

# Large Chilled Water System

## Design Seminar

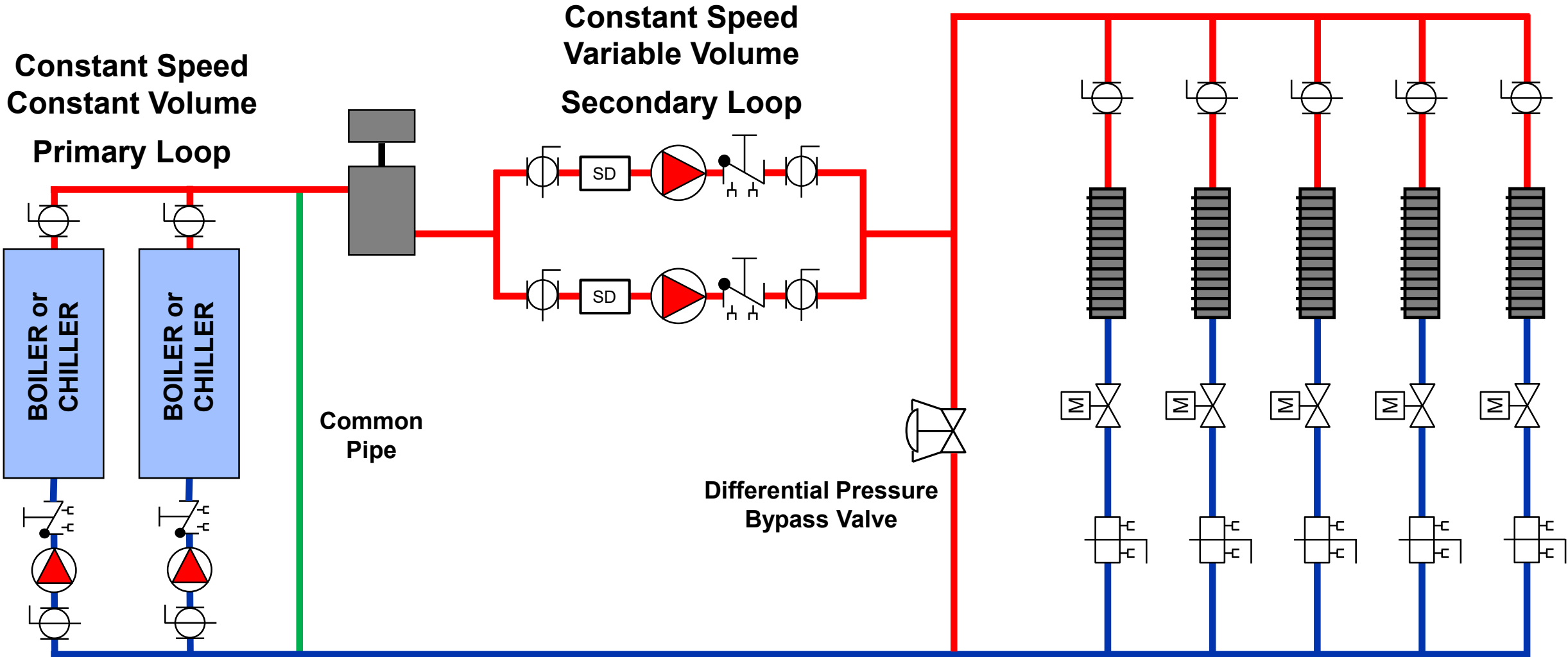
Courtesy of Oslin Nation Company

Parallel & Series Pumping

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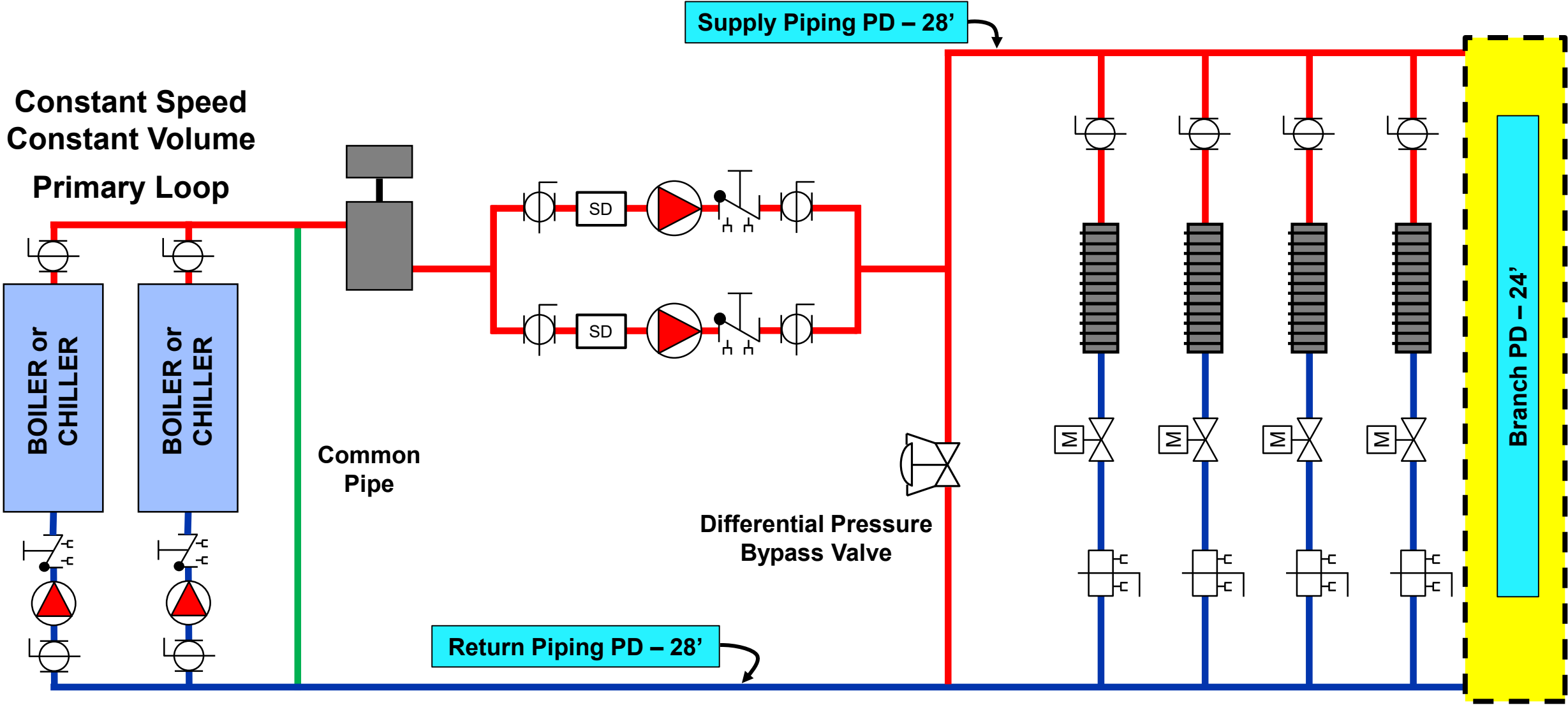
## Quick Review: Single Pump delivering 100% Duty Point

# Constant Speed, Variable Volume Secondary Pumping



# Constant Speed, Variable Volume Secondary Pumping

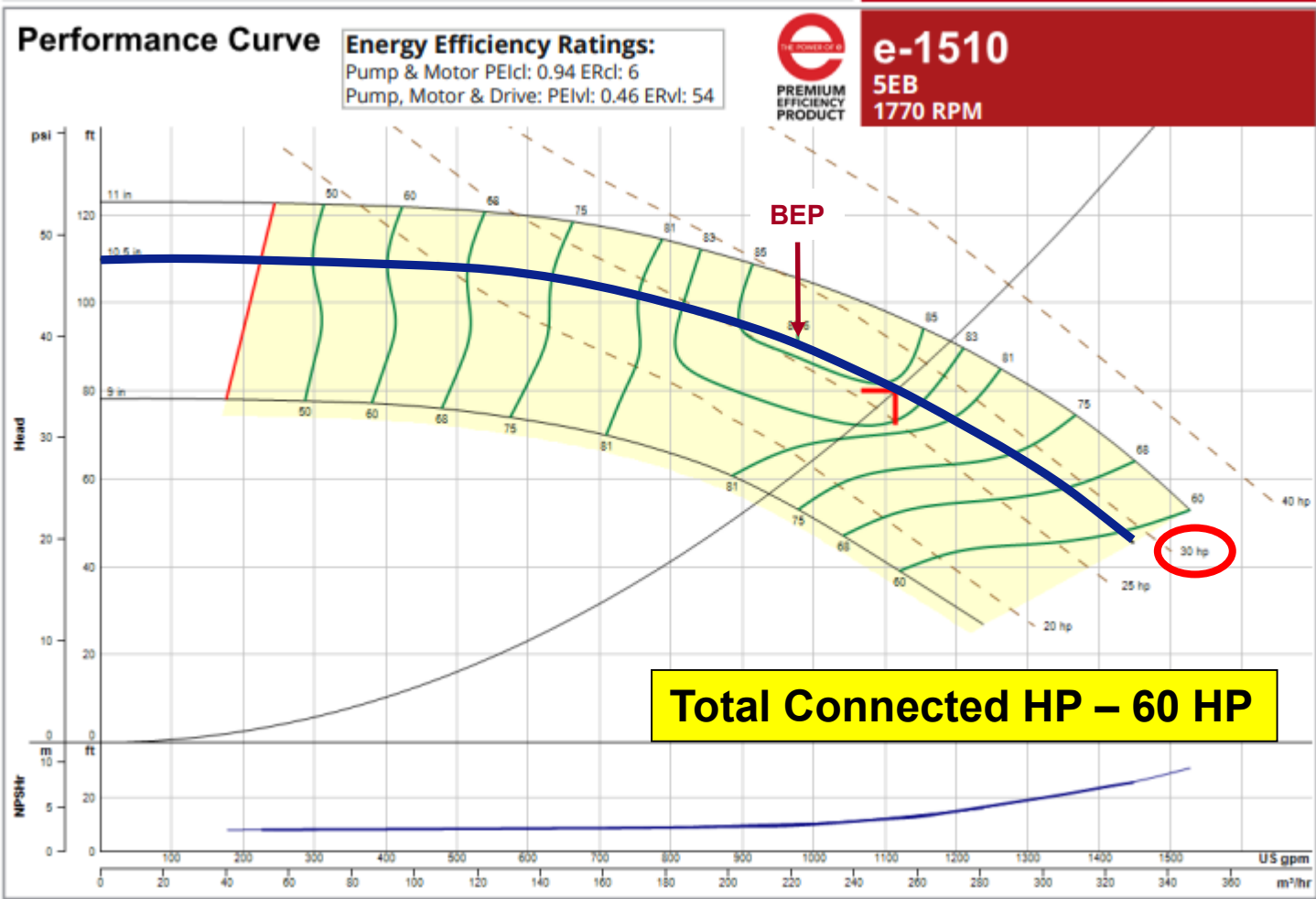
Constant Speed  
Constant Volume  
Primary Loop



Secondary Loop Design Conditions – 1115 GPM @ 80'

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# Pump Selection – 100% Duty - 100% Standby



Pump Selection Summary	
Duty Point Flow	1115 US gpm
Duty Point Head	80 ft
Control Head	110 ft
Duty Point Pump Efficiency	84.3 %
Part Load Efficiency Value (PLEV)	0.0 %
Impeller Diameter	10.5 in
Motor Power	30 hp
Duty Point Power	26.8 bhp
Motor Speed	1770 rpm
RPM @ Duty Point	1770 rpm
NPSHr	12.3 ft
Minimum Shutoff Head	110 ft
Minimum Flow at RPM	225 US gpm
Flow @ BEP	978 US gpm
Fluid Temperature	68 °F
Fluid Type	Water
Weight (approx. - consult rep for exact)	811 lbs
Pump Floor Space Calculation	7.68 ft²



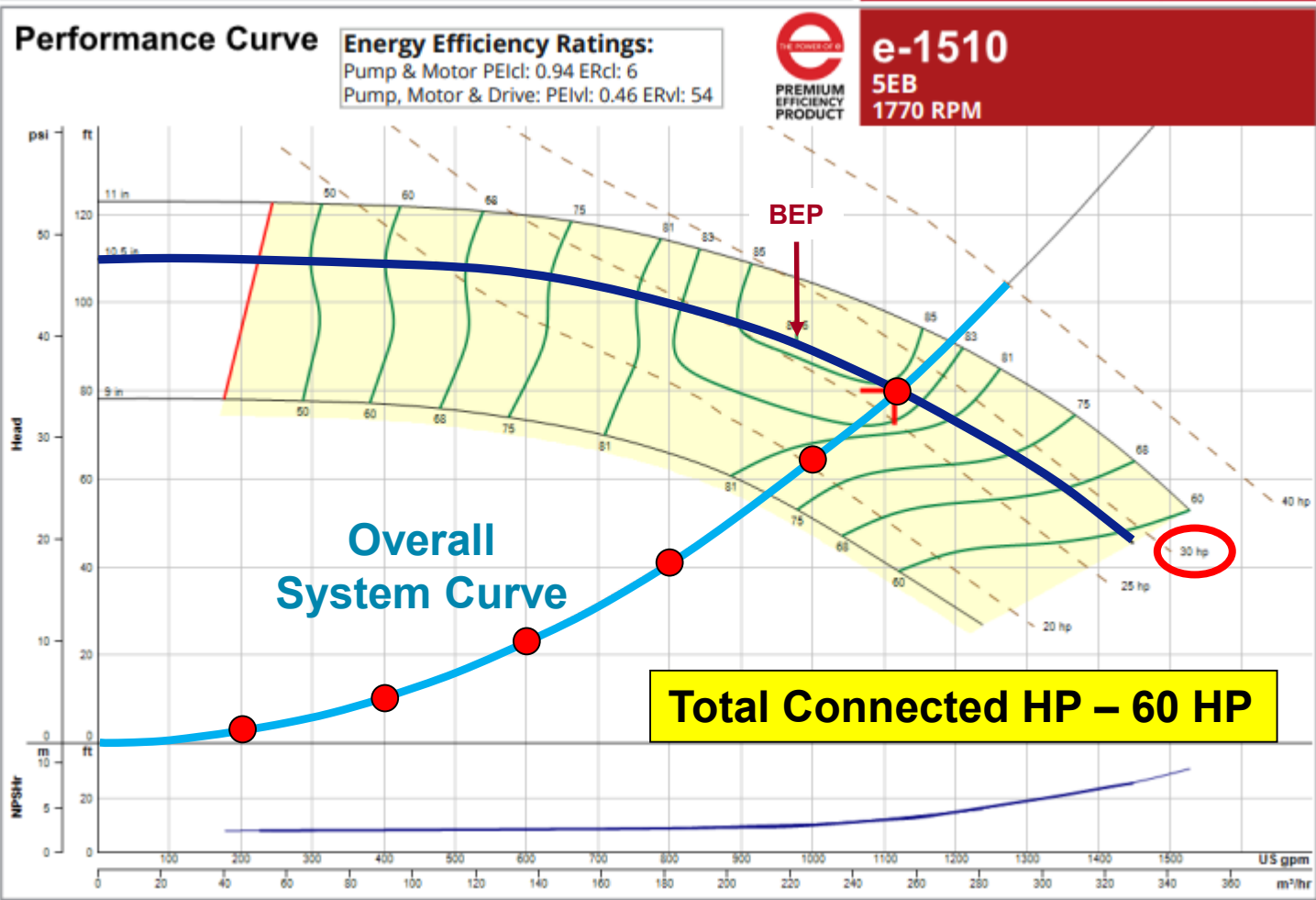
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# Pump Selection – 100% Duty - 100% Standby

The “System Curve”

$$\left(\frac{Q_2}{Q_1}\right)^2 = \left(\frac{h_2}{h_1}\right)$$

- Q<sub>1</sub> = Known Flow
- Q<sub>2</sub> = Final Flow
- h<sub>1</sub> = Known Head
- h<sub>2</sub> = Final Head

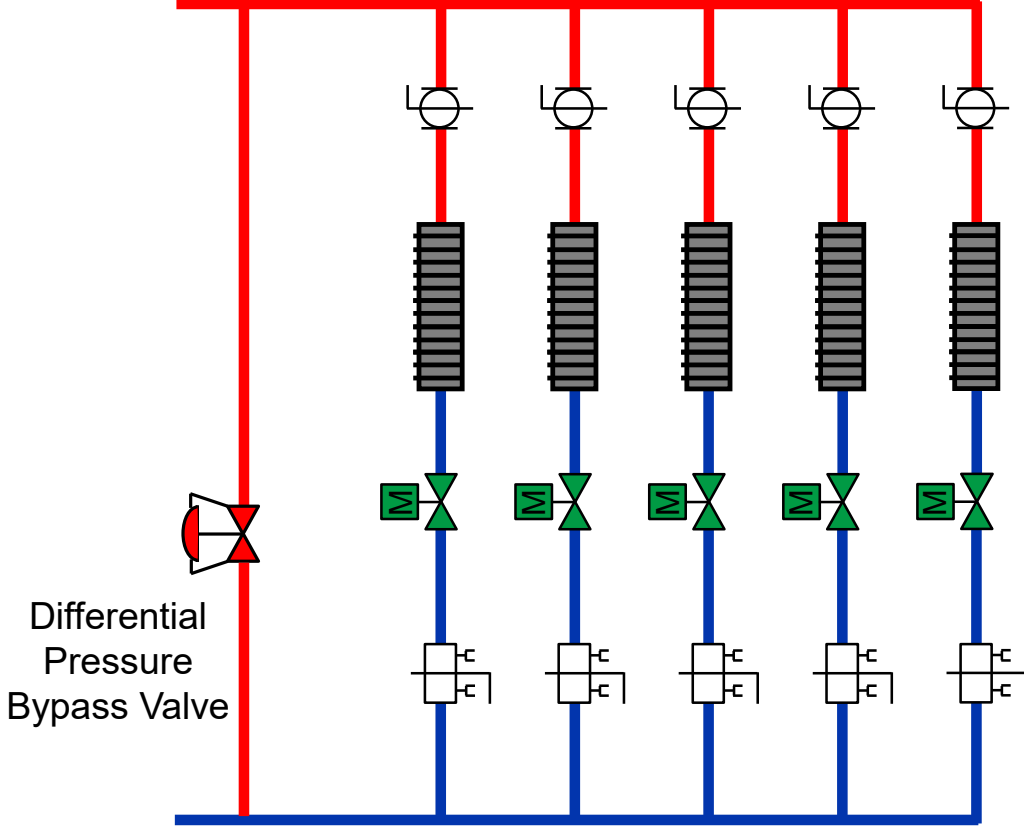
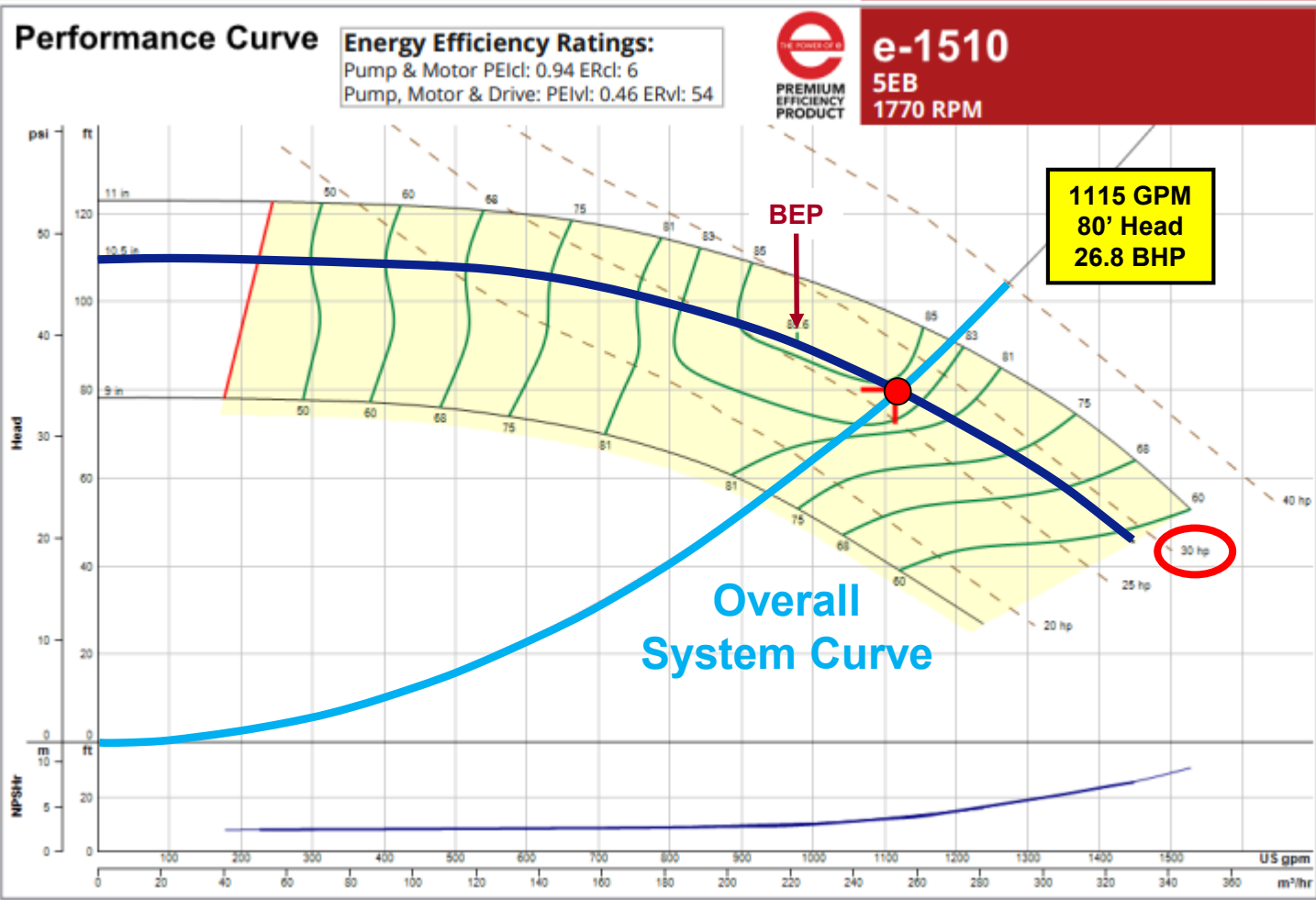


Duty Point Flow	1115 US gpm
Duty Point Head	80 ft
Control Head	110 ft
Duty Point Pump Efficiency	84.3 %
Part Load Efficiency Value (PLEV)	0.0 %
Impeller Diameter	10.5 in
Motor Power	30 hp
Duty Point Power	26.8 bhp
Motor Speed	1770 rpm
RPM @ Duty Point	1770 rpm
NPSHr	12.3 ft
Minimum Shutoff Head	110 ft
Minimum Flow at RPM	225 US gpm
Flow @ BEP	978 US gpm
Fluid Temperature	68 °F
Fluid Type	Water
Weight (approx. - consult rep for exact)	811 lbs
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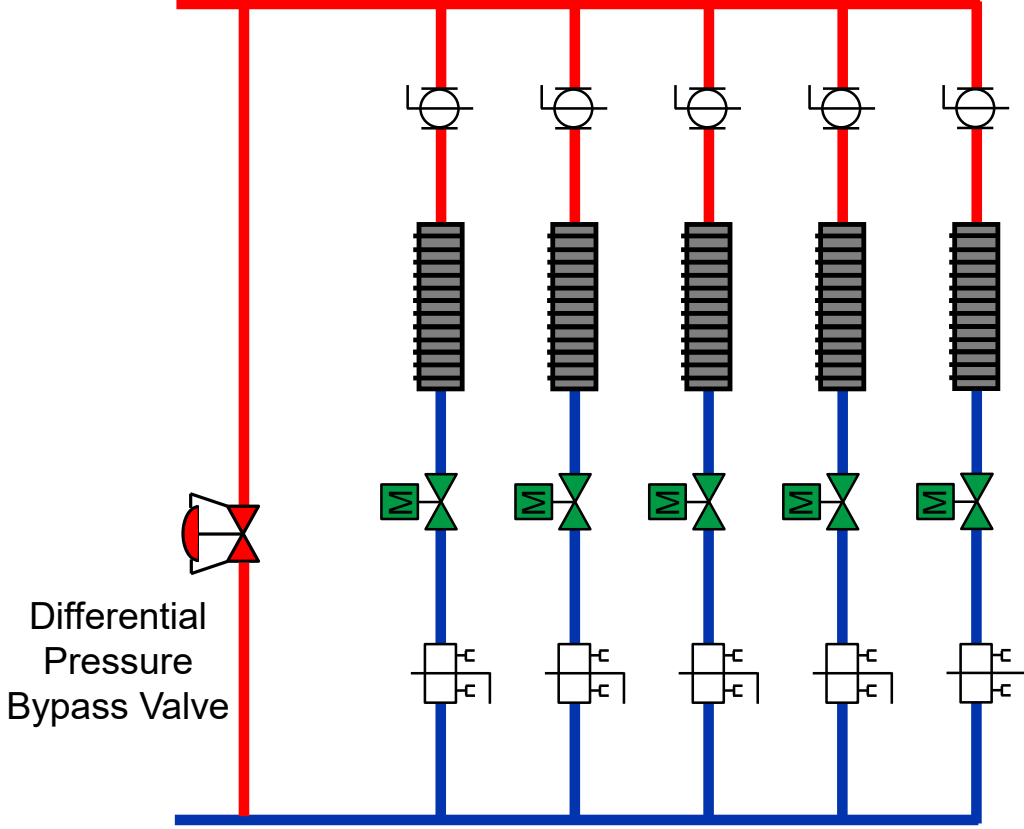
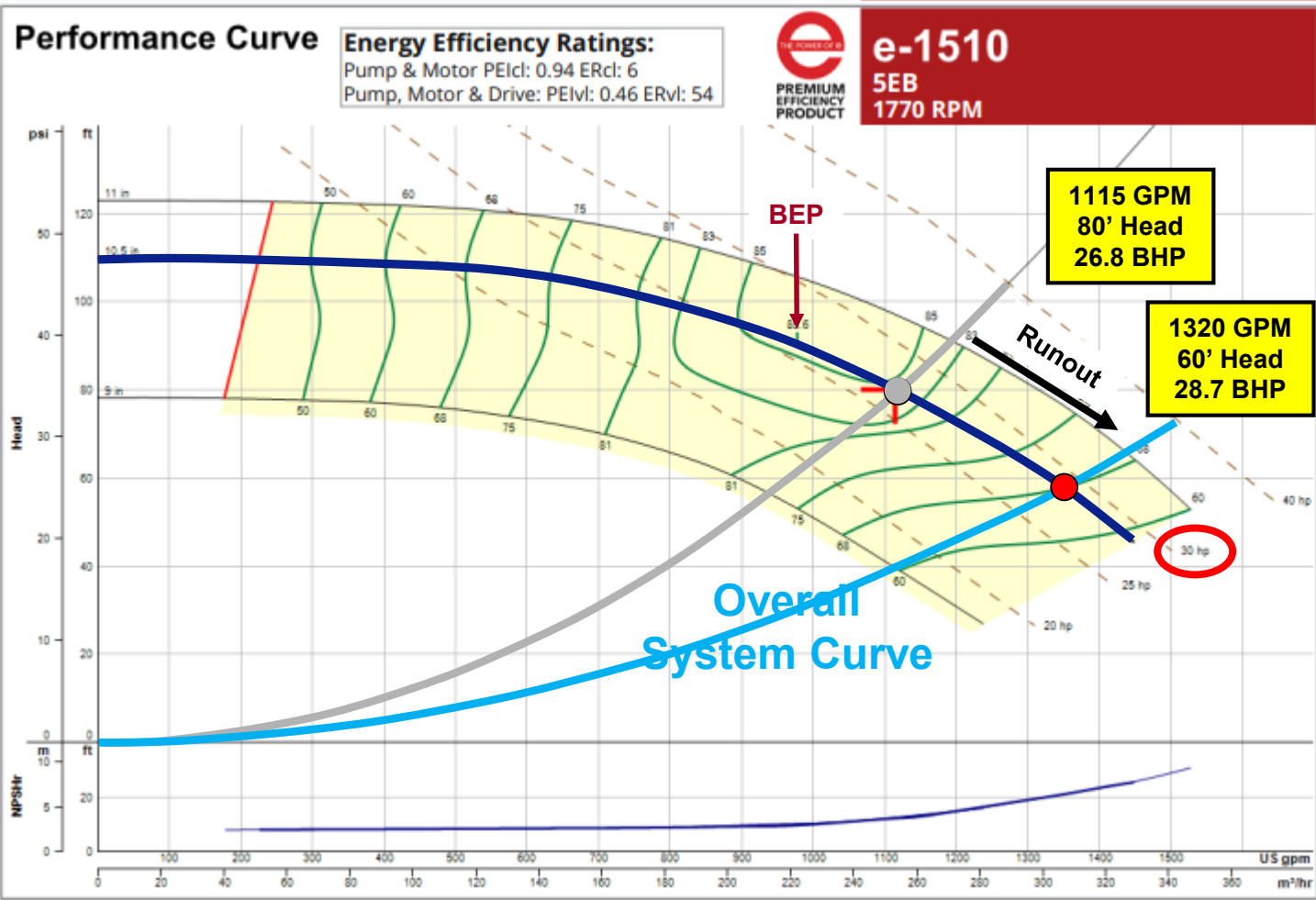
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# What influence will a Control Valve have on the System Curve?



Performance curve meets 1A.6 / ISO 9906 acceptance criteria

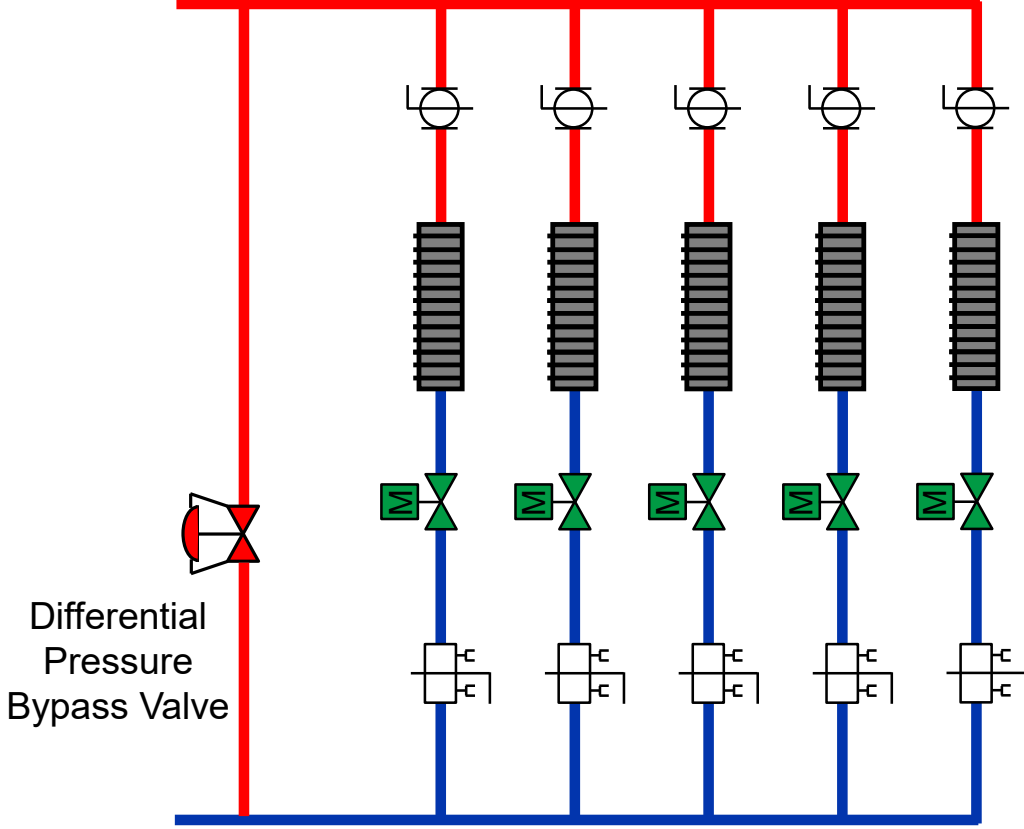
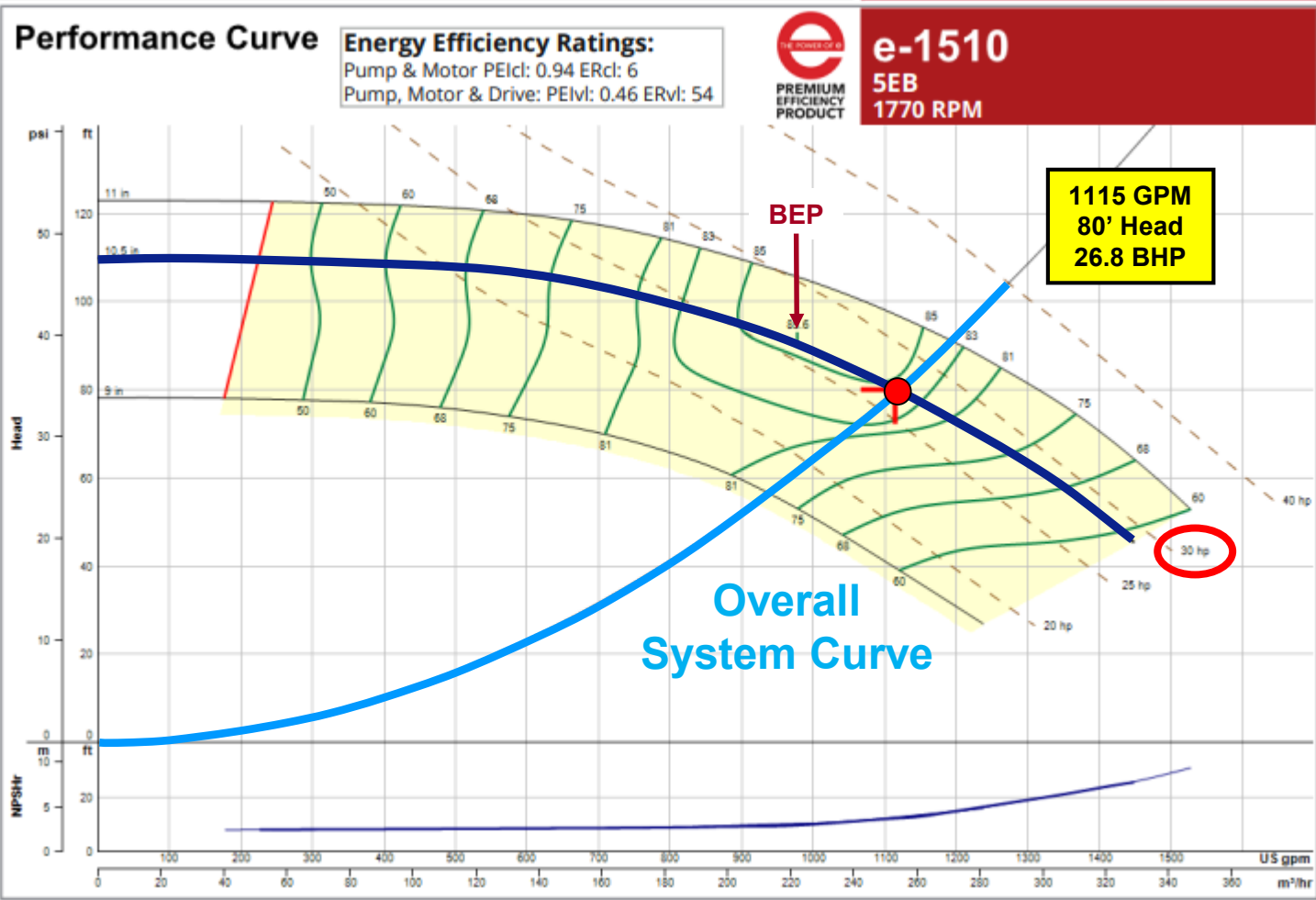
# What influence will a Control Valve have on the System Curve?



Performance curve meets 1A.6 / ISO 9906 acceptance criteria  
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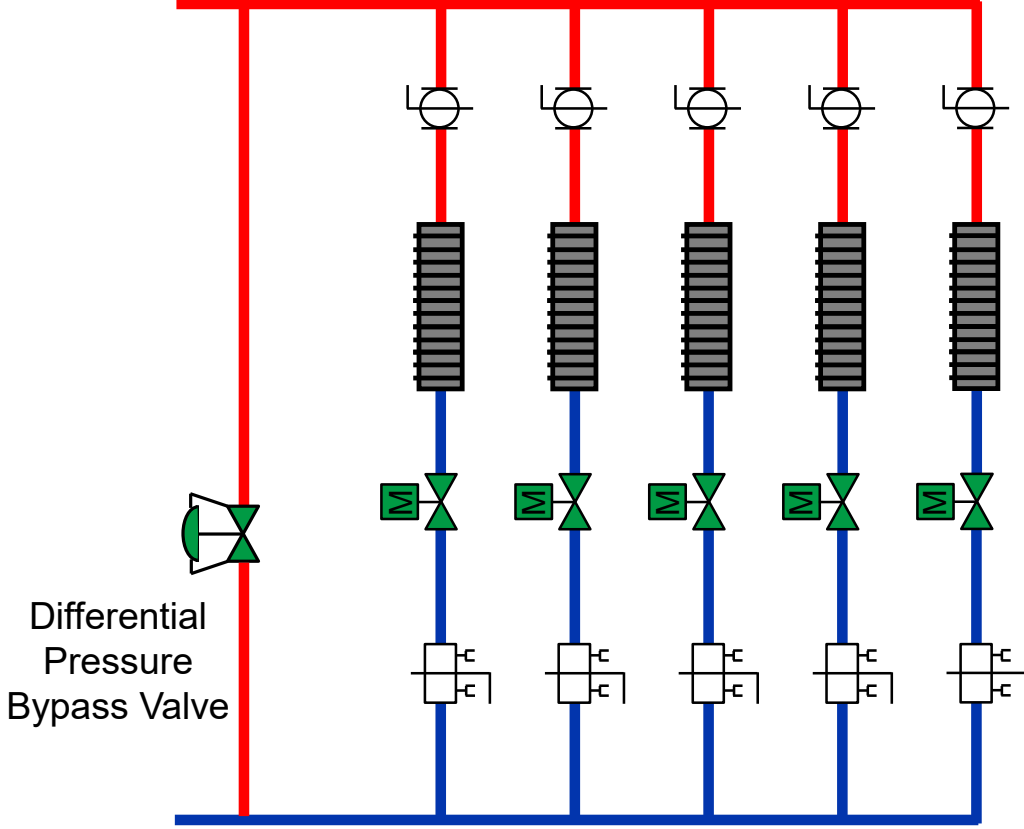
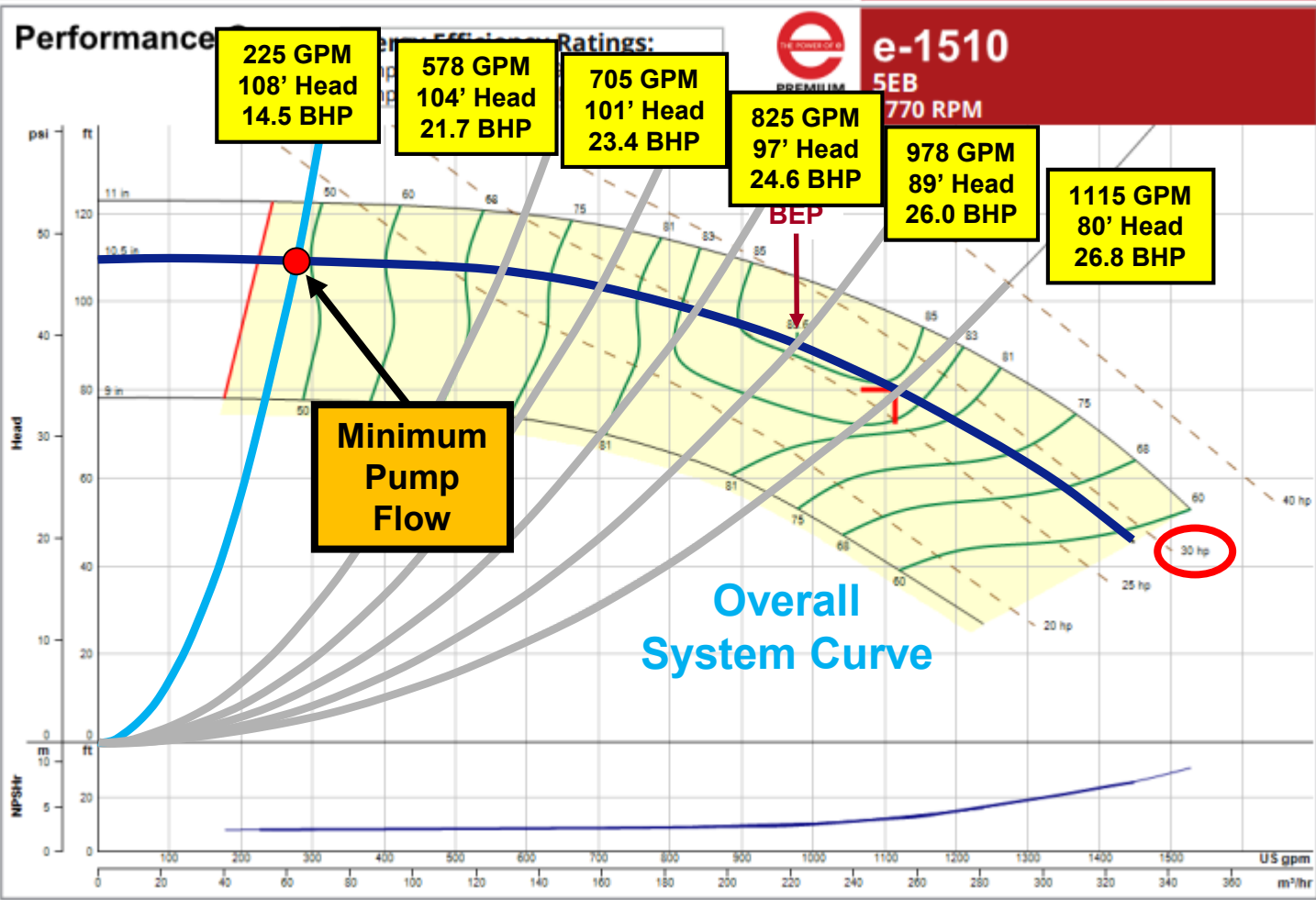


# What influence will a Control Valve have on the System Curve?



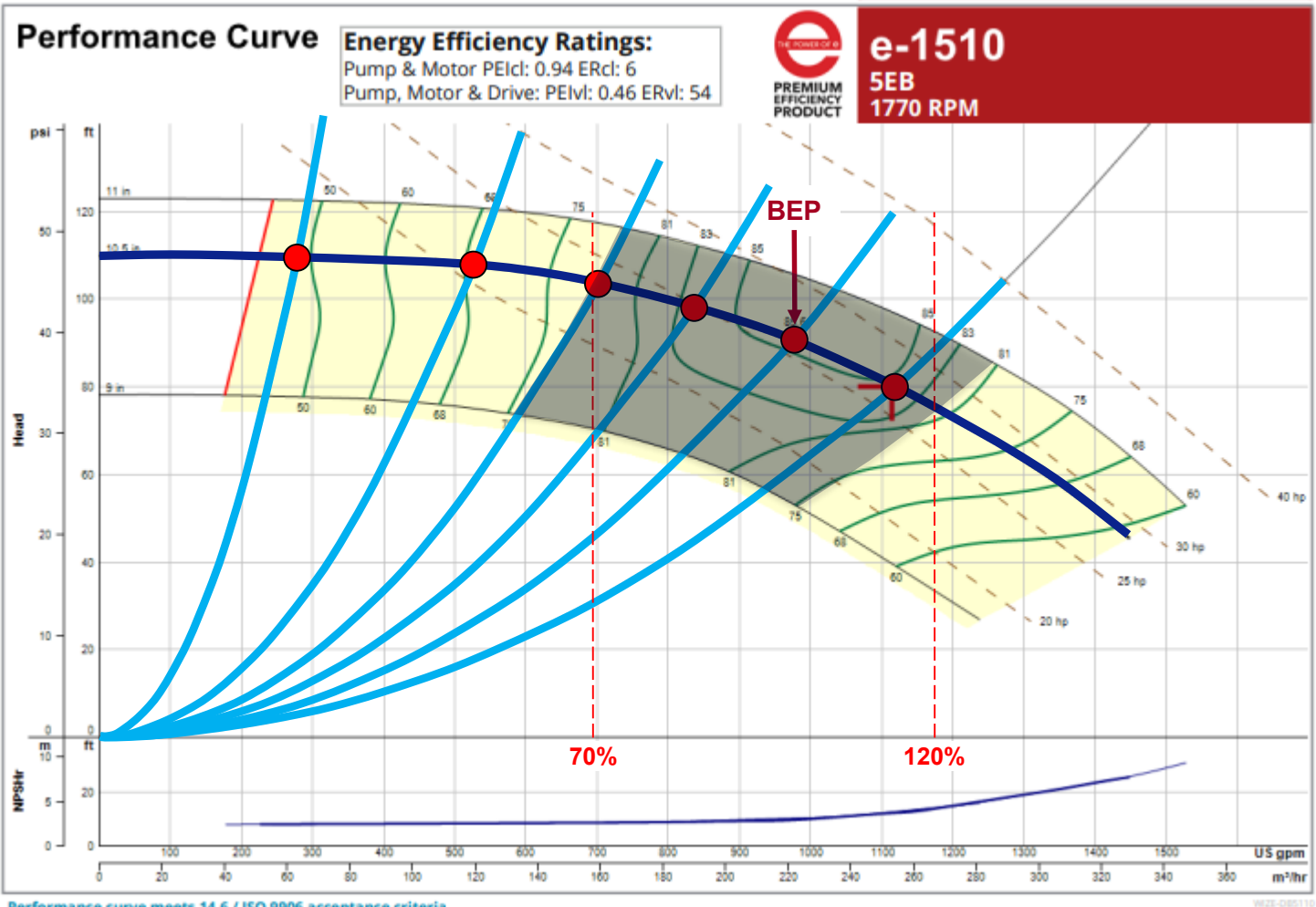
Performance curve meets 14.6 / ISO 9906 acceptance criteria  
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# What influence will a Control Valve have on the System Curve?



Performance curve meets 1A.6 / ISO 9906 acceptance criteria  
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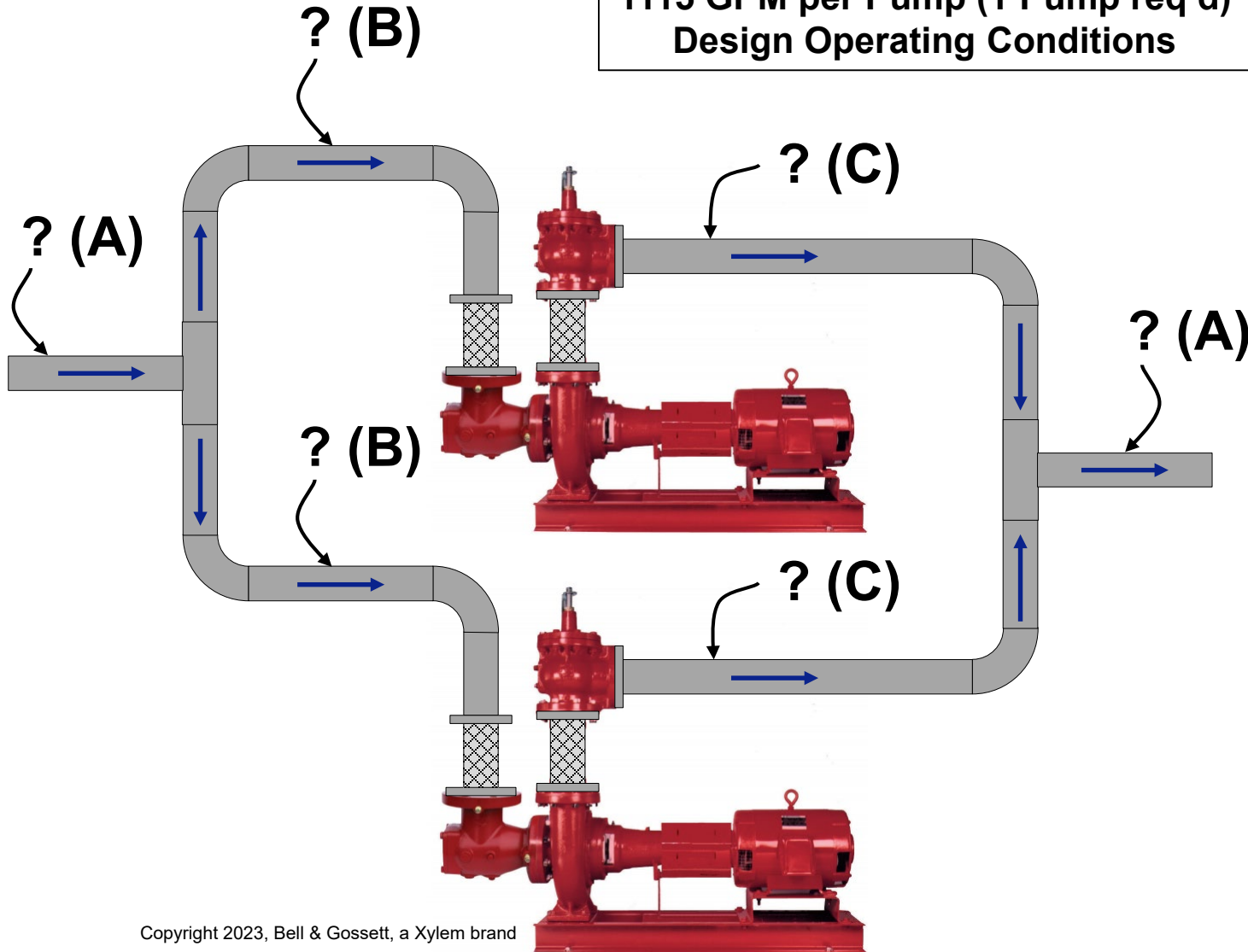
# The “Preferred” and “Acceptable” Operating Regions



# Pipe Size Selection for 100% Duty/100% Standby

**in Parallel**

1115 GPM per Pump (1 Pump req'd)  
Design Operating Conditions



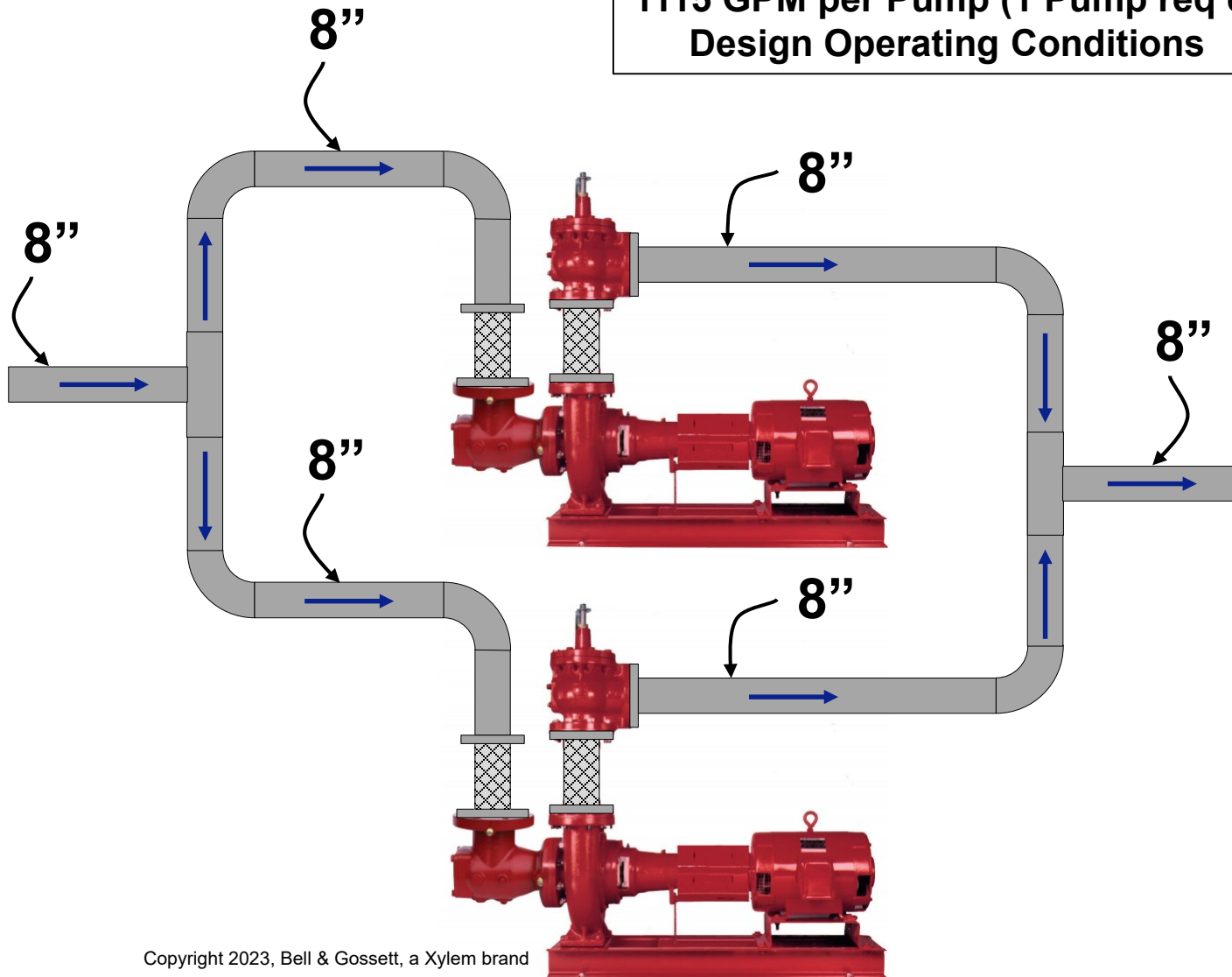
Flow/Pressure Drop Relationship		ASHRAE Information	
Pipe Size: 8 in	Pipe Material: Steel Pipe	>4400	Operation Range Hours/Year
Flow Rate: 1115.00 GPM	Friction Loss: 1.91 Feet/100 Feet	<input checked="" type="radio"/> Variable Flow Operation	
	Velocity: 7.16 Feet/Sec	<input type="radio"/> Other Operation	
	Steel Pipe thru 24" is Schedule 40	ASHRAE 90.1-2010 Max Rate for Pipe Size Selected	
	Steel Pipe 30 - 36" is Schedule 30	1100 GPM	
Annual Energy Cost		Pipe Length (T.E.L.)	
Cost/Kw Hour: 0.10		\$/KwHr	500.00 Feet
1115 GPM	393,480 Reynolds Number	Est. Pump/Driver Eff: 80 %	
149.08 Cubic Feet/Min	0.000226 Relative Roughness $\epsilon/D$	Hours of Operation/Year: 8760	
253.11 Cubic Meters/Hr	Transition Flow	Annual Energy Cost*: \$2,197	
70.25 Liters/Sec	0.0160 Friction Factor	*Pump/Driver cost at 100% load	
4,220.28 Liters/Min	7.16 Feet/Sec		
253,216.50 Liters/Hr	2.18 Meters/100 Meters		

Flow/Pressure Drop Relationship		ASHRAE Information	
Pipe Size: 10 in	Pipe Material: Steel Pipe	>4400	Operation Range Hours/Year
Flow Rate: 1115.00 GPM	Friction Loss: 0.61 Feet/100 Feet	<input checked="" type="radio"/> Variable Flow Operation	
	Velocity: 4.53 Feet/Sec	<input type="radio"/> Other Operation	
	Steel Pipe thru 24" is Schedule 40	ASHRAE 90.1-2010 Max Rate for Pipe Size Selected	
	Steel Pipe 30 - 36" is Schedule 30	1600 GPM	
Annual Energy Cost		Pipe Length (T.E.L.)	
Cost/Kw Hour: 0.10		\$/KwHr	500.00 Feet
1115 GPM	313,040 Reynolds Number	Est. Pump/Driver Eff: 80 %	
149.08 Cubic Feet/Min	0.000180 Relative Roughness $\epsilon/D$	Hours of Operation/Year: 8760	
253.11 Cubic Meters/Hr	Transition Flow	Annual Energy Cost*: \$702	
70.25 Liters/Sec	0.0160 Friction Factor	*Pump/Driver cost at 100% load	
4,220.28 Liters/Min	4.53 Feet/Sec		
253,216.50 Liters/Hr	1.38 Meters/100 Meters		

# Pipe Size Selection for 100% Duty/100% Standby

**in Parallel**

**1115 GPM per Pump (1 Pump req'd)  
Design Operating Conditions**



**Flow/Pressure Drop Relationship**

Pipe Size: 8 in	Pipe Material: Steel Pipe
Flow Rate: 1115.00 GPM	Friction Loss: 1.91 Feet/100 Feet
	Velocity: 7.16 Feet/Sec
Steel Pipe thru 24" is Schedule 40 Steel Pipe 30 - 36" is Schedule 30	

ASHRAE Information

>4400 Operation Range Hours/Year

Variable Flow Operation  
 Other Operation

ASHRAE 90.1-2010 Max Rate for Pipe Size Selected: 1100 GPM

Annual Energy Cost

Cost/Kw Hour: 0.10	Pipe Length (T.E.L.): 500.00 Feet
Est. Pump/Driver Eff: 80 %	Hours of Operation/Year: 8760
Annual Energy Cost*: \$2,197	

\*Pump/Driver cost at 100% load

1115 GPM	393,480 Reynolds Number
149.08 Cubic Feet/Min	0.000226 Relative Roughness $\epsilon/D$
253.11 Cubic Meters/Hr	Transition Flow
70.25 Liters/Sec	0.0160 Friction Factor
4,220.28 Liters/Min	7.16 Feet/Sec
253,216.50 Liters/Hr	2.18 Meters/100 Meters

**Flow/Pressure Drop Relationship**

Pipe Size: 10 in	Pipe Material: Steel Pipe
Flow Rate: 1115.00 GPM	Friction Loss: 0.61 Feet/100 Feet
	Velocity: 4.53 Feet/Sec
Steel Pipe thru 24" is Schedule 40 Steel Pipe 30 - 36" is Schedule 30	

ASHRAE Information

>4400 Operation Range Hours/Year

Variable Flow Operation  
 Other Operation

ASHRAE 90.1-2010 Max Rate for Pipe Size Selected: 1600 GPM

Annual Energy Cost

Cost/Kw Hour: 0.10	Pipe Length (T.E.L.): 500.00 Feet
Est. Pump/Driver Eff: 80 %	Hours of Operation/Year: 8760
Annual Energy Cost*: \$702	

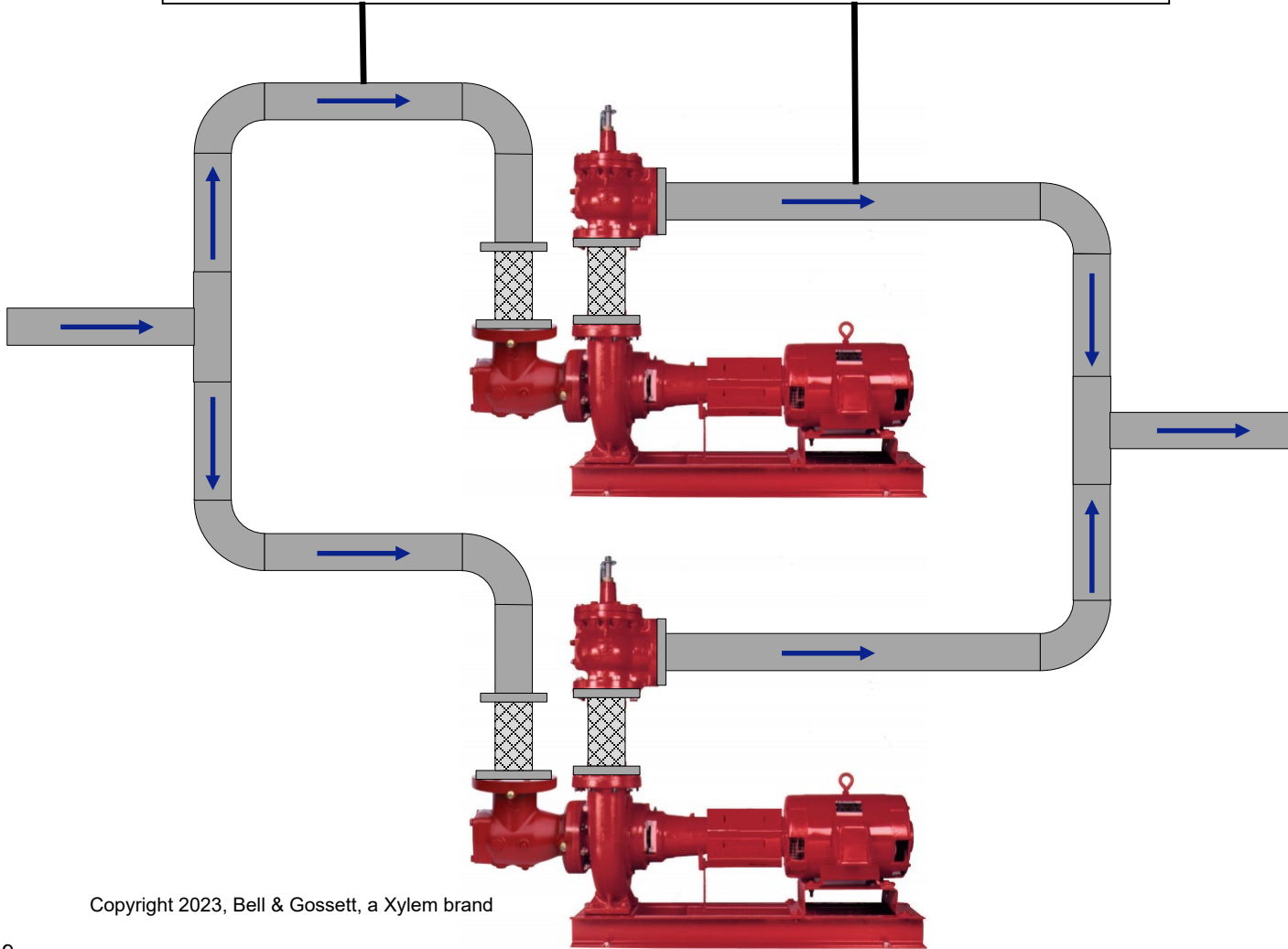
\*Pump/Driver cost at 100% load

1115 GPM	313,040 Reynolds Number
149.08 Cubic Feet/Min	0.000180 Relative Roughness $\epsilon/D$
253.11 Cubic Meters/Hr	Transition Flow
70.25 Liters/Sec	0.0160 Friction Factor
4,220.28 Liters/Min	4.53 Feet/Sec
253,216.50 Liters/Hr	1.38 Meters/100 Meters

## Parallel Pumping: Using Multiple Pumps simultaneously

# What is Parallel Pumping?

**Near pump pipe should be sized for maximum potential flowrate of single pump operation**

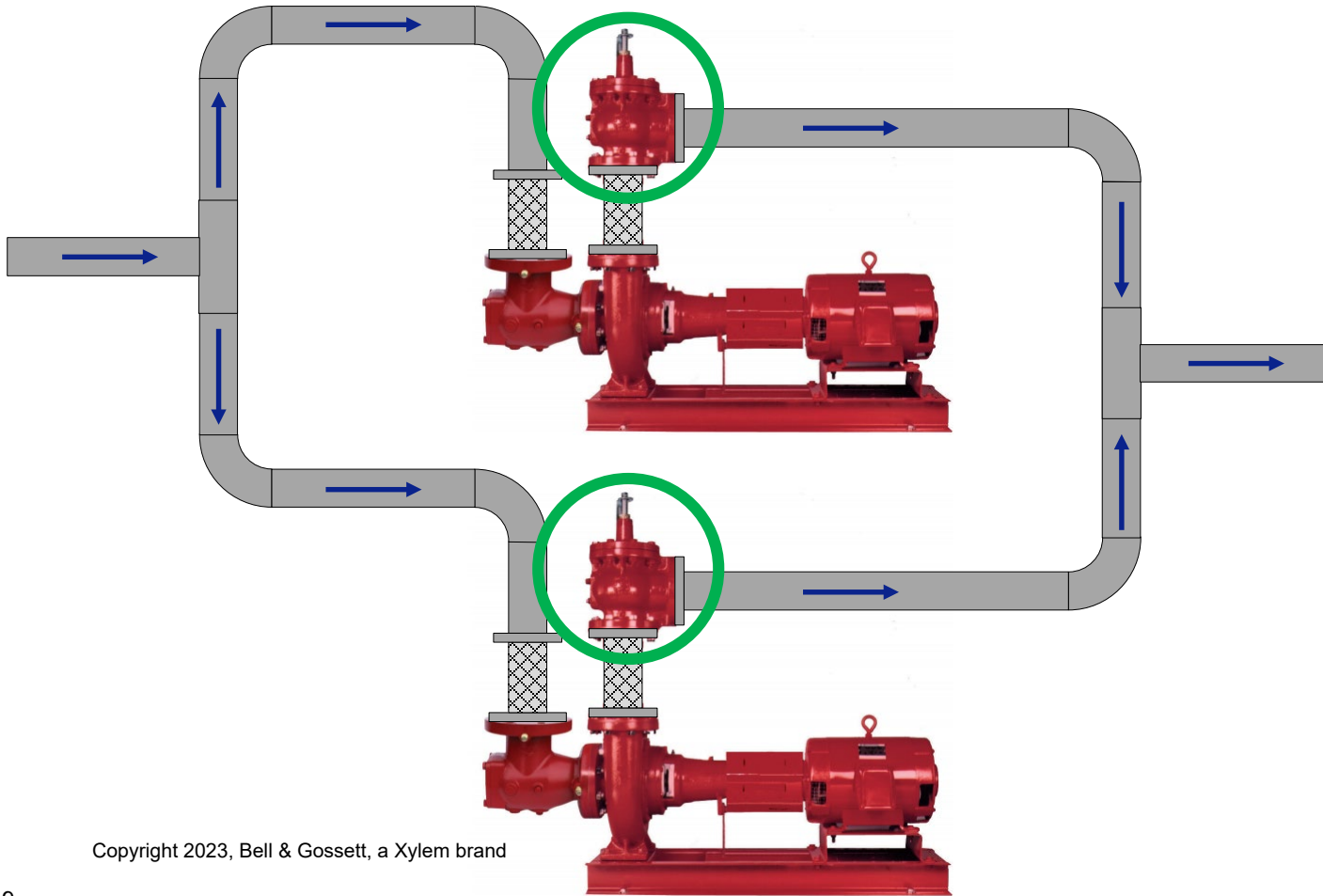


- Pumps receiving liquid from the same suction manifold and discharging into a common discharge manifold.
- Where design requires multiple pumps to run simultaneously, each pump contributes an equal percentage of the “Total” flow produced.



# What is Parallel Pumping?

**Triple Duty Valve or Check Valve on each pump to prevent reverse flow in “Off” pumps**



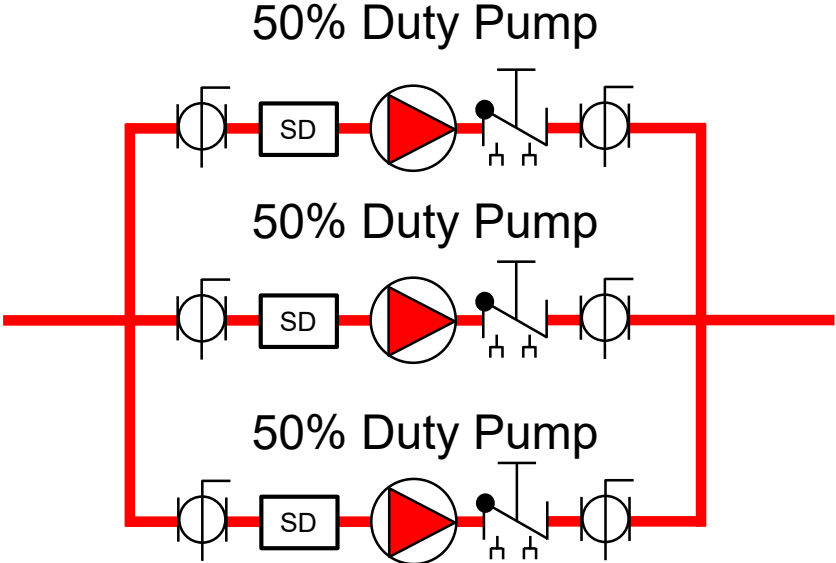
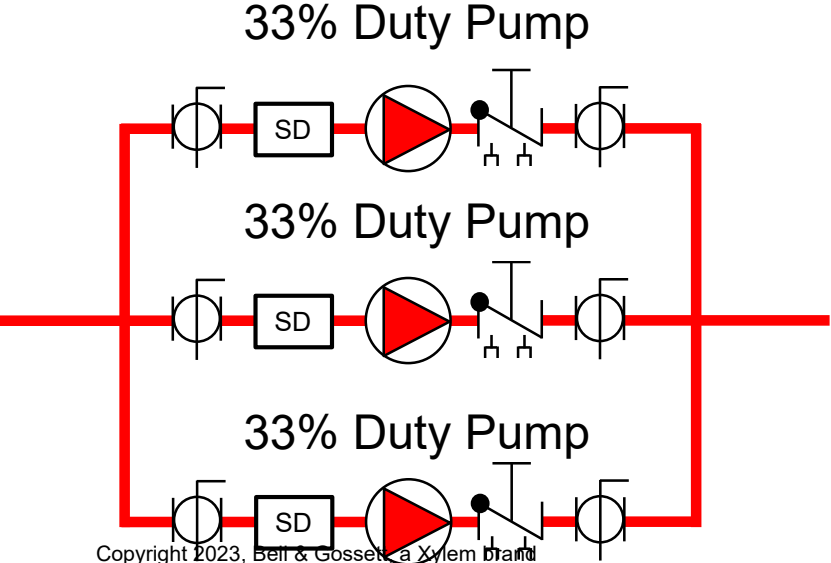
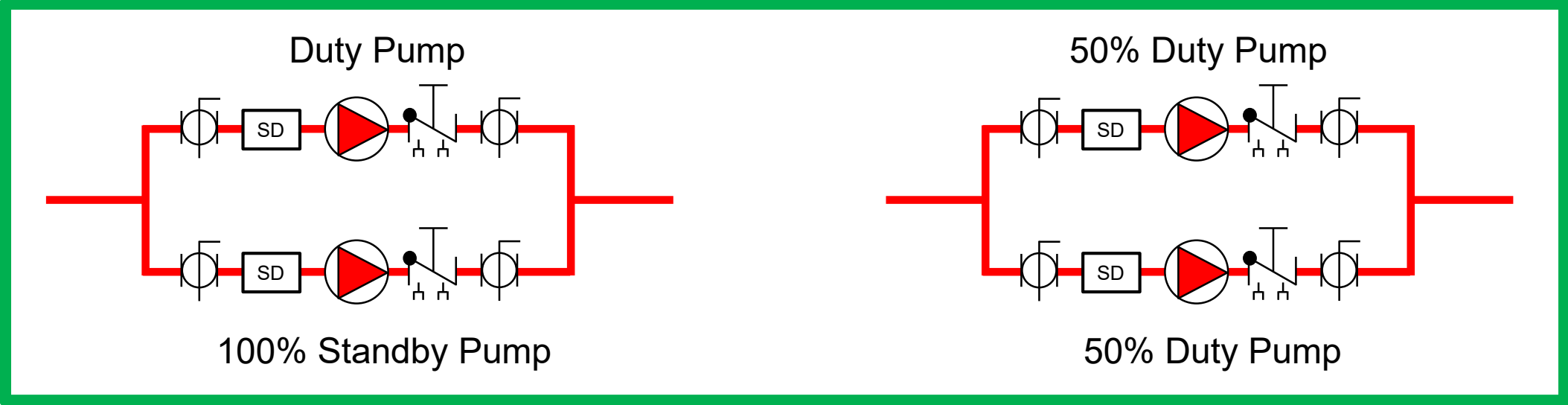
- Pumps receiving liquid from the same suction manifold and discharging into a common discharge manifold.
- Where design requires multiple pumps to run simultaneously, each pump contributes an equal percentage of the “Total” flow produced.

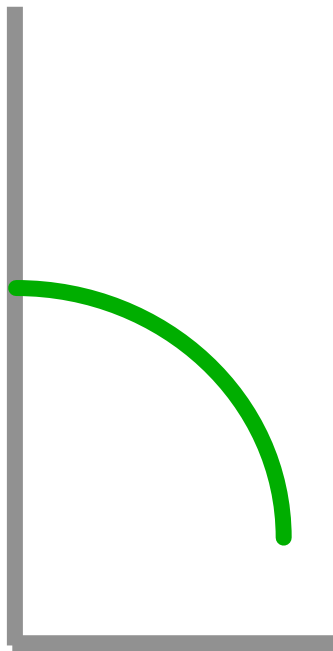
## Advantages

- Provides Adequate Redundancy
- Reduced Floor Space
- Lower Installed Cost
- Improved Turn-Down capabilities
- Pump “Best Efficiency” staging

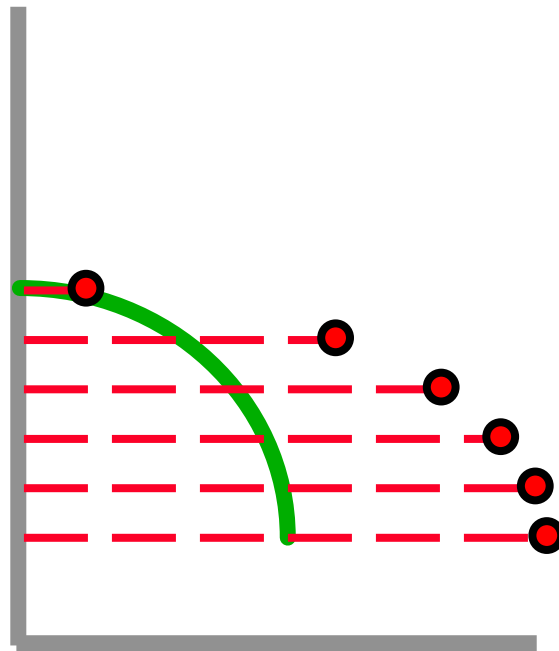


# Common Parallel Pump Configurations

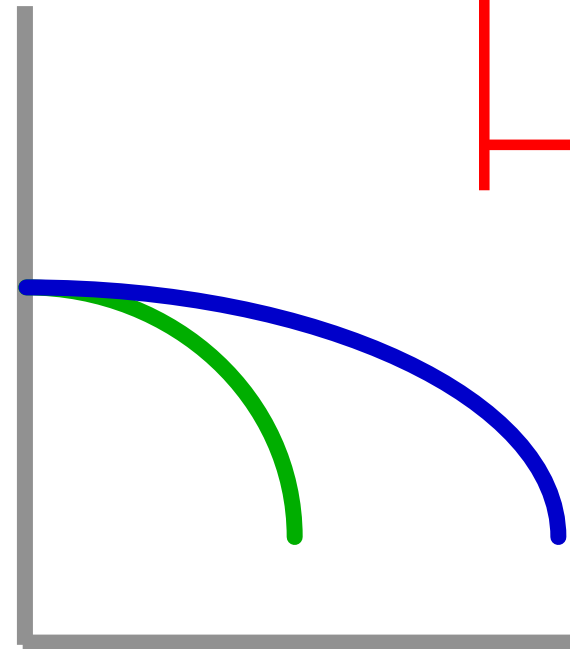




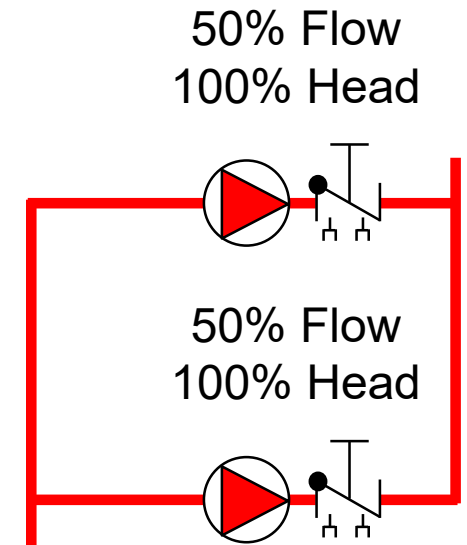
Single Pump Curve



Double the Flow at Several Values of Head

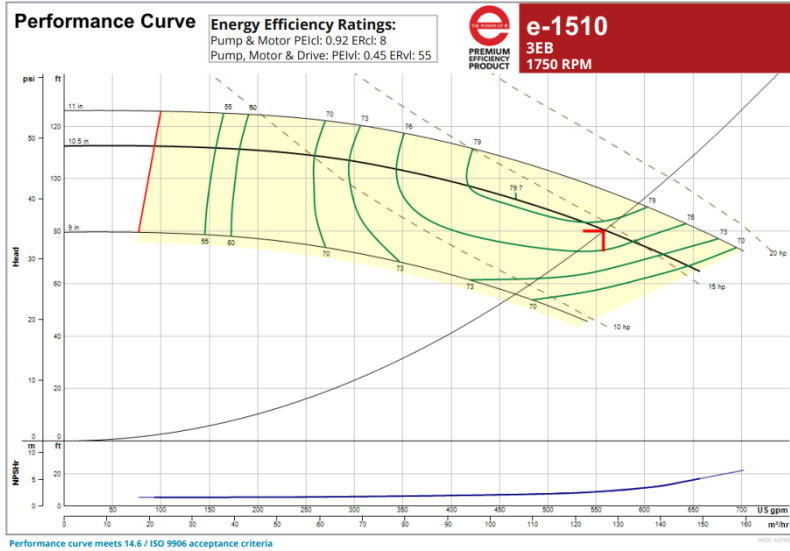


Connect the Points to Make the Parallel Curve



Two identical pumps in parallel

# Parallel Pumping – 50% Duty Flow per Pump (No Standby)

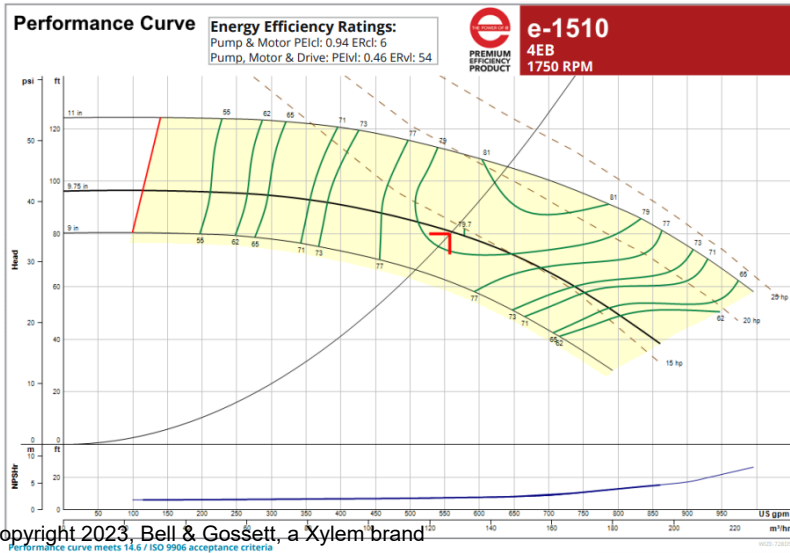


Pump Selection Summary	
Duty Point Flow	557 US gpm
Duty Point Head	80 ft
Control Head	0 ft
Duty Point Pump Efficiency	77.8 %
Part Load Efficiency Value (PLEV)	0.0 %
Impeller Diameter	10.5 in
Motor Power	20 hp
Duty Point Power	14.5 bhp
Motor Speed	1800 rpm
RPM @ Duty Point	1750 rpm
NPSHr	9.24 ft
Minimum Shutoff Head	113 ft
Minimum Flow at RPM	93.4 US gpm
Flow @ BEP	467 US gpm
Fluid Temperature	68 °F
Fluid Type	Water
Weight (approx. - consult rep for exact)	590 lbs
Pump Floor Space Calculation	6.39 ft <sup>2</sup>

## Option “A”

- (2) e-1510 3EB with 10.5” Impeller  
 557.5 GPM @ 80’ each
- 14.5 BHP each (20HP Mtr. NOL)
  - 77.8% Eff. @ Duty Point
  - 9.24’ NPSHR
  - 93 GPM Min. Flow (Per Pump)
  - 467 GPM (Flow @ BEP)

**Total Connected HP – 40 HP**

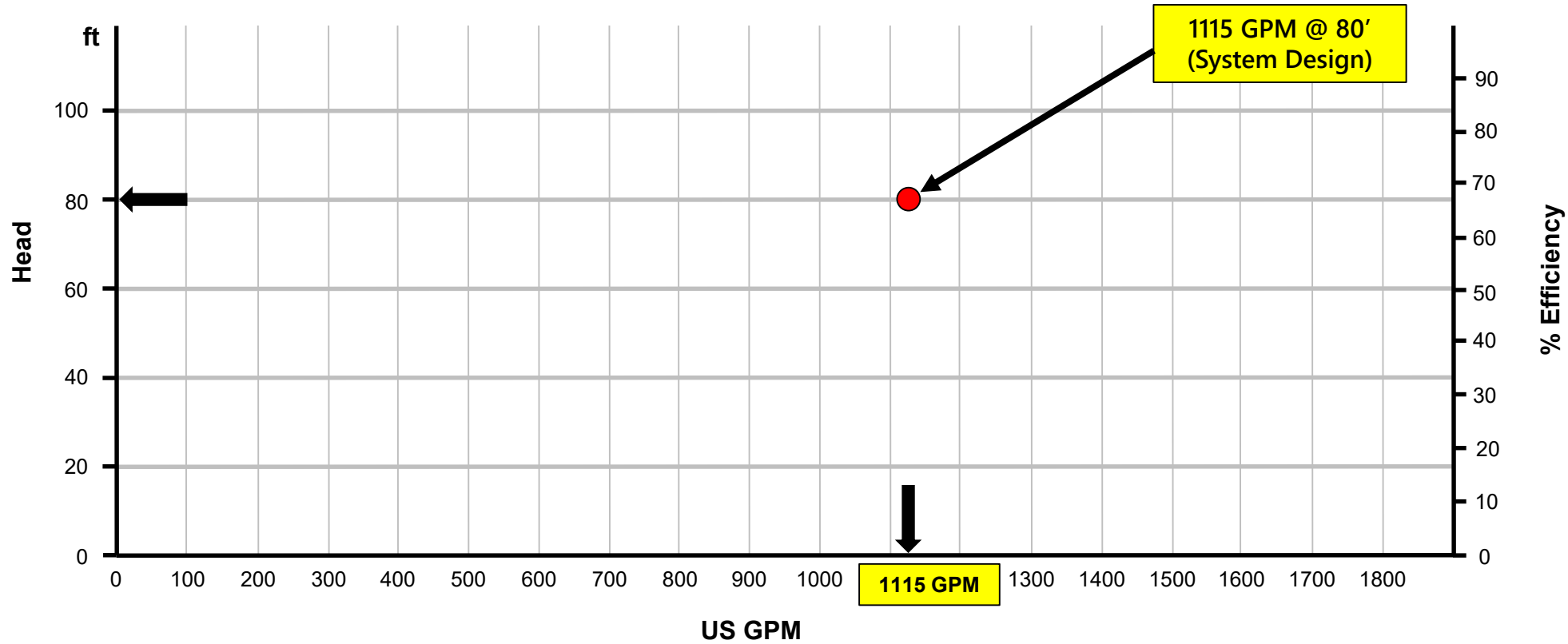


Pump Selection Summary	
Duty Point Flow	557 US gpm
Duty Point Head	80 ft
Control Head	0 ft
Duty Point Pump Efficiency	79.5 %
Part Load Efficiency Value (PLEV)	0.0 %
Impeller Diameter	9.75 in
Motor Power	20 hp
Duty Point Power	14.3 bhp
Motor Speed	1800 rpm
RPM @ Duty Point	1750 rpm
NPSHr	7.41 ft
Minimum Shutoff Head	96.3 ft
Minimum Flow at RPM	116 US gpm
Flow @ BEP	578 US gpm
Fluid Temperature	68 °F
Fluid Type	Water
Weight (approx. - consult rep for exact)	610 lbs
Pump Floor Space Calculation	6.65 ft <sup>2</sup>

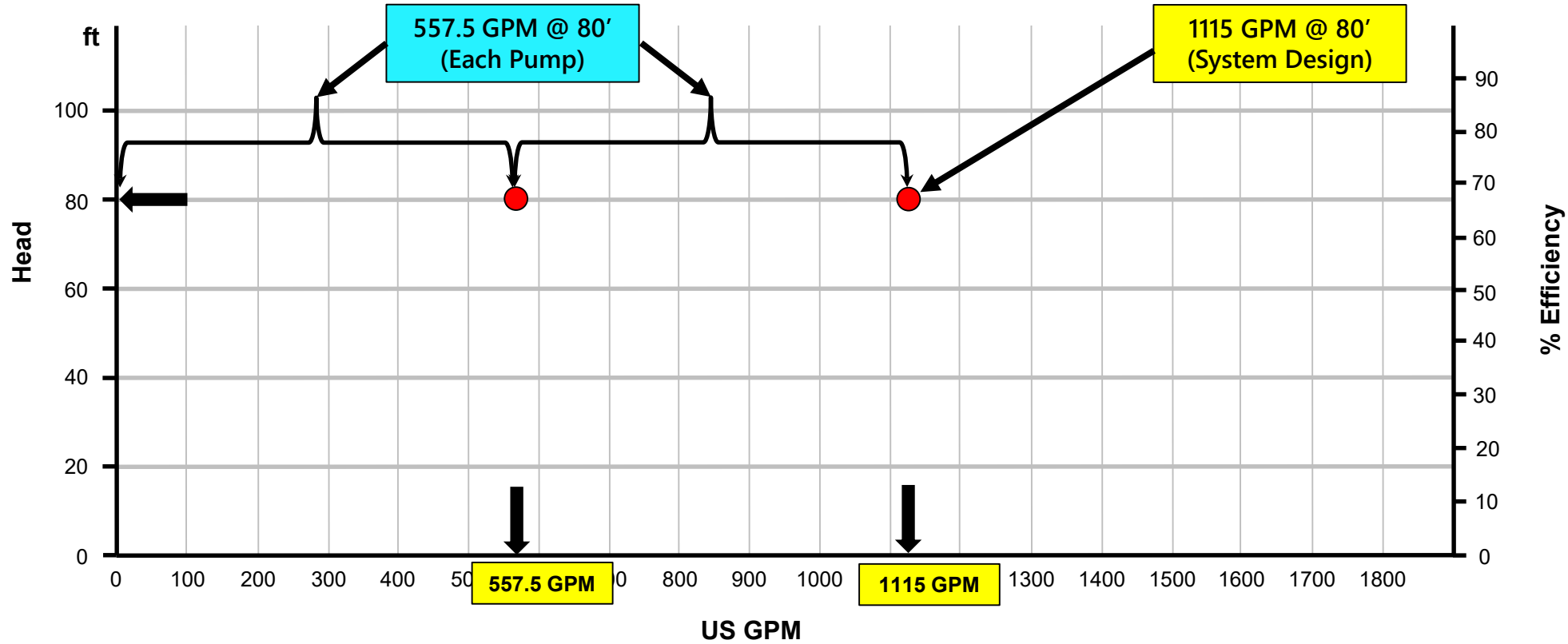
## Option “B”

- (2) e-1510 4EB with 9.75” Impeller  
 557.5 GPM @ 80’ each
- 14.3 BHP each (20HP Mtr. NOL)
  - 79.5% Eff. @ Duty Point
  - 7.41’ NPSHR
  - 116 GPM Min. Flow (Per Pump)
  - 578 GPM (Flow @ BEP)

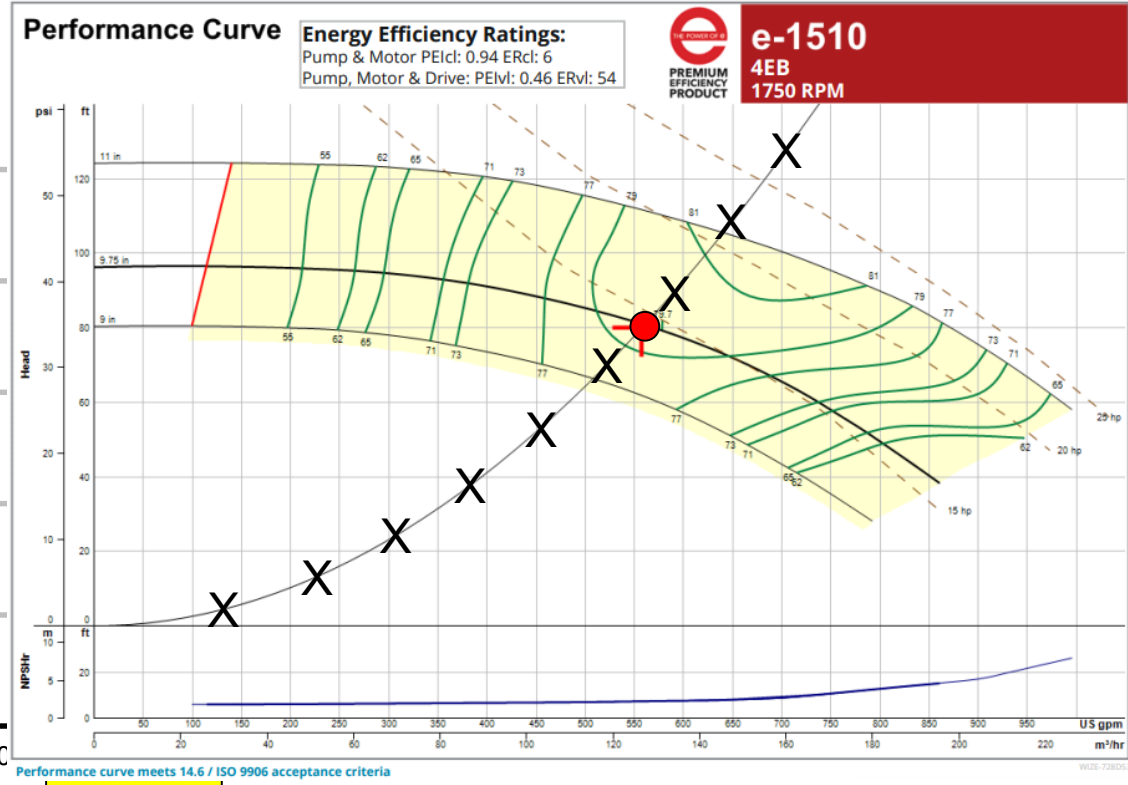
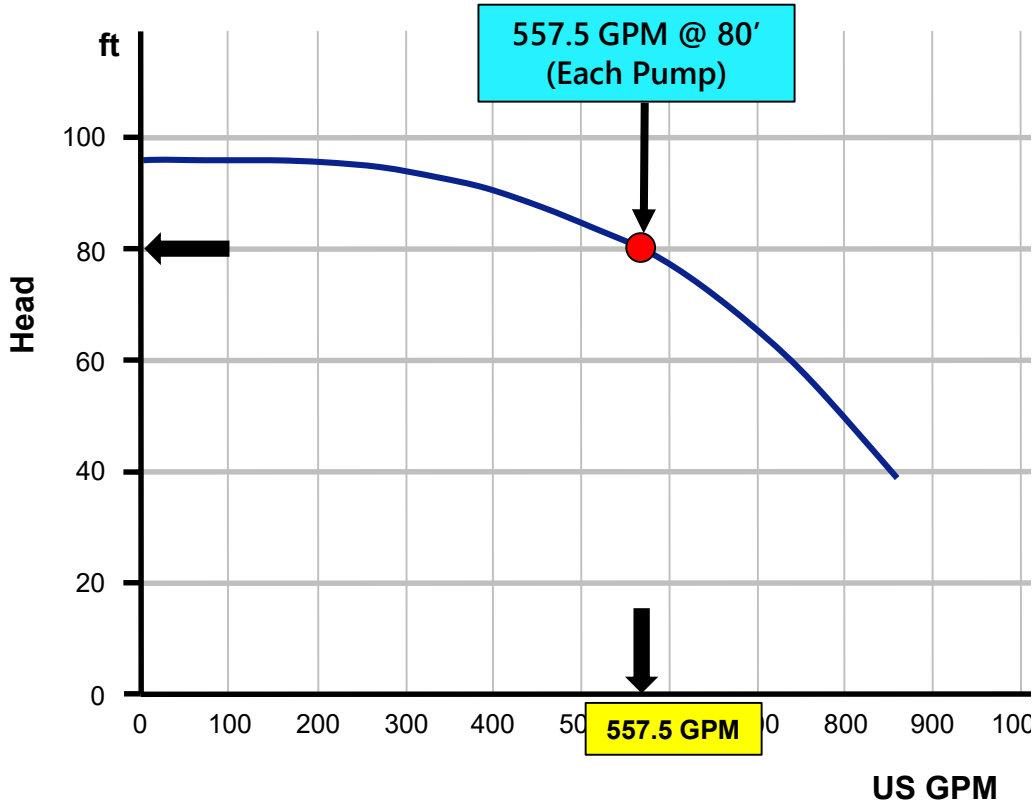
# Parallel Pumping – 50% Duty Flow per Pump (No Standby) Opt. B



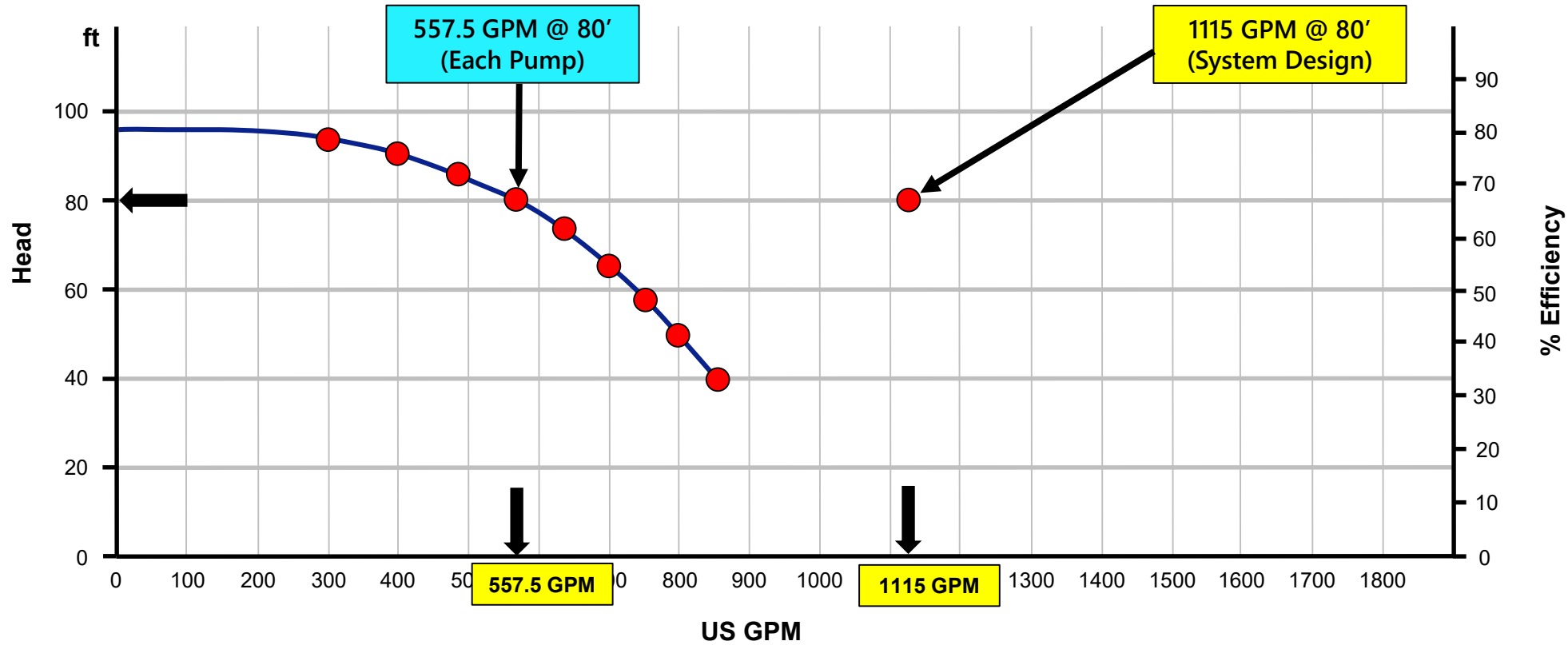
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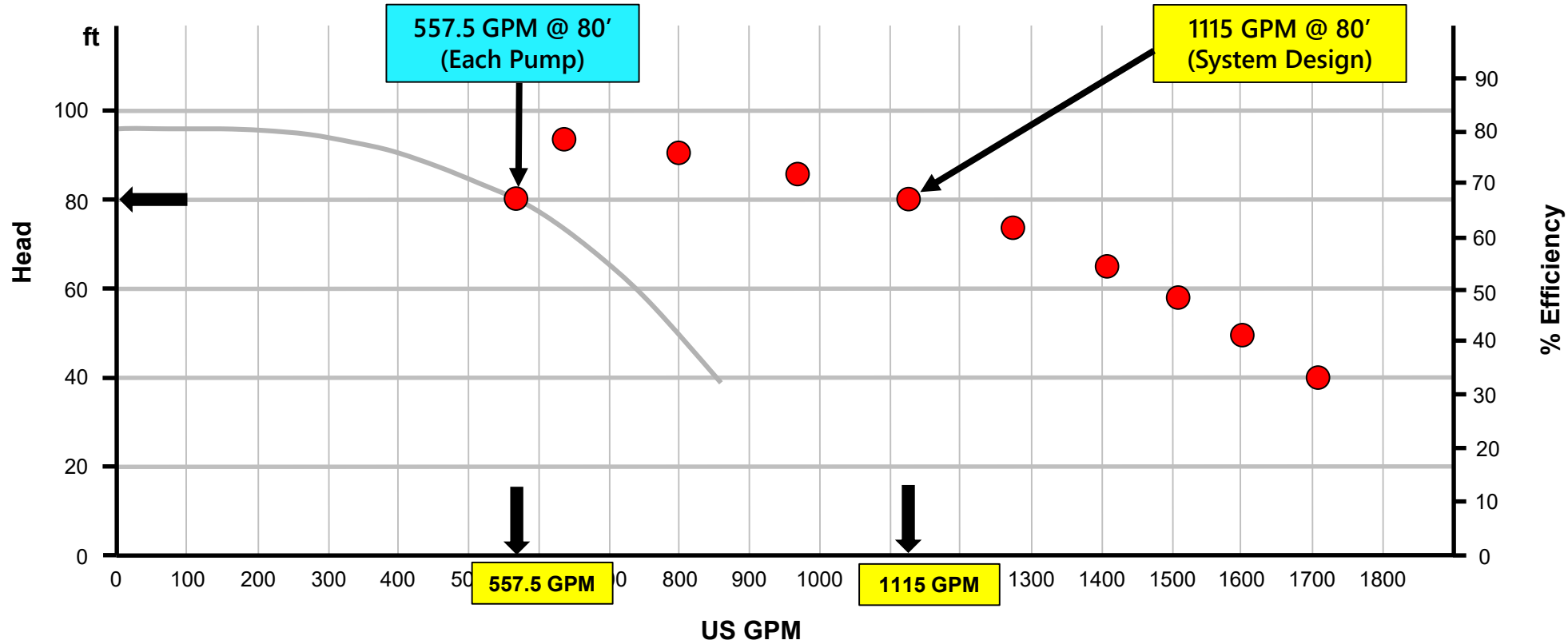
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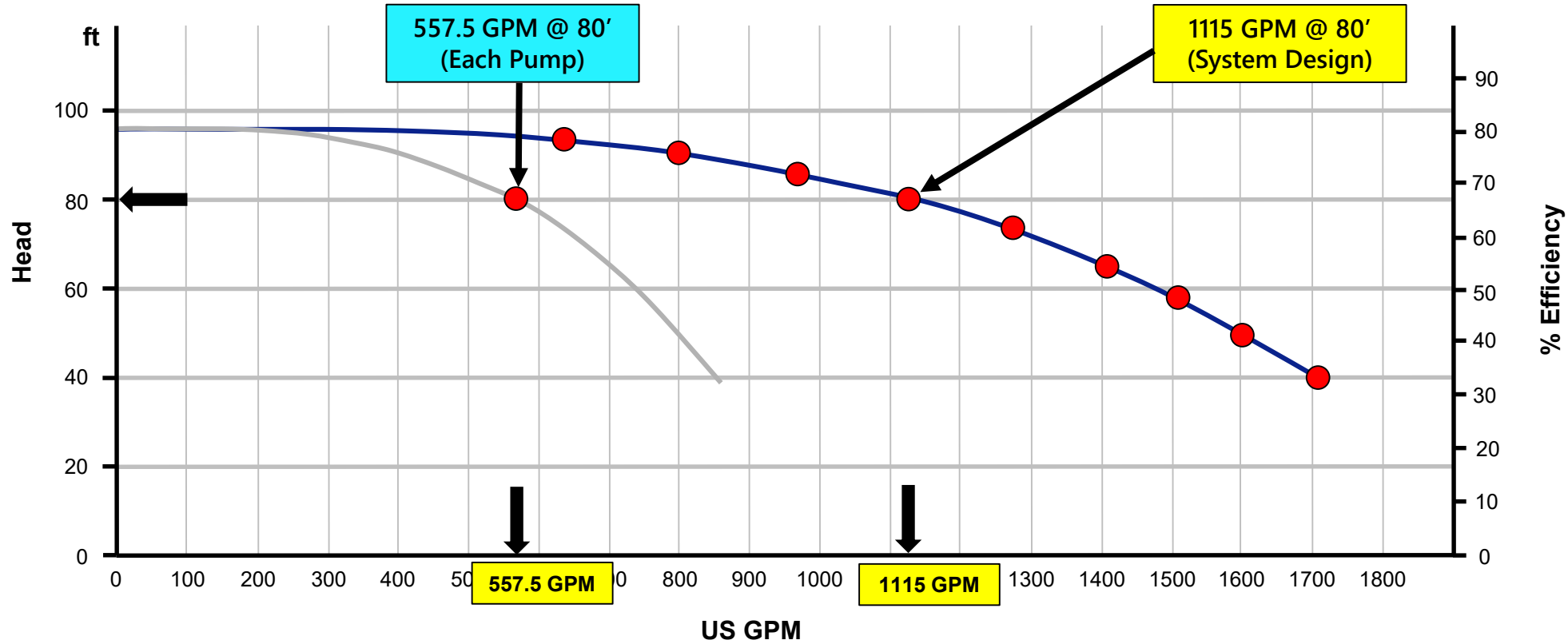


# Parallel Pumping – 50% Duty Flow per Pump (No Standby) Opt. B

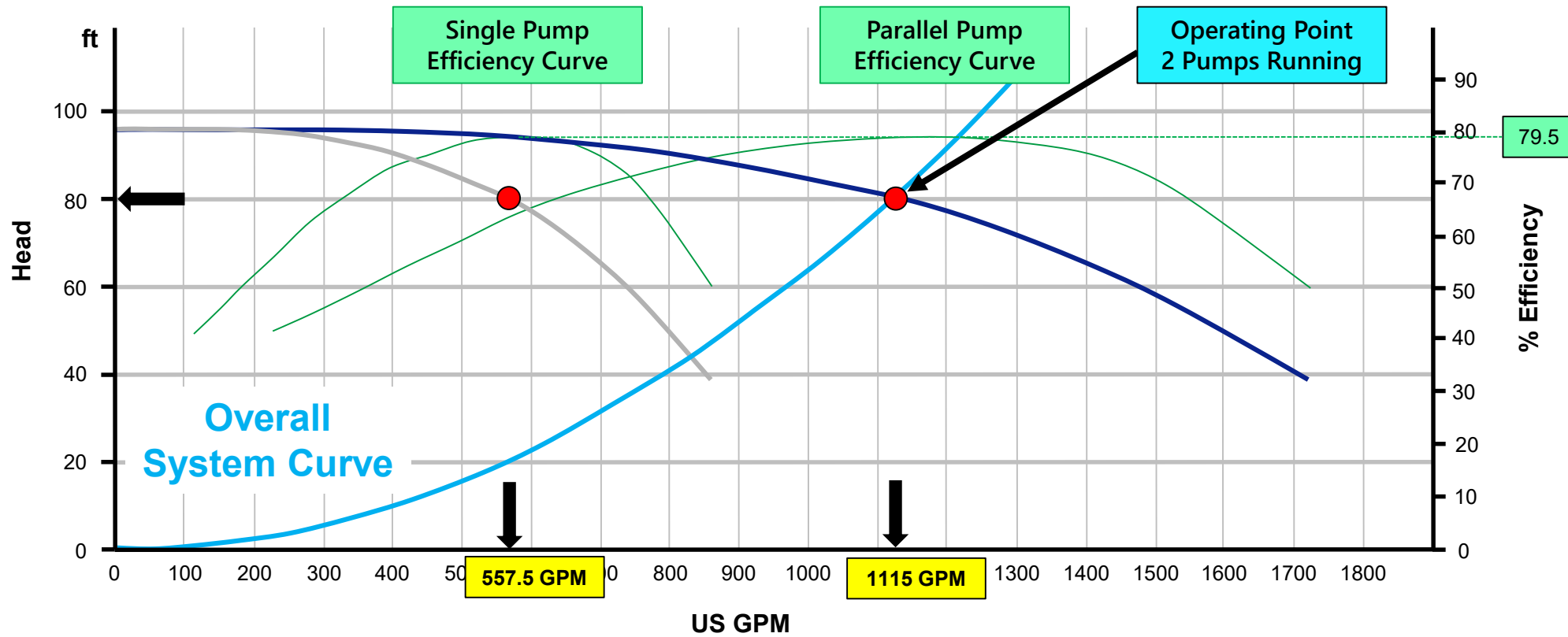




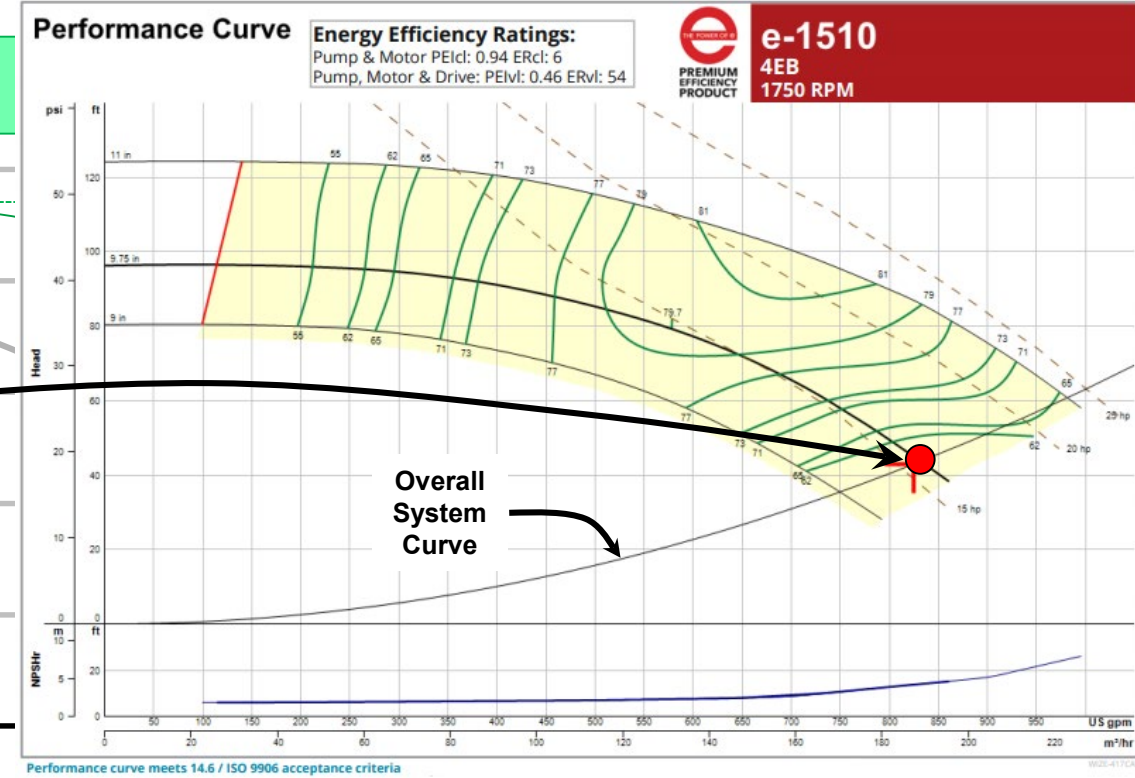
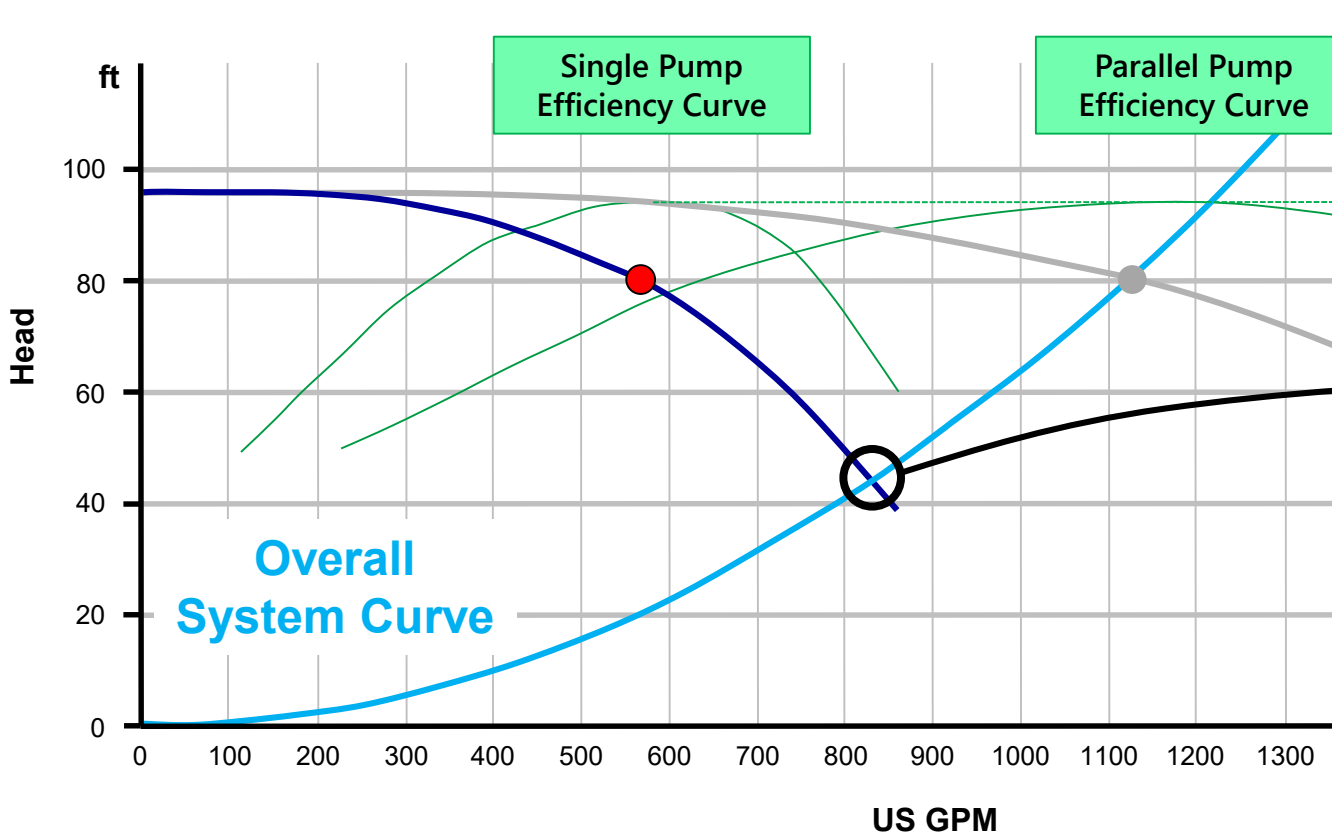
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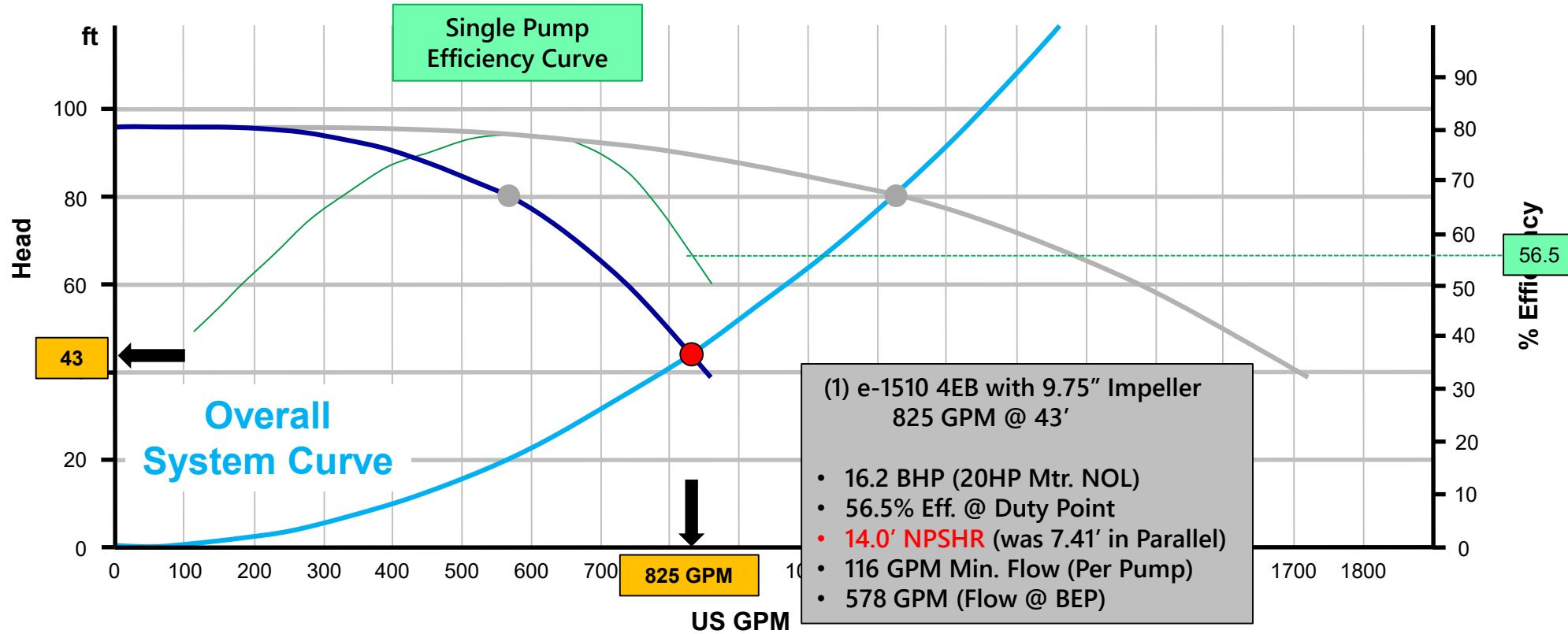


# Parallel Pumping – 50% Duty Flow per Pump (No Standby) Opt. B



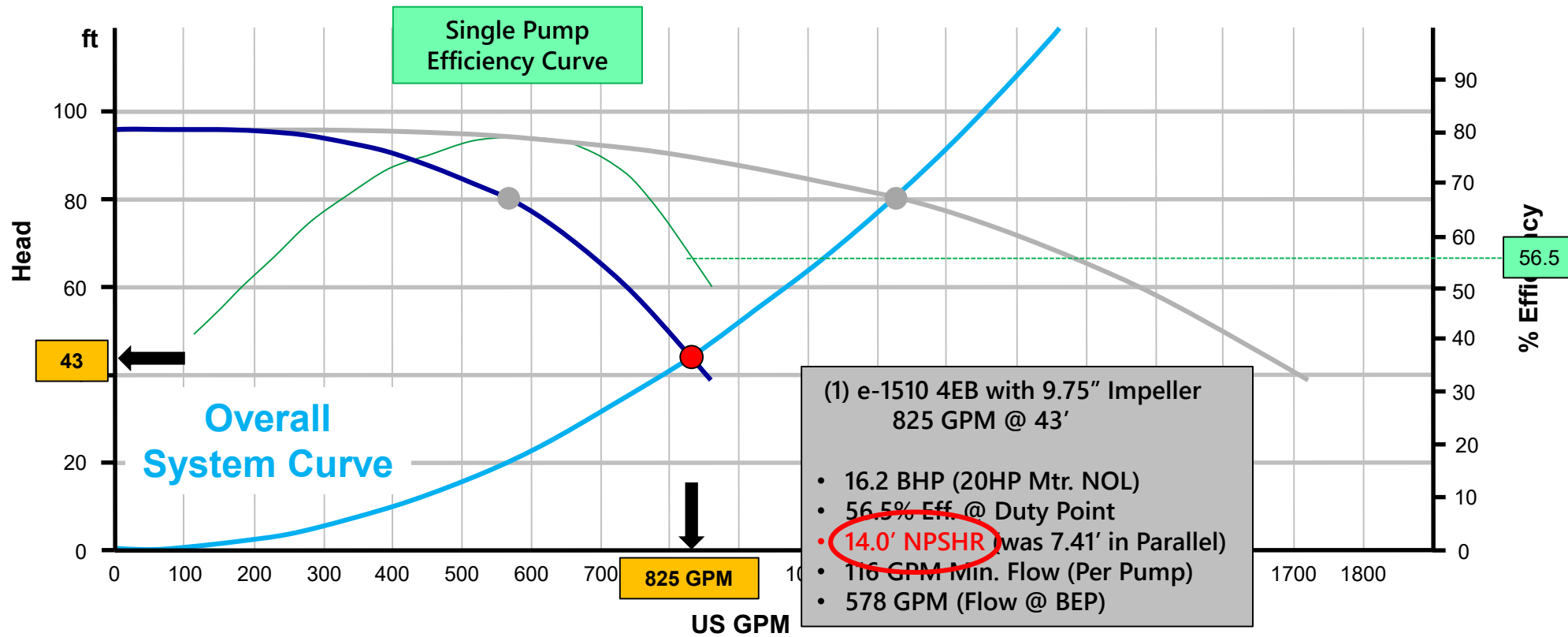
What happens when 1 pump is turned off?

# Parallel Pumping – 50% Duty Flow per Pump (No Standby) Opt. B



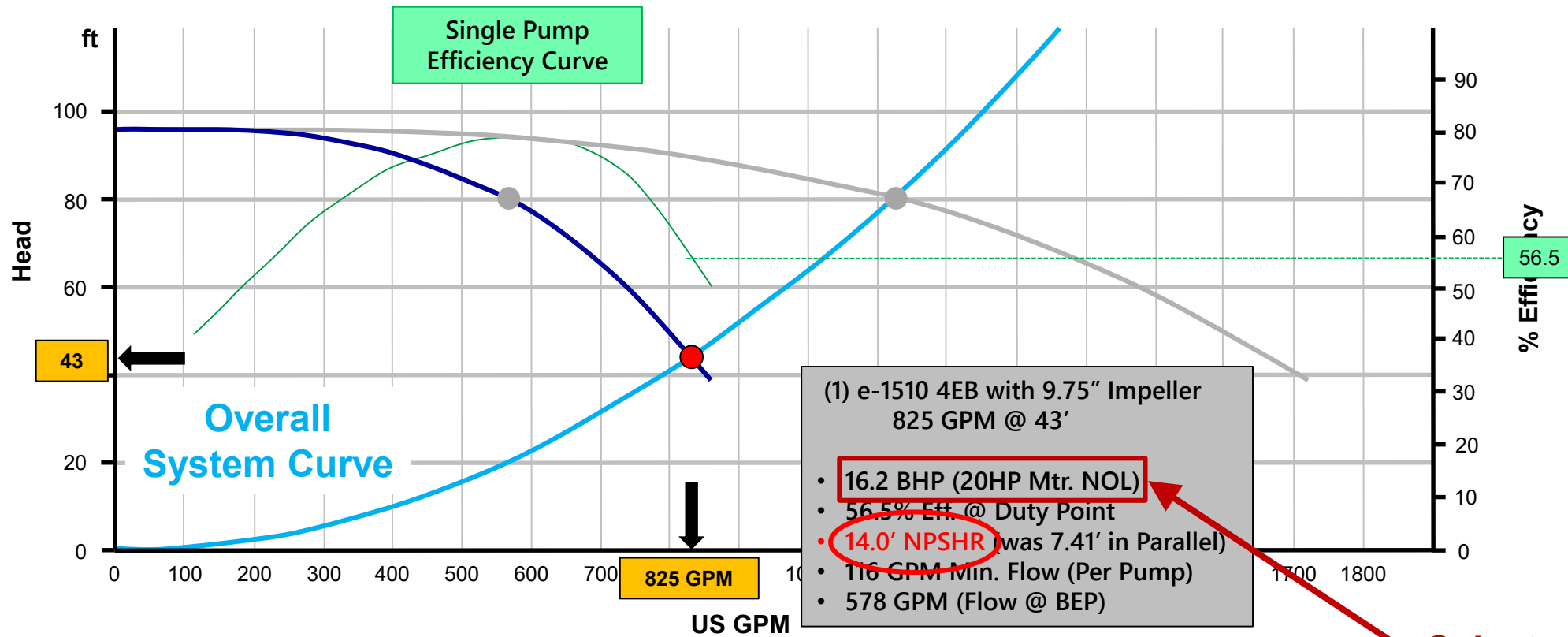
**825 GPM/1115 GPM = 74%  
Redundant Capacity**

# Parallel Pumping – 50% Duty Flow per Pump (No Standby) Opt. B



**825 GPM/1115 GPM = 74%  
Redundant Capacity**

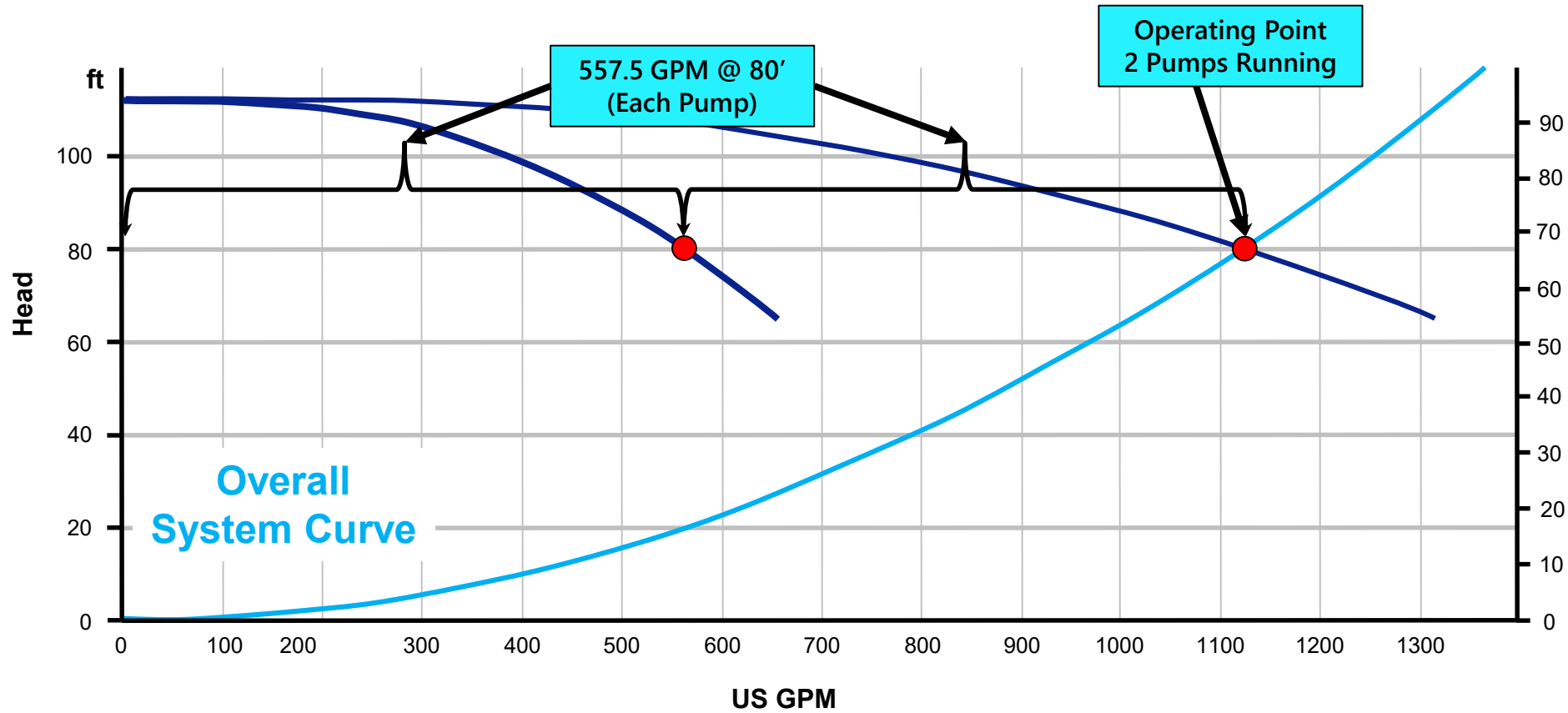
# Parallel Pumping – 50% Duty Flow per Pump (No Standby) Opt. B



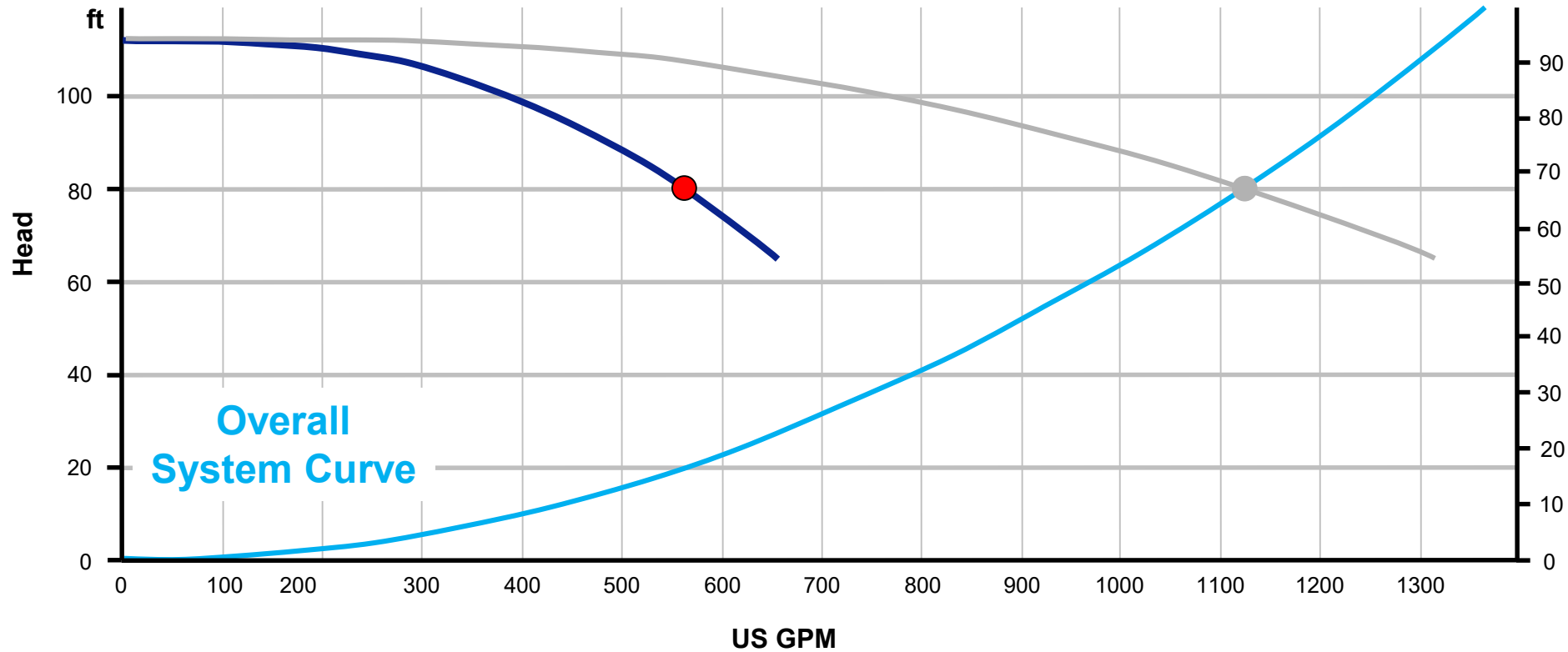
**Select motor for single pump operation on Design Day System Curve**

**825 GPM/1115 GPM = 74% Redundant Capacity**

# Parallel Pumping – 50% Duty Flow per Pump (No Standby) Opt. A



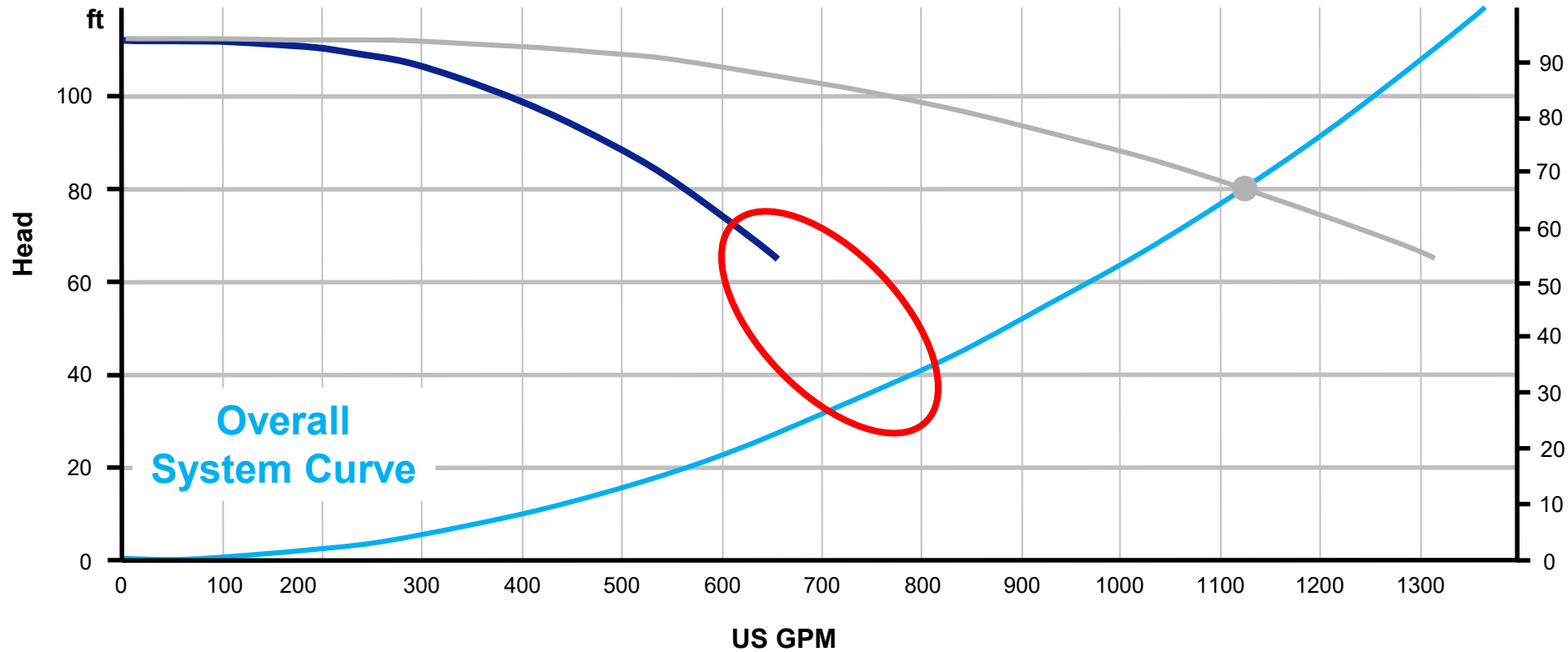
# Parallel Pumping – 50% Duty Flow per Pump (No Standby) Opt. A



What happens when 1 pump is turned off?



# Parallel Pumping – 50% Duty Flow per Pump (No Standby) Opt. A



What happens when 1 pump is turned off?

# Parallel Pumping – 50% Duty Flow per Pump (No Standby) **Opt. A**

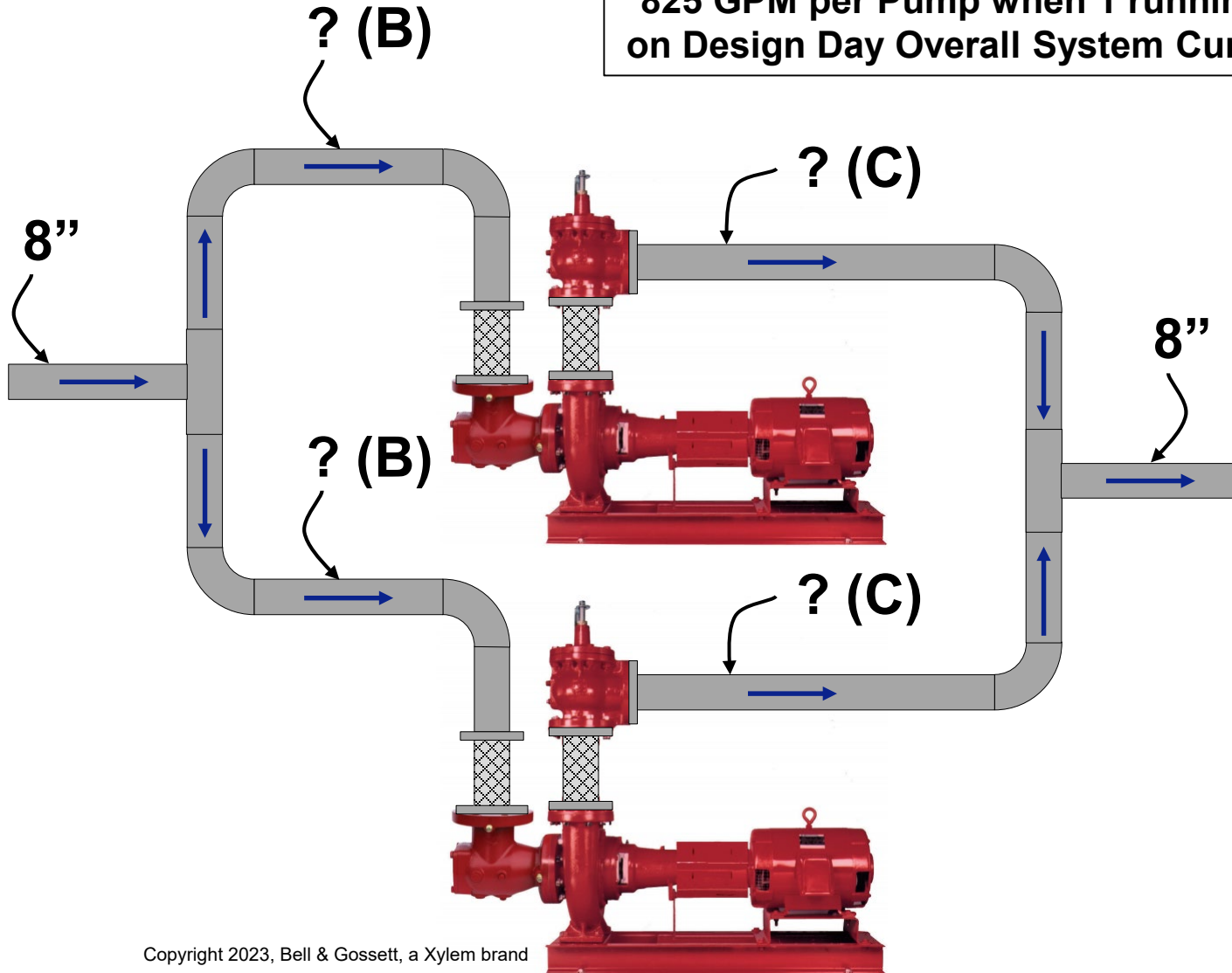
## The “Golden Rule” of Parallel Pumping

The Overall System Curve **must** intersect **all** pump curves  
(Maximum to Minimum number of operating pumps possible)

# Parallel Pumping – Pipe Size Selection 50% Duty per Pump

**in Parallel**

825 GPM per Pump when 1 running on Design Day Overall System Curve



Flow/Pressure Drop Relationship		ASHRAE Information	
Pipe Size: 6 in	Pipe Material: Steel Pipe	Operation Range: >4400 Hours/Year	Variable Flow Operation (selected)
Flow Rate: 557.5 GPM	Friction Loss: 2.03 Feet/100 Feet	ASHRAE 90.1-2010 Max Rate for Pipe Size Selected: 680 GPM	Other Operation
	Velocity: 6.19 Feet/Sec	Annual Energy Cost: 0.10 \$/KwHr	Est. Pump/Driver Eff: 80 %
	Steel Pipe thru 24" is Schedule 40 Steel Pipe 30 - 36" is Schedule 30	Pipe Length (T.E.L.): 500.00 Feet	Hours of Operation/Year: 8760
557.5 GPM	258,755 Reynolds Number		Annual Energy Cost*: \$1,167
74.54 Cubic Feet/Min	0.000297 Relative Roughness e/D		*Pump/Driver cost at 100% load
126.55 Cubic Meters/Hr	Transition Flow		
35.12 Liters/Sec	0.0172 Friction Factor		
2,110.14 Liters/Min	6.19 Feet/Sec		
126,608.25 Liters/Hr	1.89 Meters/100 Meters		

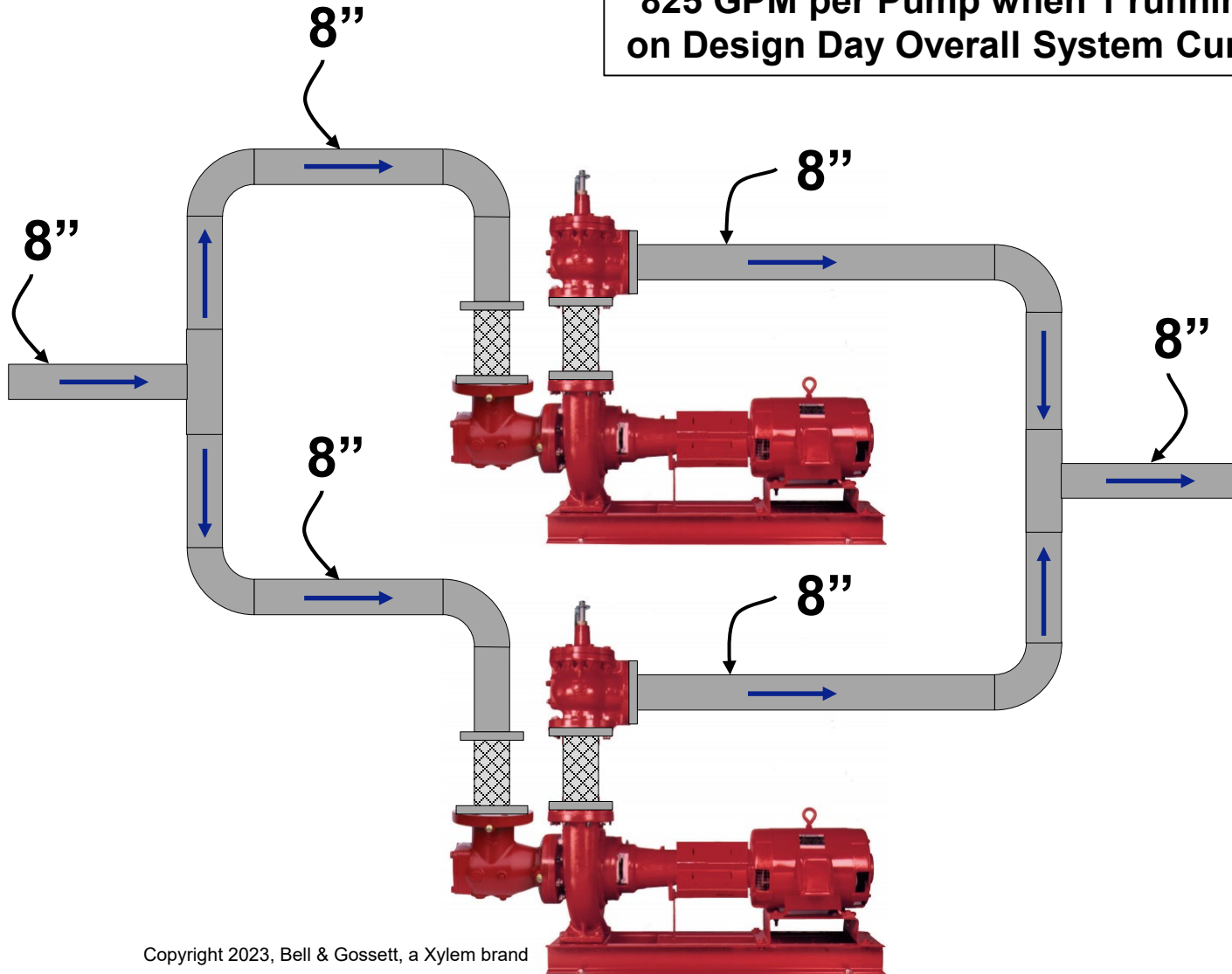
  

Flow/Pressure Drop Relationship		ASHRAE Information	
Pipe Size: 6 in	Pipe Material: Steel Pipe	Operation Range: >4400 Hours/Year	Variable Flow Operation (selected)
Flow Rate: 825 GPM	Friction Loss: 4.28 Feet/100 Feet	ASHRAE 90.1-2010 Max Rate for Pipe Size Selected: 680 GPM	Other Operation
	Velocity: 9.16 Feet/Sec	Annual Energy Cost: 0.10 \$/KwHr	Est. Pump/Driver Eff: 80 %
	Steel Pipe thru 24" is Schedule 40 Steel Pipe 30 - 36" is Schedule 30	Pipe Length (T.E.L.): 500.00 Feet	Hours of Operation/Year: 8760
825 GPM	382,912 Reynolds Number		Annual Energy Cost*: \$3,642
110.30 Cubic Feet/Min	0.000297 Relative Roughness e/D		*Pump/Driver cost at 100% load
187.28 Cubic Meters/Hr	Transition Flow		
51.98 Liters/Sec	0.0166 Friction Factor		
3,122.63 Liters/Min	9.16 Feet/Sec		
187,357.50 Liters/Hr	2.79 Meters/100 Meters		

# Parallel Pumping – Pipe Size Selection 50% Duty per Pump

## in Parallel

825 GPM per Pump when 1 running on Design Day Overall System Curve



**Flow/Pressure Drop Relationship**

Pipe Size: 6 in | Pipe Material: Steel Pipe

Flow Rate: 557.5 GPM | Friction Loss: 2.03 Feet/100 Feet | Velocity: 6.19 Feet/Sec

Steel Pipe thru 24" is Schedule 40  
Steel Pipe 30 - 36" is Schedule 30

557.5	GPM	258,755	Reynolds Number
74.54	Cubic Feet/Min	0.000297	Relative Roughness $\epsilon/D$
126.55	Cubic Meters/Hr	Transition Flow	Flow Type
35.12	Liters/Sec	0.0172	Friction Factor
2,110.14	Liters/Min	6.19	Feet/Sec
126,608.25	Liters/Hr	1.89	Meters/100 Meters

ASHRAE Information

>4400 | Operation Range Hours/Year

Variable Flow Operation  
 Other Operation

ASHRAE 90.1-2010 Max Rate for Pipe Size Selected: 680 GPM

Annual Energy Cost

0.10	\$/KwHr	500.00	Feet
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Est. Pump/Driver Eff: 80 %  
Hours of Operation/Year: 8760  
Annual Energy Cost\*: \$1,167  
\*Pump/Driver cost at 100% load

**Flow/Pressure Drop Relationship**

Pipe Size: 8 in | Pipe Material: Steel Pipe

Flow Rate: 825.00 GPM | Friction Loss: 1.08 Feet/100 Feet | Velocity: 5.29 Feet/Sec

Steel Pipe thru 24" is Schedule 40  
Steel Pipe 30 - 36" is Schedule 30

825	GPM	291,140	Reynolds Number
110.30	Cubic Feet/Min	0.000226	Relative Roughness $\epsilon/D$
187.28	Cubic Meters/Hr	Transition Flow	Flow Type
51.98	Liters/Sec	0.0165	Friction Factor
3,122.63	Liters/Min	5.29	Feet/Sec
187,357.50	Liters/Hr	1.61	Meters/100 Meters

ASHRAE Information

>4400 | Operation Range Hours/Year

Variable Flow Operation  
 Other Operation

ASHRAE 90.1-2010 Max Rate for Pipe Size Selected: 1100 GPM

Annual Energy Cost

0.10	\$/KwHr	500.00	Feet
------	---------	--------	------

Est. Pump/Driver Eff: 80 %  
Hours of Operation/Year: 8760  
Annual Energy Cost\*: \$919  
\*Pump/Driver cost at 100% load

# Advantage of Parallel Pumps – Reduced Footprint and Weight

**Base Mounted End Suction Pump**  
**Series: e-1510**  
**Model: 5EB**



**Features & Design**

- ANSI/OSHA Coupling Guard
- Center Drop Out Spacer Coupling
- Fabricated Heavy Duty Baseplate
- Internally Self-Flushing Mechanical Seal

\*The Bell & Gossett Series e-1510 is available in 26 sizes and a variety of configuration options that enable customization and flexibility to fit a broad range of operating conditions.

<http://belgosssett.com/pumps-circulators/end-suction-pumps/e-1510/>

**Pump Selection Summary**

Duty Point Flow	1115 US gpm
Duty Point Head	80 ft
Control Head	0 ft
Duty Point Pump Efficiency	84.3 %
Part Load Efficiency Value (PLEV)	0.0 %
Impeller Diameter	10.5 in
Motor Power	30 hp
Duty Point Power	26.8 bhp
Motor Speed	1800 rpm
RPM @ Duty Point	1770 rpm
NPSHr	12.3 ft
Minimum Shutoff Head	110 ft
Minimum Flow at RPM	225 US gpm
Flow @ BEP	978 US gpm
Fluid Temperature	68 °F
Fluid Type	Water
Weight (approx. - consult rep for exact)	811 lbs
Pump Floor Space Calculation	7.68 ft <sup>2</sup>

811 Lbs. each  
 7.68 ft<sup>2</sup> x 2 = 15.36 ft<sup>2</sup>

**Base Mounted End Suction Pump**  
**Series: e-1510**  
**Model: 4EB**



**Features & Design**

- ANSI/OSHA Coupling Guard
- Center Drop Out Spacer Coupling
- Fabricated Heavy Duty Baseplate
- Internally Self-Flushing Mechanical Seal

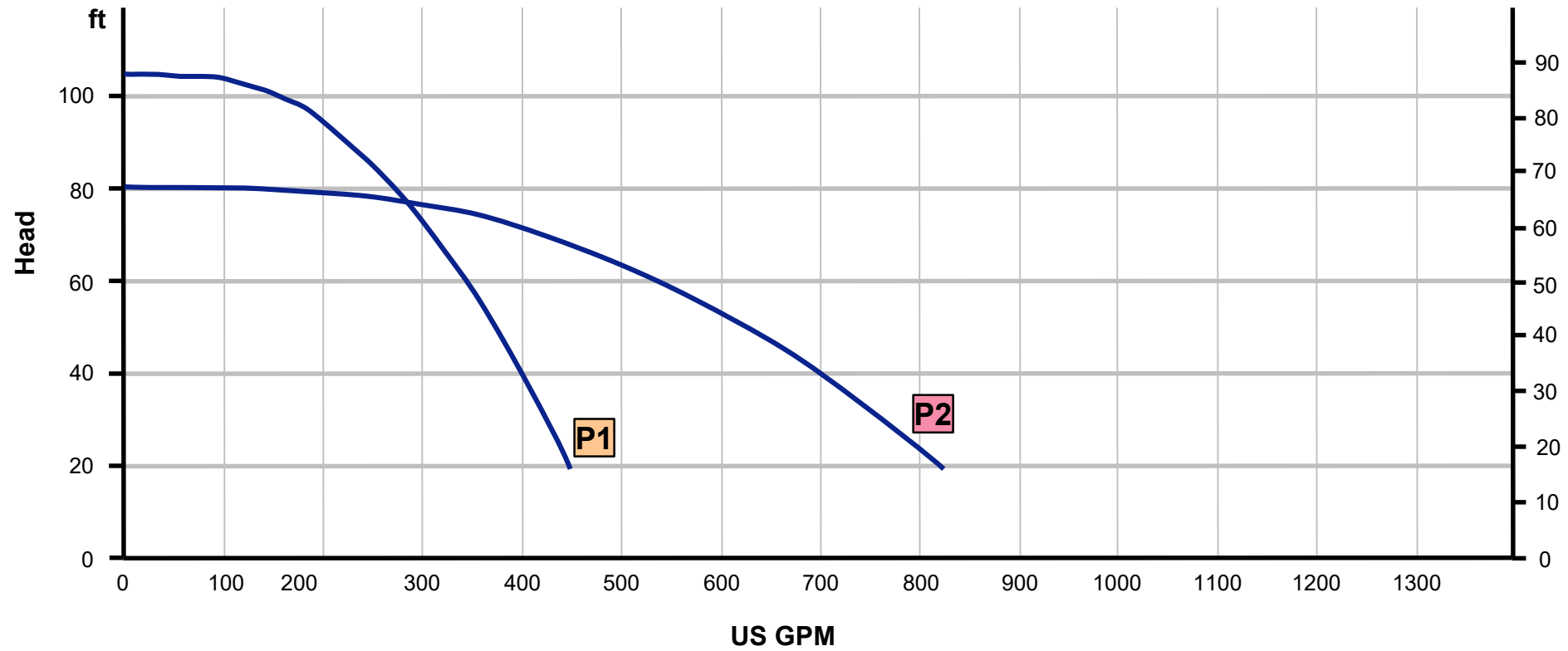
\*The Bell & Gossett Series e-1510 is available in 26 sizes and a variety of configuration options that enable customization and flexibility to fit a broad range of operating conditions.

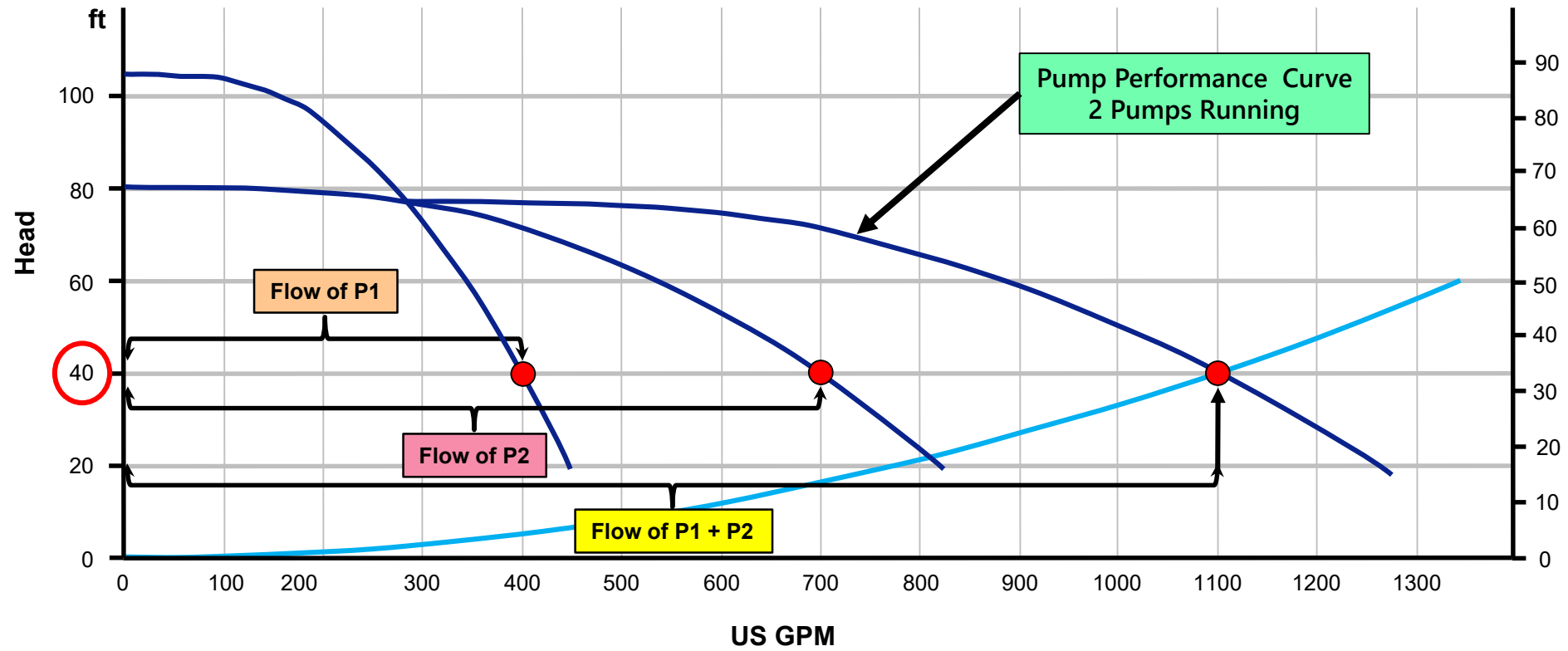
<http://belgosssett.com/pumps-circulators/end-suction-pumps/e-1510/>

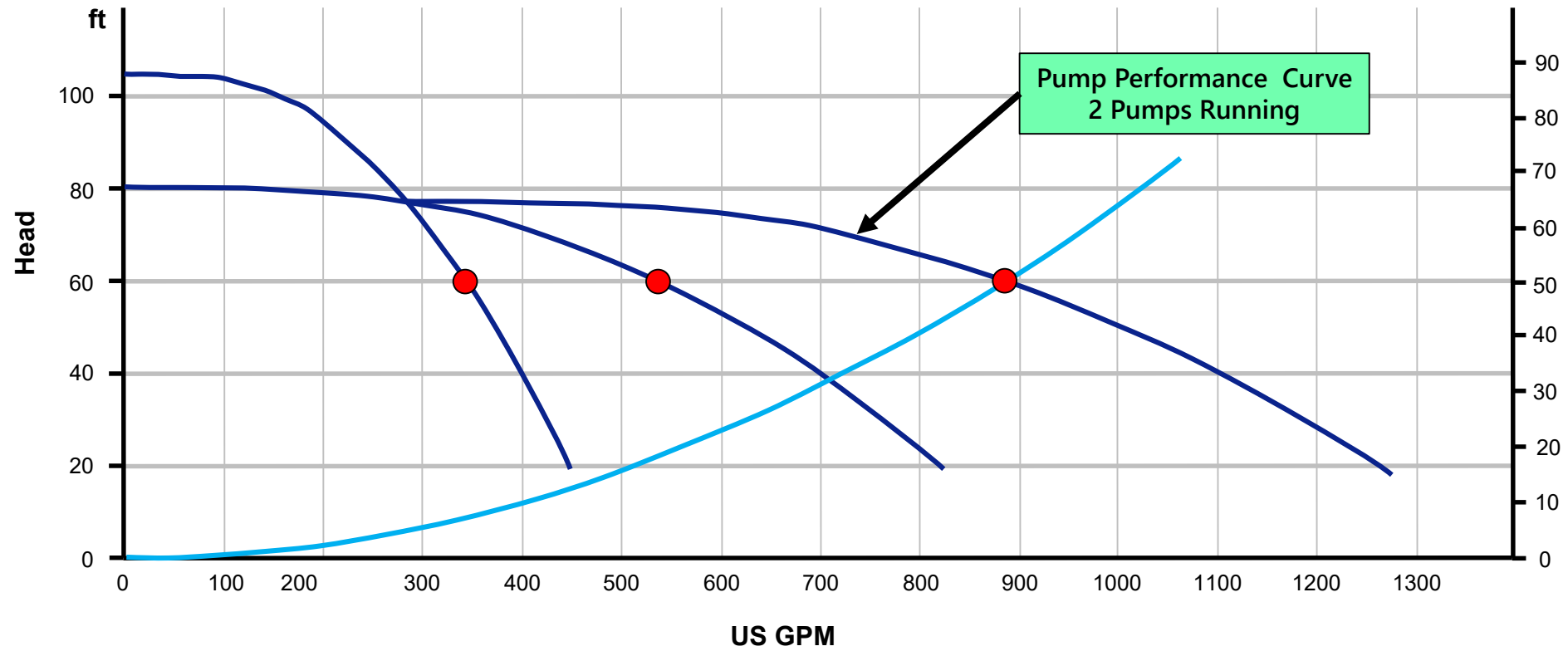
**Pump Selection Summary**

Duty Point Flow	557.5 US gpm
Duty Point Head	80 ft
Control Head	0 ft
Duty Point Pump Efficiency	80 %
Part Load Efficiency Value (PLEV)	0.0 %
Impeller Diameter	9.75 in
Motor Power	20 hp
Duty Point Power	14.3 bhp
Motor Speed	1800 rpm
RPM @ Duty Point	1750 rpm
NPSHr	7.41 ft
Minimum Shutoff Head	96.3 ft
Minimum Flow at RPM	116 US gpm
Flow @ BEP	578 US gpm
Fluid Temperature	68 °F
Fluid Type	Water
Weight (approx. - consult rep for exact)	610 lbs
Pump Floor Space Calculation	6.65 ft <sup>2</sup>

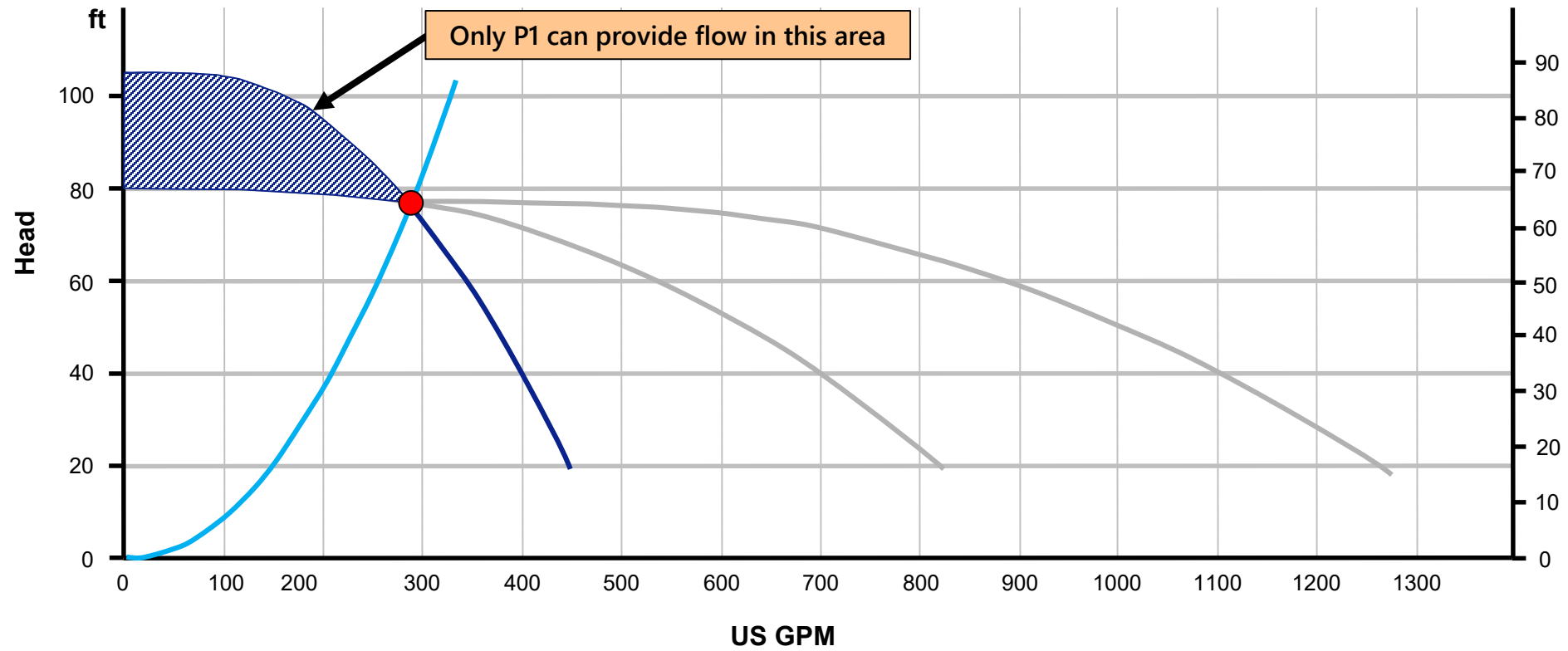
610 Lbs. each  
 6.65 ft<sup>2</sup> x 2 = 13.30 ft<sup>2</sup>







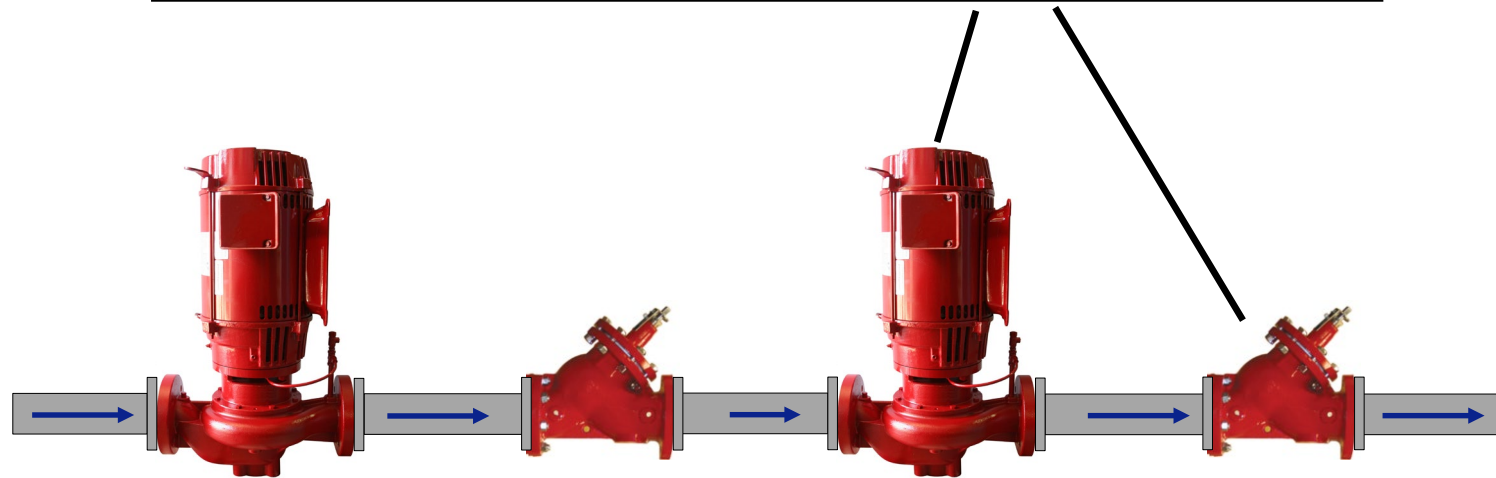




## Series Pumping: Using Multiple Pumps simultaneously

# What is Series Pumping?

**Caution not exceed Maximum Working Pressure of any pumps or accessories installed after lead pump**



100% Flow  
50% Head

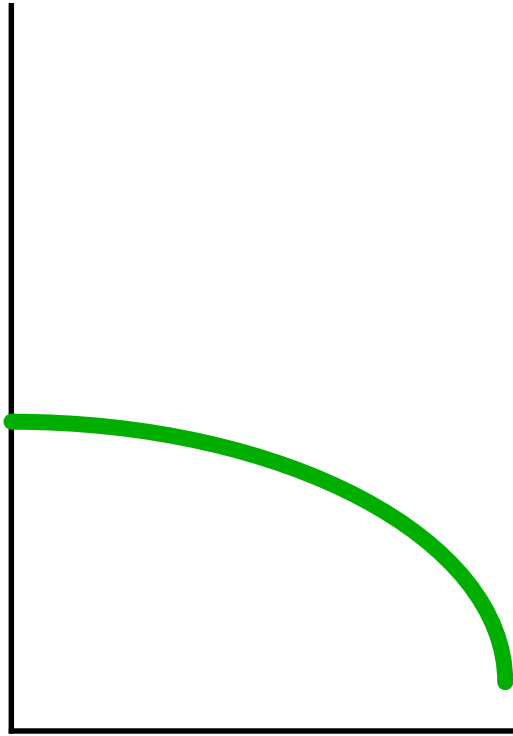
100% Flow  
50% Head



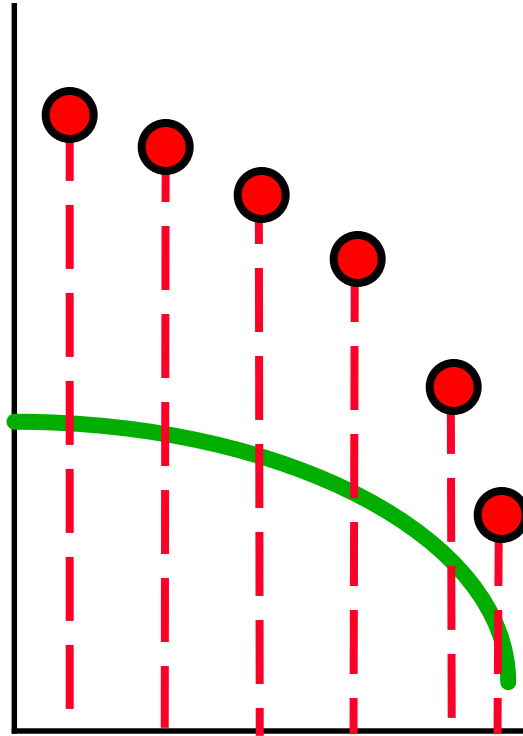
- Pumps are connected one after the other, with the discharge pressure of the first pump providing the suction pressure for the second pump.
- Where design requires multiple pumps to run simultaneously, each pump contributes an equal percentage of the “Total” head produced.

## Advantages (over Single Pump, same duty)

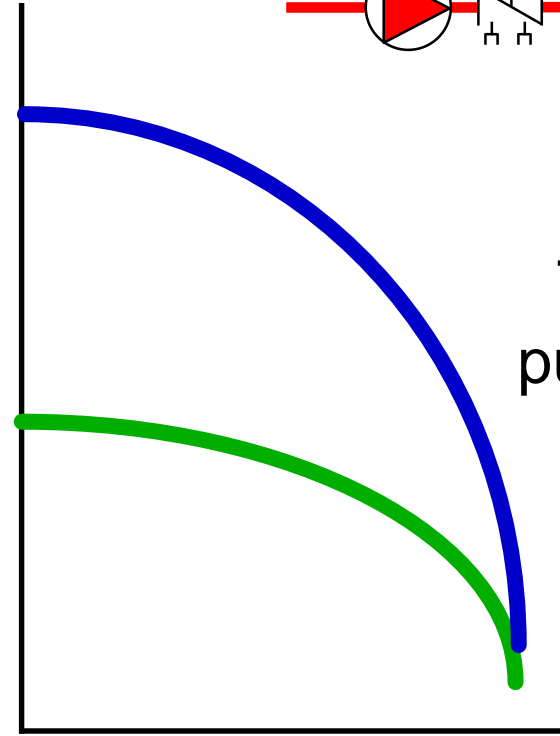
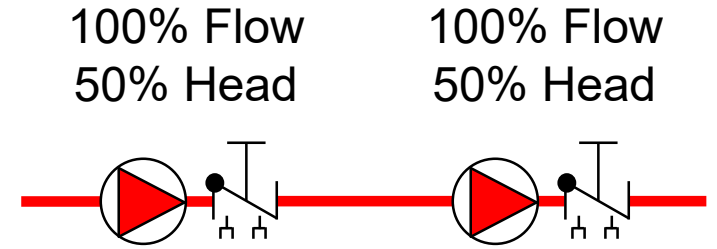
- Typically requires less horsepower
- Lower operating speeds
- Smaller pumps possible
- Higher duty point efficiency achieved
- Generally most applicable for high differential pressure requirements



Single Pump Curve



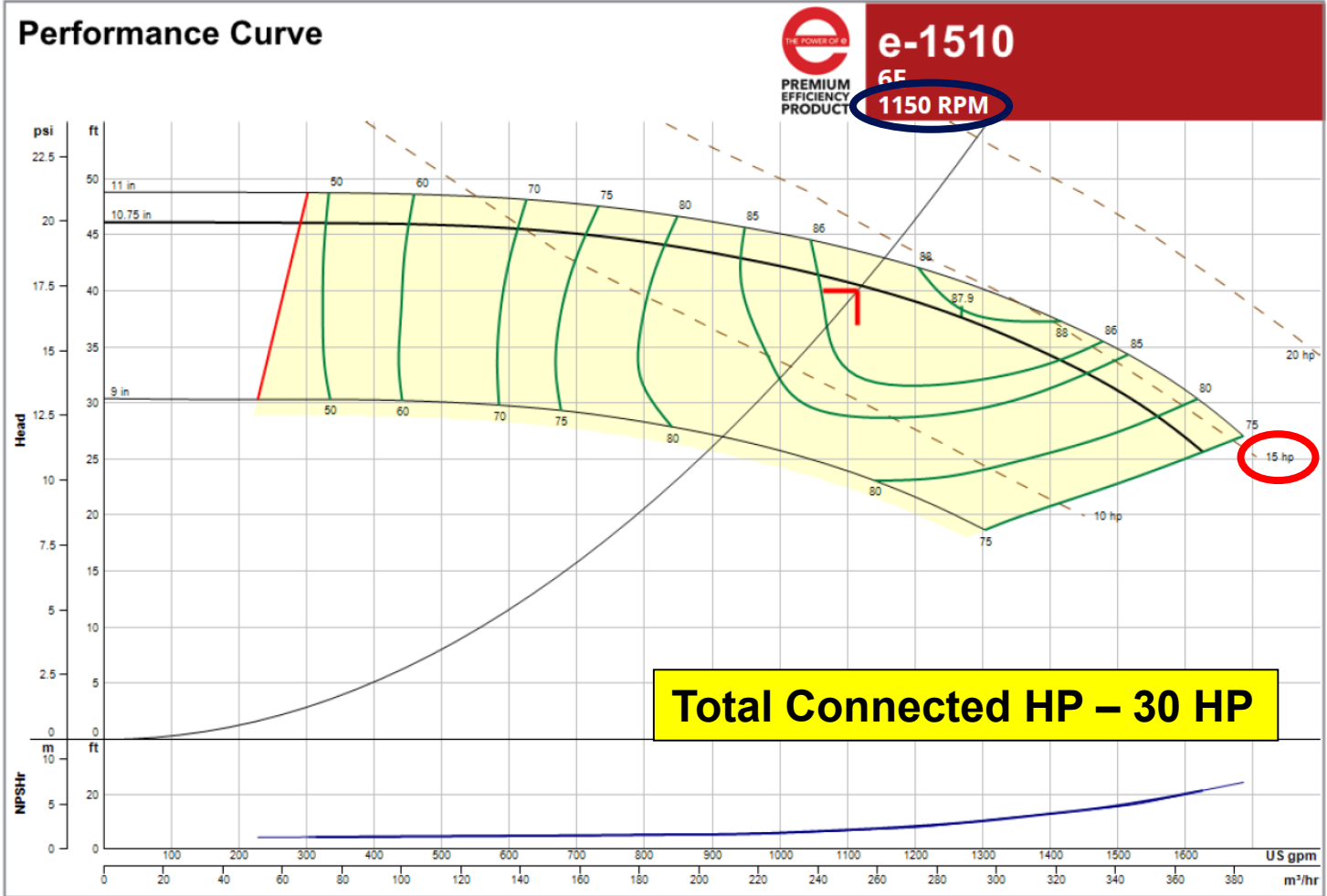
Double the Head at Several Values of Flow



Two identical pumps in series

Connect the Points to Make the Series Curve

# Series Pumping – 50% Duty Head per Pump (No Standby)

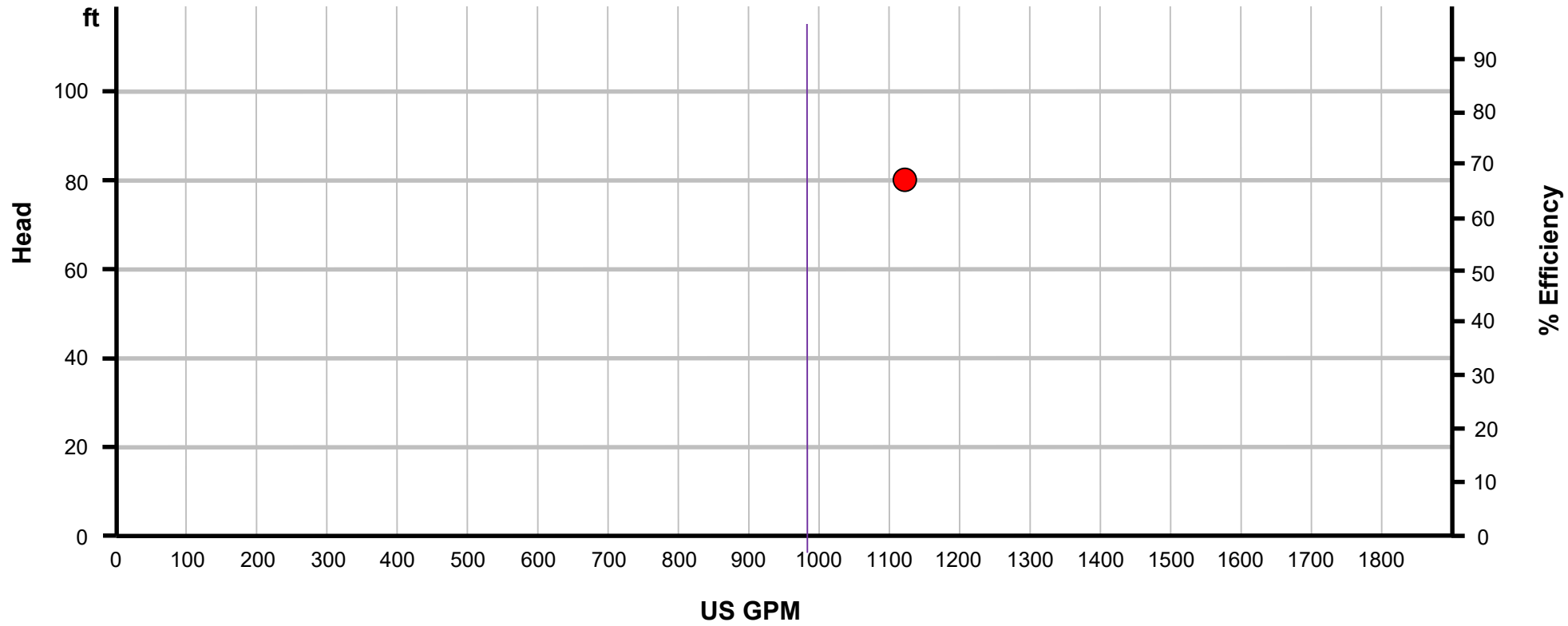


Pump Selection Summary	
Duty Point Flow	1115 US gpm
Duty Point Head	40 ft
Control Head	0 ft
Duty Point Pump Efficiency	86.6 %
Part Load Efficiency Value (PLEV)	0.0 %
Impeller Diameter	10.75 in
Motor Power	15 hp
Duty Point Power	13.1 bhp
Motor Speed	1200 rpm
RPM @ Duty Point	1150 rpm
NPSHr	7.34 ft
Minimum Shutoff Head	46.1 ft
Minimum Flow at RPM	292 US gpm
Flow @ BEP	1269 US gpm
Fluid Temperature	68 °F
Fluid Type	Water
Weight (approx. - consult rep for exact)	875 lbs
Pump Floor Space Calculation	12.32 ft²

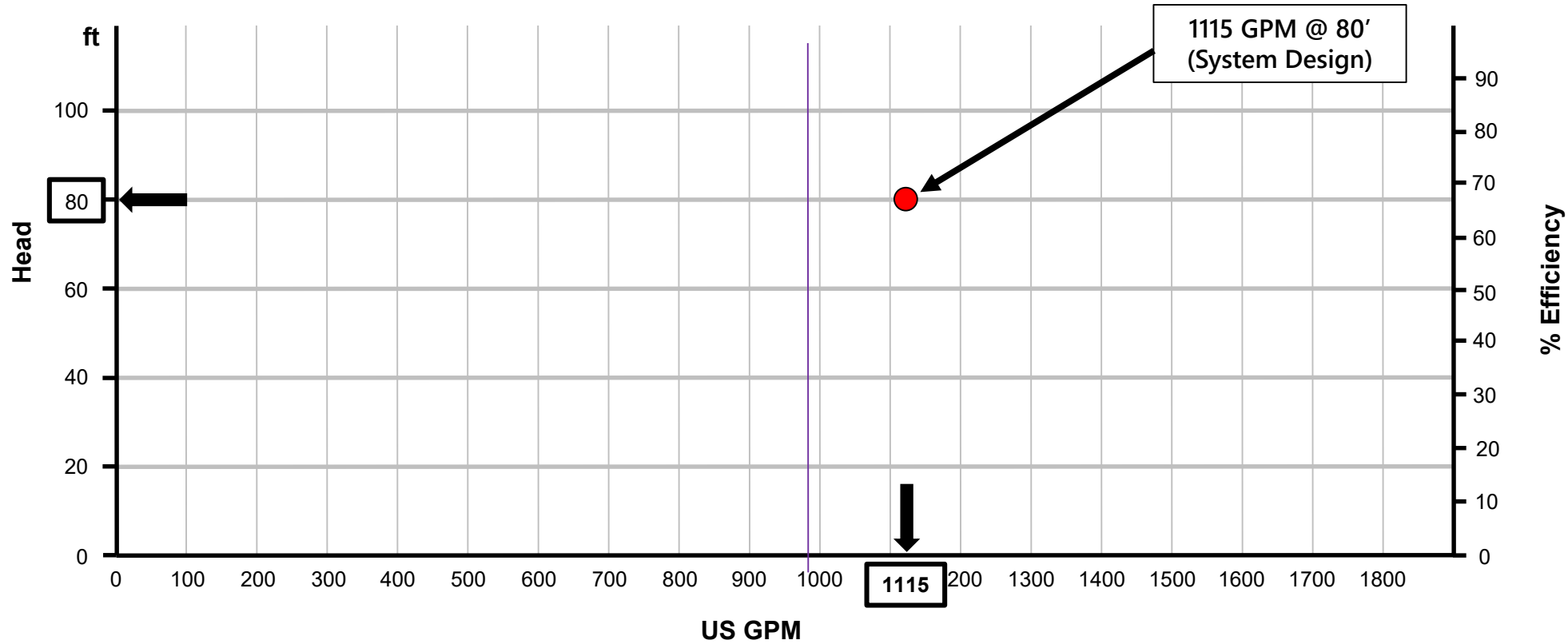
(2) e-1510 6E with 10.75" Impeller  
 1,115 GPM @ 40' each

- 13.1 BHP each (15HP Mtr. NOL)
- 86.6% Eff. @ Duty Point
- 7.34' NPSHR
- 292 GPM Min. Flow (Per Pump)
- 1,269 GPM (Flow @ BEP)

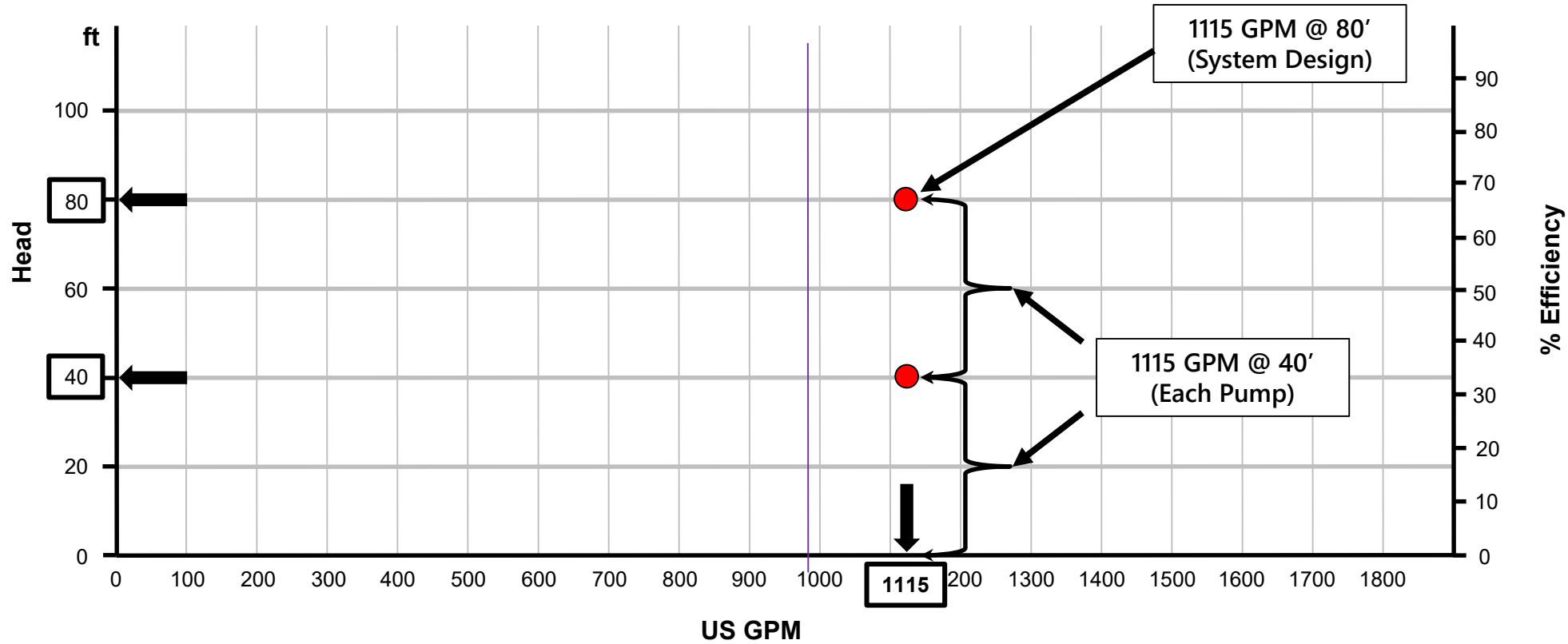
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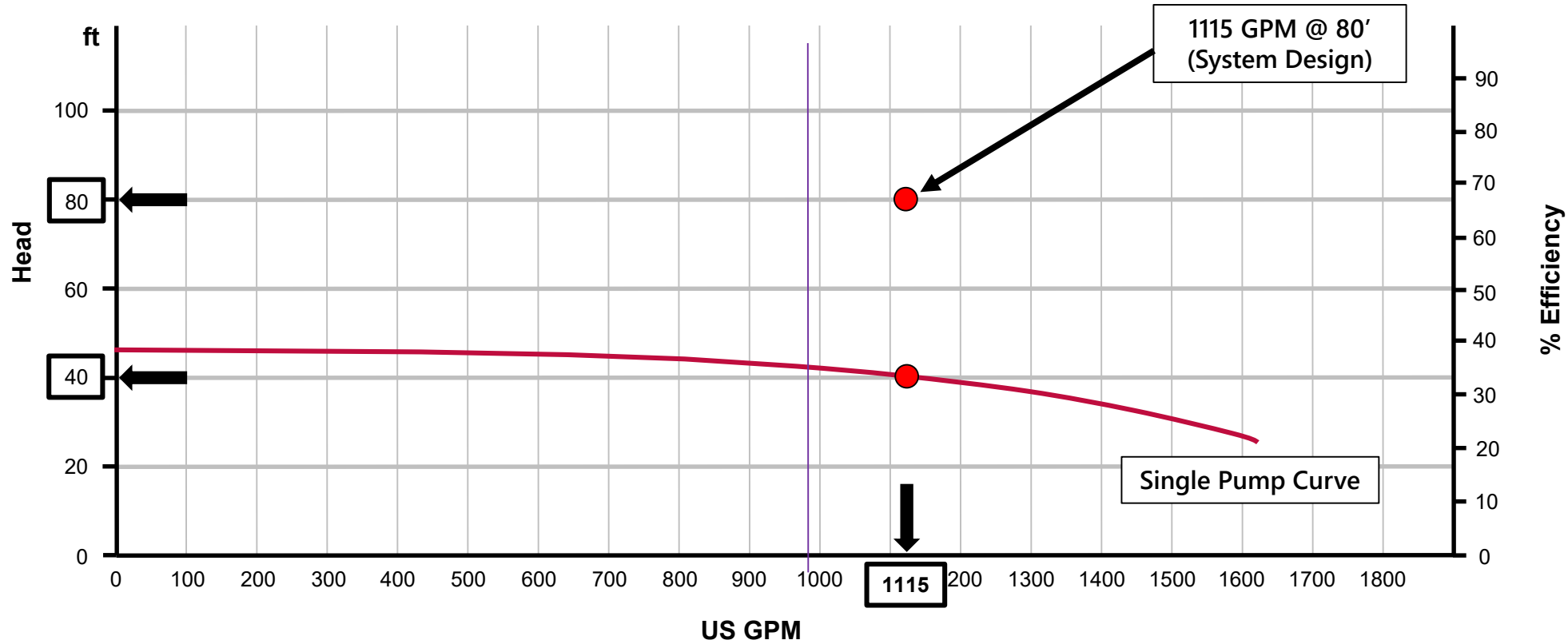


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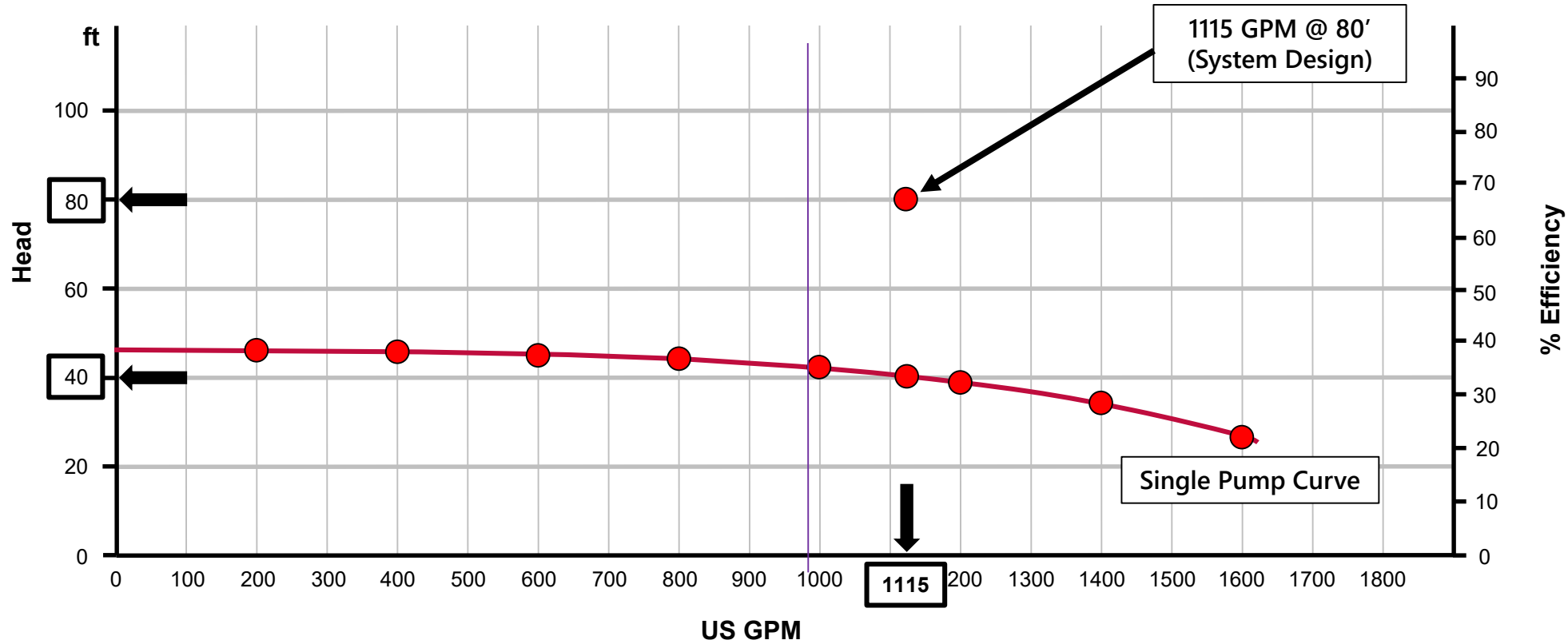




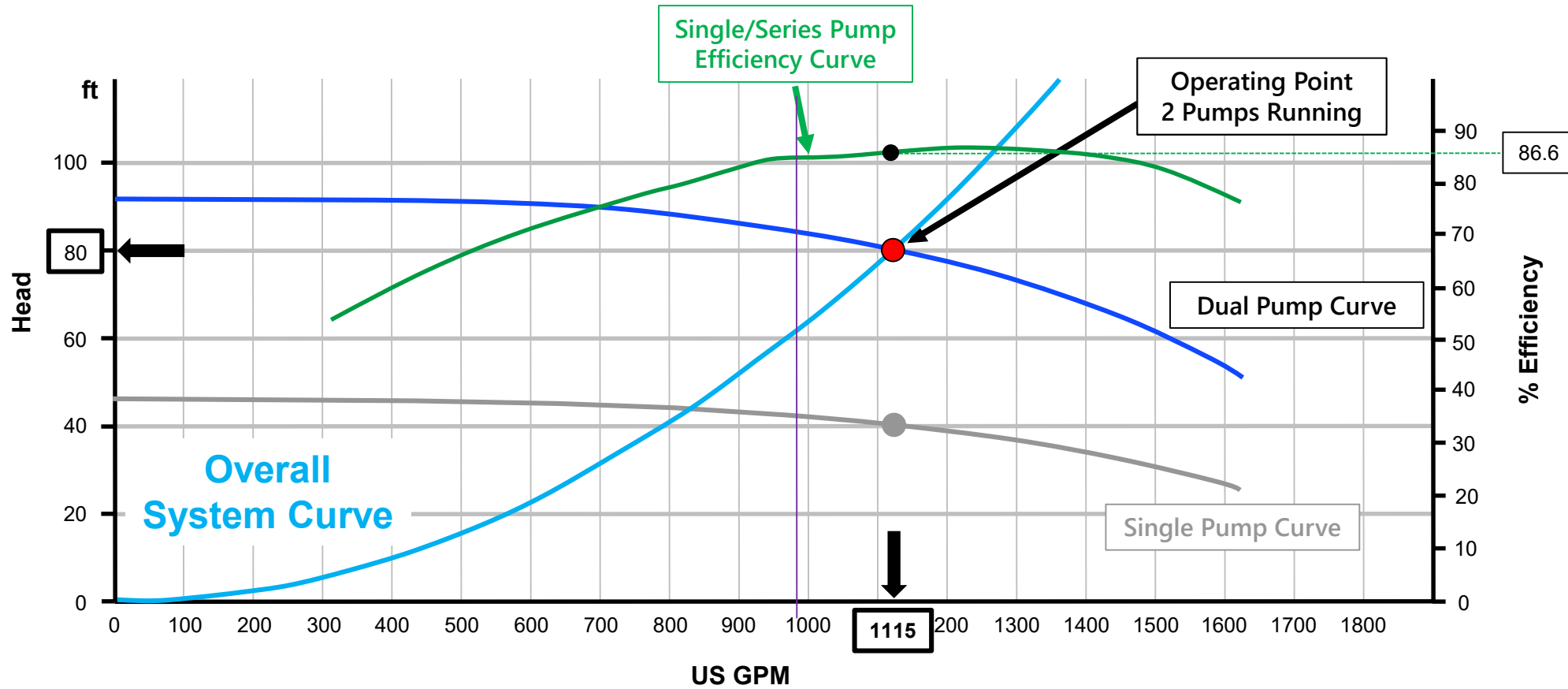
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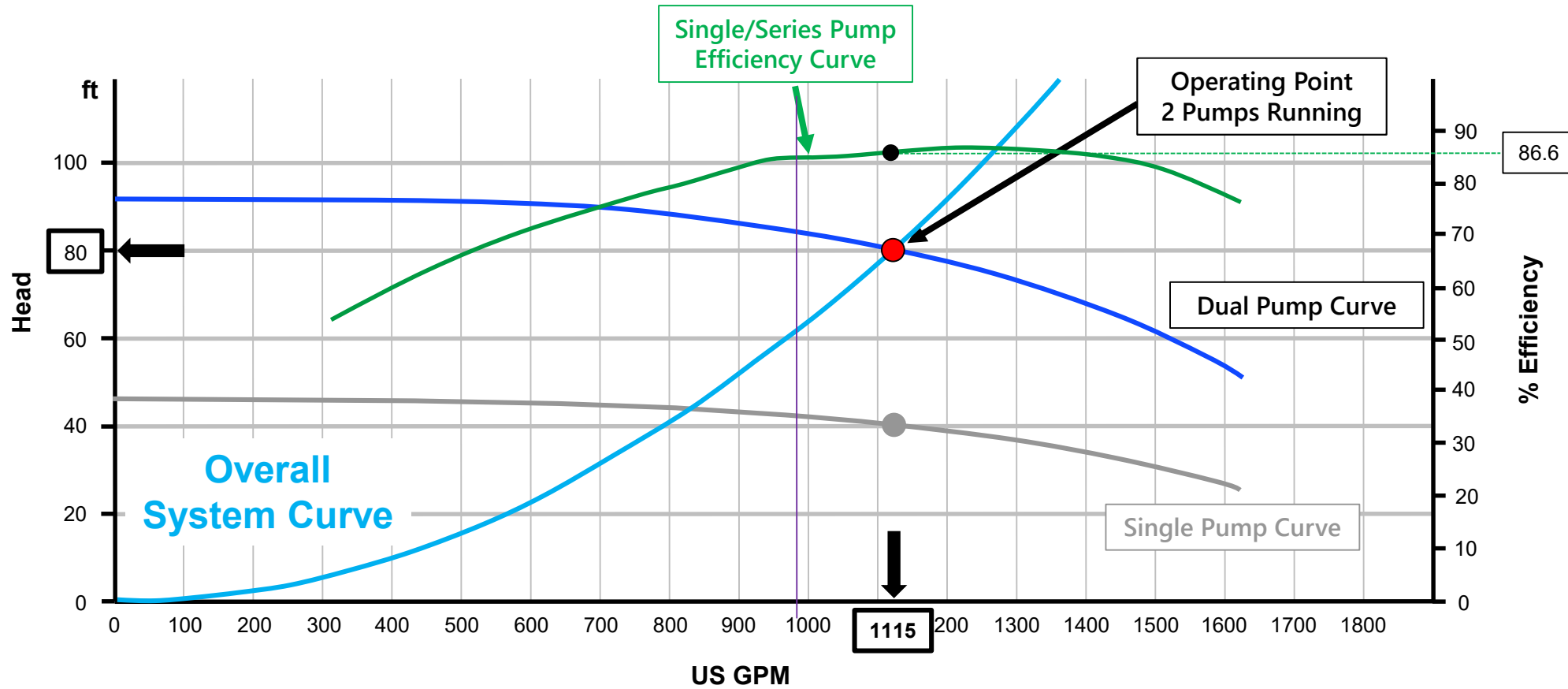
# Series Pumping – 50% Duty Head per Pump (No Standby)



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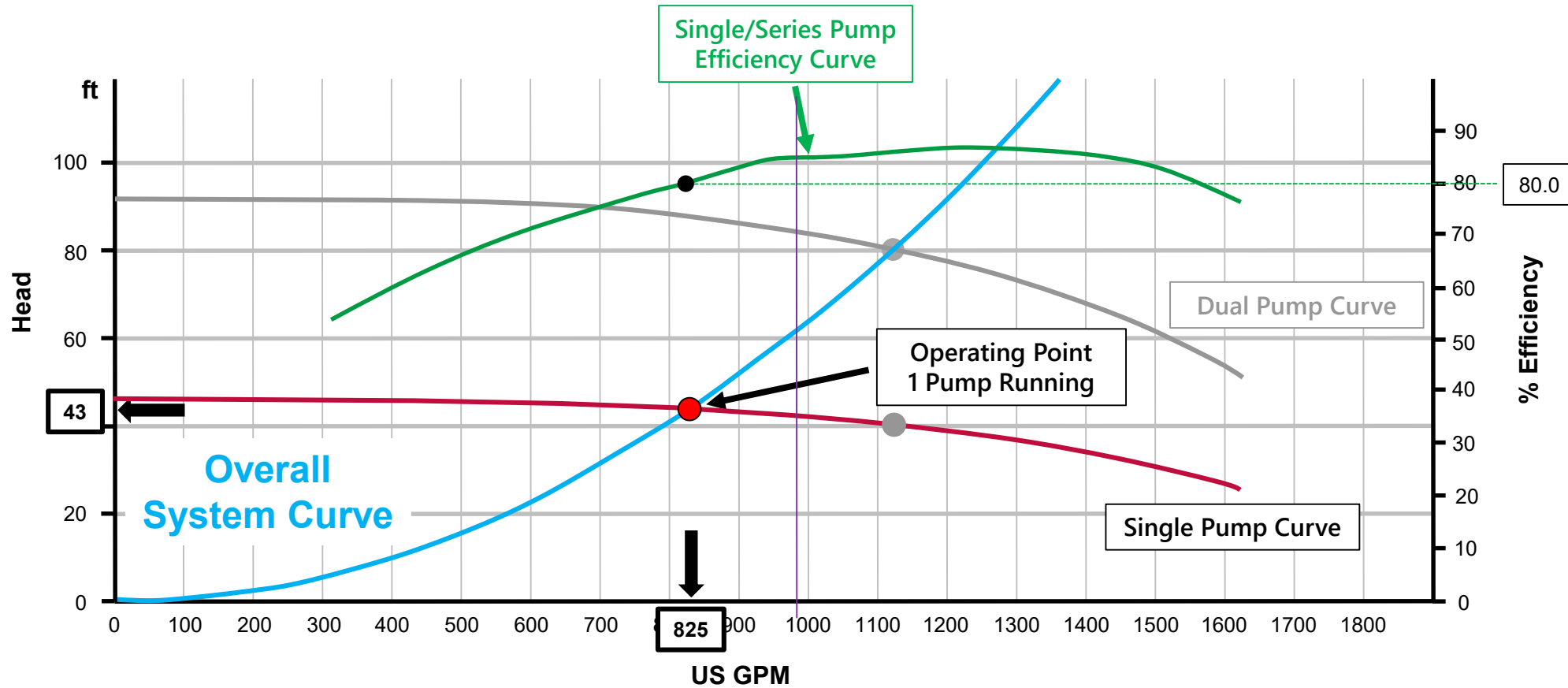


# Series Pumping – 50% Duty Head per Pump (No Standby)



What happens when 1 pump is turned off?

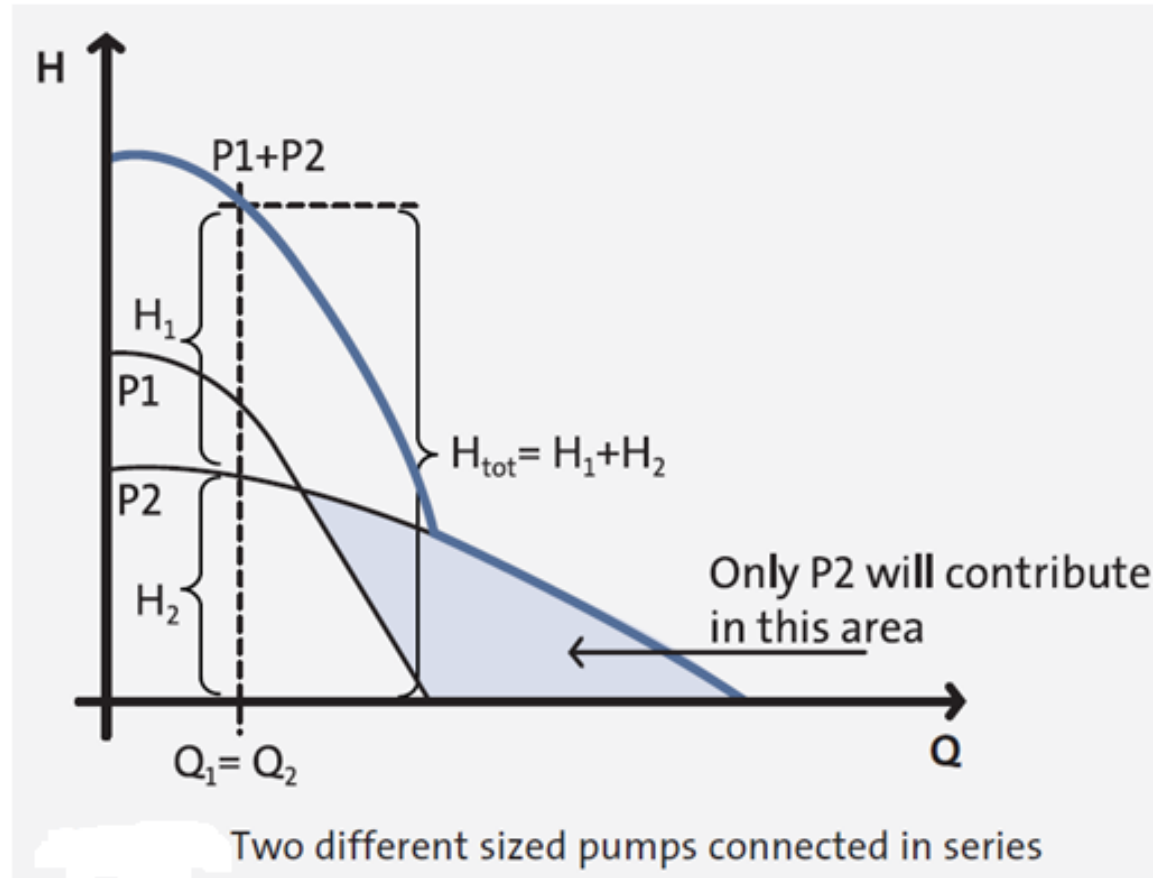
# Series Pumping – 50% Duty Head per Pump (No Standby)



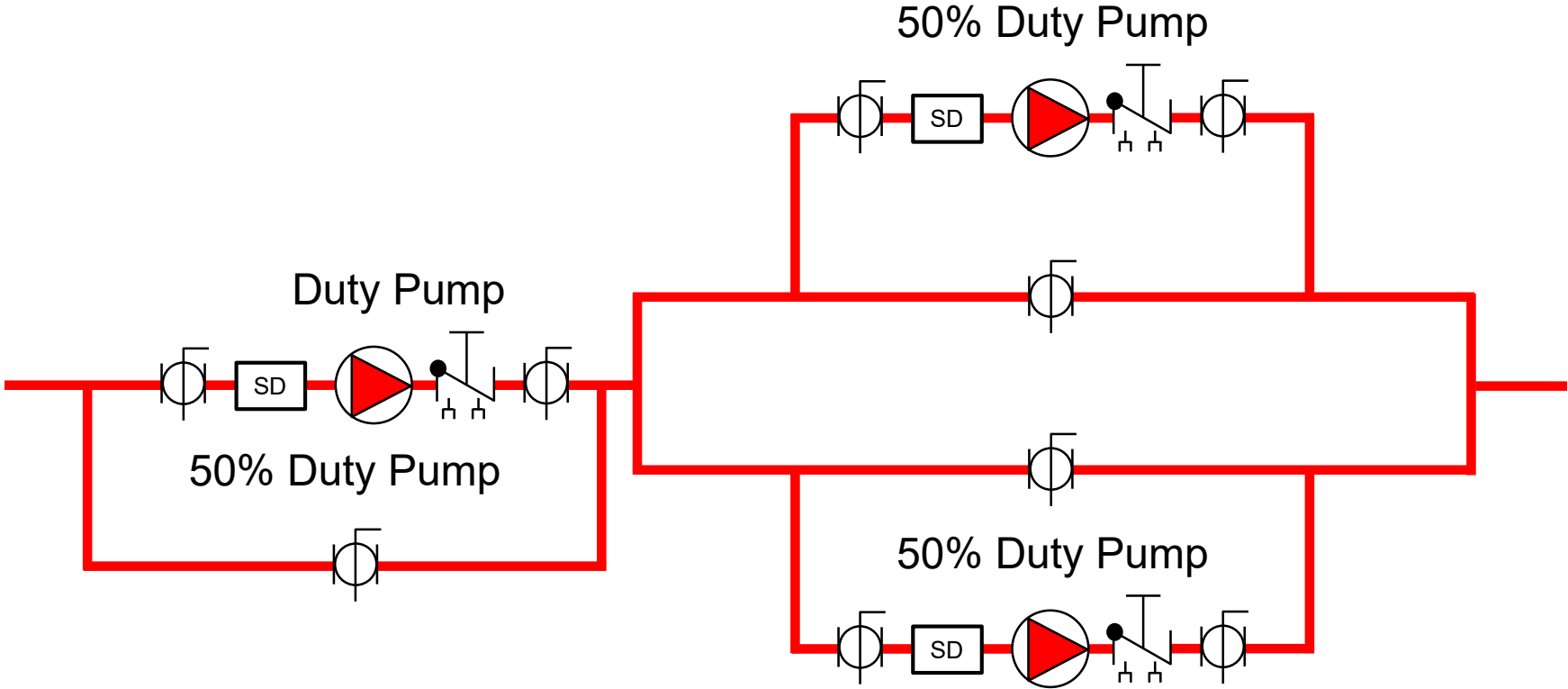
What happens when 1 pump is turned off?

**825 GPM/1115 GPM = 74%  
Redundant Capacity**

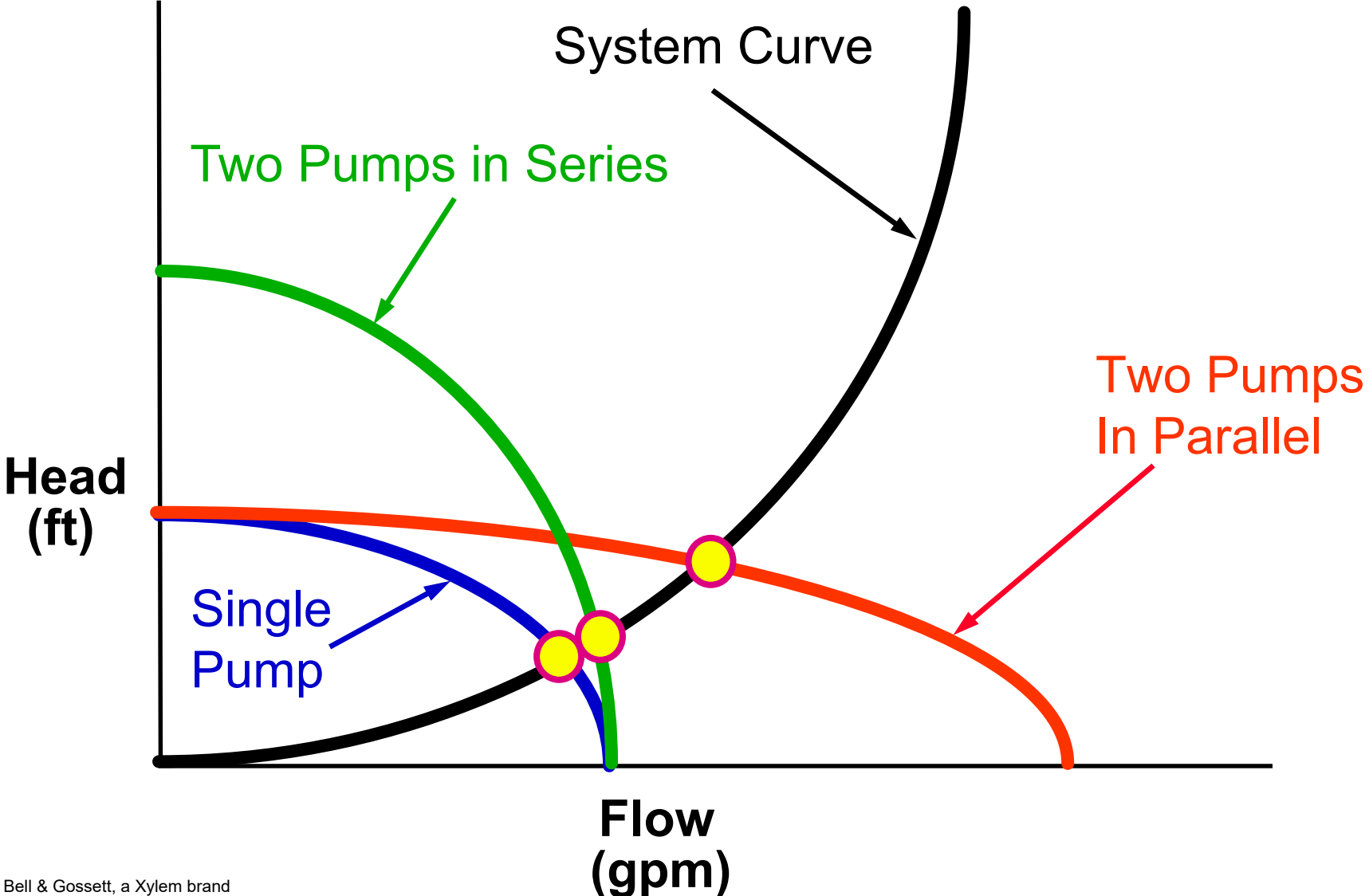
# Series Pumping – Different Size Pumps



# Combination Parallel & Series Pump Configuration

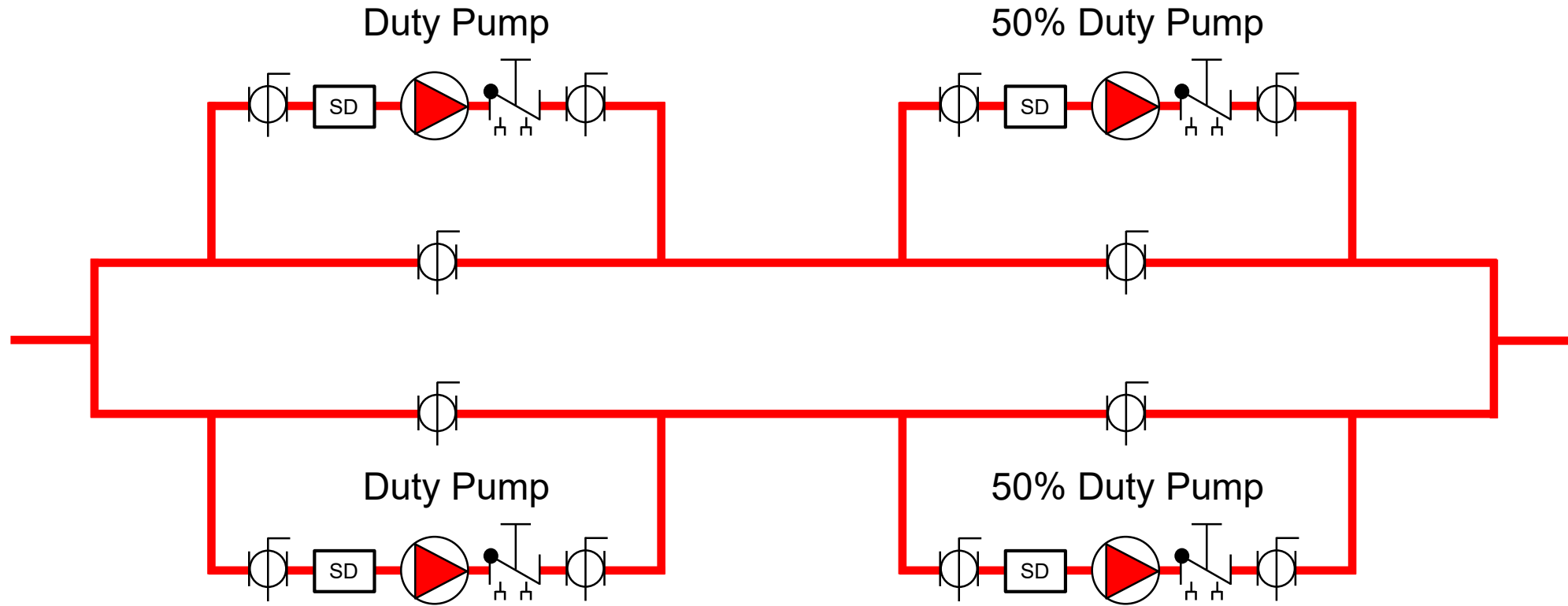


# Combination Parallel & Series Pump Configuration





# Combination Parallel & Series Pump Configuration



# Combination Parallel & Series Pump Configuration

