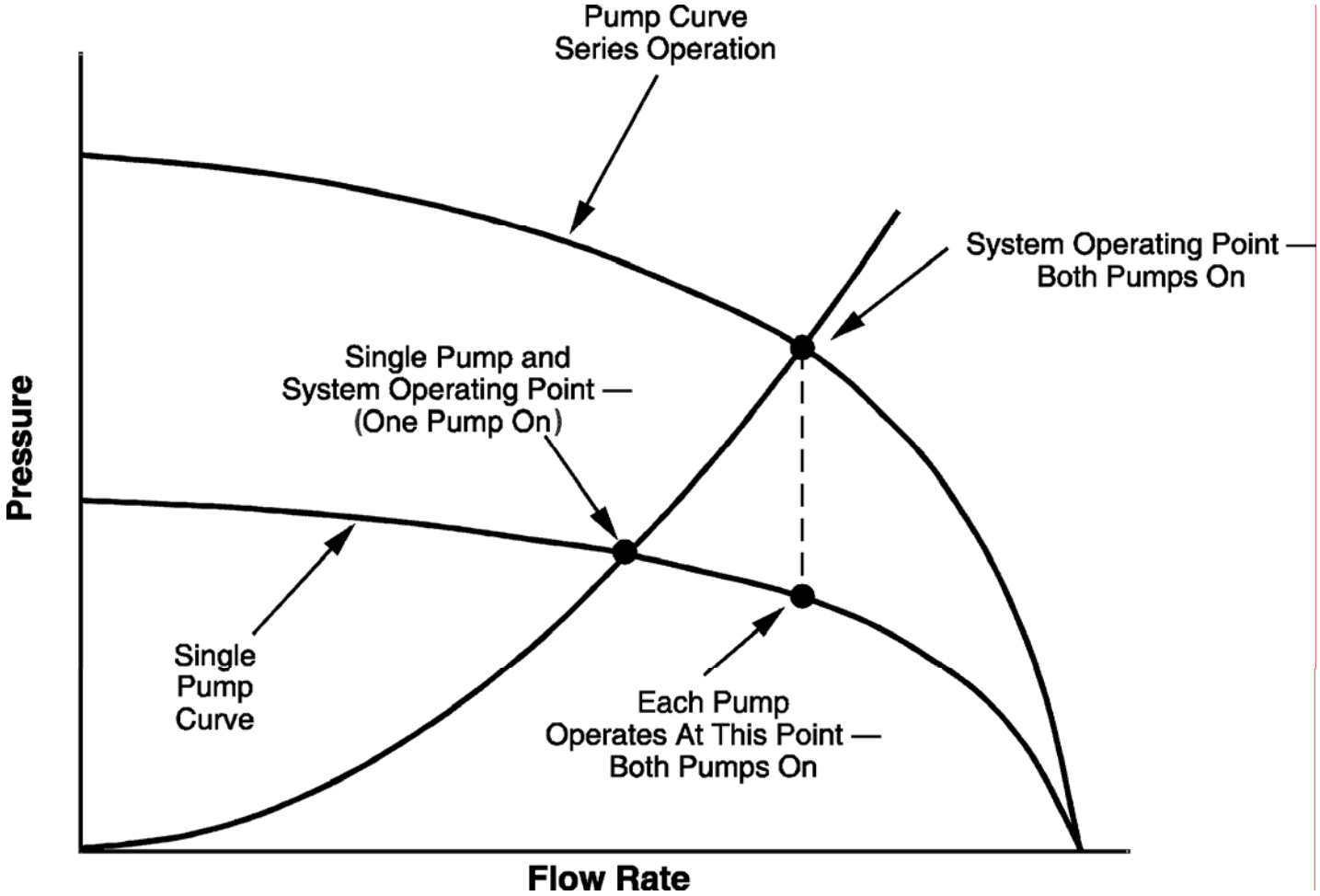
Piping Schematic of Parallel Pumps



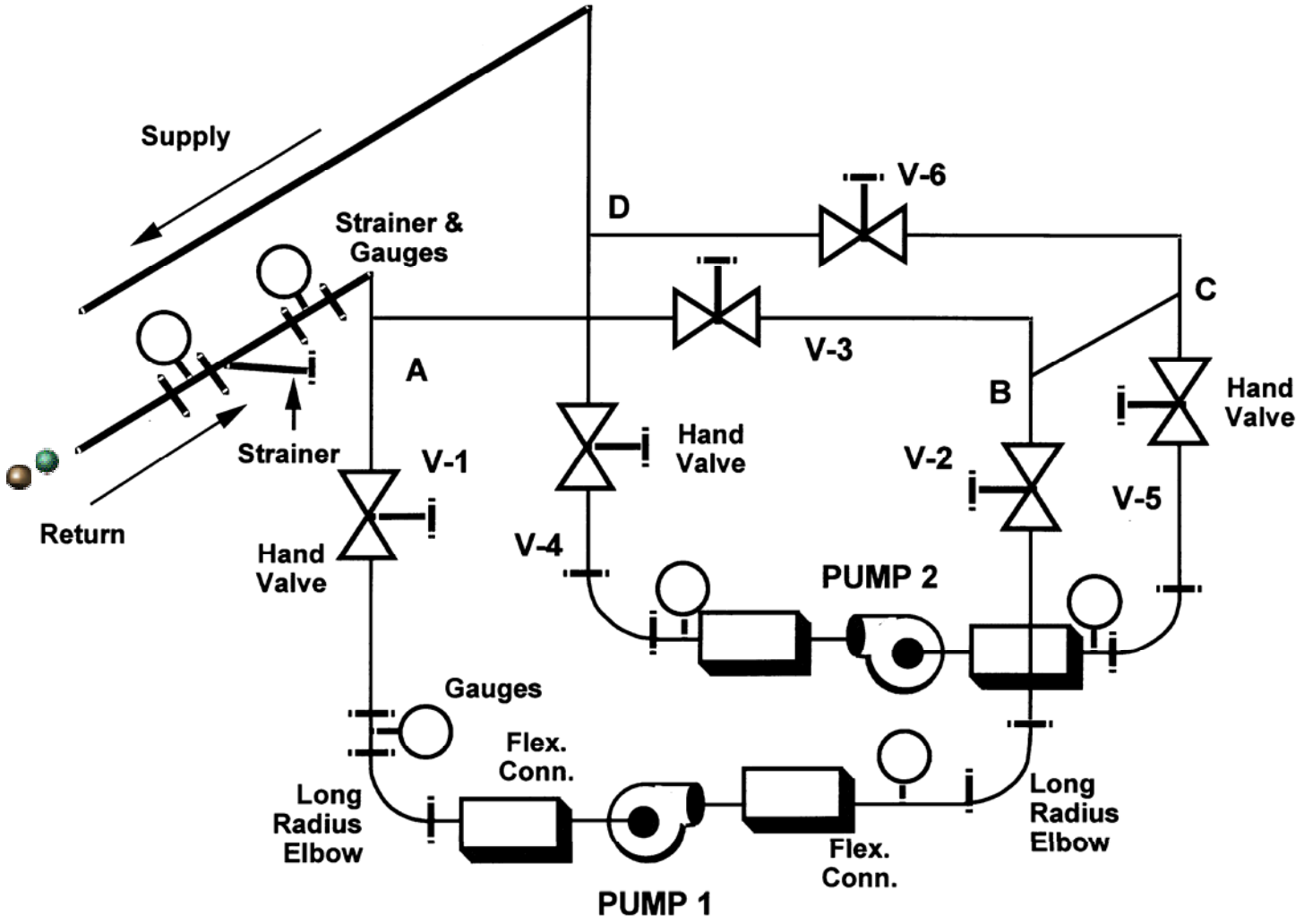
Pump Curve for Series Operation



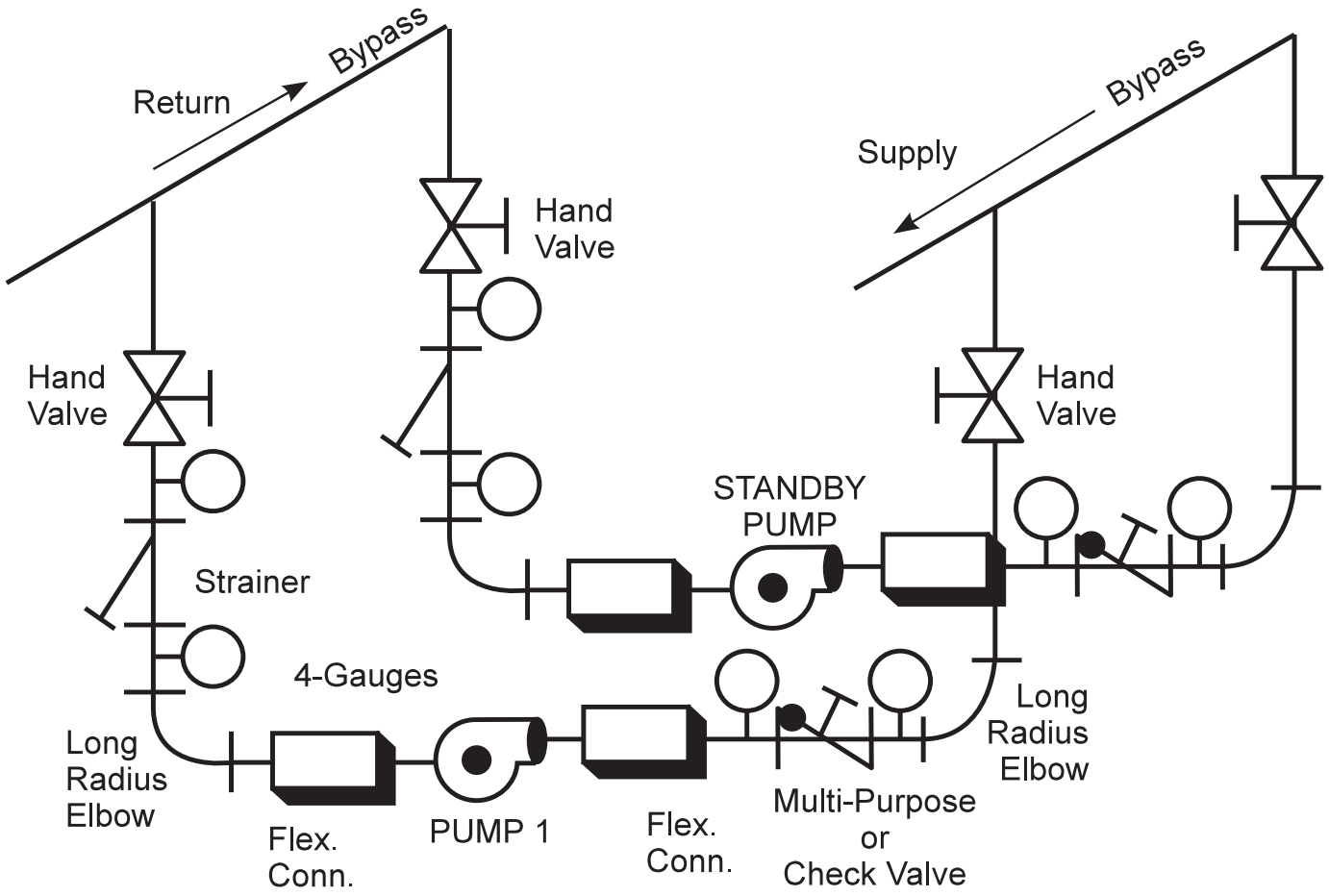
Operating Conditions for Series Pump



Piping Schematic of Series Pumps



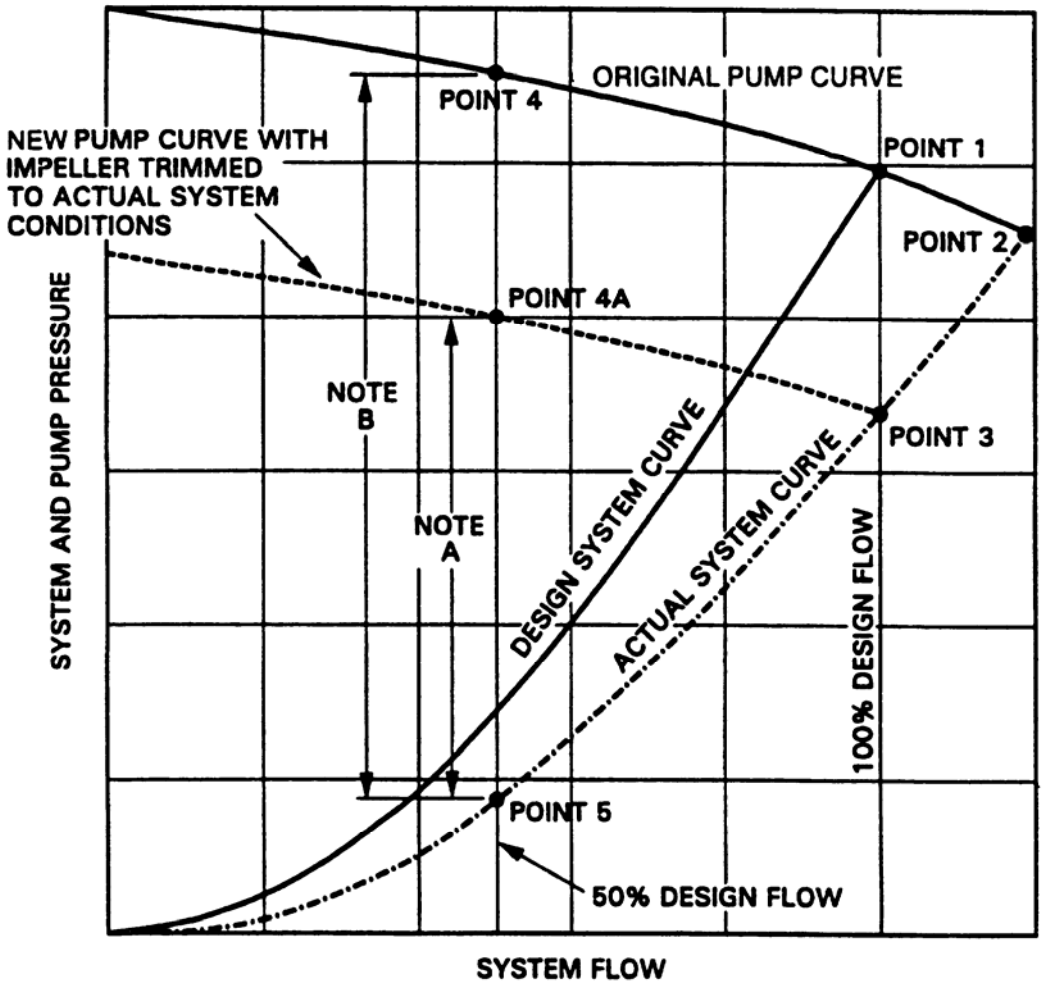
Standby Pump



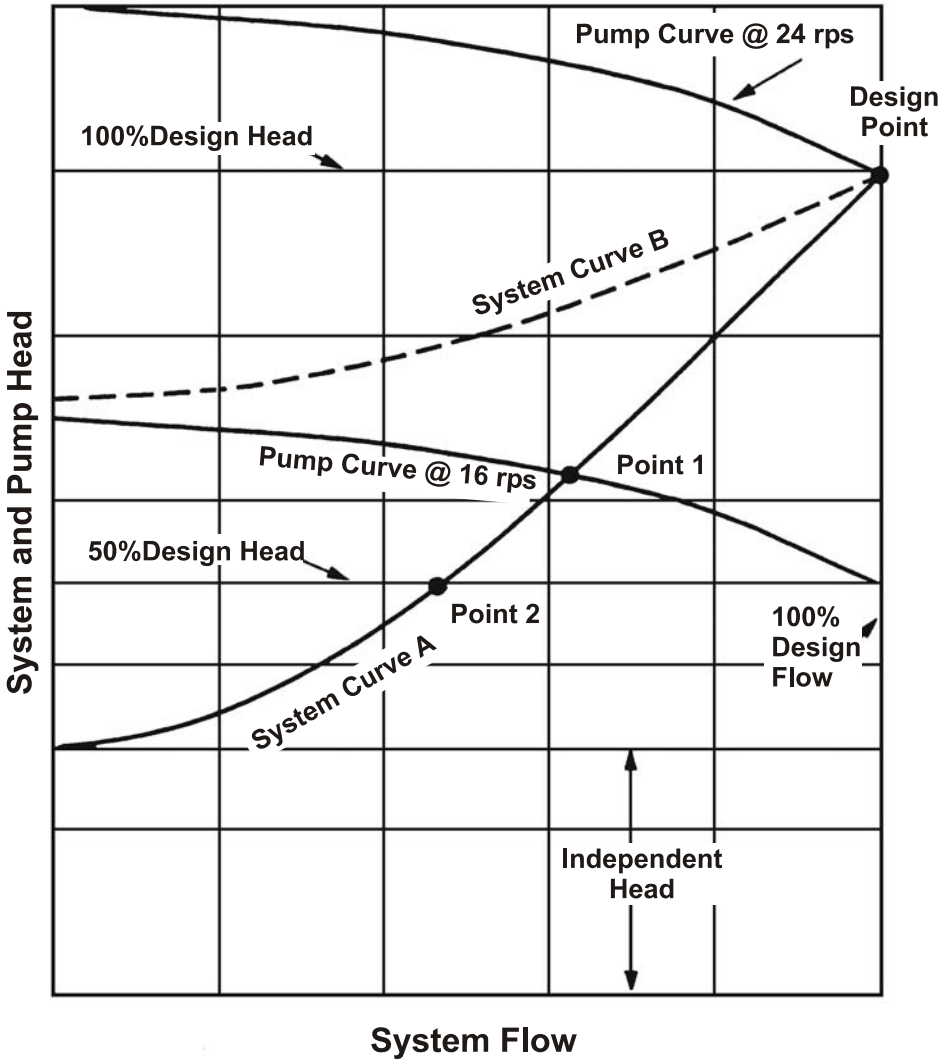
Pump Affinity Laws

	Speed Change	Impeller Diameter Change
Flow:	$Q_2 = Q_1\left(\frac{N_2}{N_1}\right)$	$Q_2 = Q_1\left(\frac{D_2}{D_1}\right)$
Pressure:	$p_2 = p_1\left(\frac{N_2}{N_1}\right)^2$	$p_2 = p_1\left(\frac{D_2}{D_1}\right)^2$
Power:	$P_2 = P_1\left(\frac{N_2}{N_1}\right)^3$	$P_2 = P_1\left(\frac{D_2}{D_1}\right)^3$

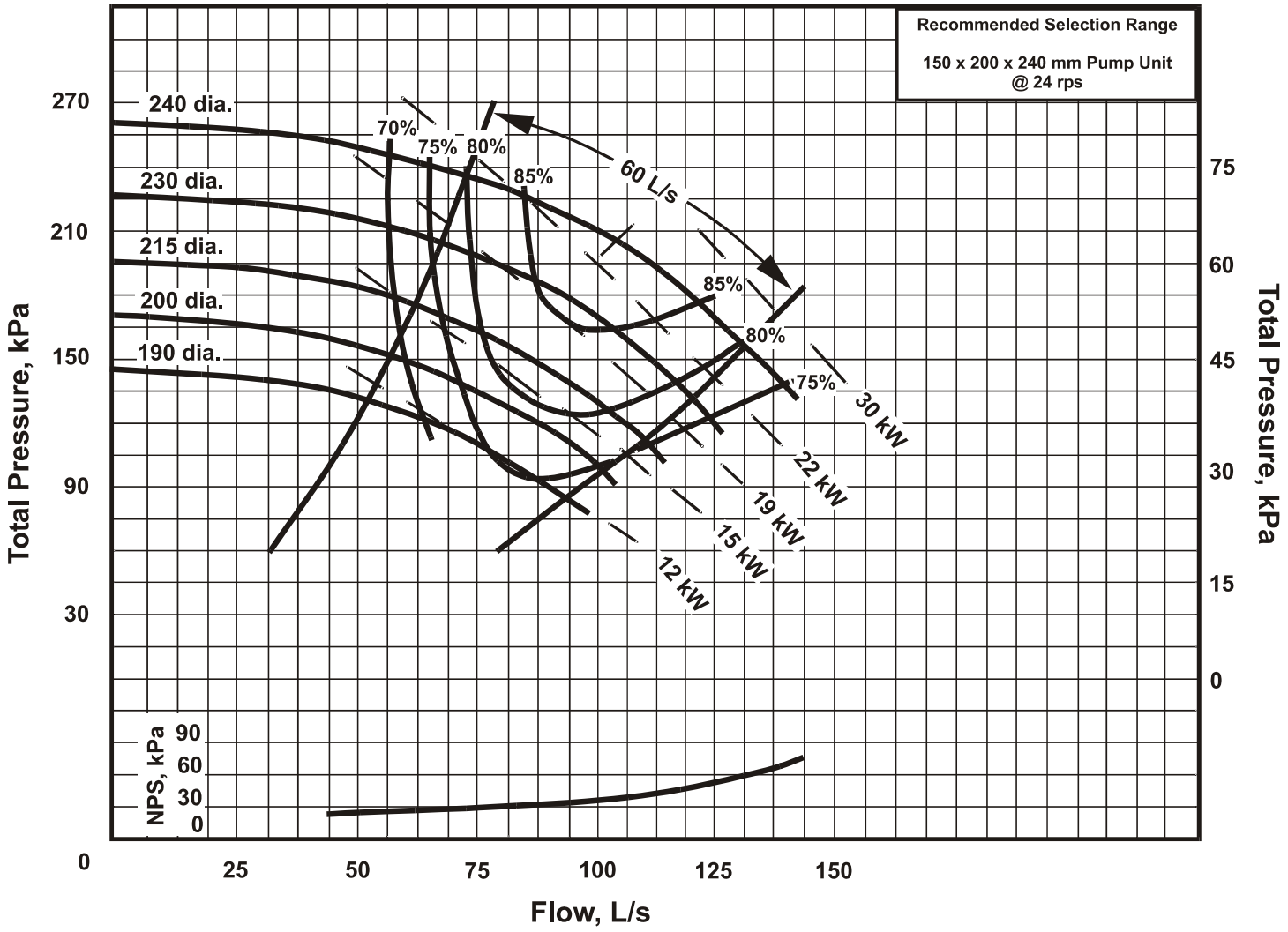
Pump Operating Points



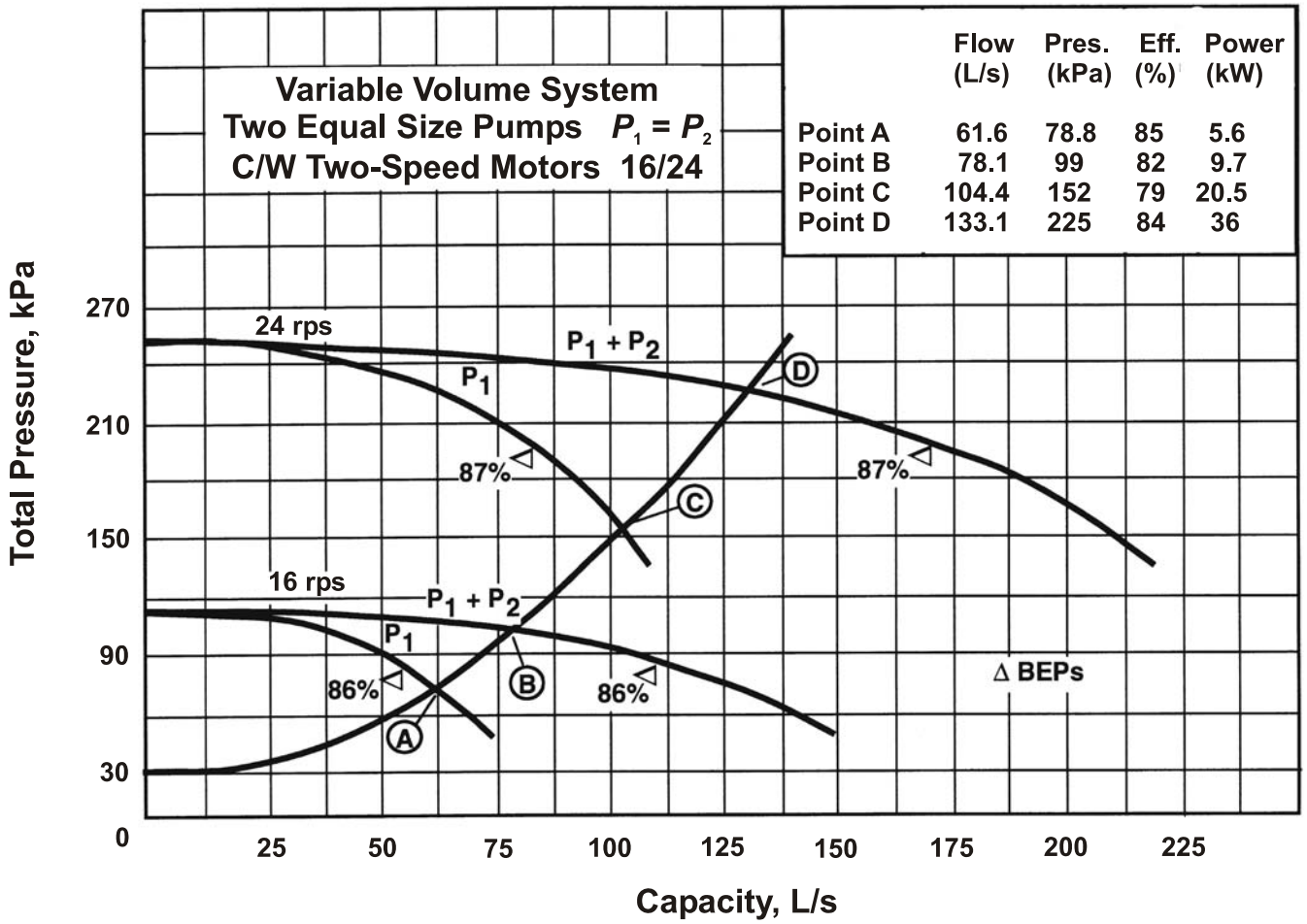
Two-Speed Pumping



Typical Impeller Performance Curve



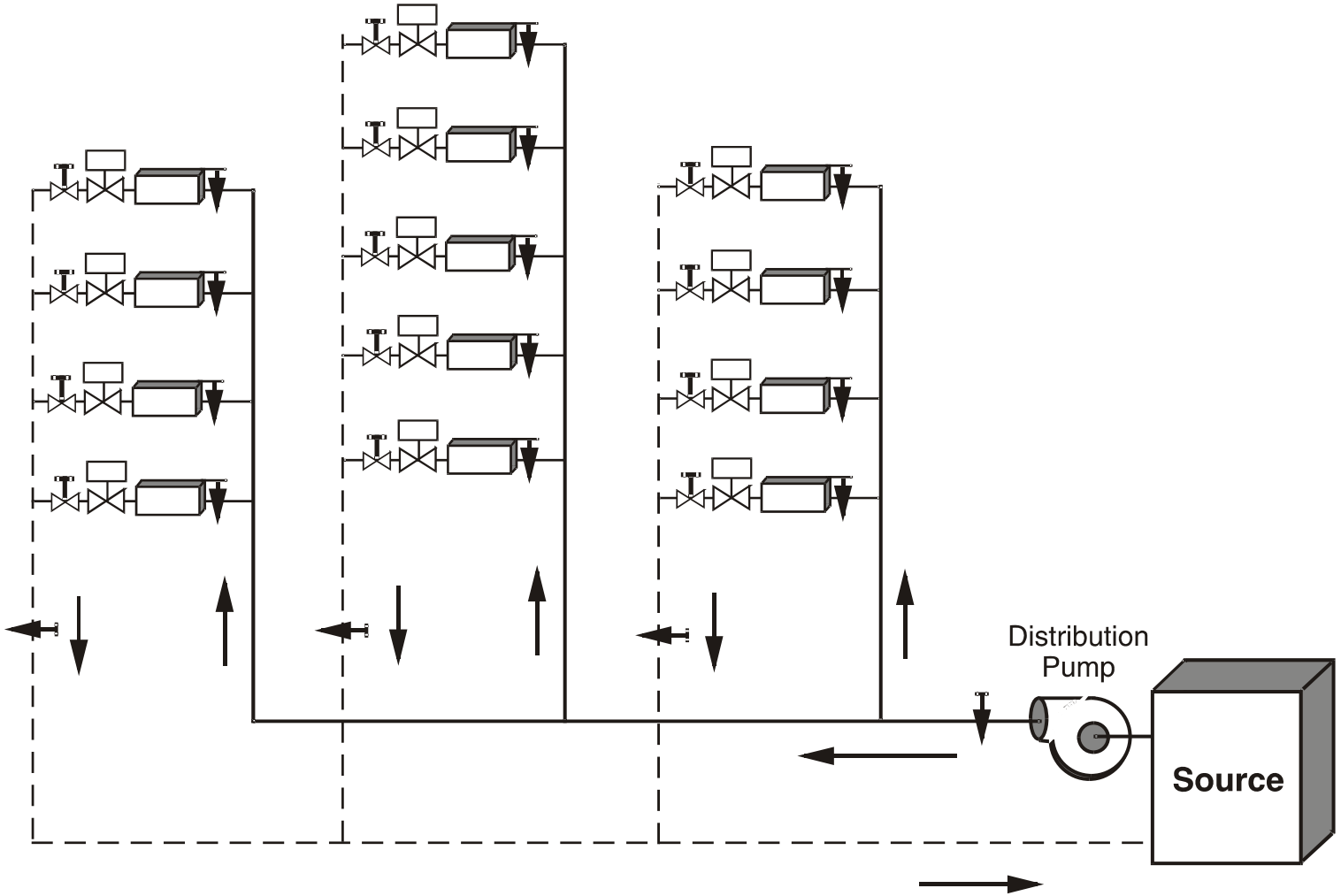
Two-Speed Pumping Example



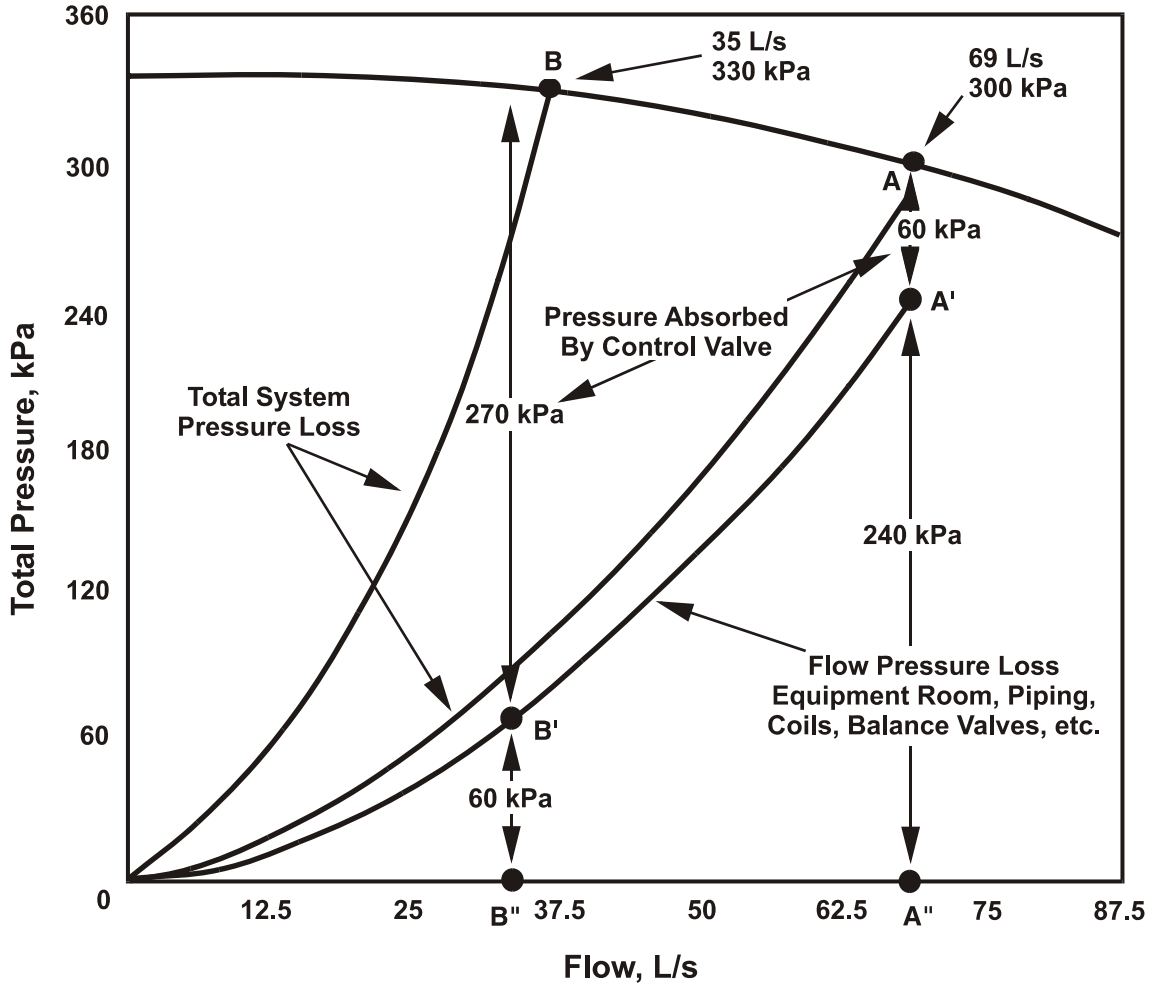
	Flow (L/s)	Pres. (kPa)	Eff. (%)	Power (kW)
Point A	61.6	78.8	85	5.6
Point B	78.1	99	82	9.7
Point C	104.4	152	79	20.5
Point D	133.1	225	84	36

% Change Flow	Power
46	16
58	27
78	57
100	100

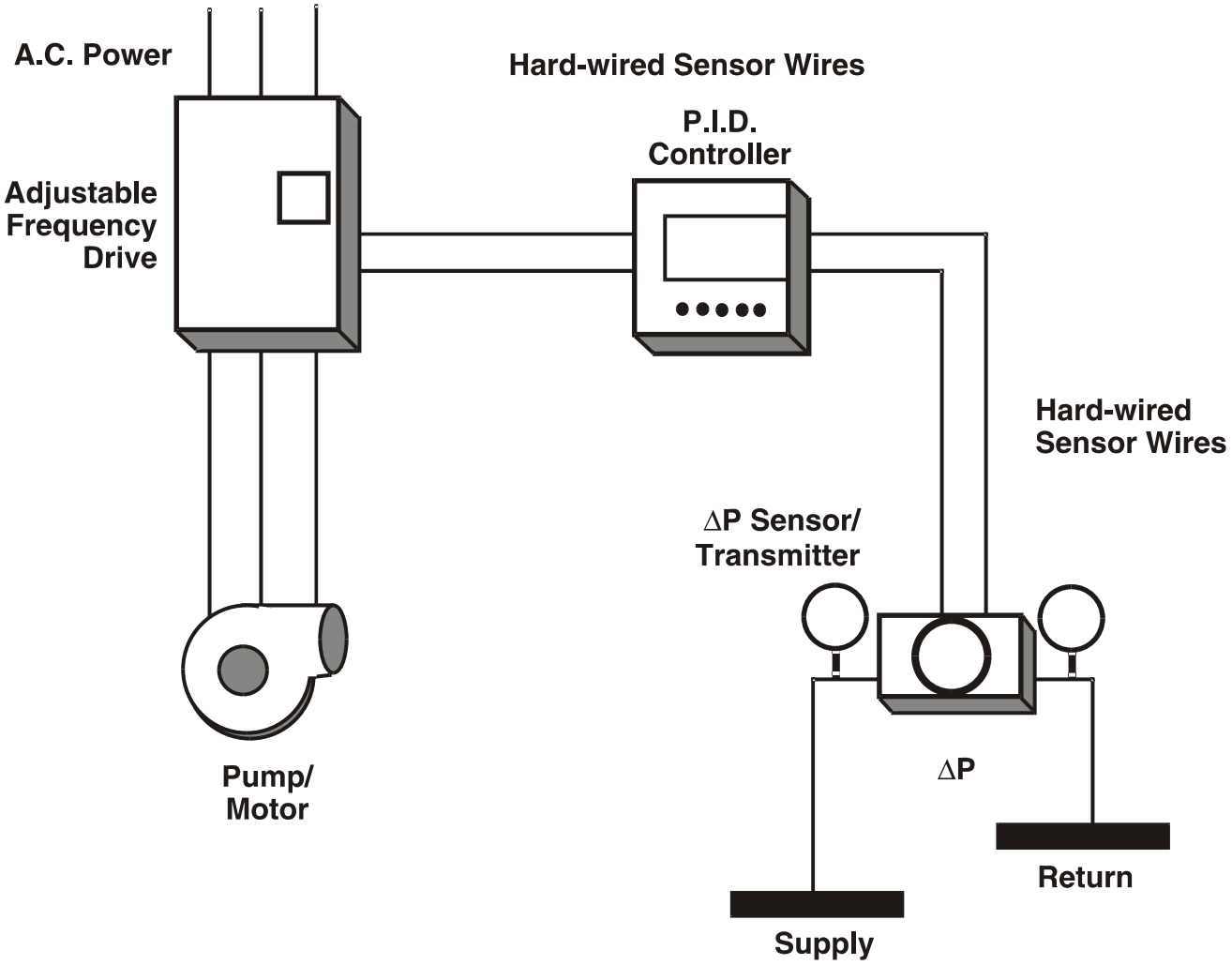
Typical Direct Return System



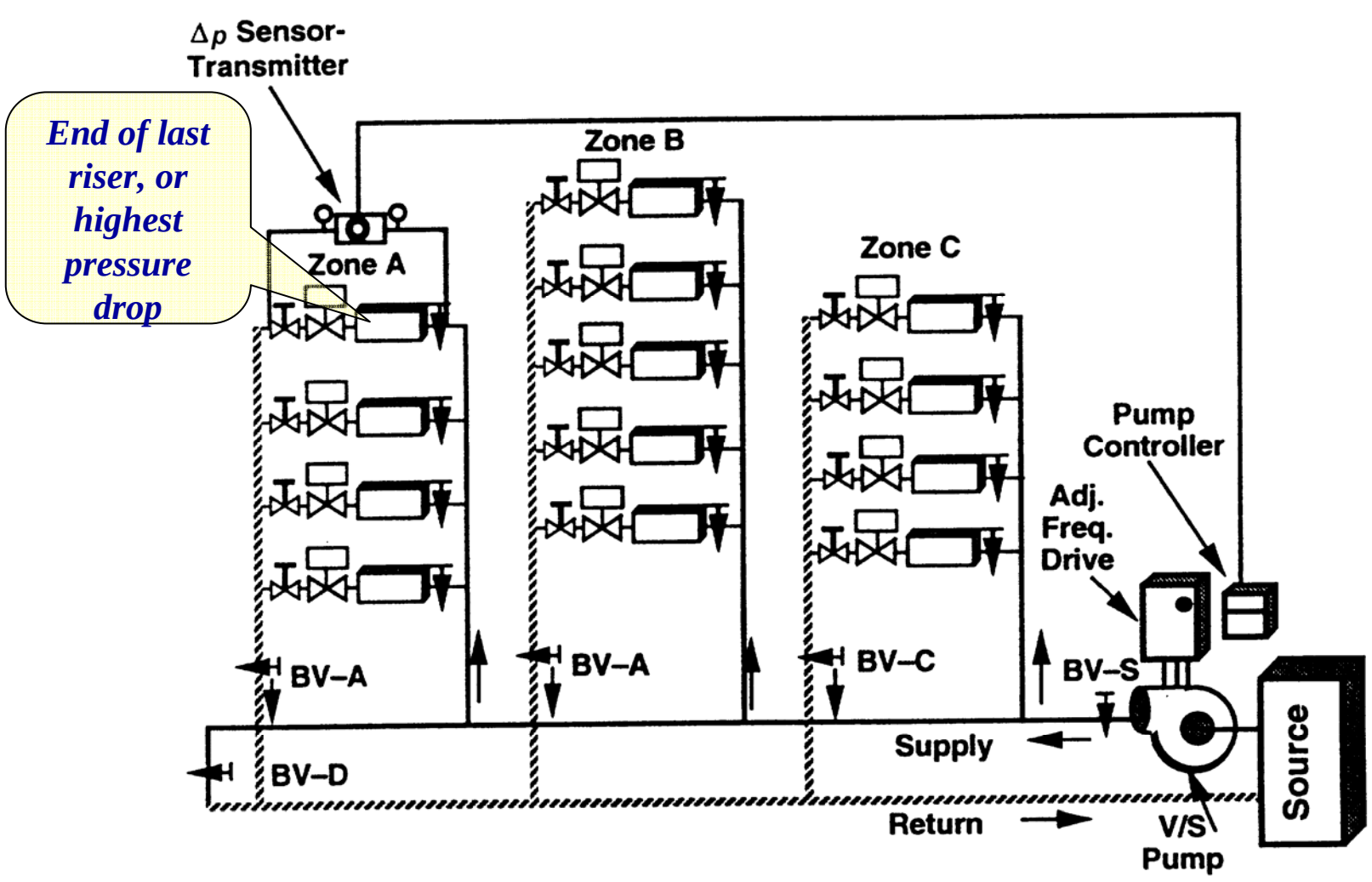
Pressure Loss With Two-Way Valves



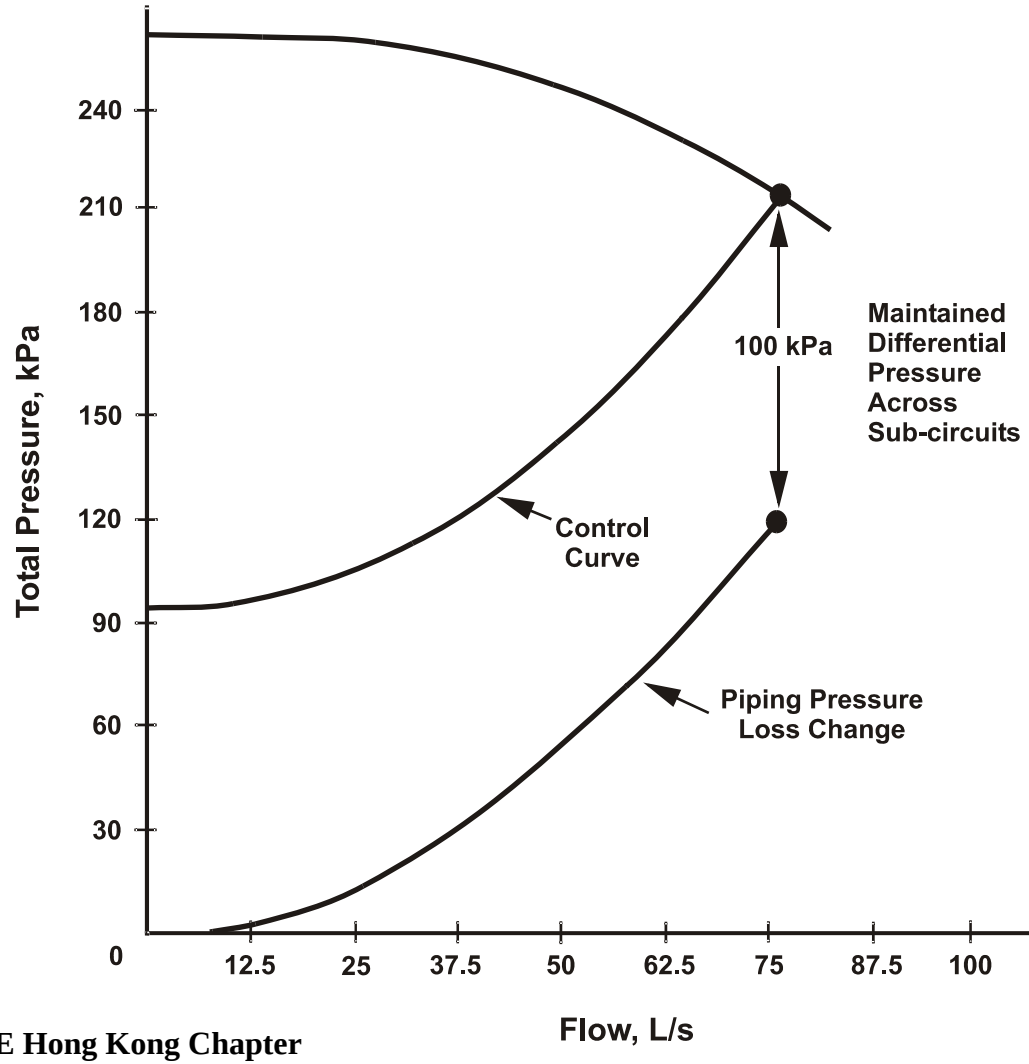
Proportional Controller and AFD



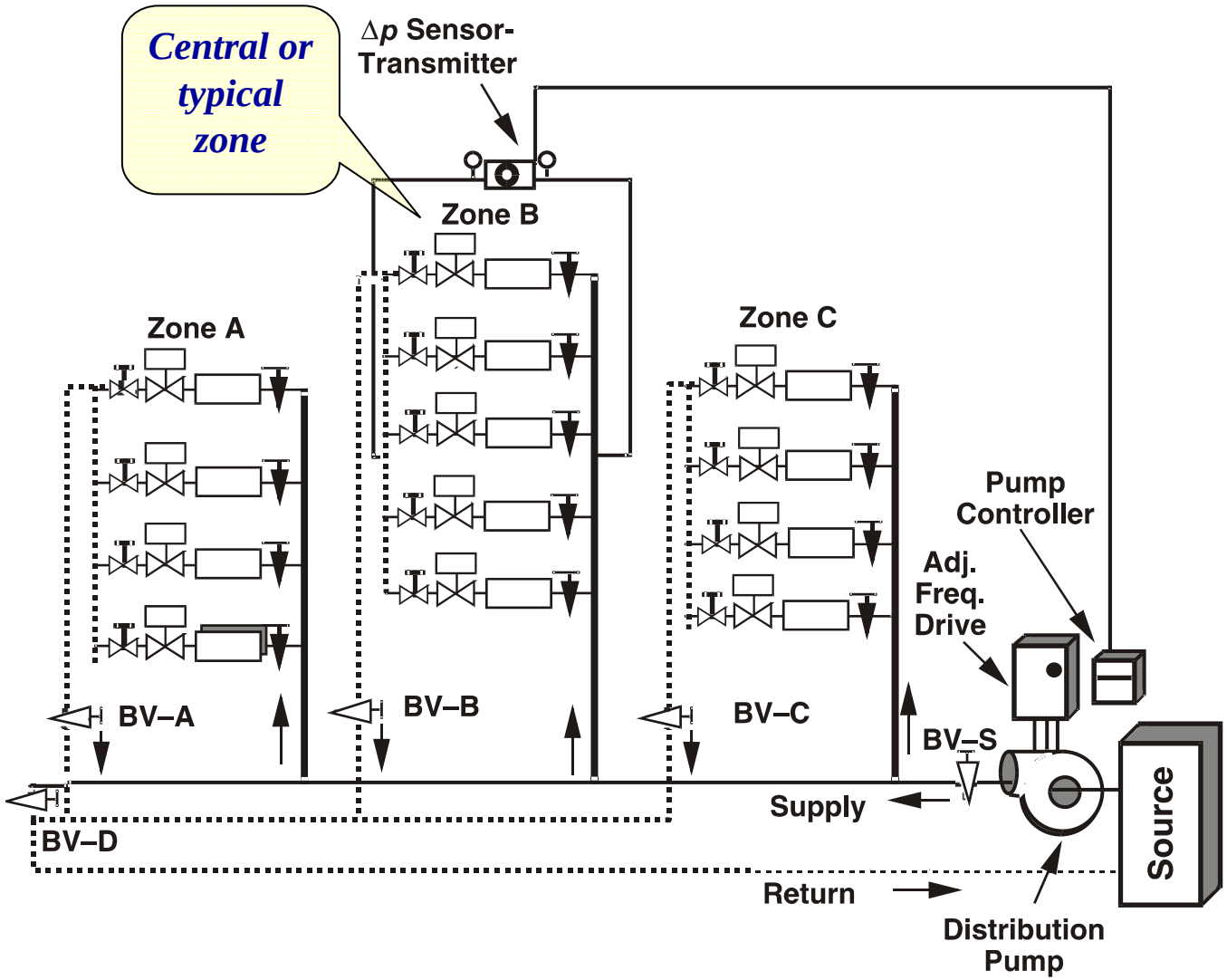
Measuring Δp in Direct Return System



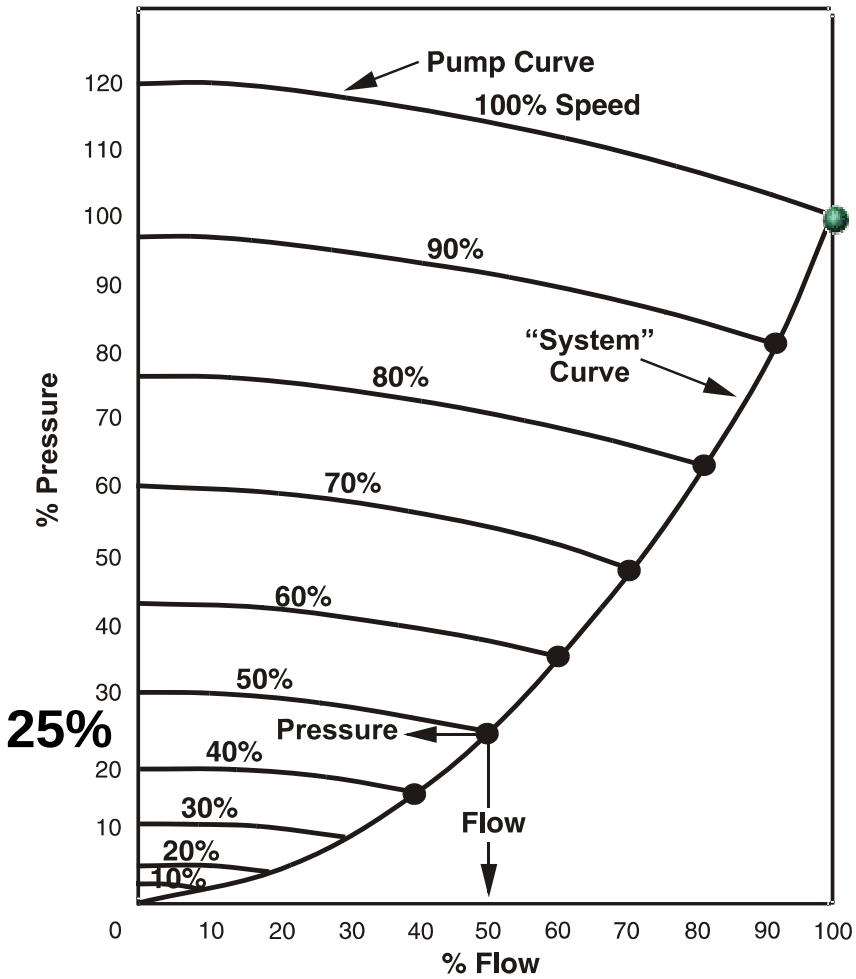
Differential Pressure Control Curve Above Piping Friction Loss



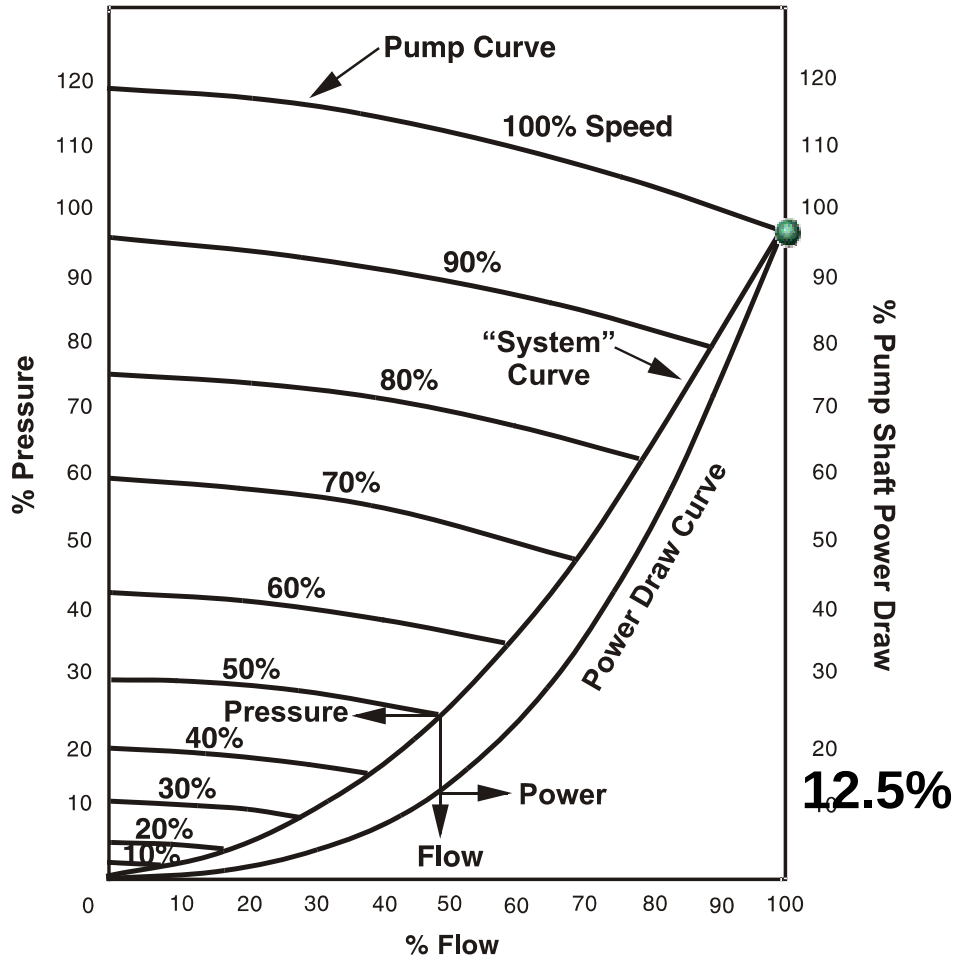
Measuring Δp in Reverse Return System



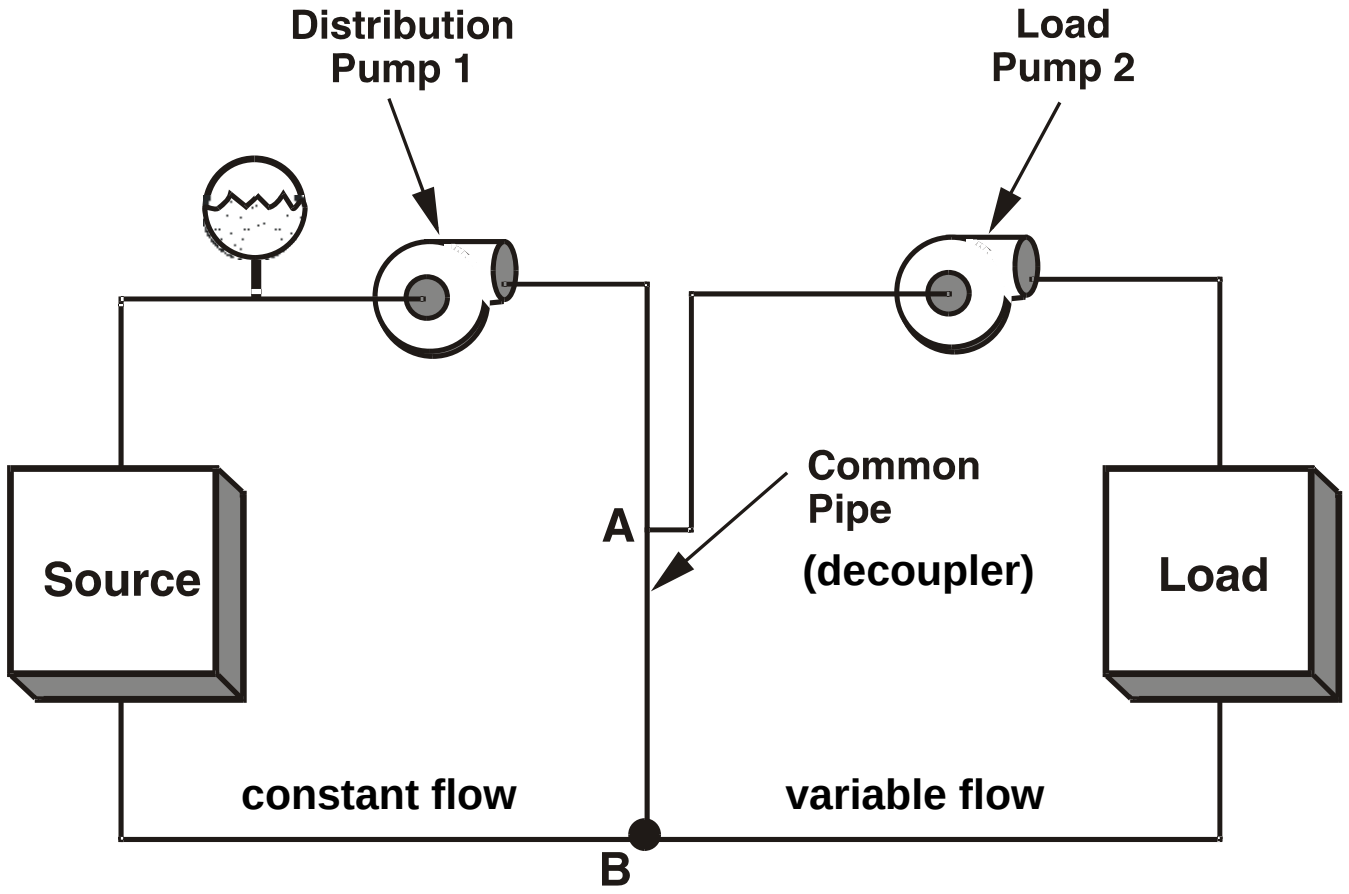
Pressure Reduction With Change in Pump Speed



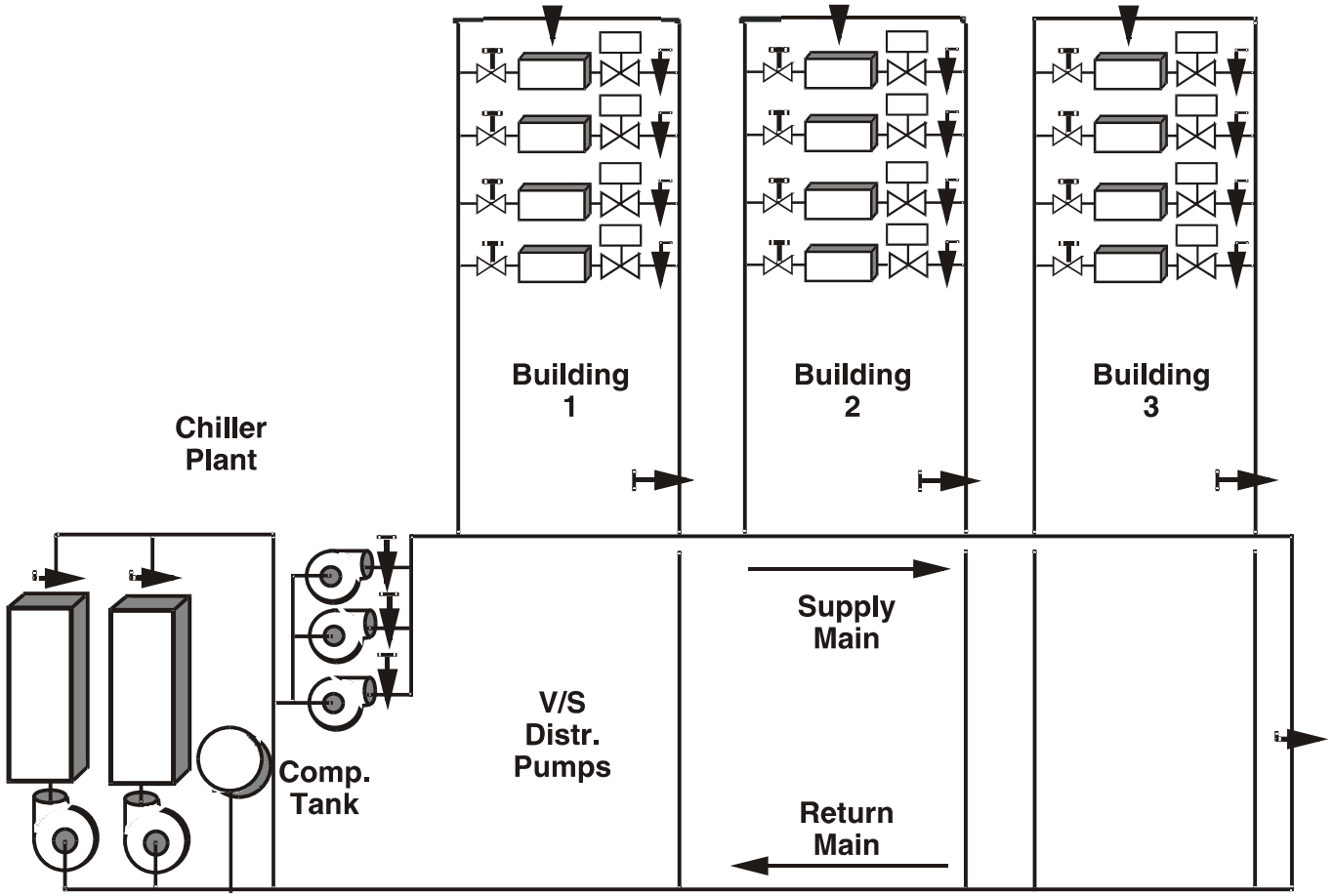
Pumping Power Reduction With Change in Pump Speed



Primary-Secondary Pumping Concept



Primary-Secondary Variable Speed Pumping



Distributed Variable Speed Pumping