PITFALLS IN HYDRONIC DESIGN, APPLICATION & INSTALLATION

ORANGE COUNTY ASHRAE 11/17/09 DINNER PROGRAM

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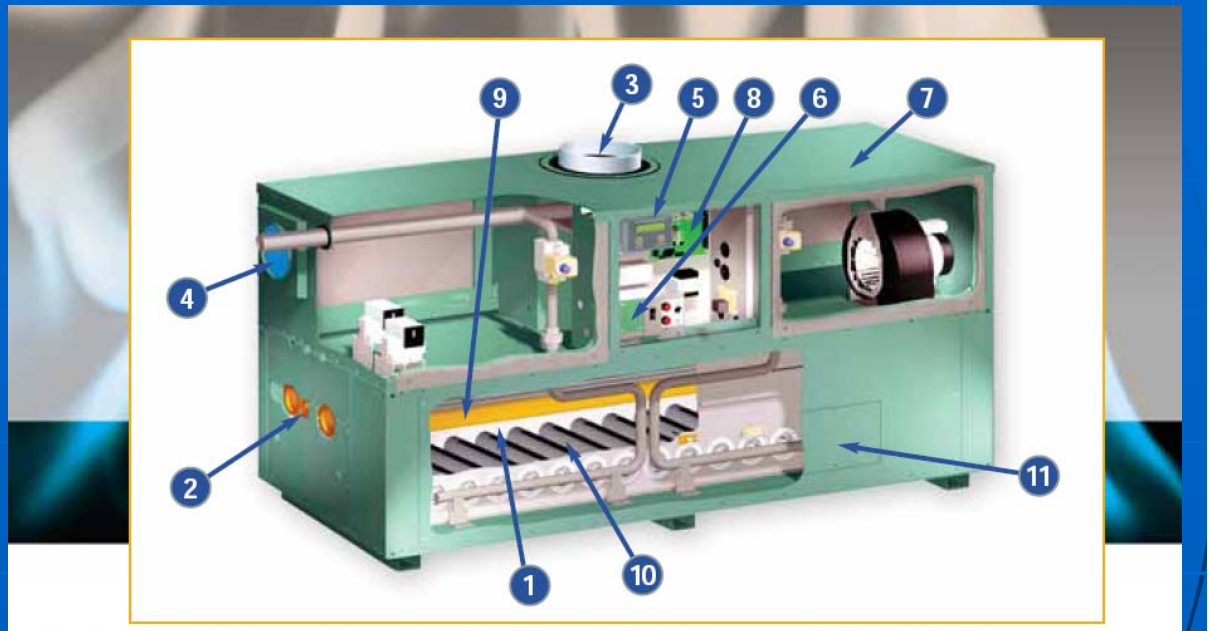
Dawson Company

What Is A Copper Finned Tube Boiler?

- USUALLY 100 TO 3000 MBH
- LOW MASS
- LOW COST
- LIGHT WIEGHT
- SMALL FOOTPRINT
- HIGH HEAT TRANSFER



1. Lightweight Refractory Panels
Multi-piece ceramic fiber panels enhance combustion while minimizing heat retention.

2. Fully-enclosed Headers
Temperature sensors and lead wires/capillaries are protected from weather, vandalism, and accidental damage during installation and service.

3. Flue Connection
Top or back outlet flue connections offer greater installation flexibility.

4. Air Filter
An easily-cleaned combustion air filter protects the burners from airborne particles including flying insects.

5. On-Board Diagnostic Center
Factory mounted standard equipment (302-2342). Gives relevant service feedback as well as possible solutions to clear the fault. All in plain English, no cryptic codes to decipher. The control stores up to 16 fault codes in its history file for the service technician to review.

6. Status Display Lights
Up to 12 high-intensity LED lights, visible up-front, indicate the operating status of the boiler.

7. Construction
The cabinet and all internal parts are made from galvanized, aluminized or stainless steel. The exterior is protected by textured powder-coat paint, ideally designed for indoor or outdoor installations.

8. Central Point Wiring
Factory-made wire harnesses connect all electrical components to an easy-to-troubleshoot circuit board with multi-pin connectors.

9. Heat Exchanger Tubes
Time-proven copper finned tubes and optional cupro-nickel tubes stand up to even the harshest water conditions.

10. Burners
Special stainless steel alloy pre-mix burners provide clean, robust combustion and meet all low NOx regulations.

11. HSI Access Panel
A small panel provides access to both the hot surface igniter and the flame sensor to aid inspection and service.

What A Copper Finned Tube Boiler Is Not

HIGH MASS BOILERS

- Fire Tube (Cleaver Brooks, Superior, McKenna)

MEDIUM MASS BOILERS

- Water Tube (Rite Engineering, Parker, Ajax)
- Cast Iron Sectional (Weil McLain, Peerless, Hydrotherm)

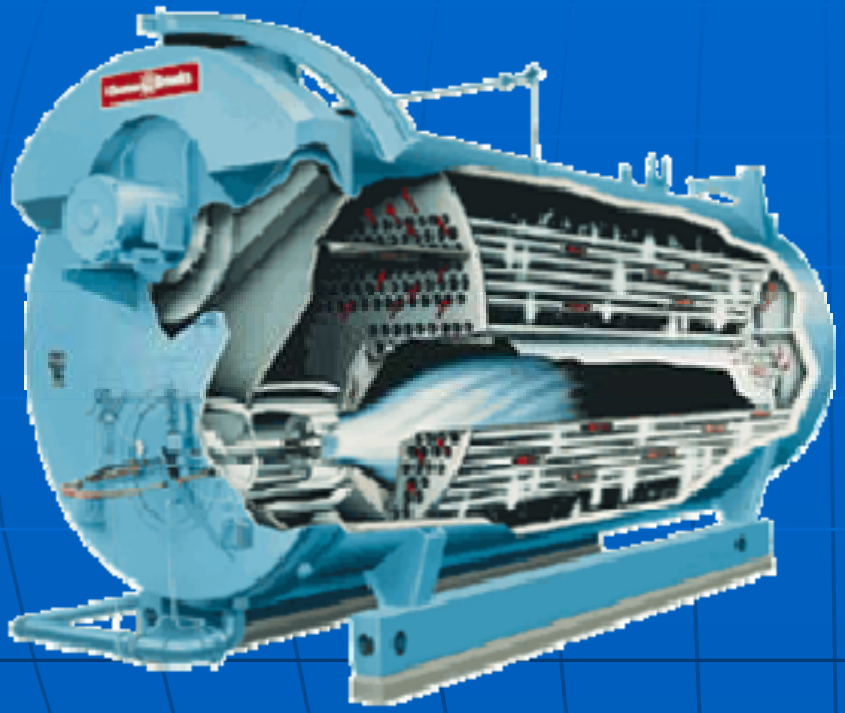
Average Water Mass >500 Gallon Per 2000 MBTU

Average Operating Weight @ 2000 MBTU > 8,000 lbs.

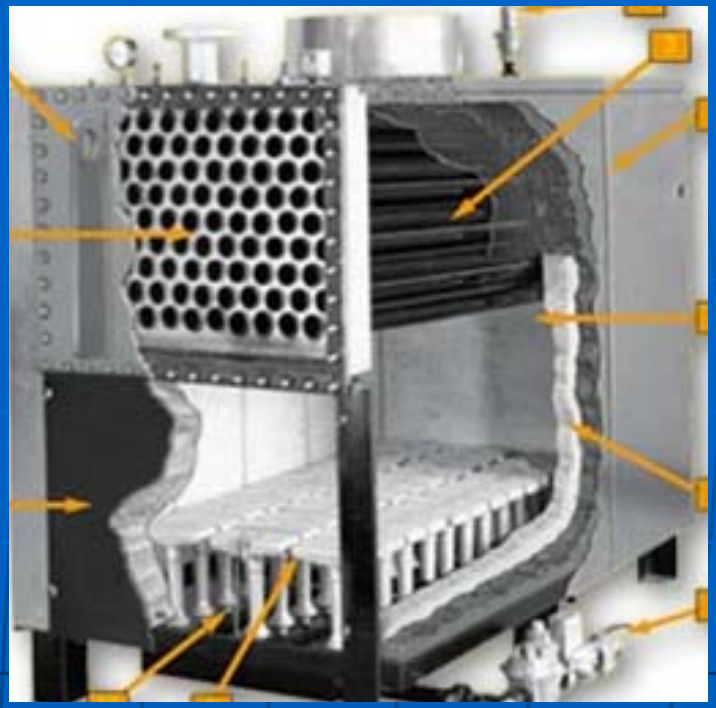
Minimum Inlet Temperature 140 Degrees To Prevent Thermal Shock

Typically Require 24/7 Operation

What A Copper Finned Tube Boiler Is Not



FIRE TUBE BOILER
BOILER



STEEL TUBE
BOILER

Copper Finned Tube Boiler History

ATMOSPHERIC STANDARD EFFICIENCY:

- 80%-82% efficiency
- Bullet proof: could take some condensation, primary pumping ok
- Category I appliance
- Pre SCAQMD low NOx era

SEALED COMBUSTION MID EFFICIENCY:

- 84%-87% efficiency
- Susceptible to condensation failure: min inlet temp 105-120F
- Work best if piped primary/secondary
- May require low temp bypass piping or cold water start option
- Came about mainly due to higher efficiency & SCAQMD requirements
- Are more efficient at full load

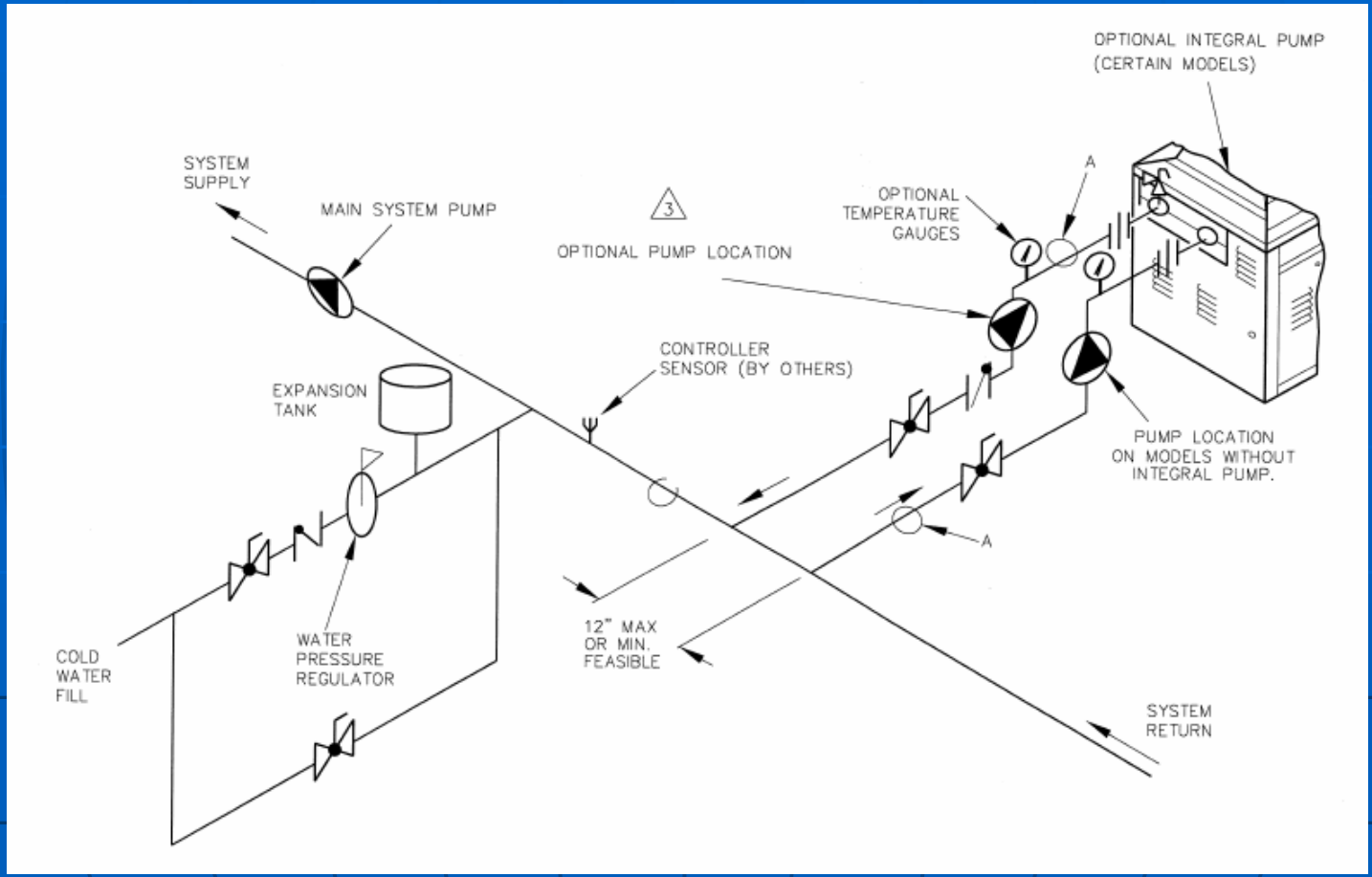
CONDENSING ULTRA HIGH EFFICIENCY:

- 86%-99% efficiency
- Maximum efficiency above 140F inlet temperature is 87%-89%
- Requires inlet temperatures below 110F to achieve ultra high efficiencies
- May or may not require primary/secondary piping arrangement
- High turn down ratios
- Are more efficient at part load

Why Primary/Secondary Piping?

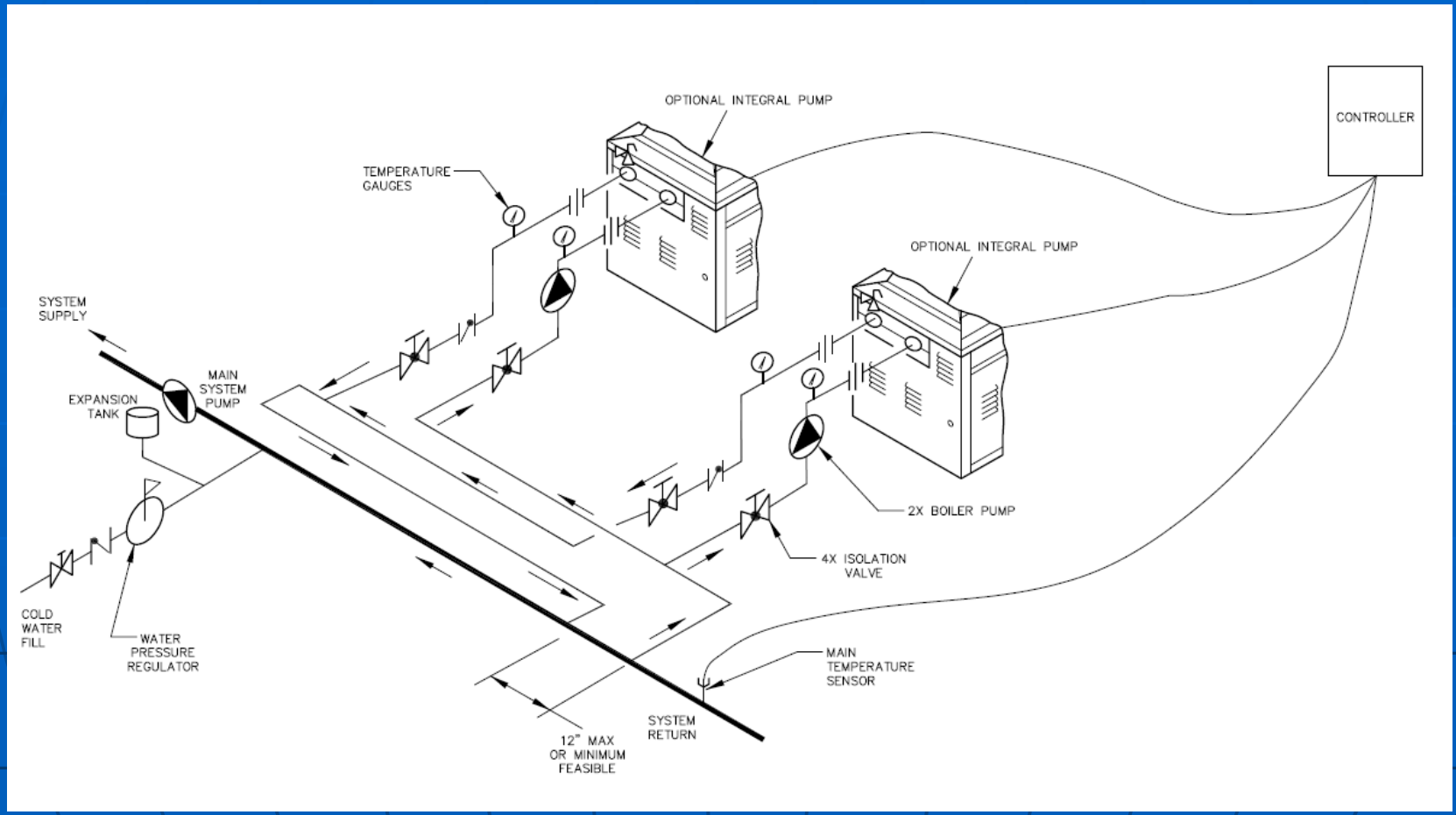
- INSURES THE BOILER WILL GIVE LONG TROUBLE FREE OPERATION
- PROTECTS THE BOILER UNDER LOW SECONDARY LOOP FLOW CONDITION
- PROTECTS THE BOILER FROM CONDENSING
- PROTECTS THE BOILER FROM OVER PUMPING
- INSURES RESIDUAL HEAT IN THE BOILER IS DISSIPATED UPON SHUT DOWN

Mid Efficiency Boiler Piping
Comfort Heating



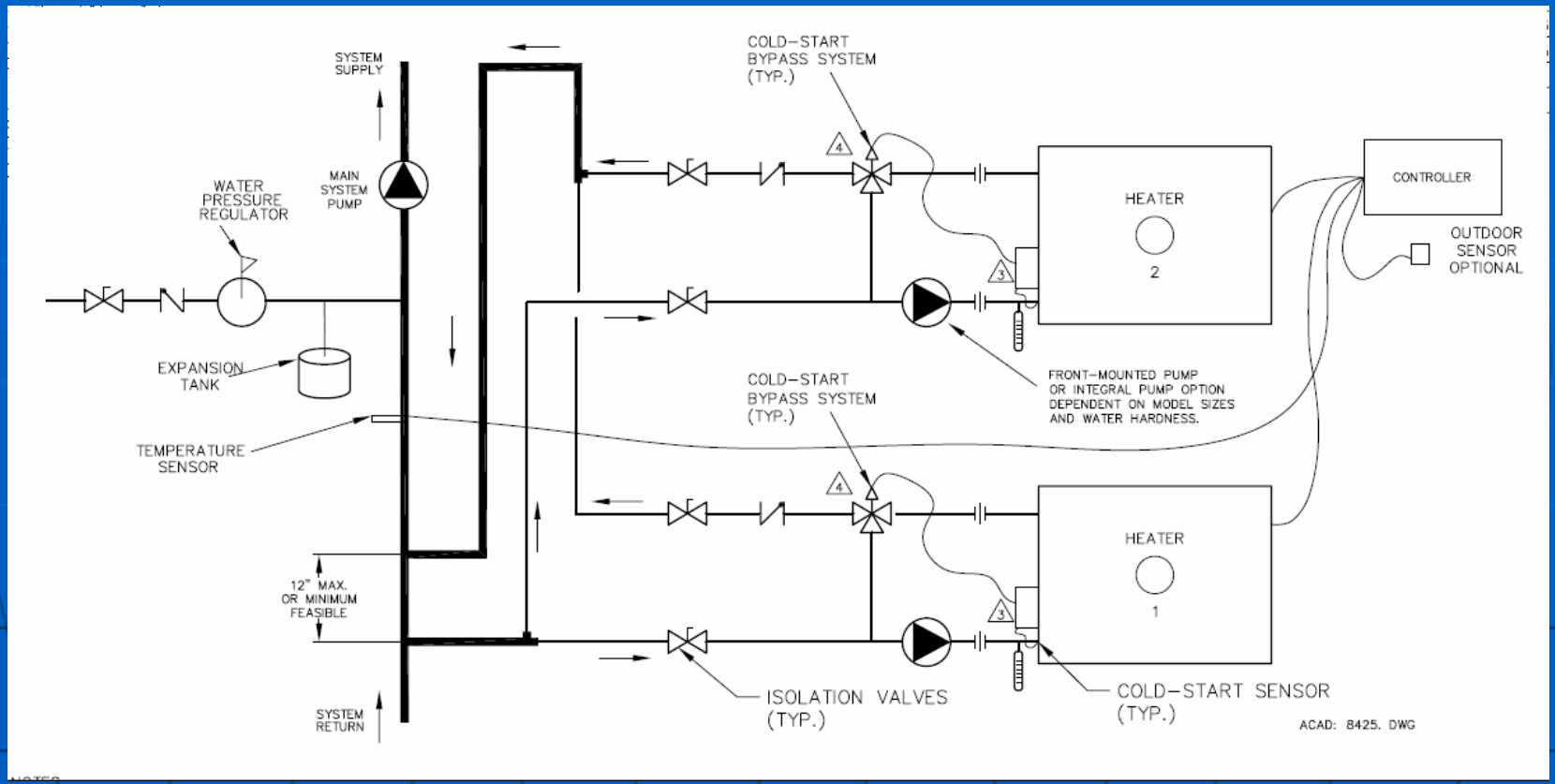
SINGLE BOILER PRIMARY/SECONDARY ARRANGEMENT

Mid Efficiency Boiler Piping
Comfort Heating



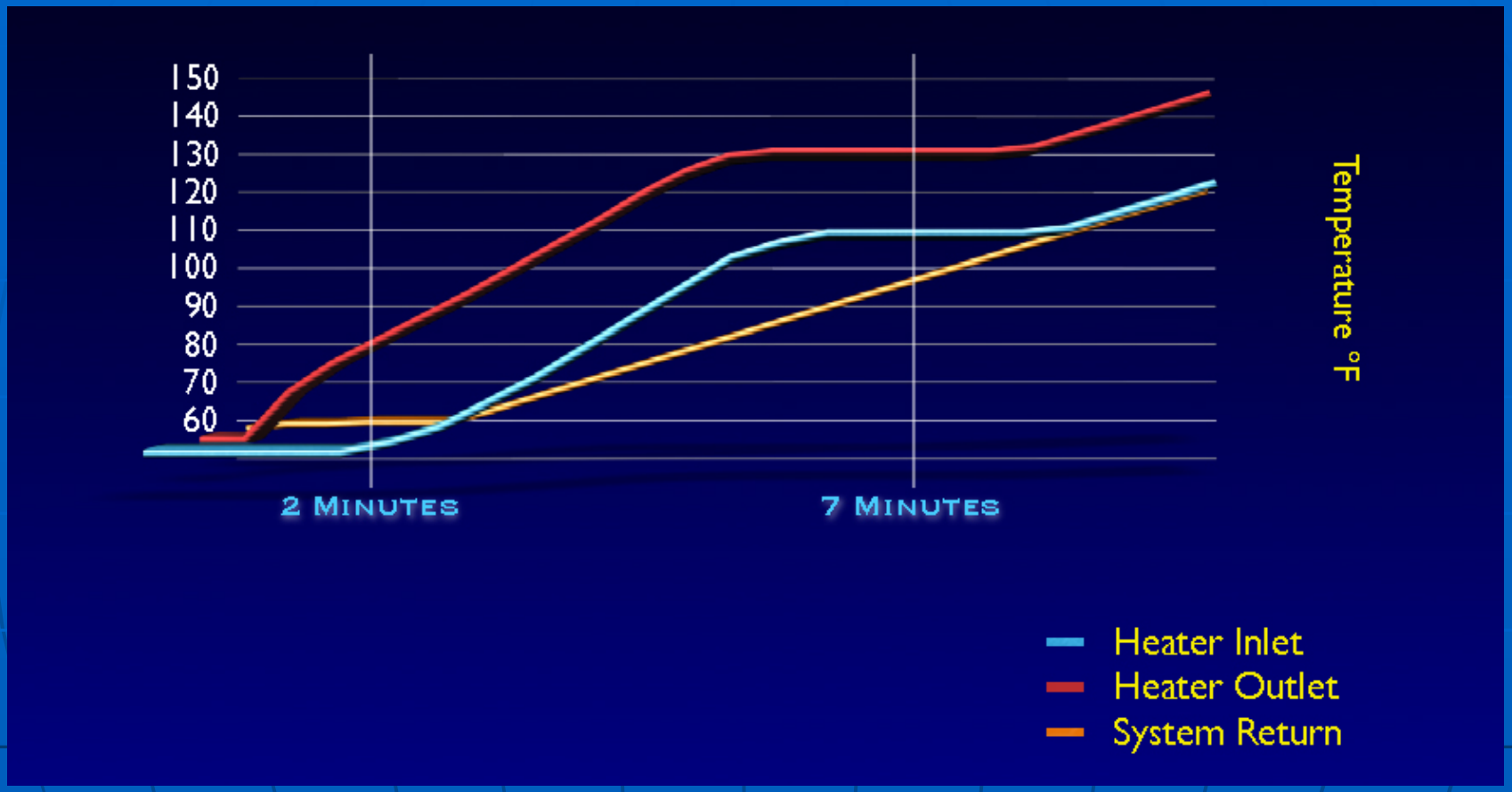
MULTIPLE BOILER PRIMARY/SECONDARY
REVERSE RETURN ARRANGEMENT

Mid Efficiency Boiler Piping
Comfort Heating Cold Start



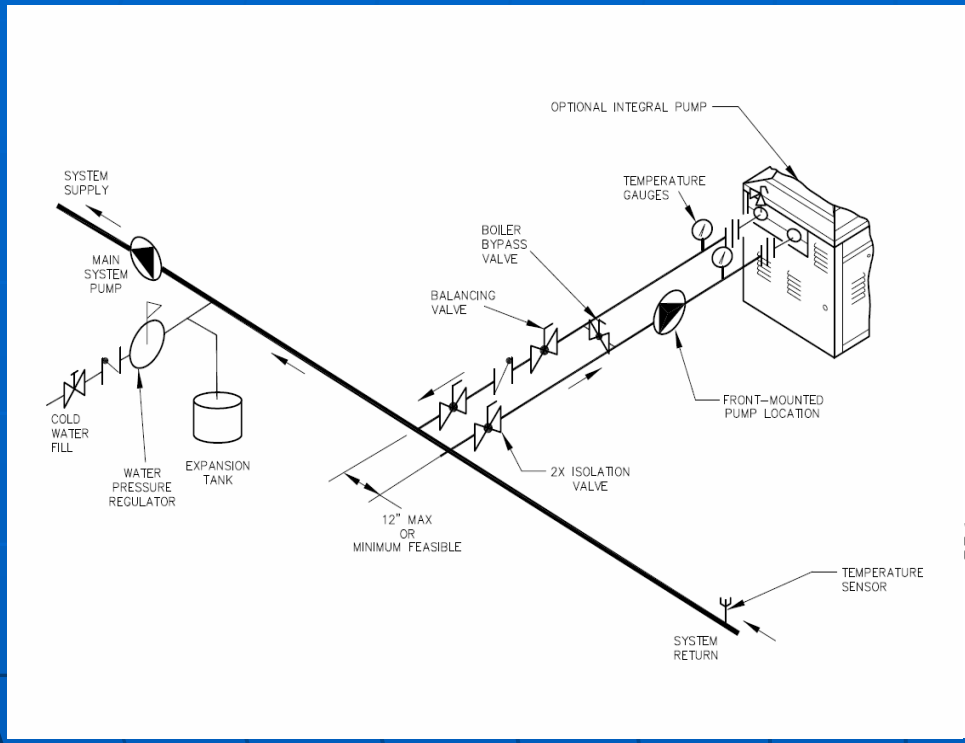
MULTIPLE BOILER PRIMARY/SECONDARY
REVERSE RETURN ARRANGEMENT

Why Cold Start?

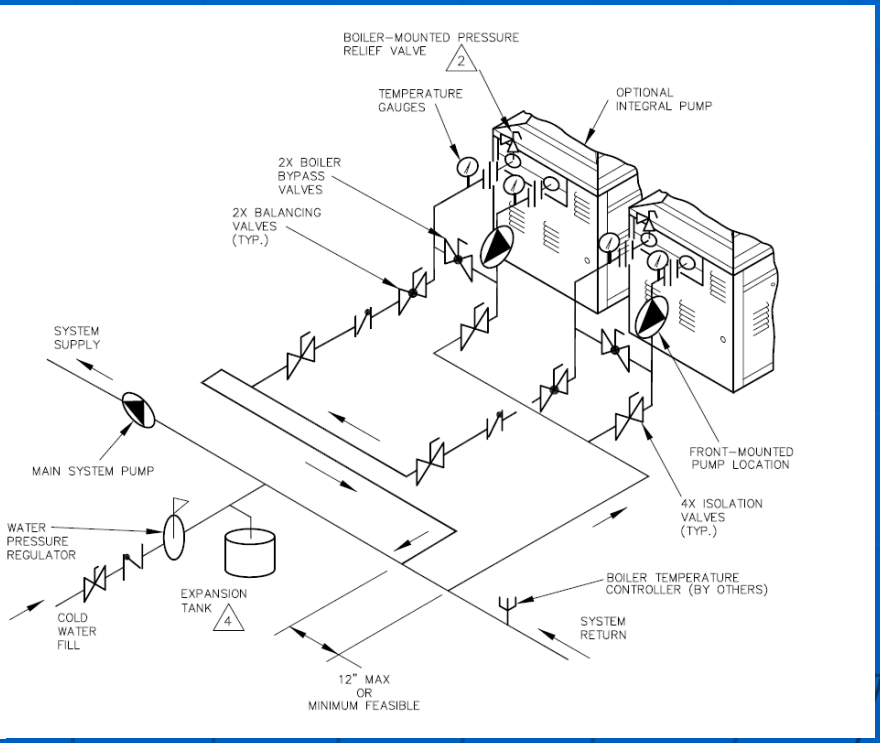


- GUARANTEES BOILER REACHES MINIMUM INLET TEMPERATURE WITHIN THE MANUFACTURER'S RECOMMENDED TIME LIMIT
- MAINTAINS MINIMUM INLET TEMPERATURE AT ALL TIMES

Mid Efficiency Boiler Piping
Low Temp Return

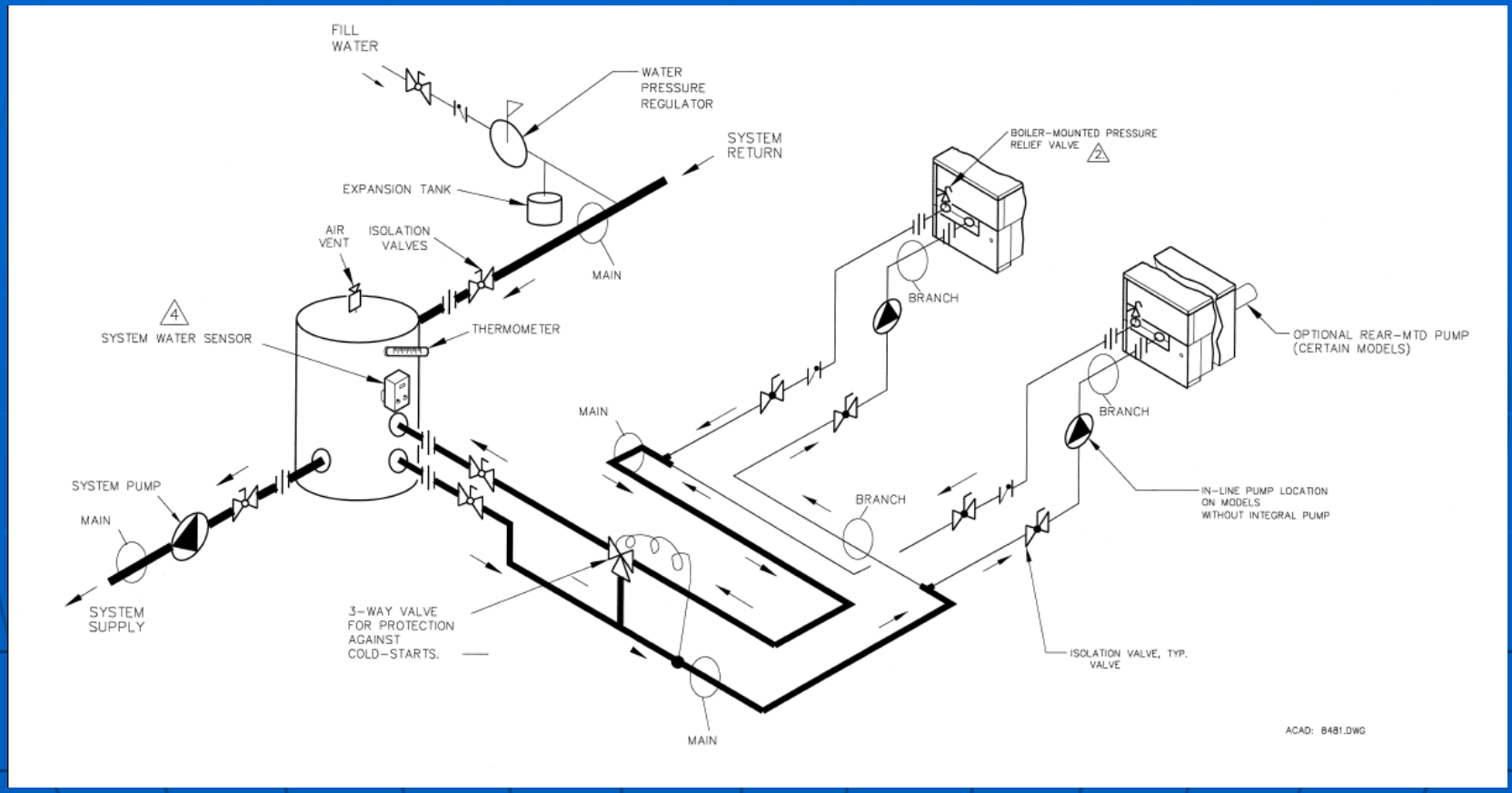


SINGLE BOILER PRIMARY/SECONDARY
LOW TEMPERATURE RETURN
(COLD RUN)



MULTIPLE BOILER PRIMARY/SECONDARY
REVERSE RETURN ARRANGEMENT
LOW TEMPERATURE RETURN (COLD RUN)

Mid Efficiency Boiler Piping Buffer Tanks



MULTIPLE BOILER PRIMARY/SECONDARY REVERSE RETURN ARRANGEMENT WITH COLD START AND BUFFER TANK

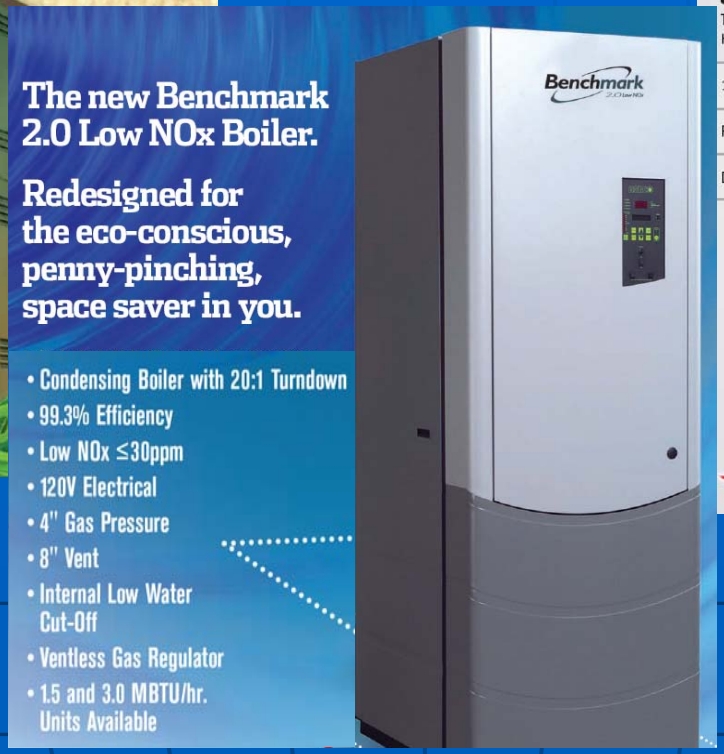
When Do I Need A Buffer Tank?

- ANY TIME THE MINIMUM SYSTEM LOAD IS LESS THAN THE MINIMUM FIRING RATE OF THE BOILER
- BUFFER TANKS WILL PREVENT SHORT CYCLING UNDER LOW LOAD CONDITIONS BY CREATING A “FLY WHEEL AFFECT”
- IN VARIBLE VOLUME SYSTEMS WHERE THE BUILDING LOOP FLOW RATE HAS THE POTENTIAL TO BE MUCH LESS THAN THE BOILER FLOW RATE
- HIGHER BOILER FLOW RATE MAY SHORT CYCLE BACK TO THE BOILER CAUSING ERRATIC OPERATION AND POTENTIAL OVER HEATING

Condensing Boilers

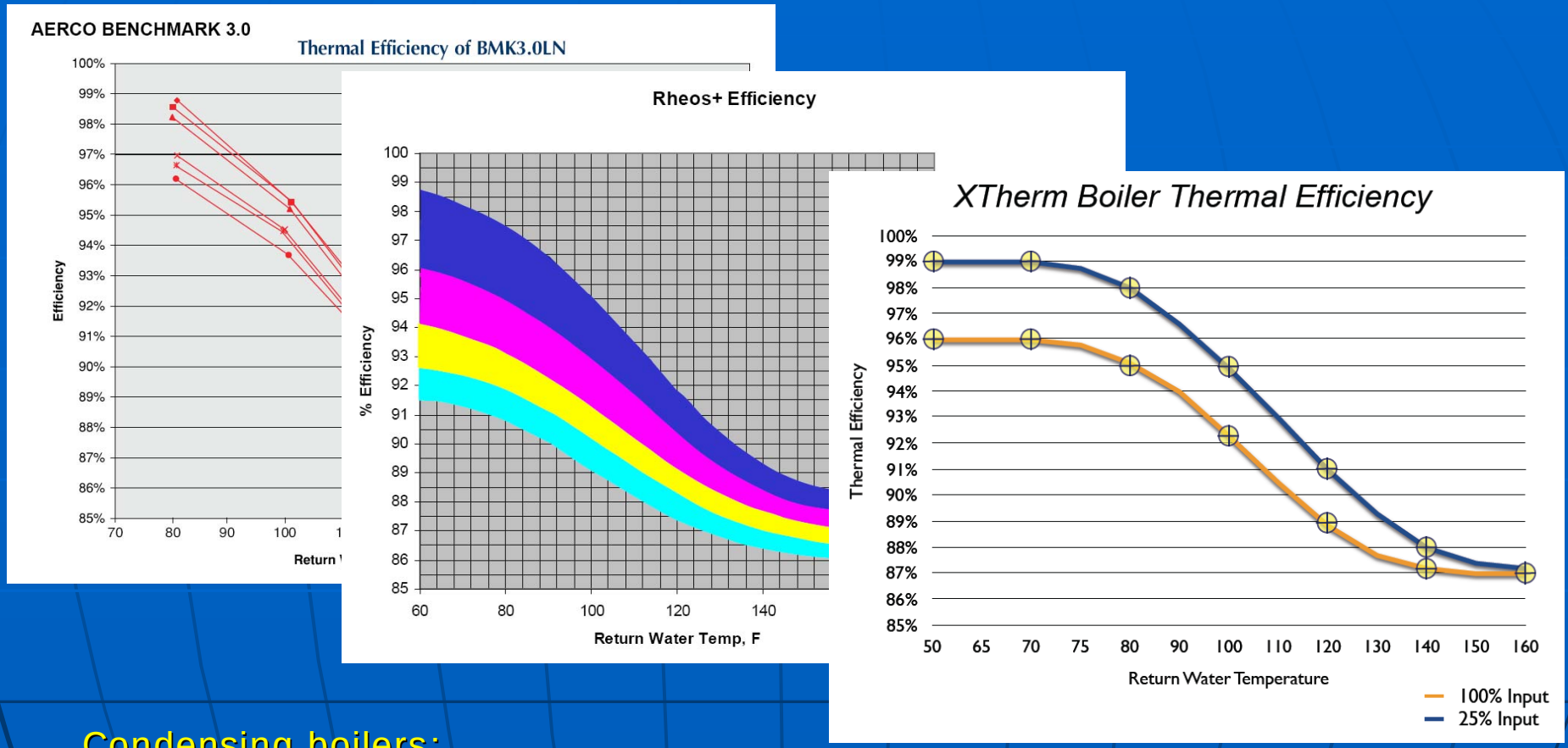
- UTILIZE LATENT HEAT GIVEN OFF BY FLUE GASES WHEN CONDENSATION OCCURS
- CAN REACH EFFICIENCIES UP TP 98% IF ENTERING BOILER WATER IS COOL ENOUGH
- ARE MORE EFFICIENT AT PART LOAD CONDITIONS
- WORK BEST IN SYSTEMS WITH LOW TEMPERATURE RETURN WATER SUCH AS WATER SOURCE HEAT PUMPS, POOLS AND DOMESTIC HOT WATER
- HAVE LARGE TURN DOWN RATIOS: AS HIGH AS 20:1

Condensing Boiler Hype



Be careful with marketing brochures that require comprehensive overview to get the whole story

Condensing Boiler Efficiency Curves



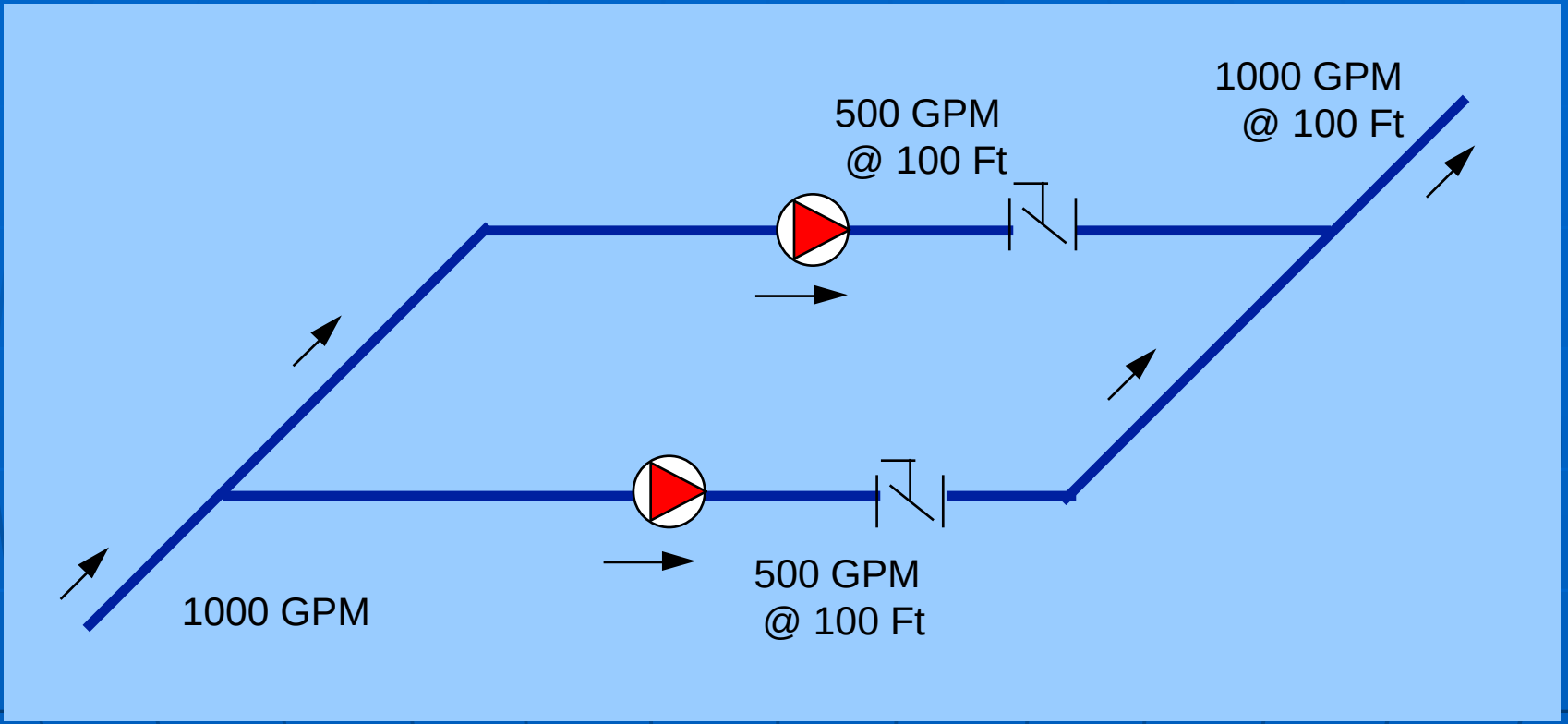
Condensing boilers:

- Require low return water temperatures to achieve ultra high efficiencies
- Typically do not exceed 88% efficiency at full fire with entering water temperatures above 140F
- Are more efficient at part load

Hybrid System Layout

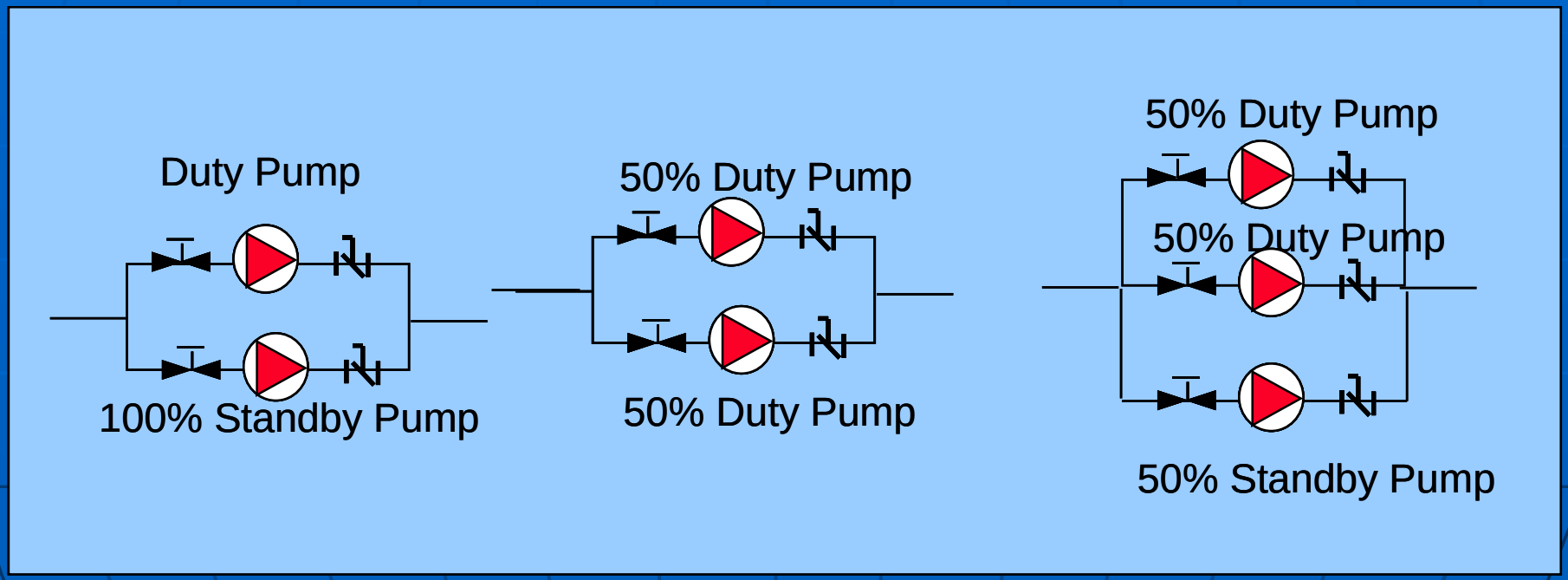
- Combines non-condensing boilers with condensing boilers
- Non-condensing boilers are used for high heating load conditions
- Condensing boilers are used for low load conditions or when mild climate conditions prevail and boiler set point temperatures are set back

Parallel Pumping

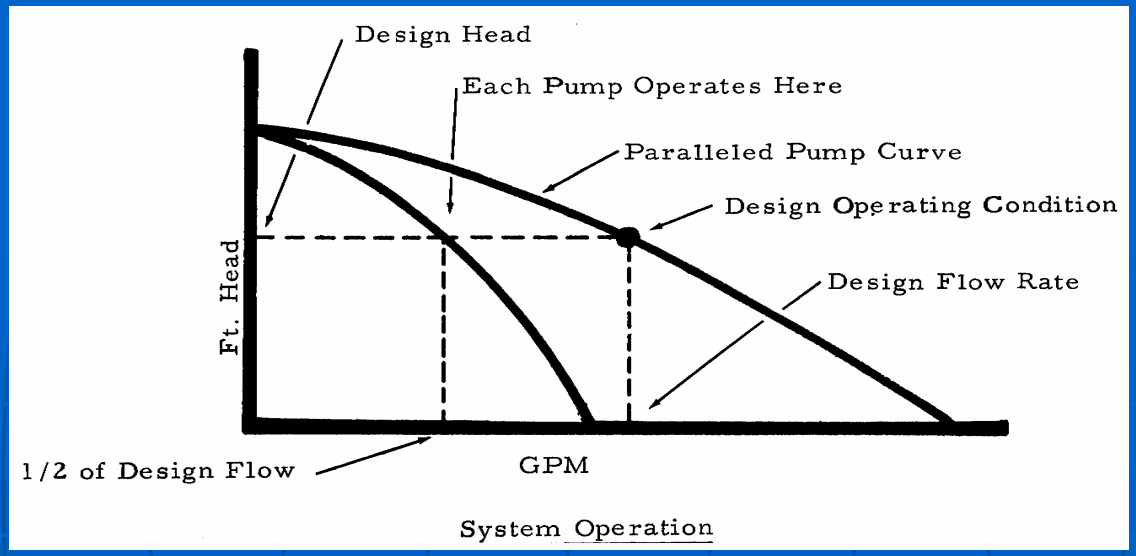


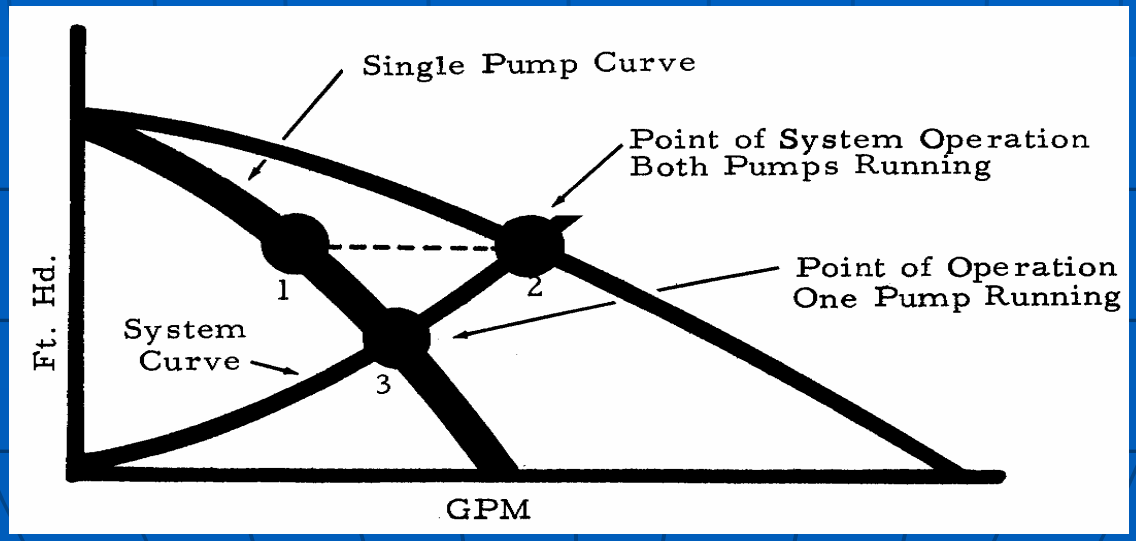
- PROVIDES ENERGY SAVING POTENTIAL
- ADDS REDUNDANCY
- TWO SMALLER PUMPS REPLACE ONE LARGE PUMP

Pump Configuration Options

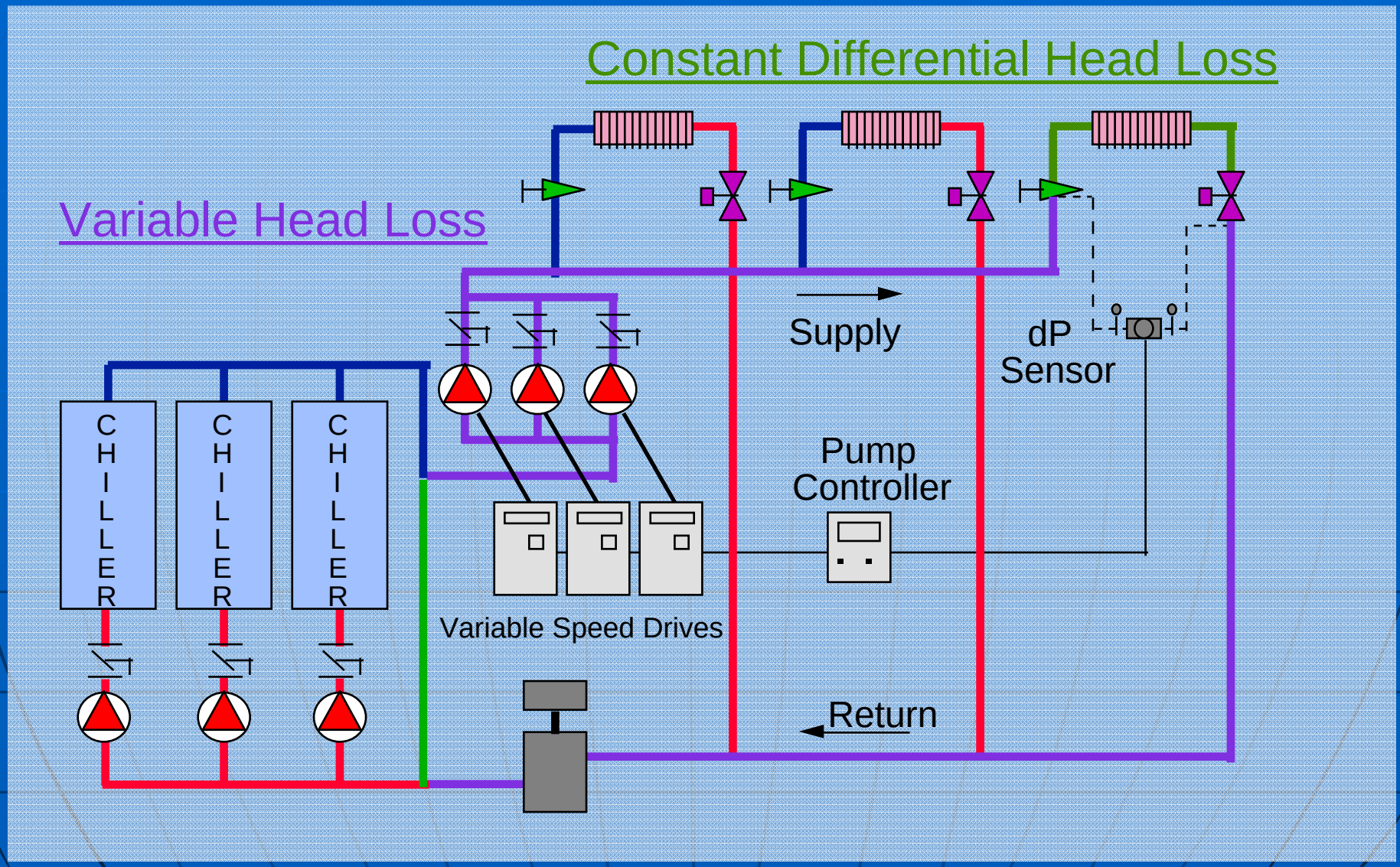


Parallel Pump Curves

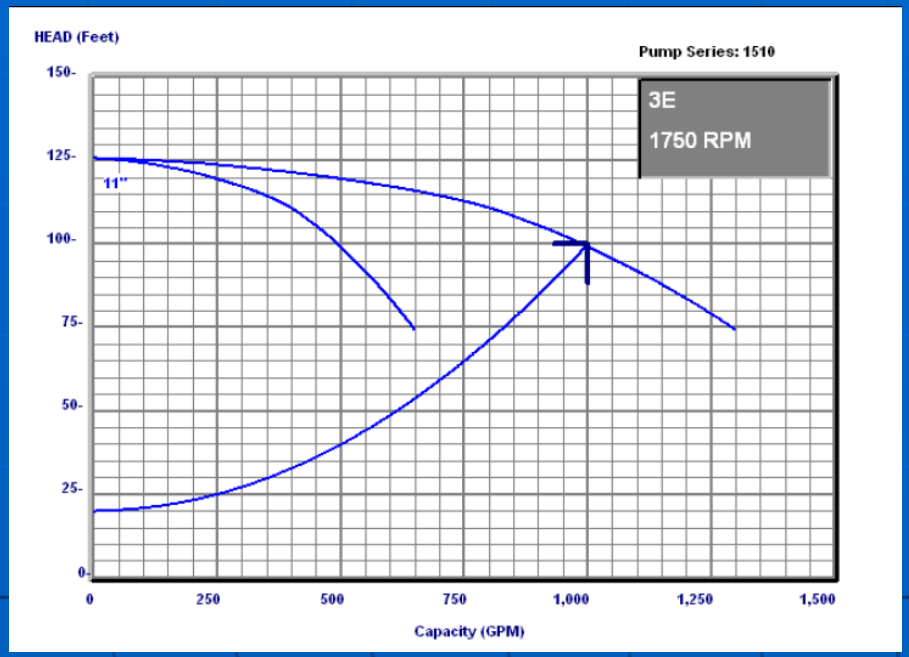


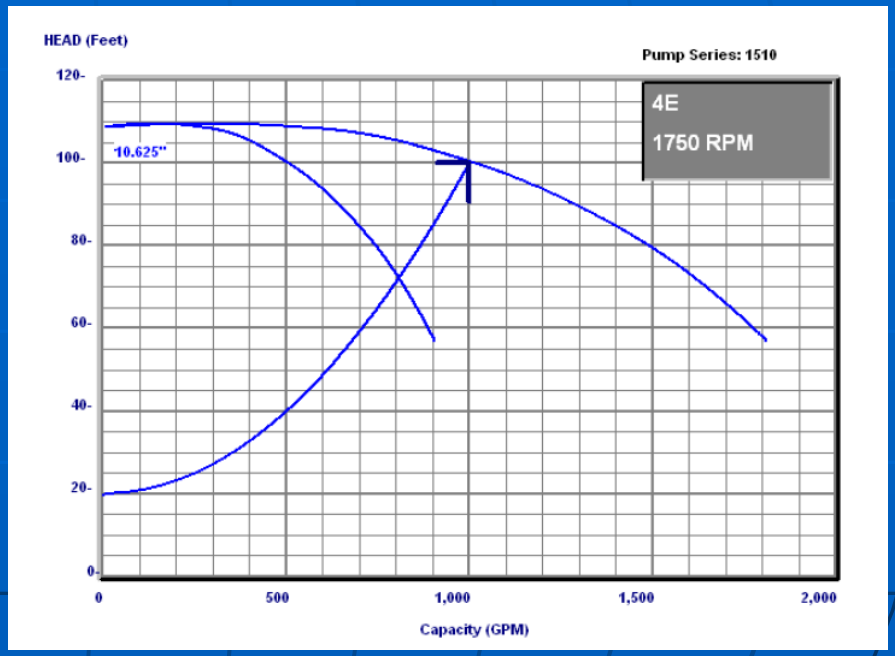


Variable Head Loss

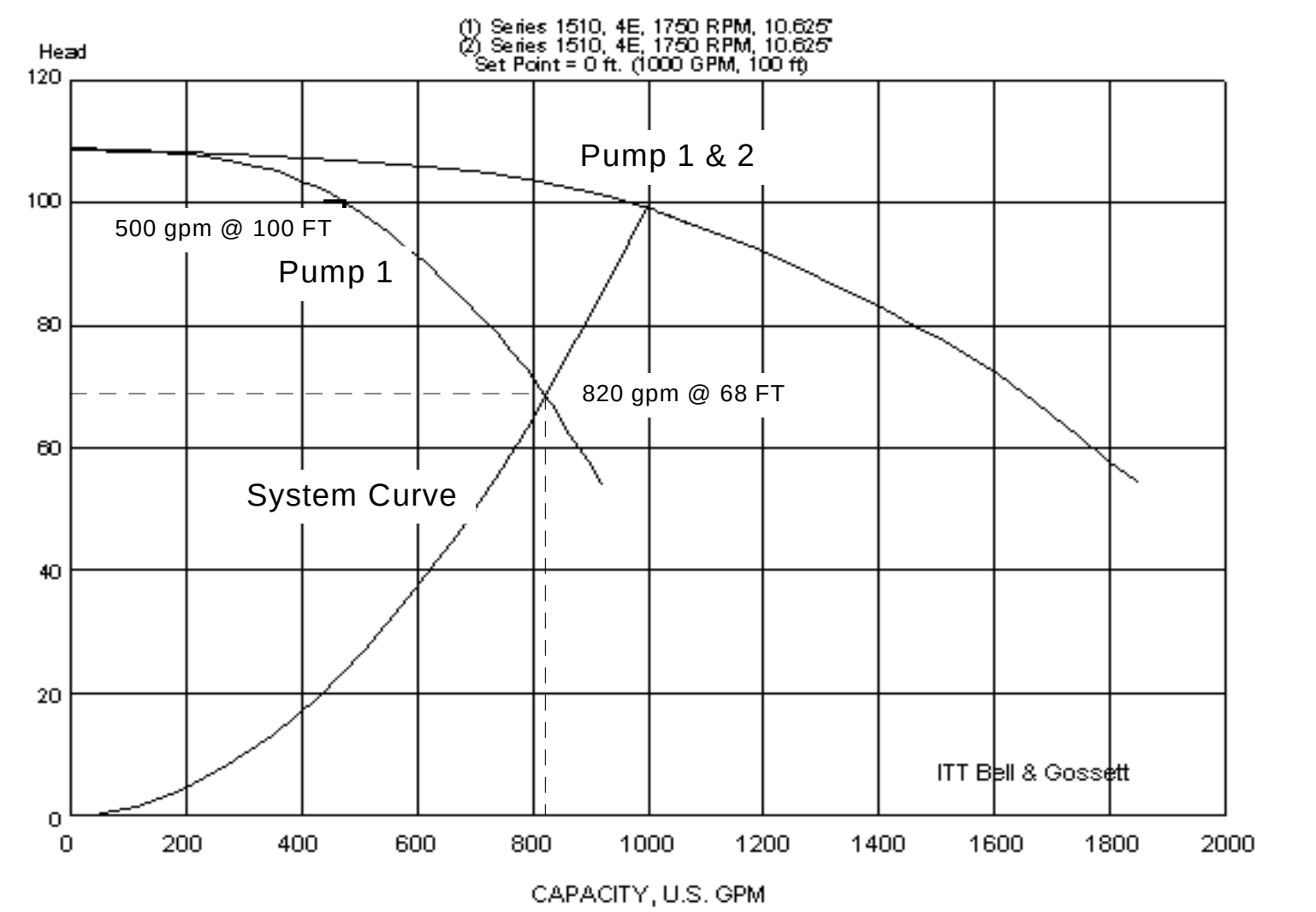


PARALLEL PUMPING CURVES

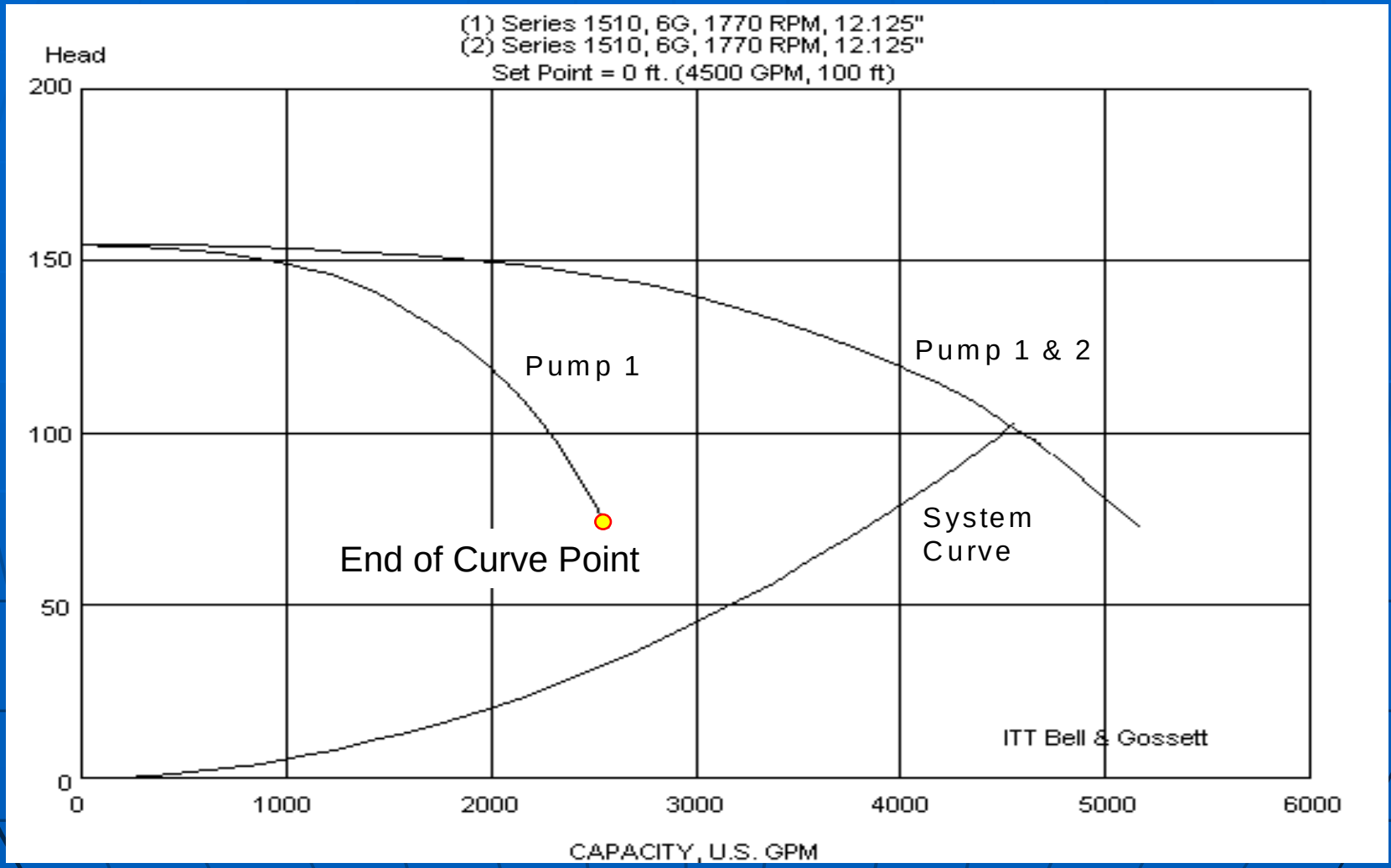




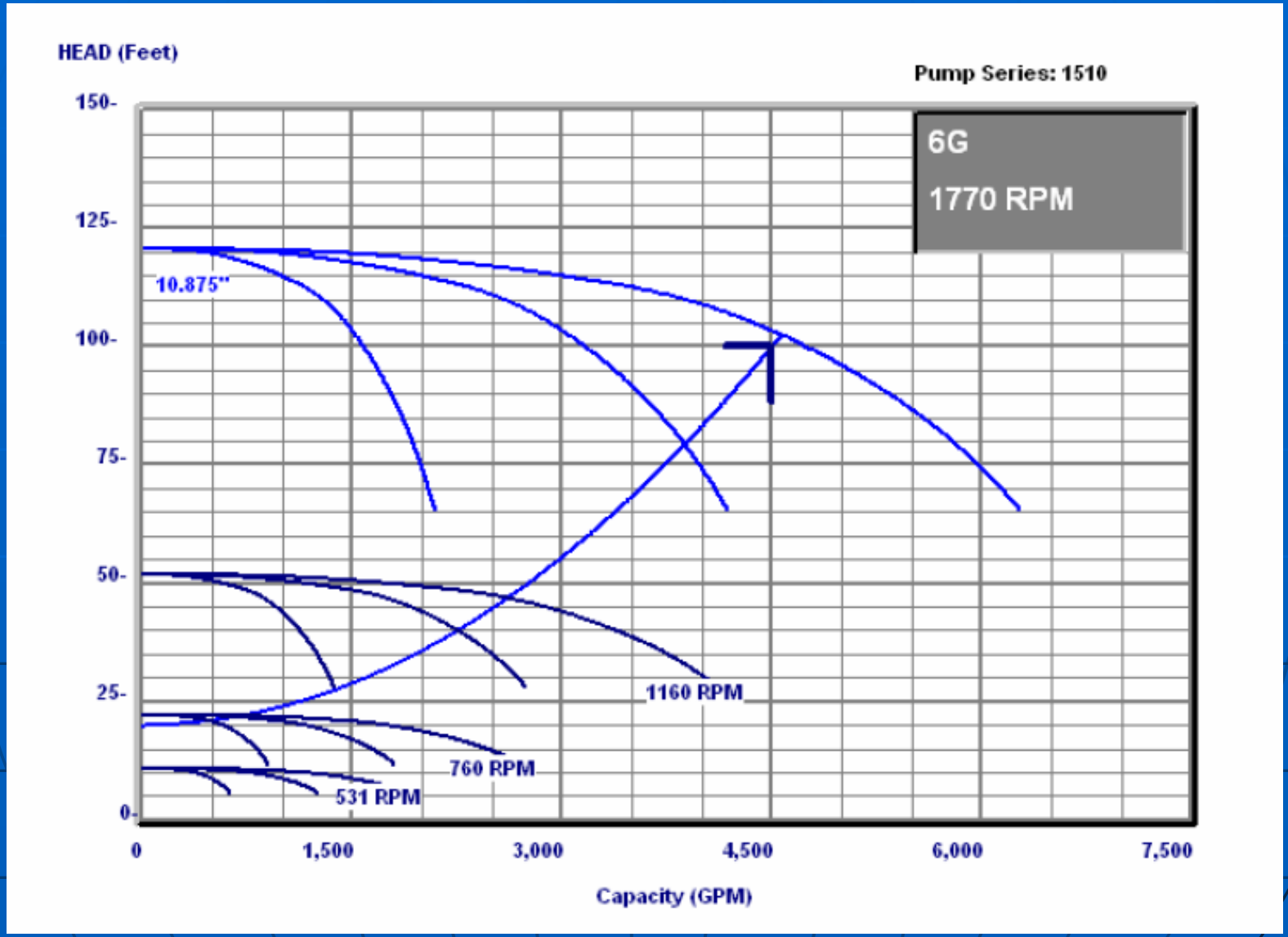
Parallel Pump Operation



Single Pump End of Curve



Pump Staging



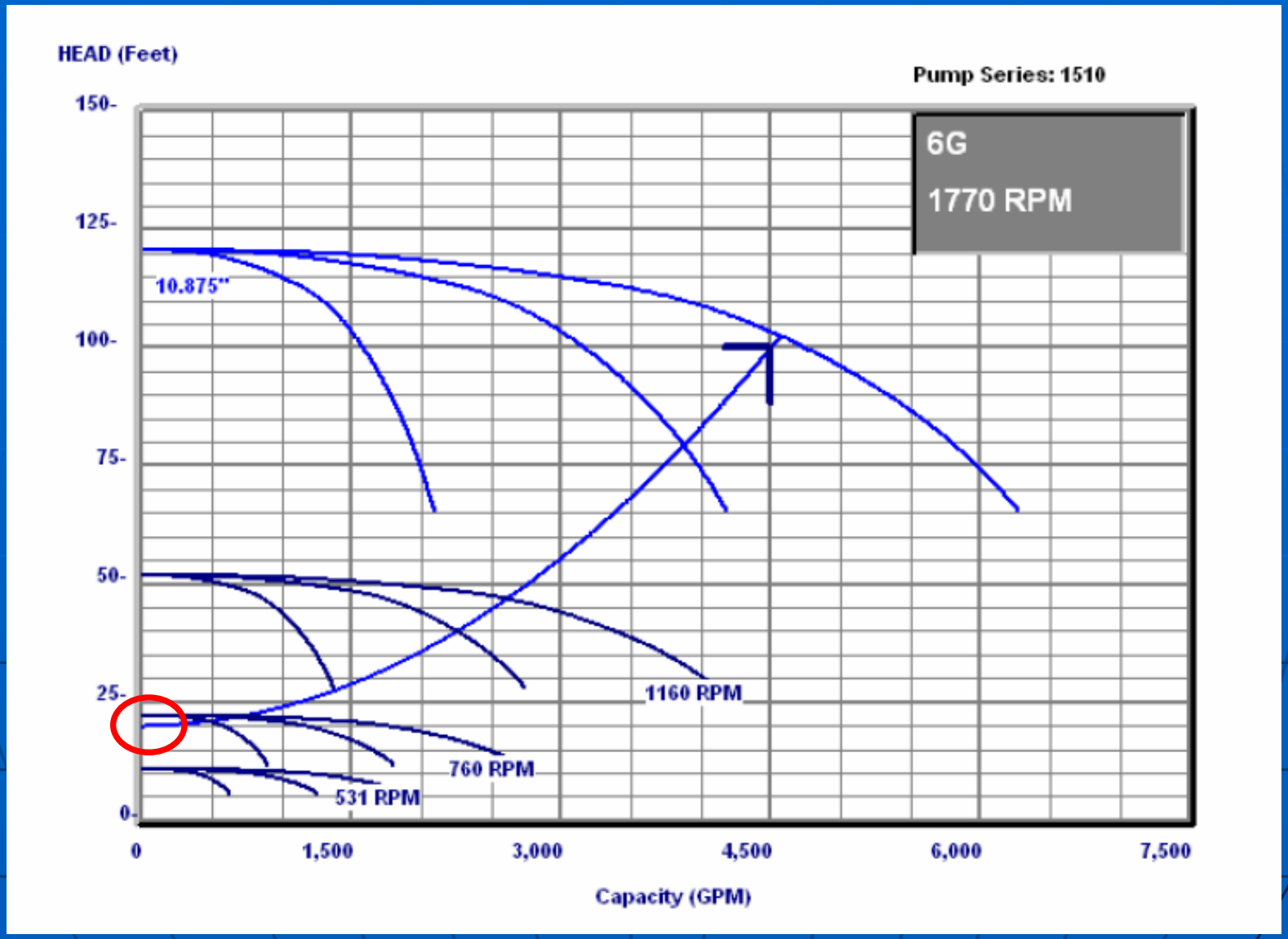
Best Efficiency Pump Staging

Load	Hours	Flow GPM	Head Feet	RPM	Pump Eff.	BHP	Drive/ Motor Eff.	kWHR	Cost/day	Wire/Water Eff
Single Pump Operation										
20%	1.20	900.0	23.2	895	80.92	6.52	88.82	6.57	$0.66	71.9%
Two Pumps Operating in Parallel										
30%	2.40	675.0 675.0	27.2 27.2	887 887	82.79 82.79	5.60	88.82	22.57	$2.26	73.5%
40%	2.40	900.0 900.0	32.8 32.8	1012 1012	83.40 83.40	8.94	88.76	36.05	$3.60	74.0%
50%	4.80	1,125.0 1,125.0	40.0 40.0	1156 1156	81.95 81.95	13.87	88.46	112.24	$11.22	72.5%
Three Pumps Operating in Parallel										
60%	2.40	900.0 900.0 900.0	48.8 48.8 48.8	1187 1187 1187	82.74 82.74 82.74	13.41	88.38	81.46	$8.15	73.1%
70%	4.80	1,050.0 1,050.0 1,050.0	59.2 59.2 59.2	1320 1320 1320	83.29 83.29 83.29	18.85	88.04	229.92	$22.99	73.3%
80%	2.40	1,200.0 1,200.0 1,200.0	71.2 71.2 71.2	1459 1459 1459	83.51 83.51 83.51	25.84	87.69	158.24	$15.82	73.2%
90%	2.40	1,350.0 1,350.0 1,350.0	84.8 84.8 84.8	1602 1602 1602	83.58 83.58 83.58	34.60	87.32	212.75	$21.27	73.0%
100%	1.20	1,500.0 1,500.0 1,500.0	100.0 100.0 100.0	1748 1748 1748	83.57 83.57 83.57	45.34	86.95	139.99	$14.00	72.7%

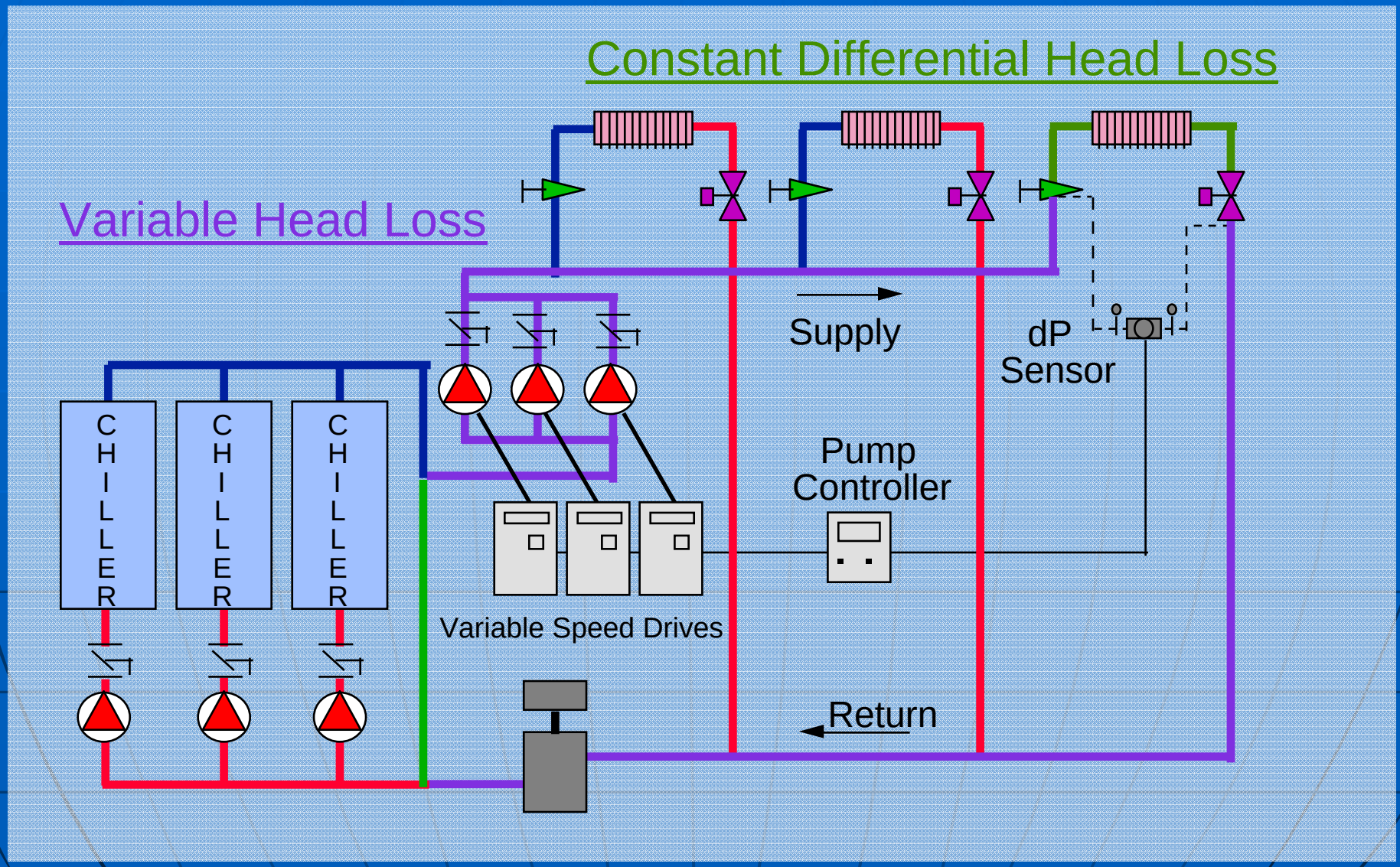
End of Curve Pump Staging

Load	Hours	Flow GPM	Head Feet	RPM	Pump Eff.	BHP	Drive/ Motor Eff.	kWHR	Cost/day	Wire/Water Eff
20%	1.20	900.0	23.2	895	79.47	6.64	88.82	6.69	$0.67	70.6%
30%	2.40	1,350.0	27.2	1136	66.50	13.94	88.51	28.20	$2.82	58.9%
Two Pumps Operating in Parallel										
40%	2.40	900.0 900.0	32.8 32.8	1012 1012	82.07 82.07	9.08	88.76	36.64	$3.66	72.8%
50%	4.80	1,125.0 1,125.0	40.0 40.0	1156 1156	81.29 81.29	13.98	88.46	113.15	$11.31	71.9%
60%	2.40	1,350.0 1,350.0	48.8 48.8	1314 1314	79.46 79.46	20.94	88.06	85.12	$8.51	70.0%
70%	4.80	1,575.0 1,575.0	59.2 59.2	1481 1481	78.28 78.28	30.09	87.63	245.80	$24.58	68.6%
80%	2.40	1,800.0 1,800.0	71.2 71.2	1655 1655	76.72 76.72	42.20	87.19	173.23	$17.32	66.9%
Three Pumps Operating in Parallel										
90%	2.40	1,350.0 1,350.0 1,350.0	84.8 84.8 84.8	1602 1602 1602	83.58 83.58 83.58	34.60	87.32	212.75	$21.27	73.0%
100%	1.20	1,500.0 1,500.0 1,500.0	100.0 100.0 100.0	1748 1748 1748	83.57 83.57 83.57	45.34	86.95	139.99	$14.00	72.7%

Minimum Control Head



dP Sensor Set Point



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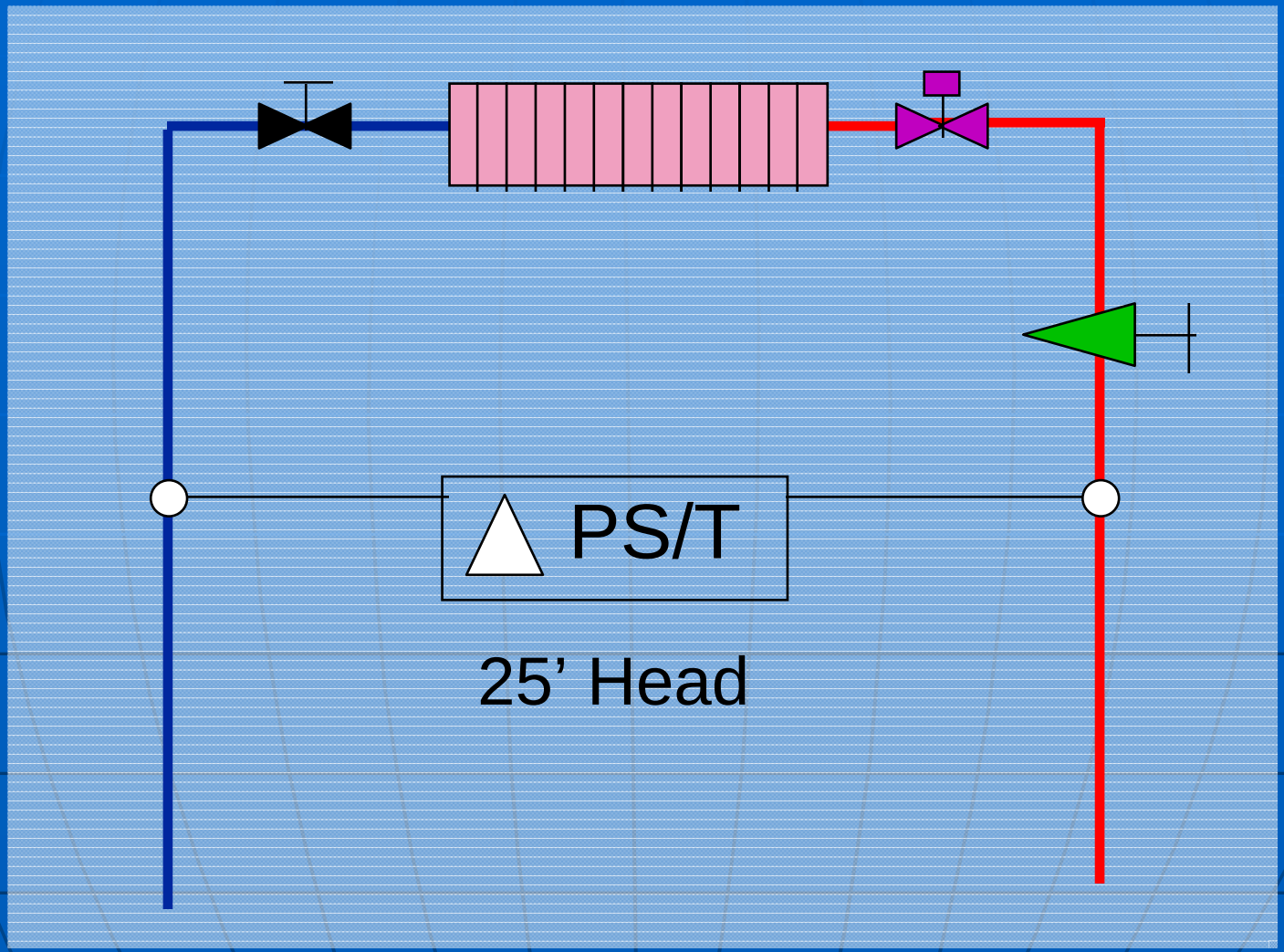
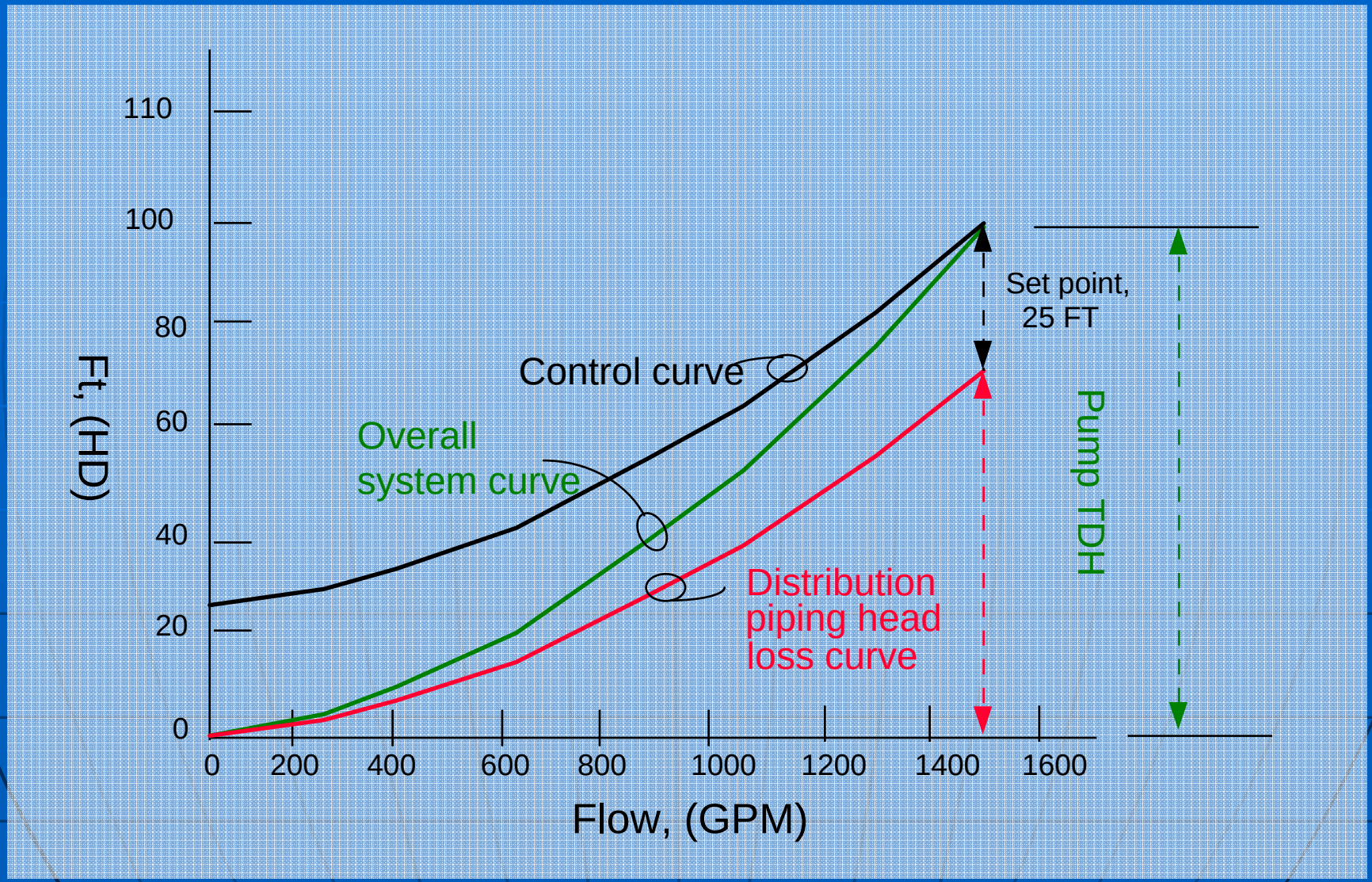
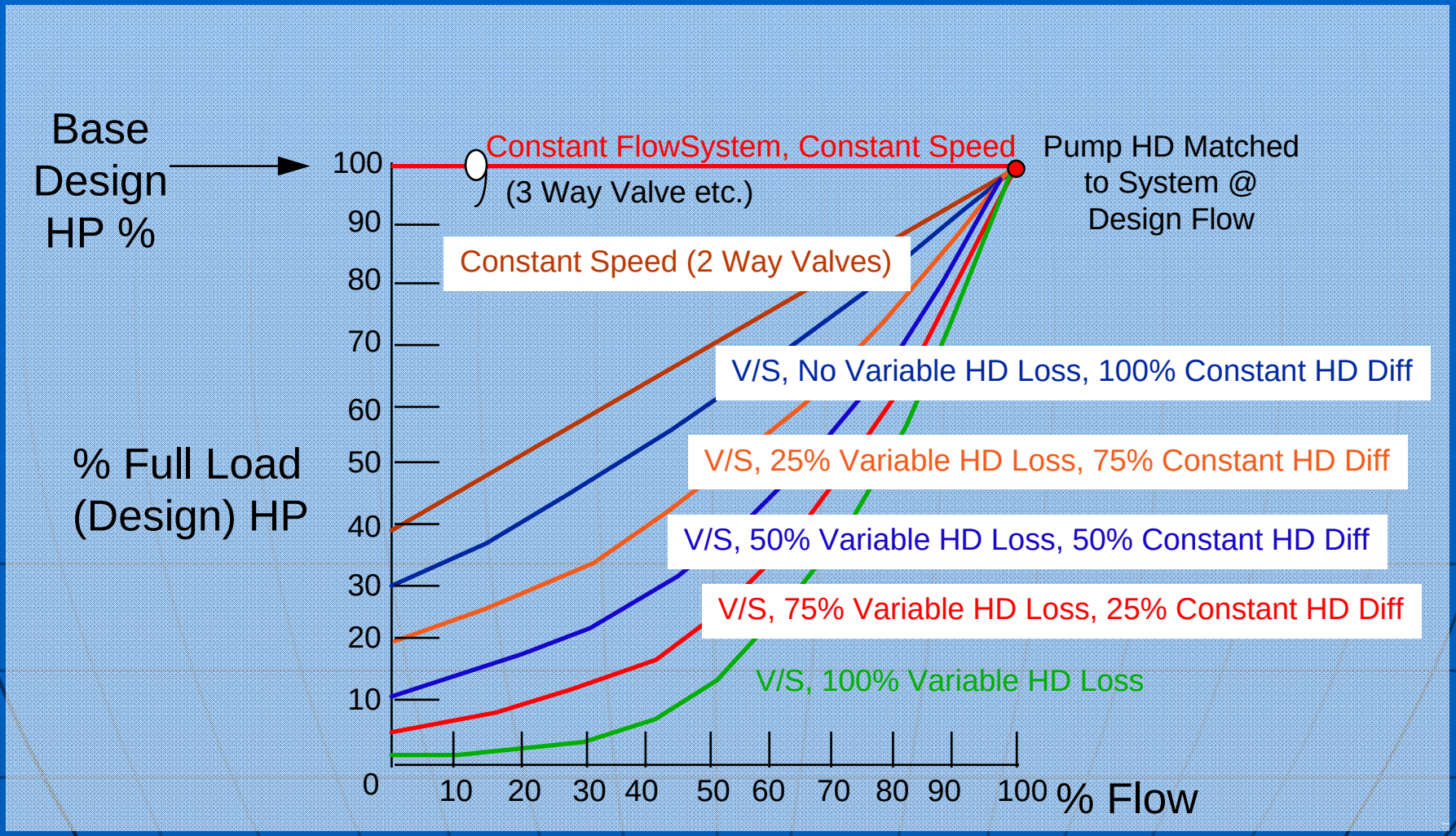


Minimum Control Head



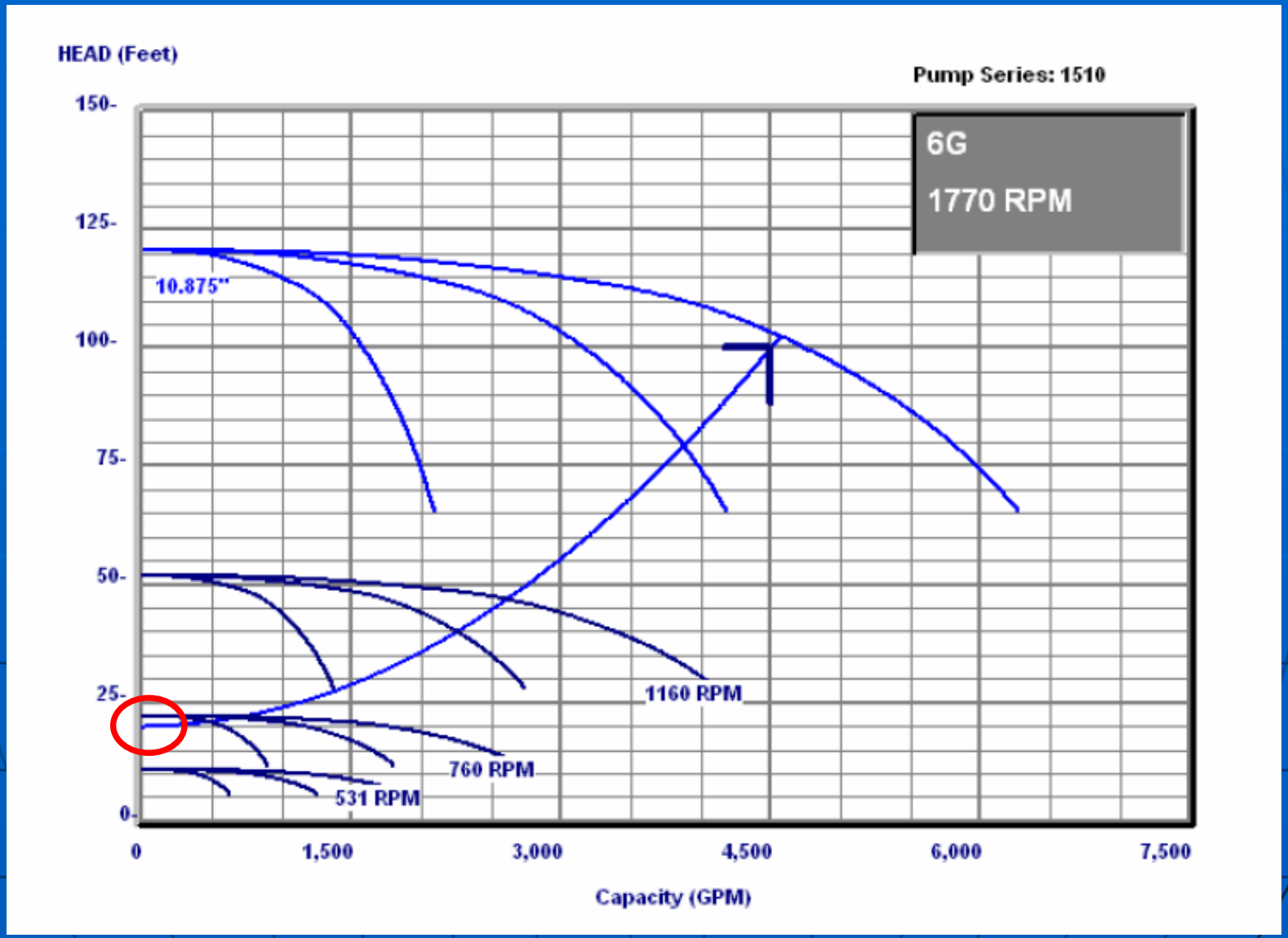
Effect of Variable Head Ratio



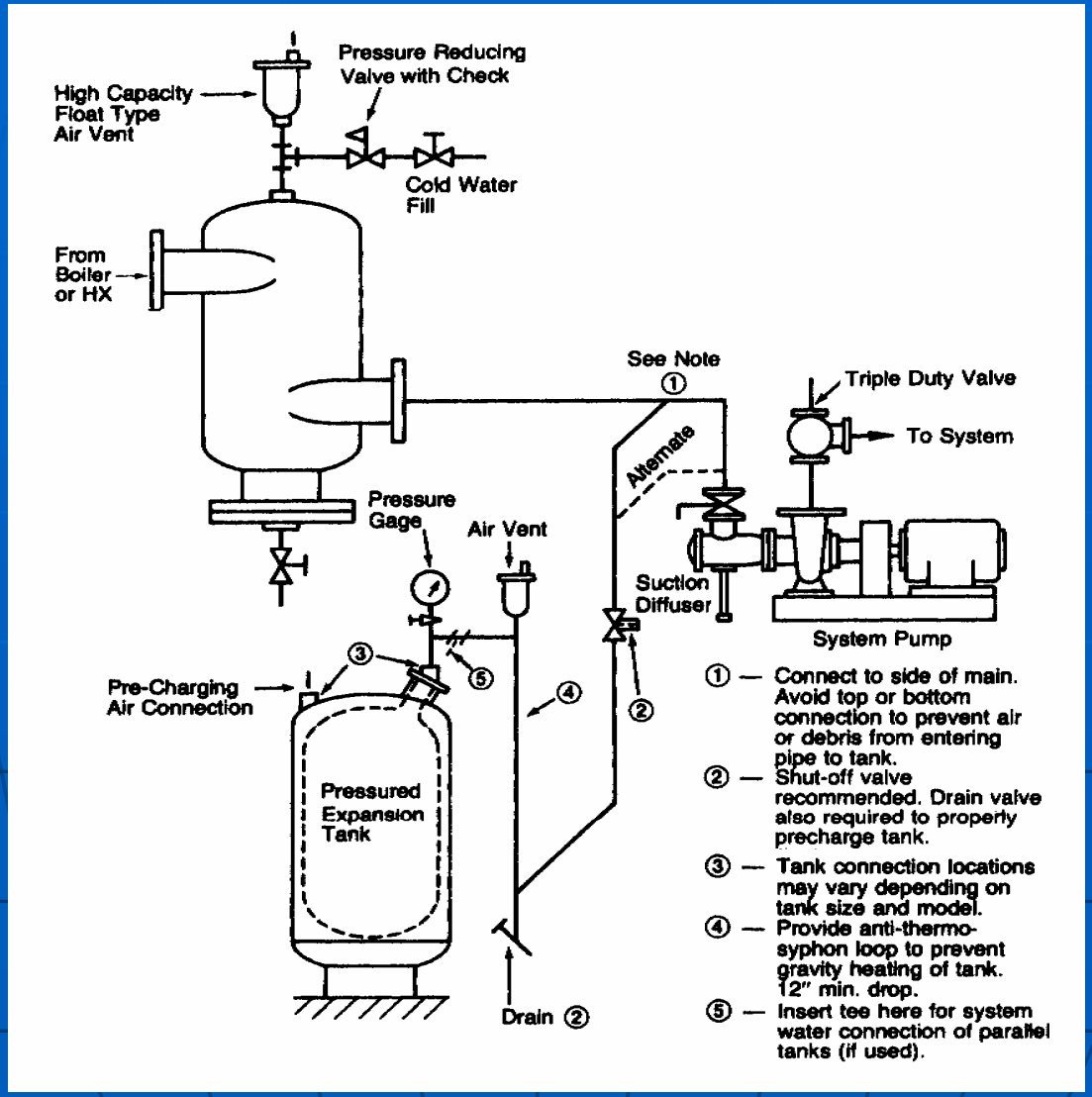
Minimum Pump Speed/Flow?

- Rule of thumb is 30% speed or 18Hz
- What are the pump's limitations? Flushed seal?
- What are the motor limitations? 10:1 variable torque turndown?
- What will the minimum control head allow?
- Keep the operating point away from the flat portion of the curve

Minimum Pump Speed/Flow?



Bladder Tank Piping (Air Elimination)



Questions?