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Let's Solve Water

The Little Red Schoolhouse

Large Chilled Water System Design Seminar

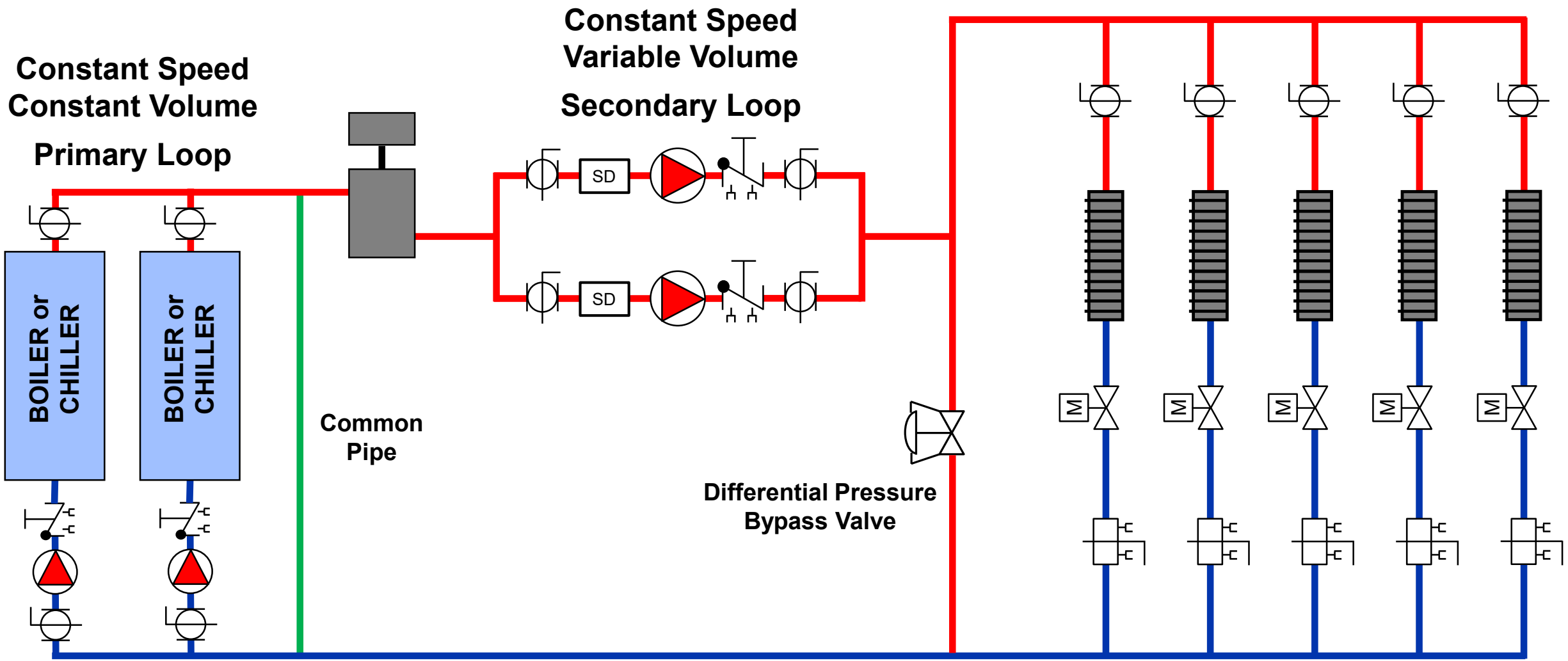
Courtesy of Oslin Nation Company

Parallel & Series Pumping

Bell & Gossett
a xylem brand

Quick Review: Single Pump delivering 100% Duty Point

Constant Speed, Variable Volume Secondary Pumping



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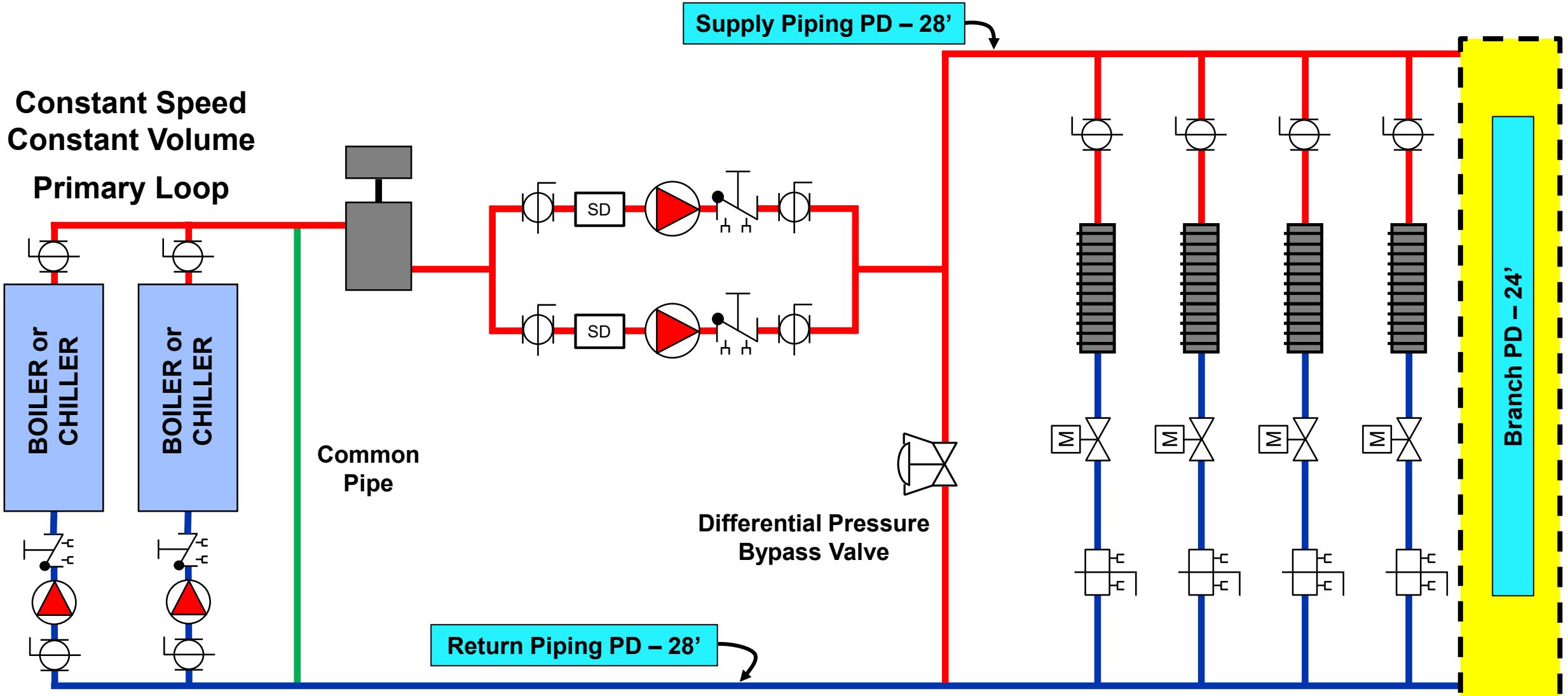
Constant Speed, Variable Volume Secondary Pumping



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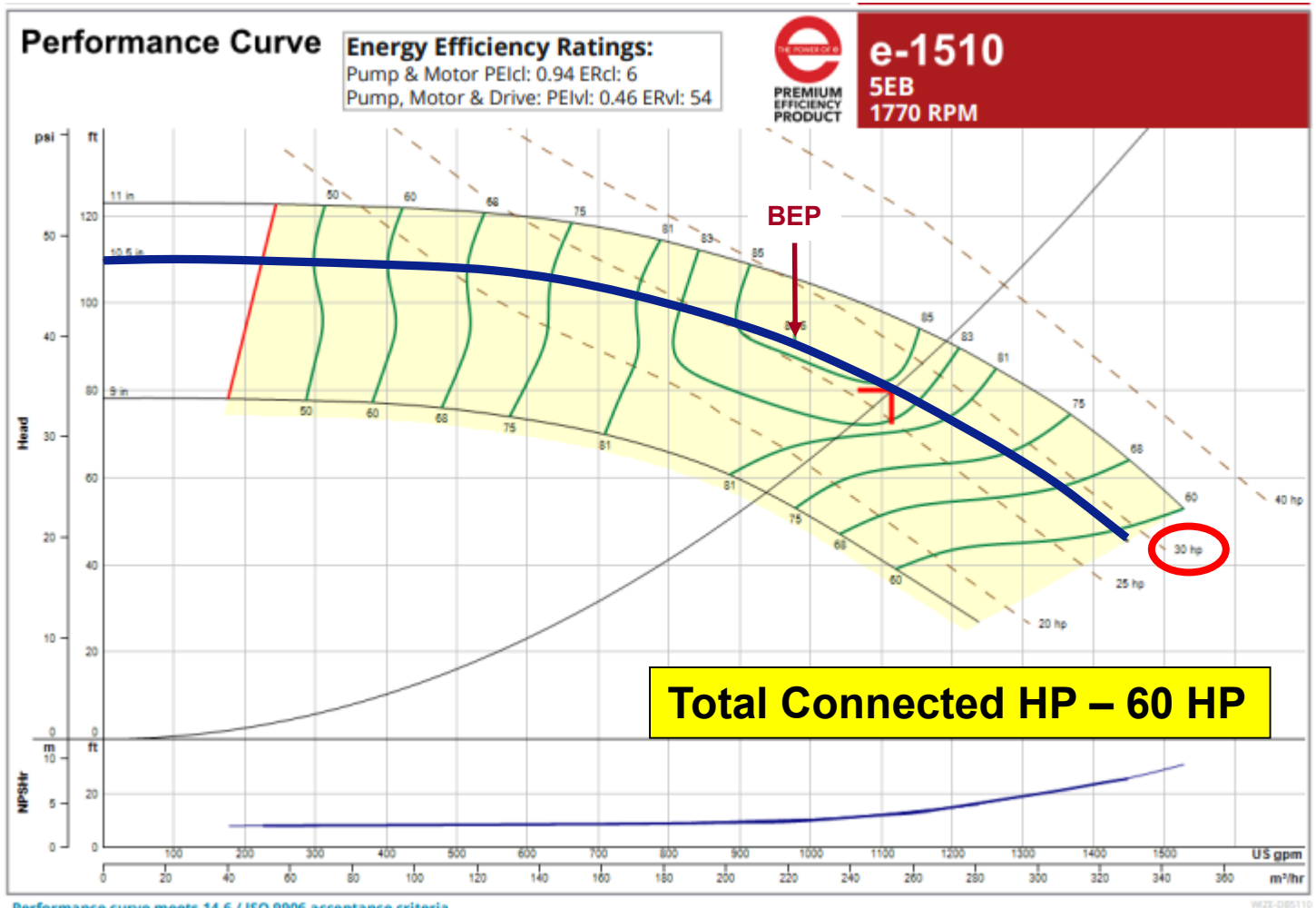
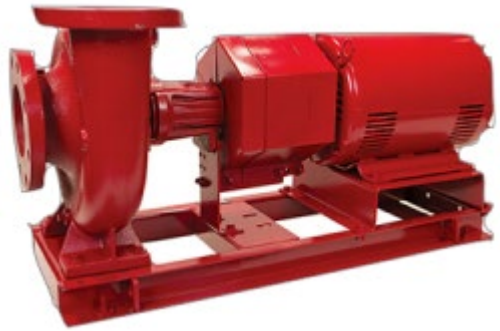
Pump Selection – 100% Duty - 100% Standby



Pump Selection Summary	
Duty Point Flow	1115 US gpm
Duty Point Head	80 ft
Control Head	
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	
RPM @ Duty Point	
NPSHr	12.3 ft
Minimum Shutoff Head	110 ft
Minimum Flow at RPM	225 US gpm
Flow @ BEP	978 US gpm
Fluid Temperature	
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"

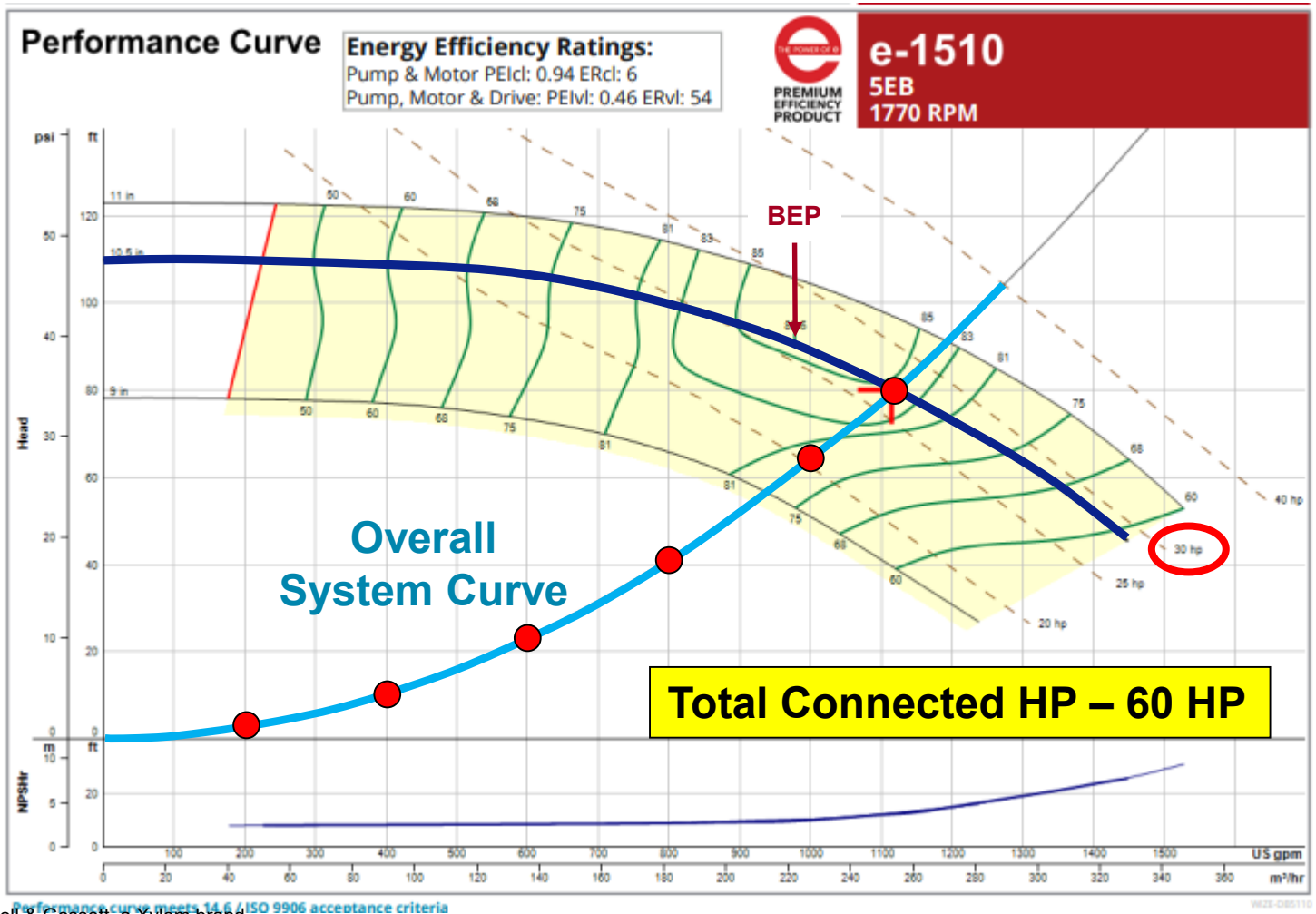
$$\left(\frac{Q_2}{Q_1}\right)^2 = \left(\frac{h_2}{h_1}\right)$$

Q_1 = Known Flow

Q_2 = Final Flow

h_1 = Known Head

h_2 = Final Head



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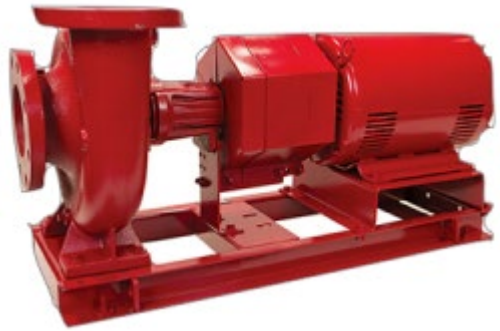

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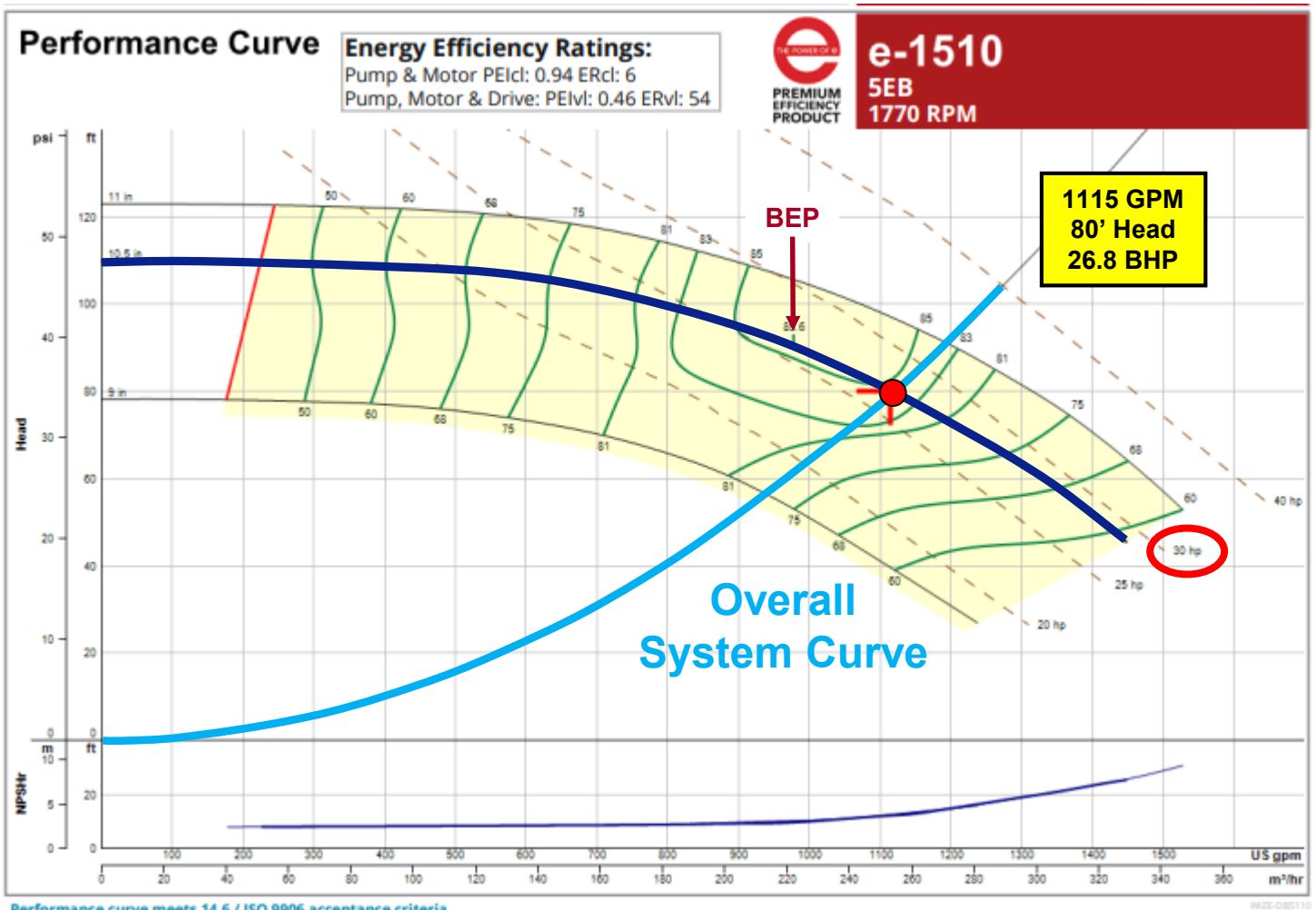
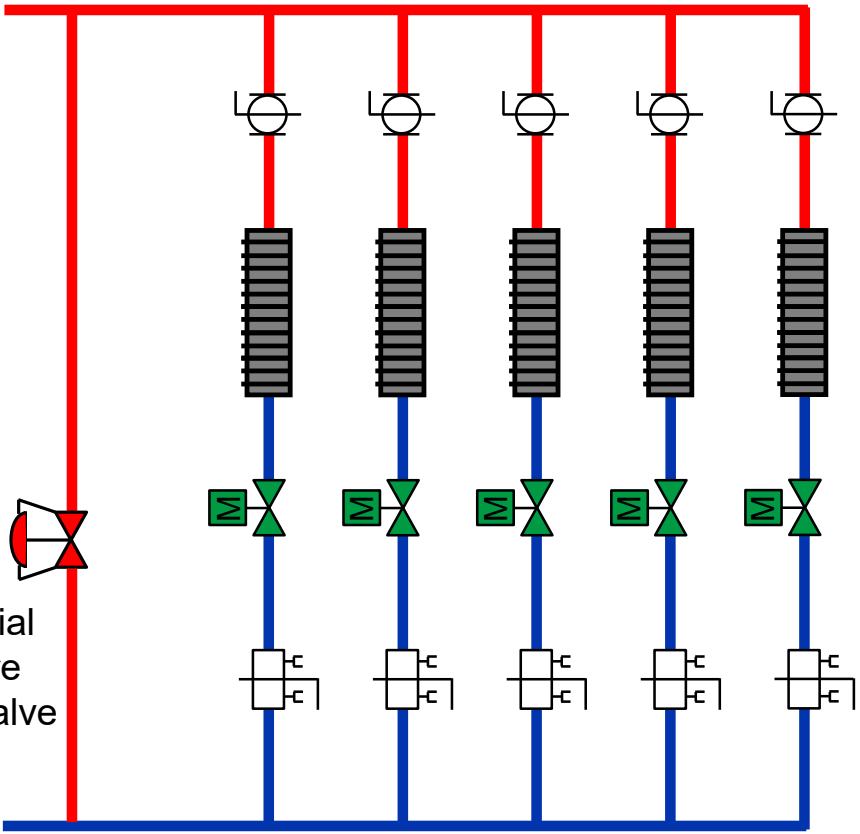
What influence will a Control Valve have on the System Curve?





Differential
Pressure
Bypass Valve

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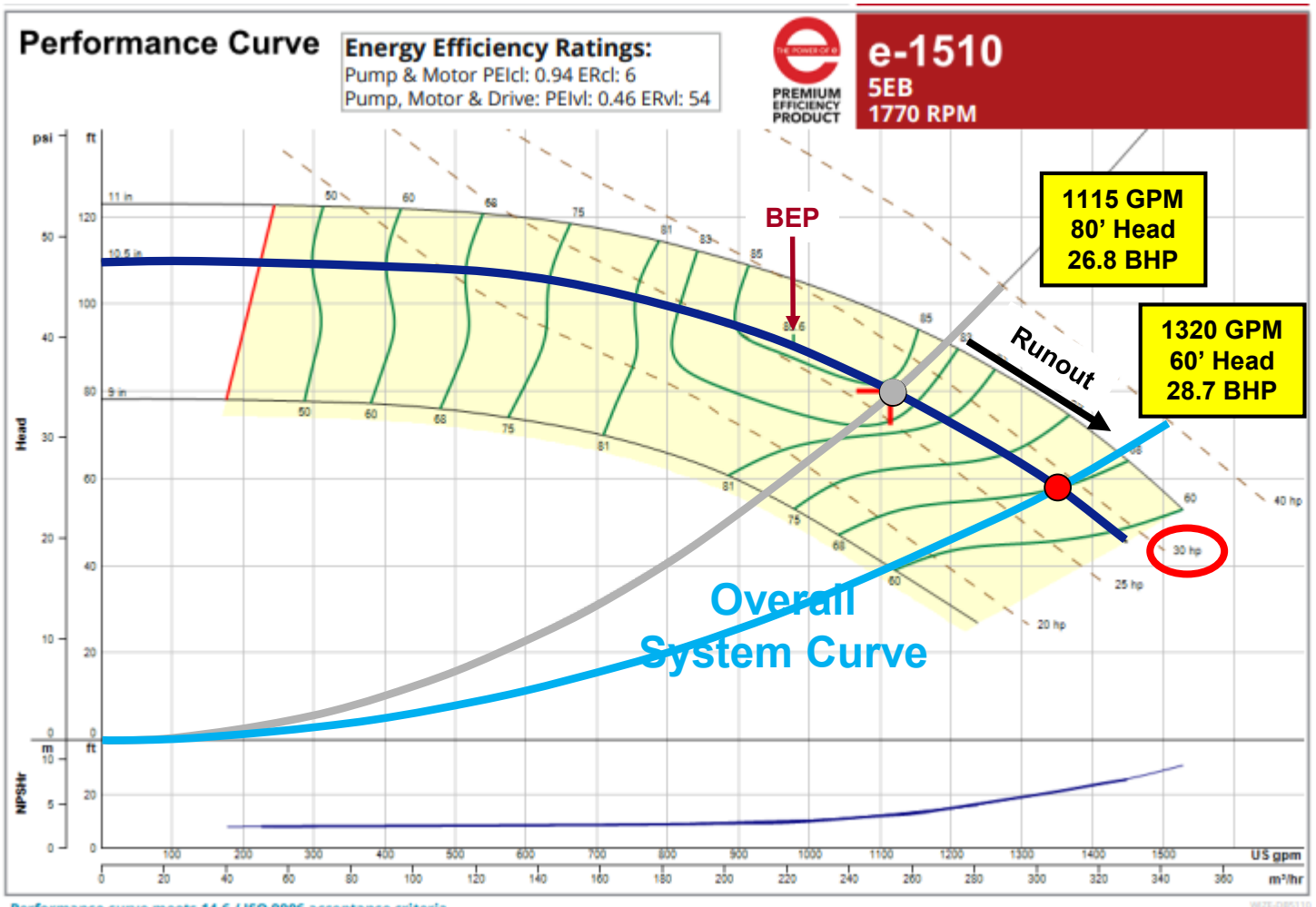

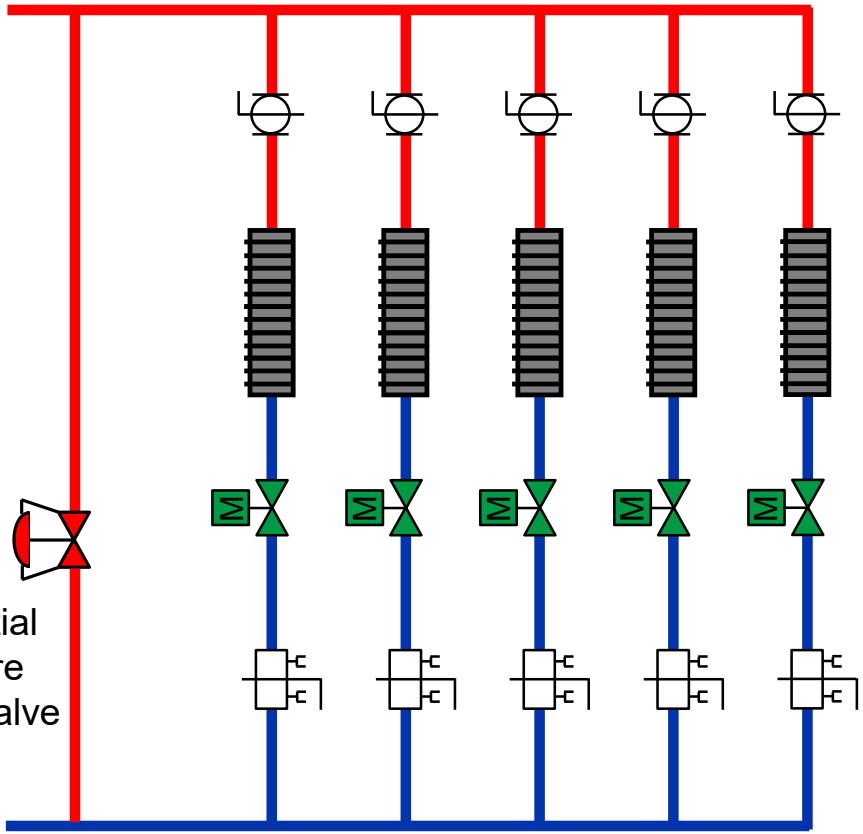

Differential Pressure Bypass Valve

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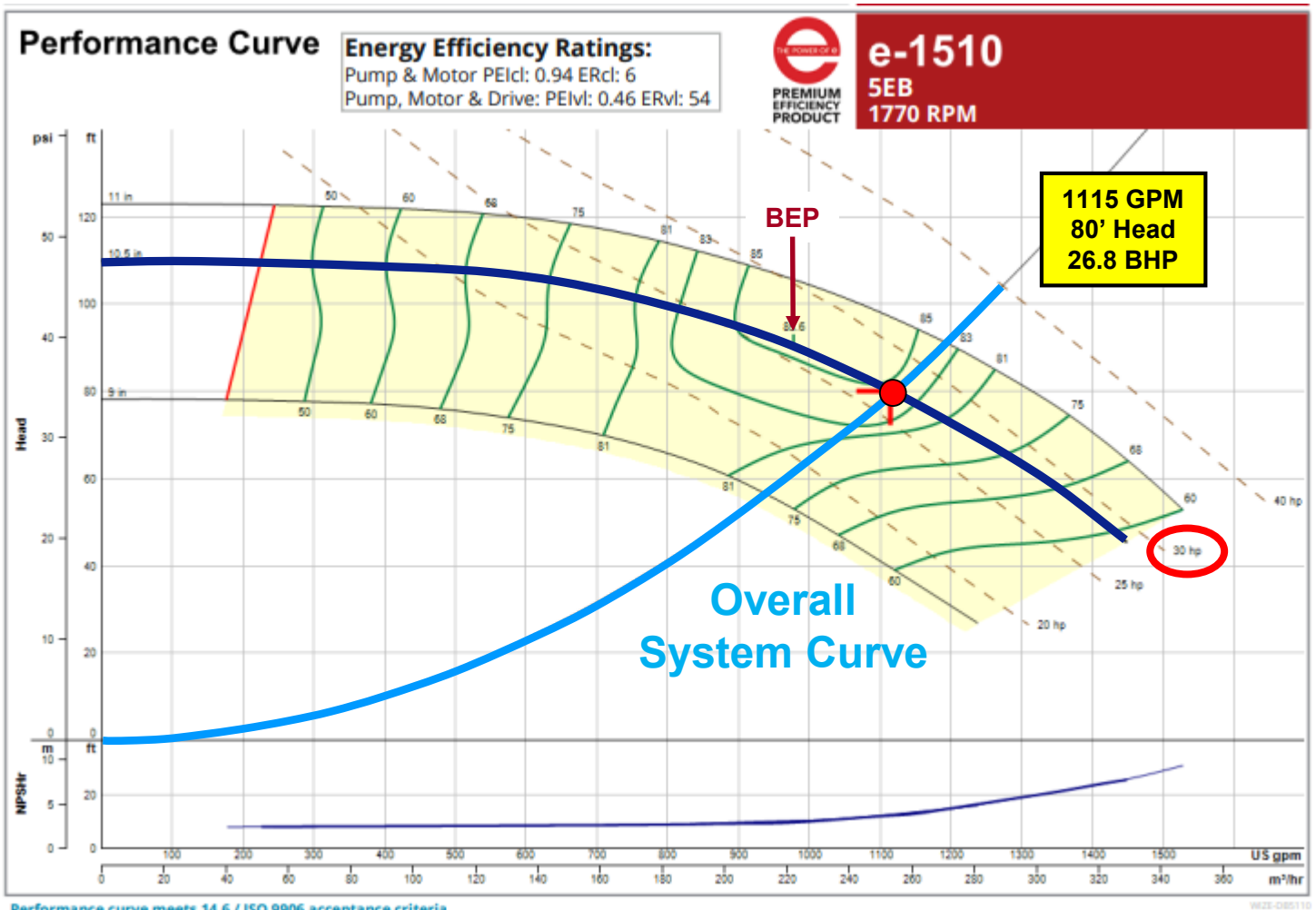

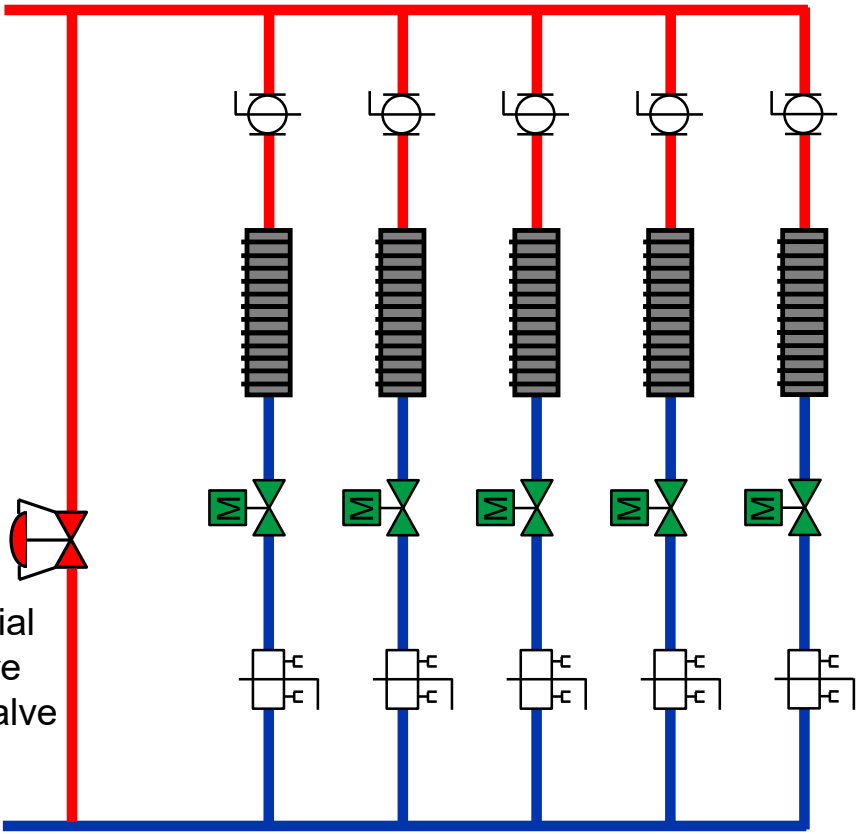

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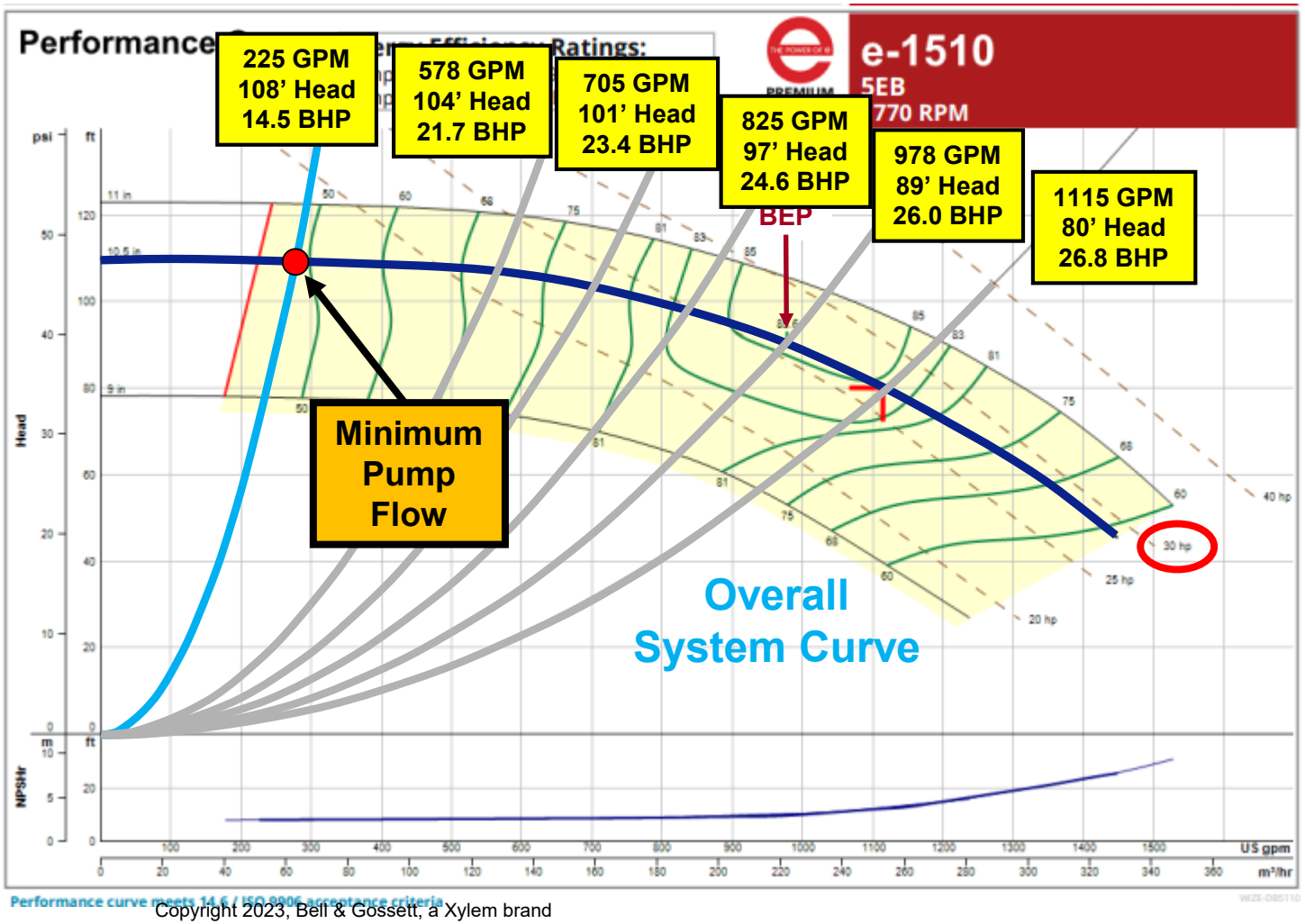

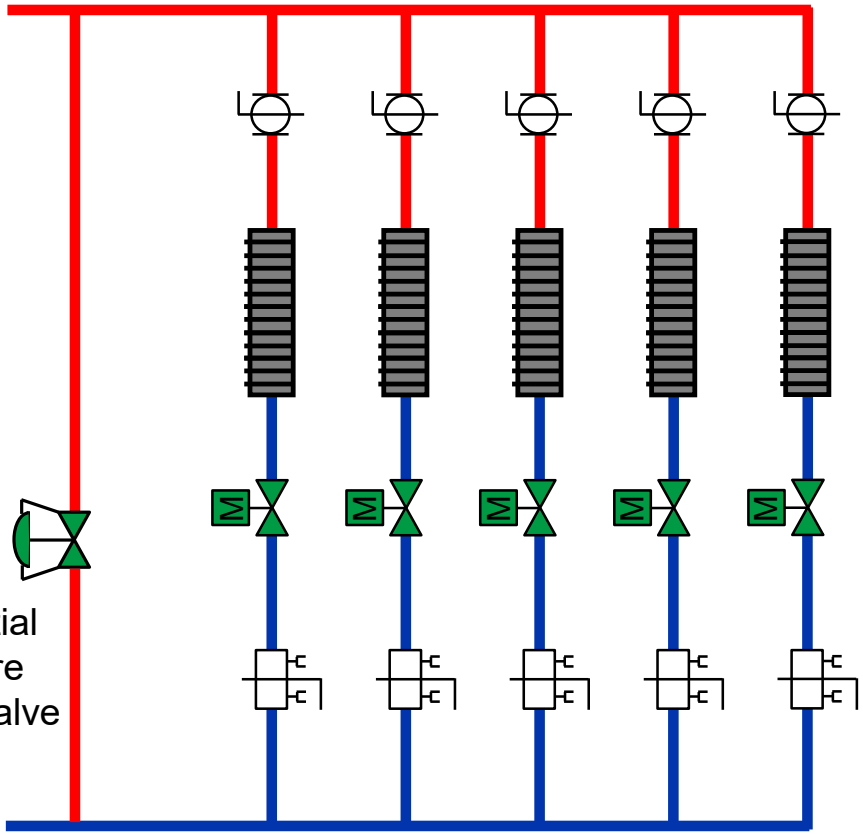

Differential
Pressure
Bypass Valve

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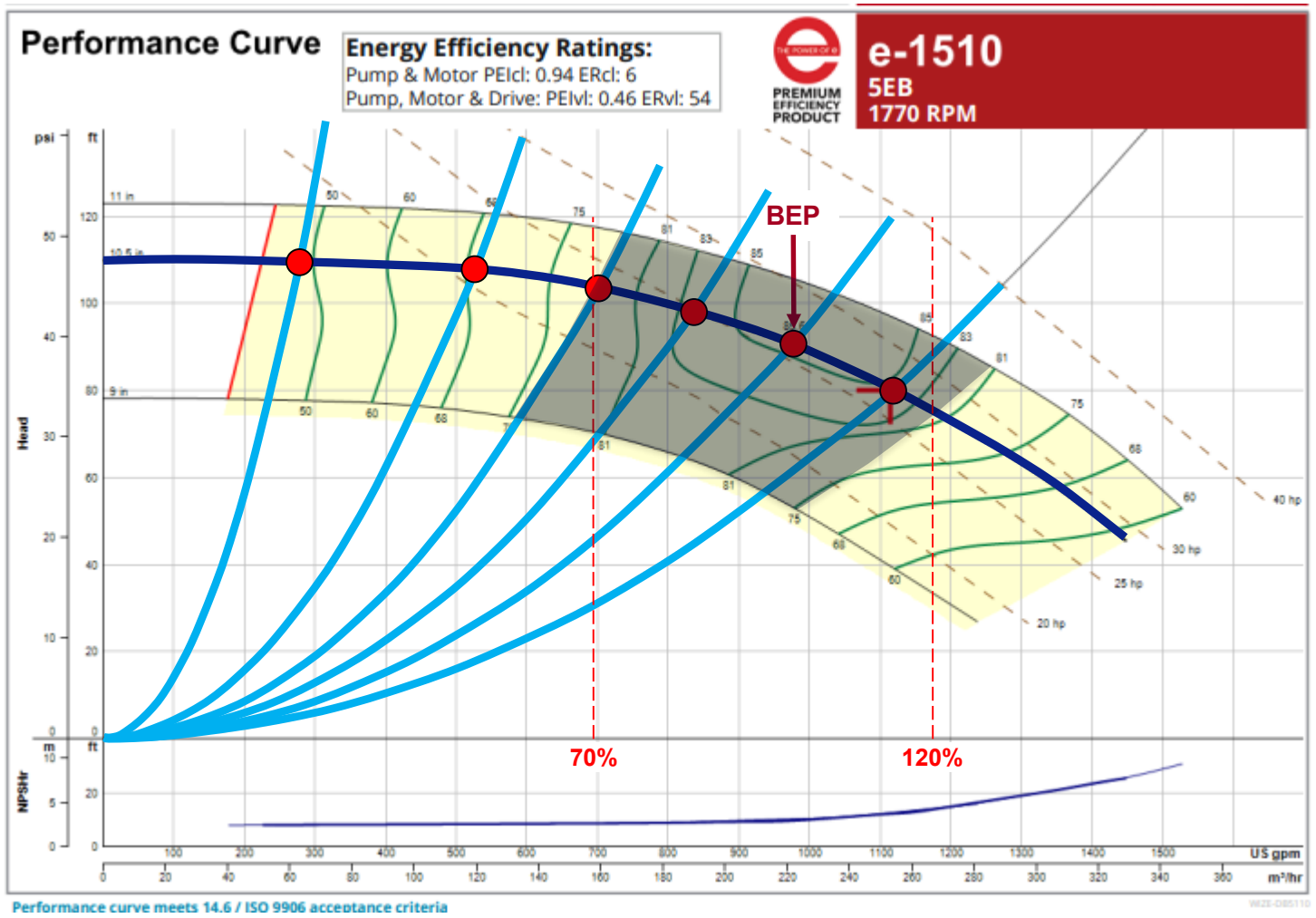
The “Preferred” and “Acceptable” Operating Regions



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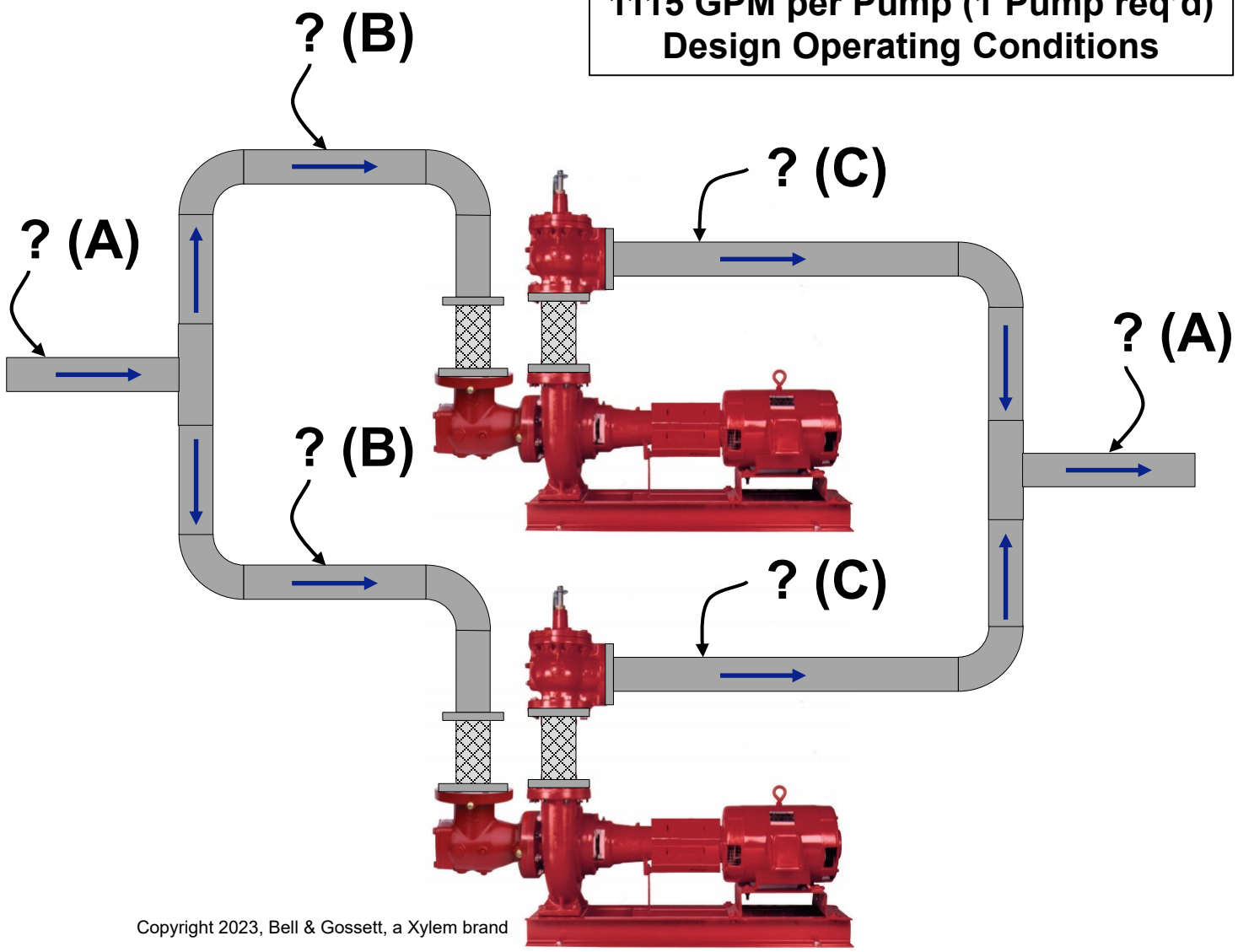
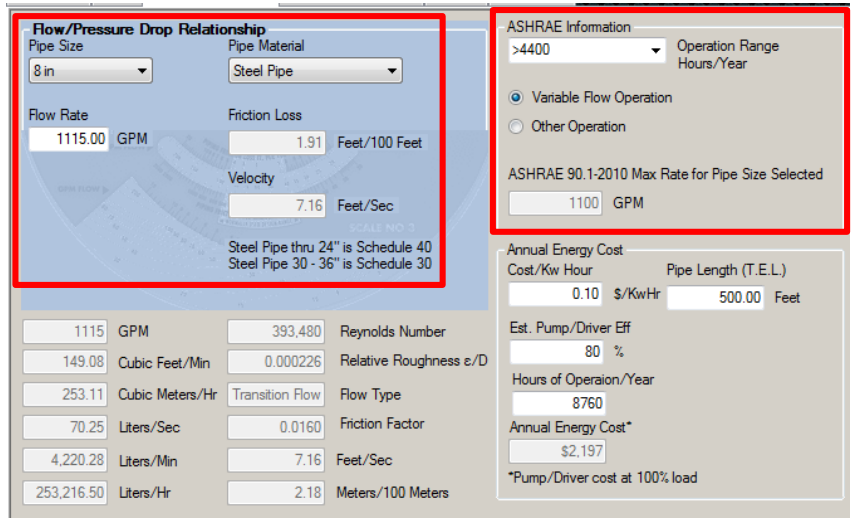
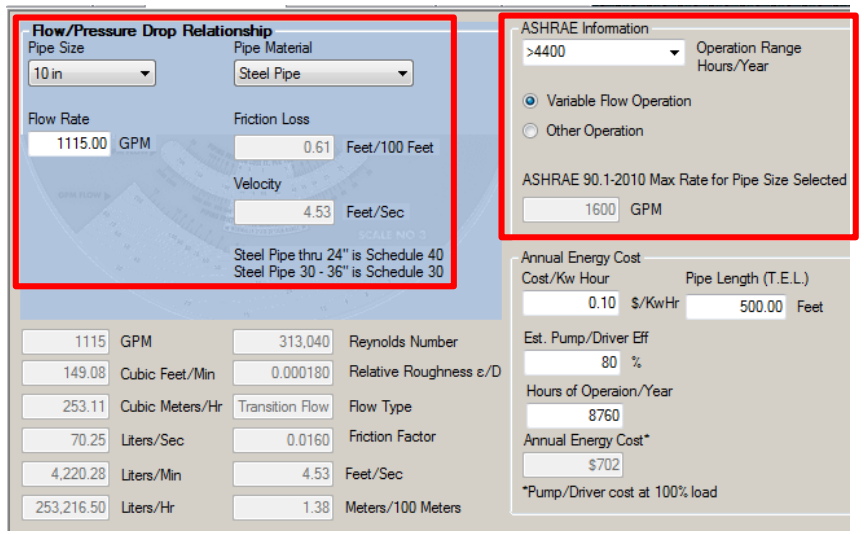
Pipe Size Selection for 100% Duty/100% Standby

_____ in Parallel

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







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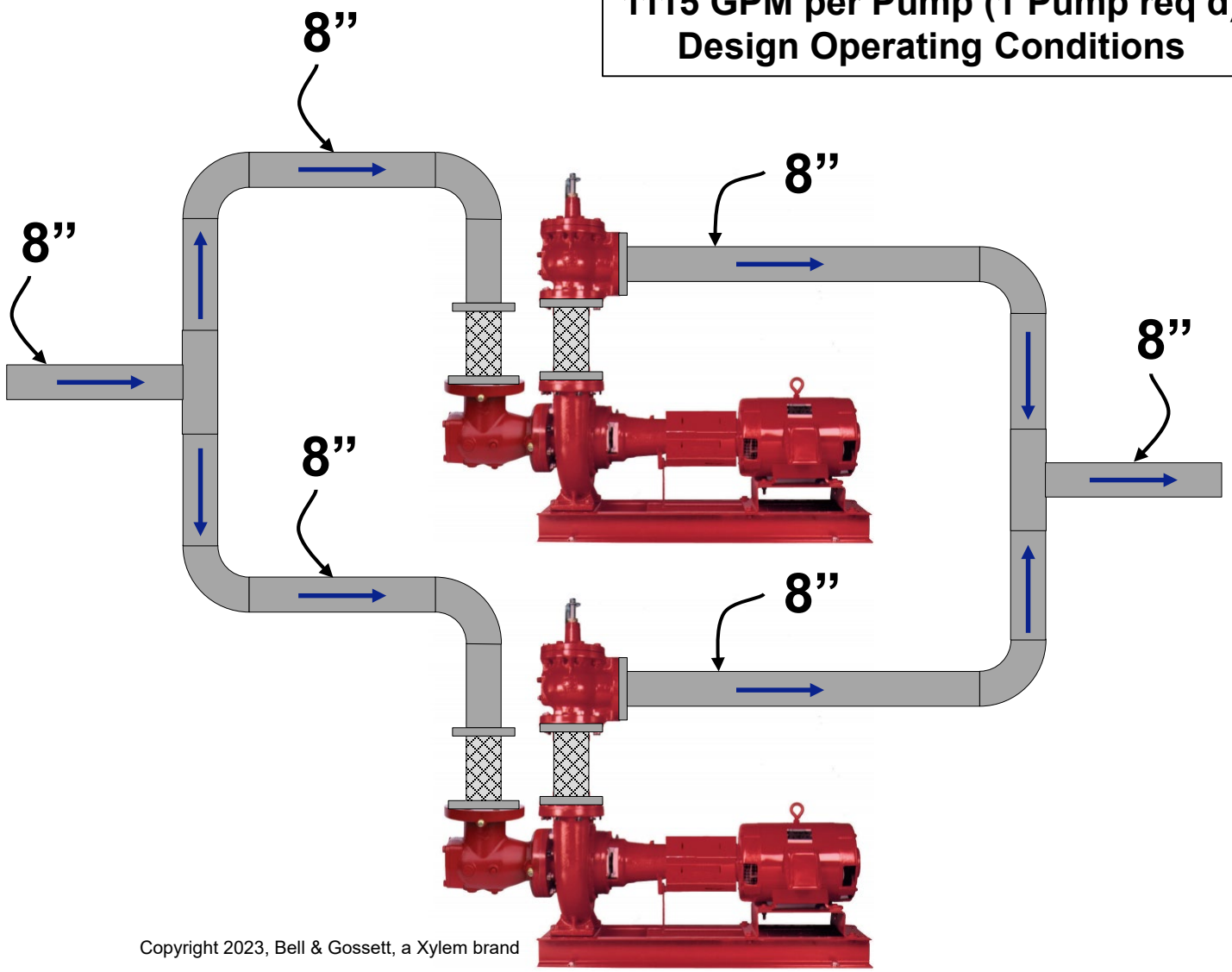

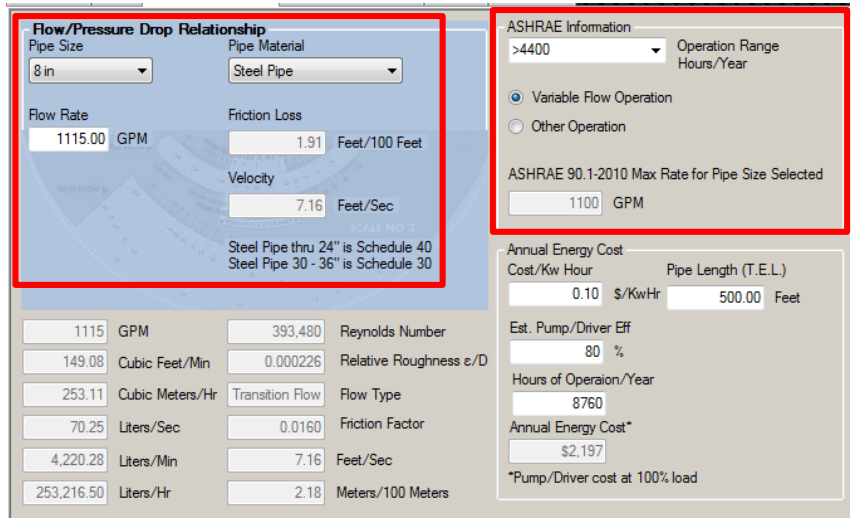

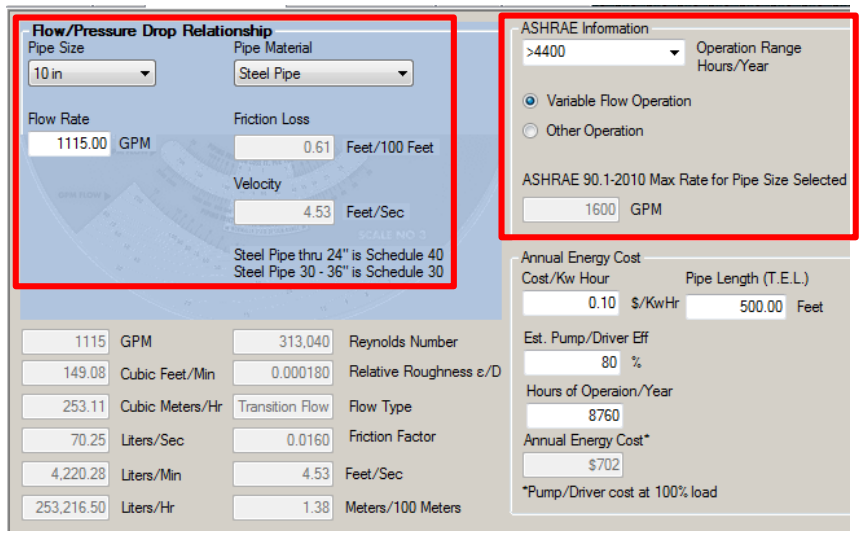

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Parallel Pumping: Using Multiple Pumps simultaneously

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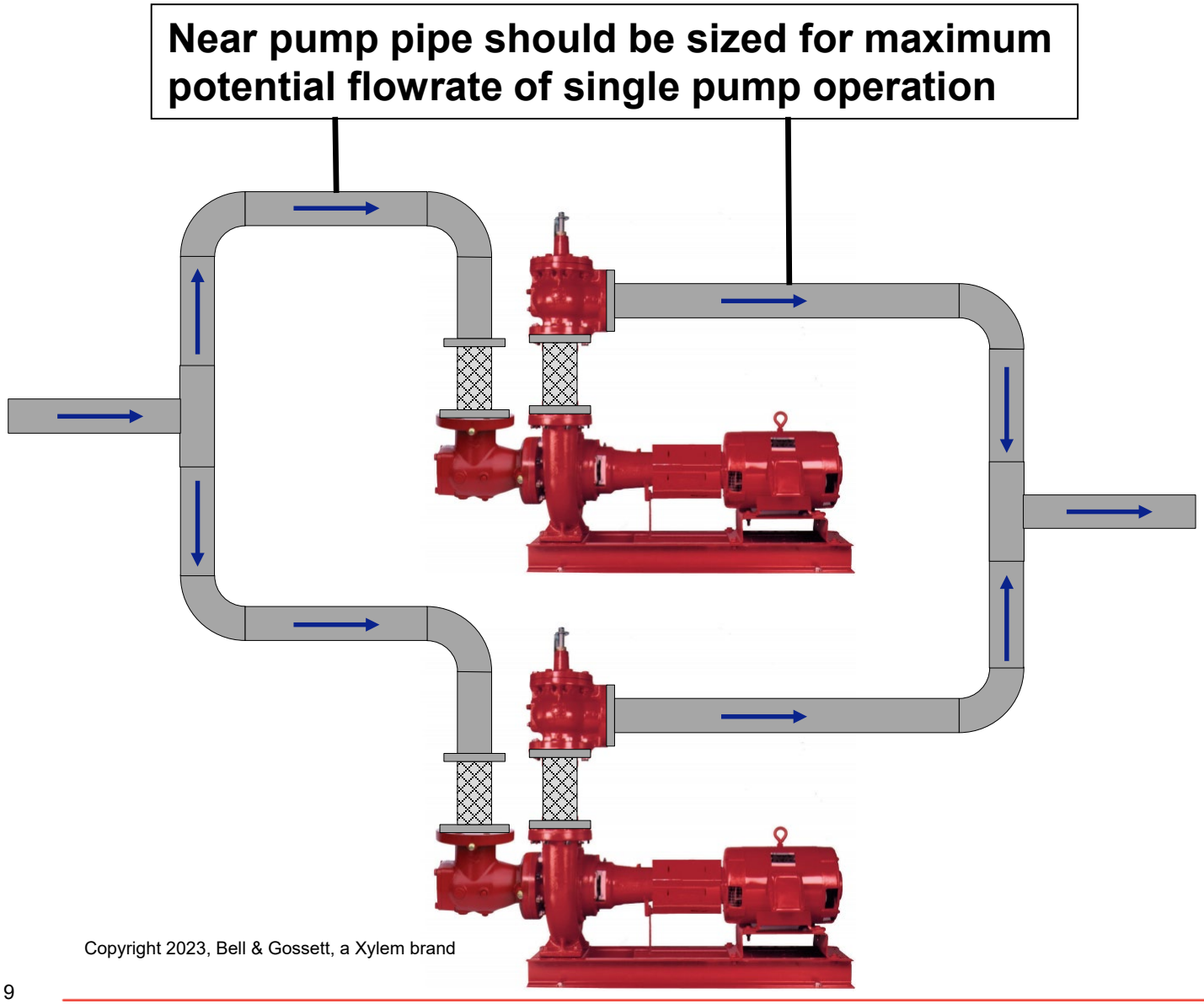
What is Parallel Pumping?



- 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.

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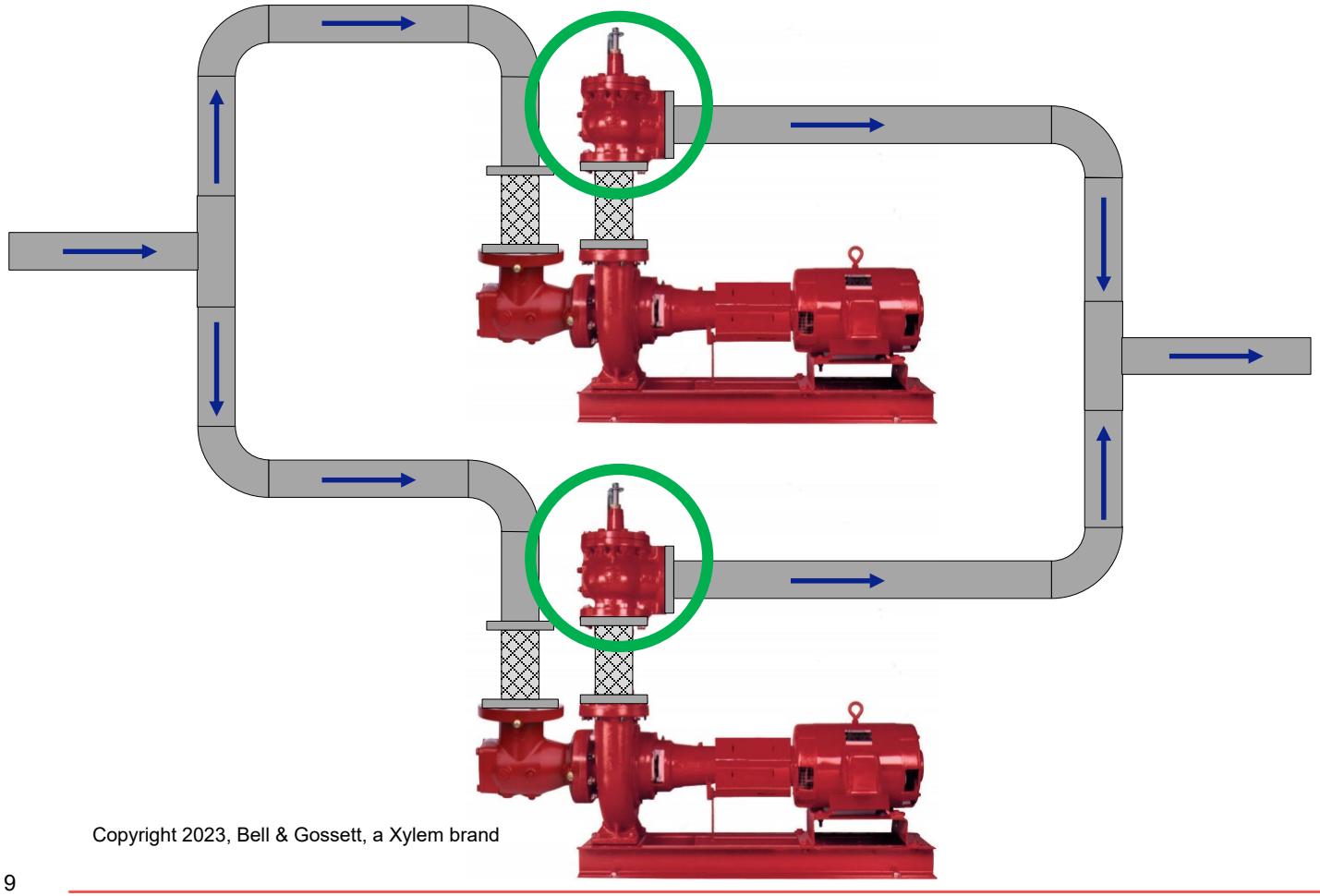
What is Parallel Pumping?

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

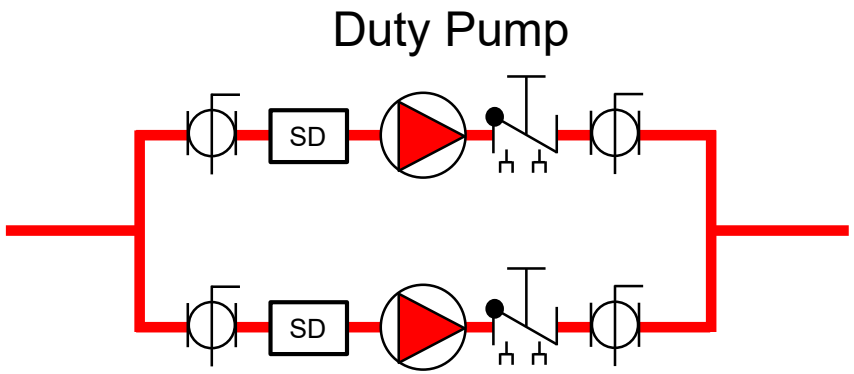


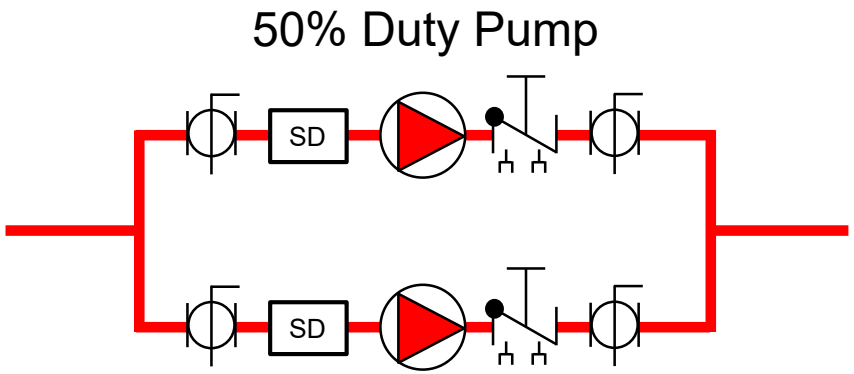
- Pumps receiving liquid from the same suction manifold and discharging into a common discharge manifold.
- Where design requires multiple pumps to run simultaneously, each pump contributes an equal percentage of the “Total” flow produced.

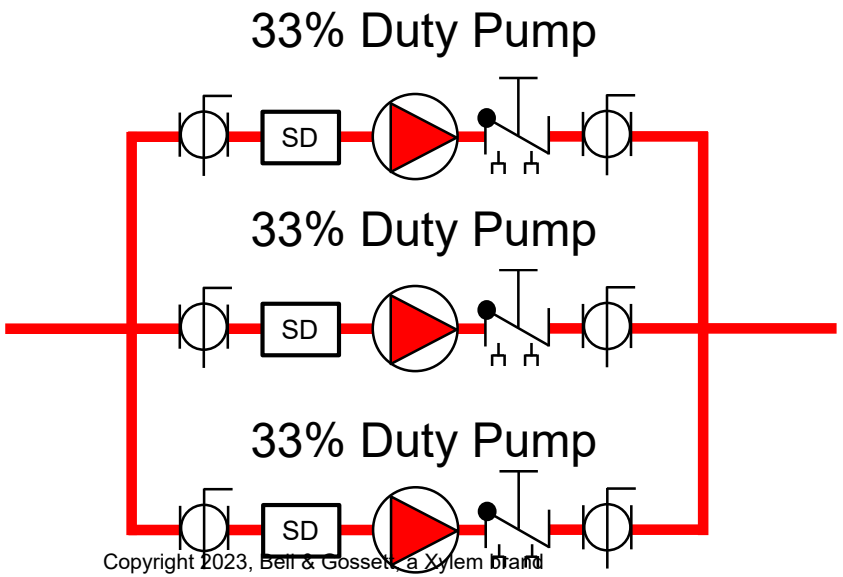
<u>Advantages</u>

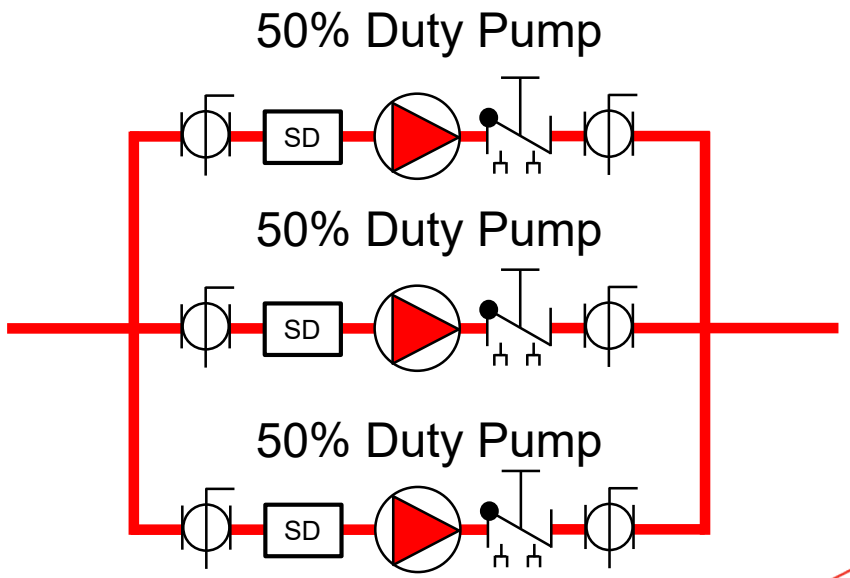
- Provides Adequate Redundancy
- Reduced Floor Space
- Lower Installed Cost
- Improved Turn-Down capabilities
- Pump “Best Efficiency” staging

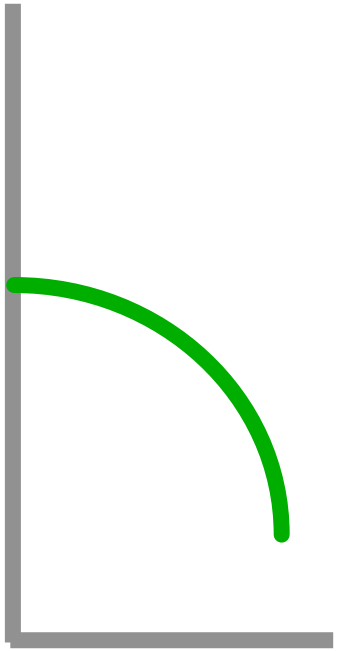
Common Parallel Pump Configurations



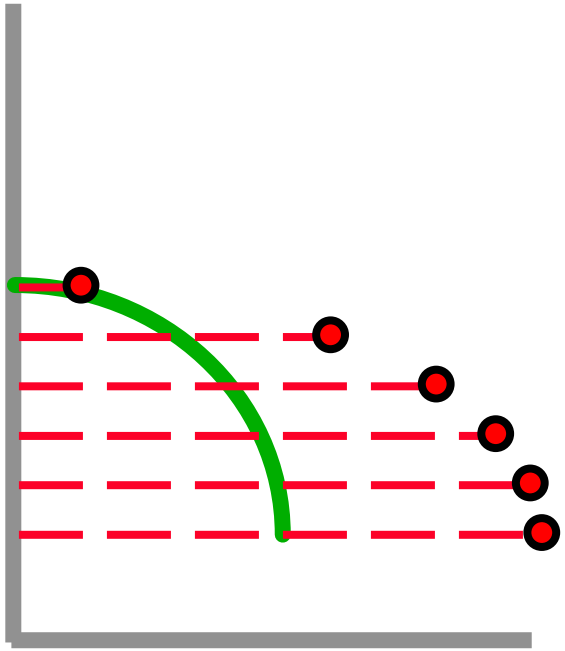




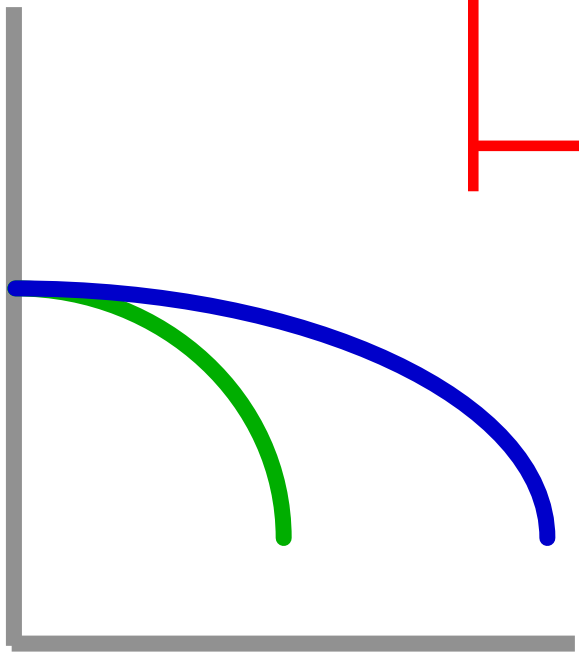




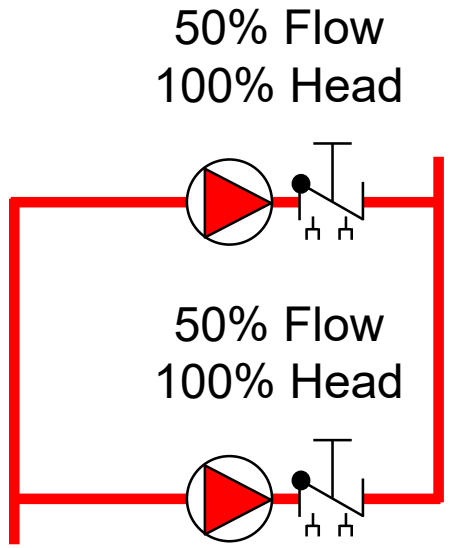
Single Pump Curve



Double the Flow at Several Values of Head

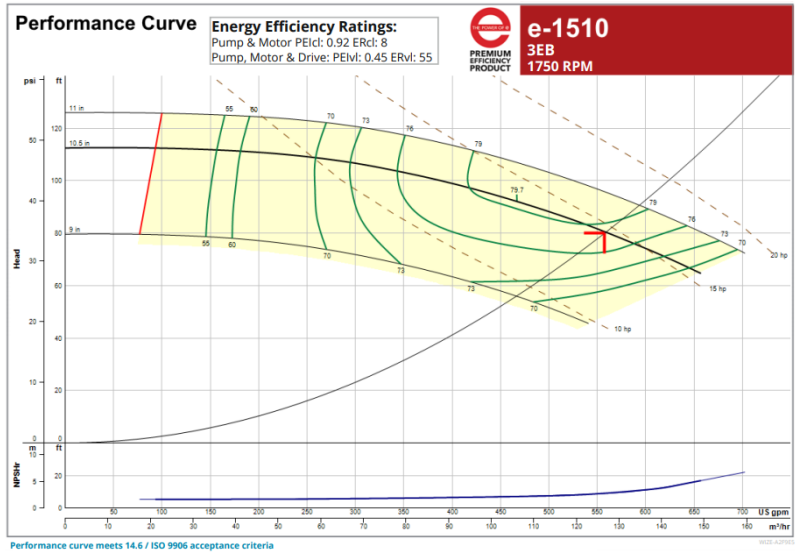


Connect the Points to Make the Parallel Curve



Two identical pumps in parallel

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



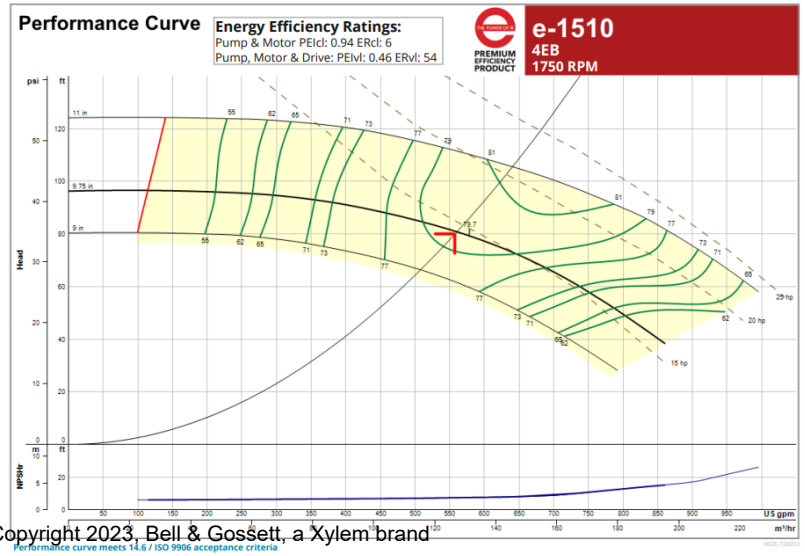
Pump Selection Summary	
Duty Point Flow	557 US gpm
Duty Point Head	80 ft
Control Head	0 ft
Duty Point Pump Efficiency	77.8 %
Part Load Efficiency Value (PLEV)	0.0 %
Impeller Diameter	10.5 in
Motor Power	20 hp
Duty Point Power	14.5 bhp
Motor Speed	1800 rpm
RPM @ Duty Point	1750 rpm
NPSHr	9.24 ft
Minimum 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 ft²

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 ft²

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)

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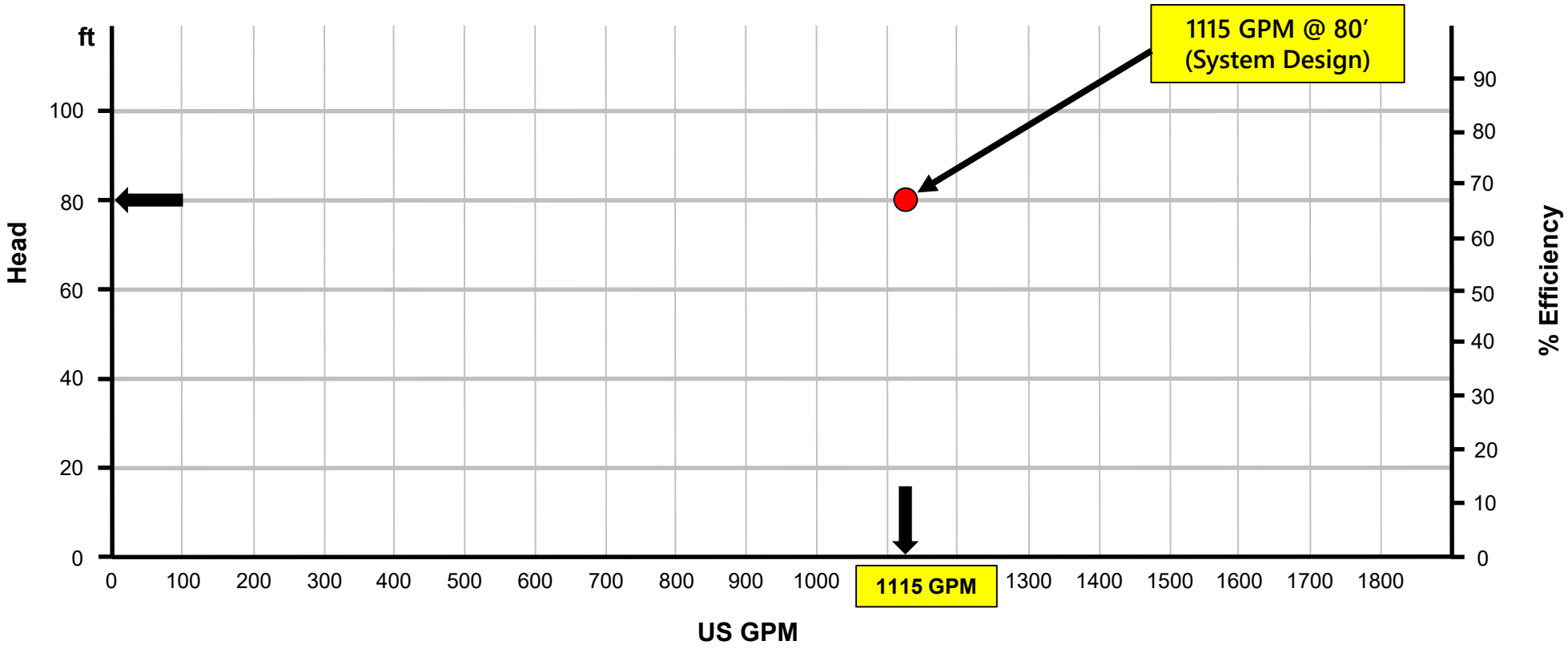
Parallel Pumping – 50% Duty Flow per Pump (No Standby) **Opt. B**



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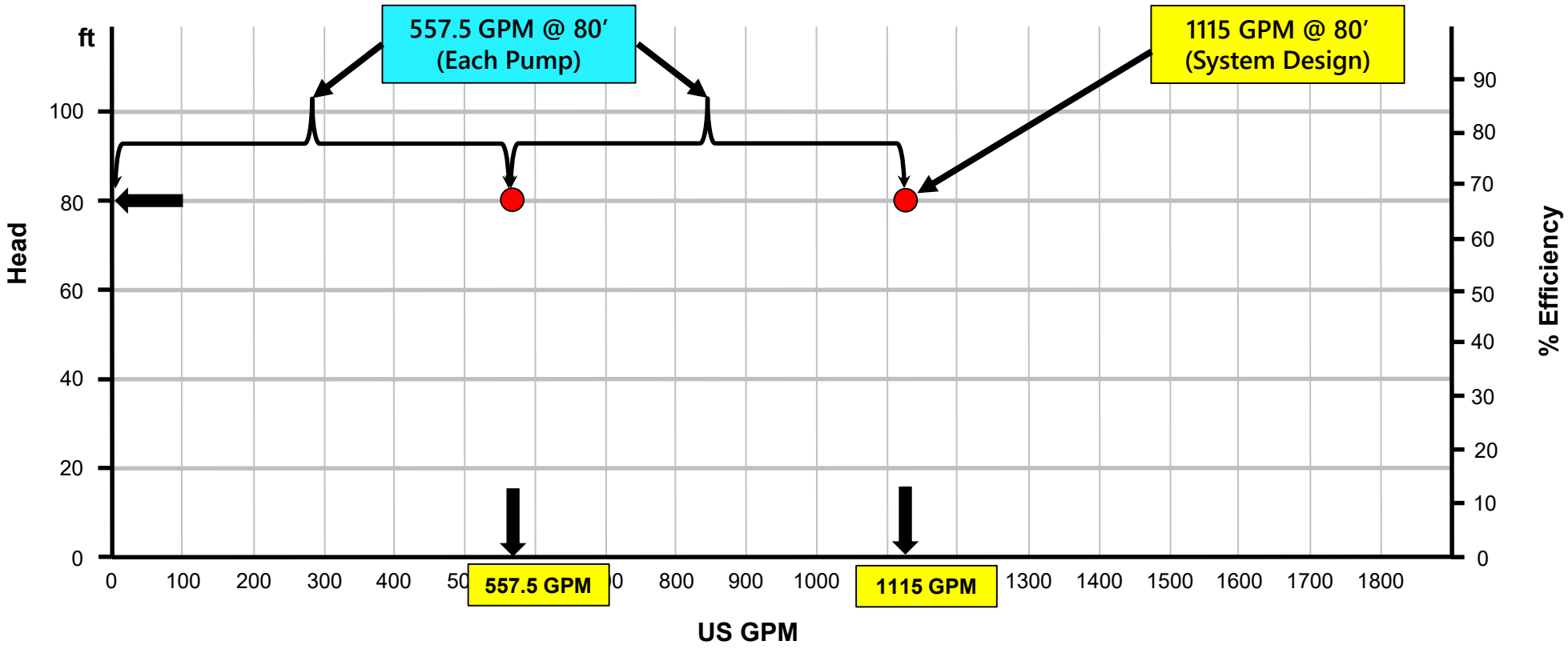

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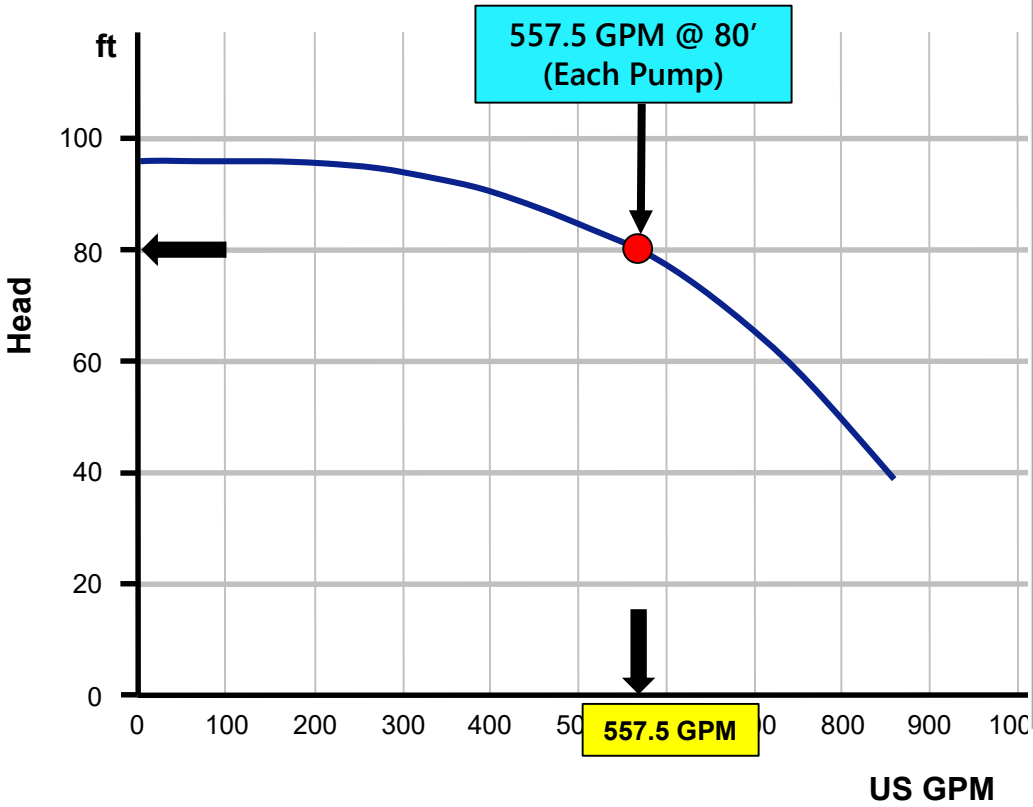

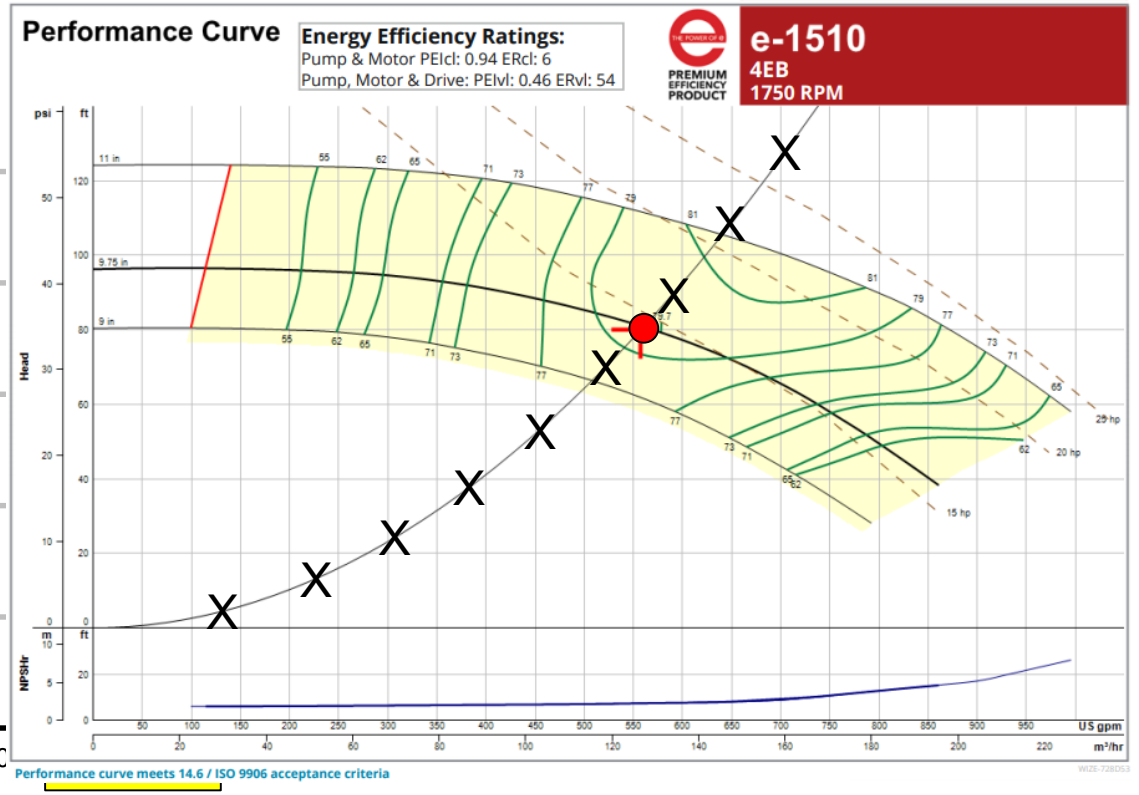

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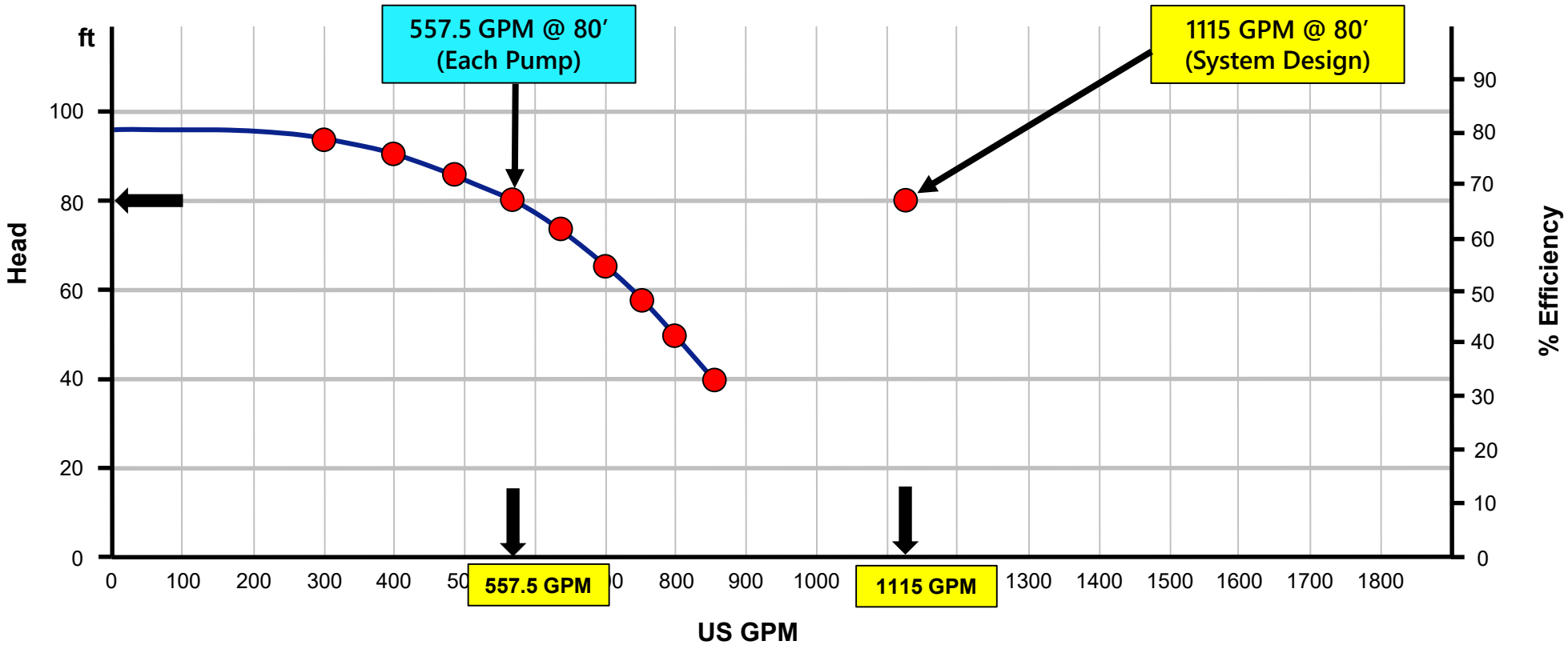

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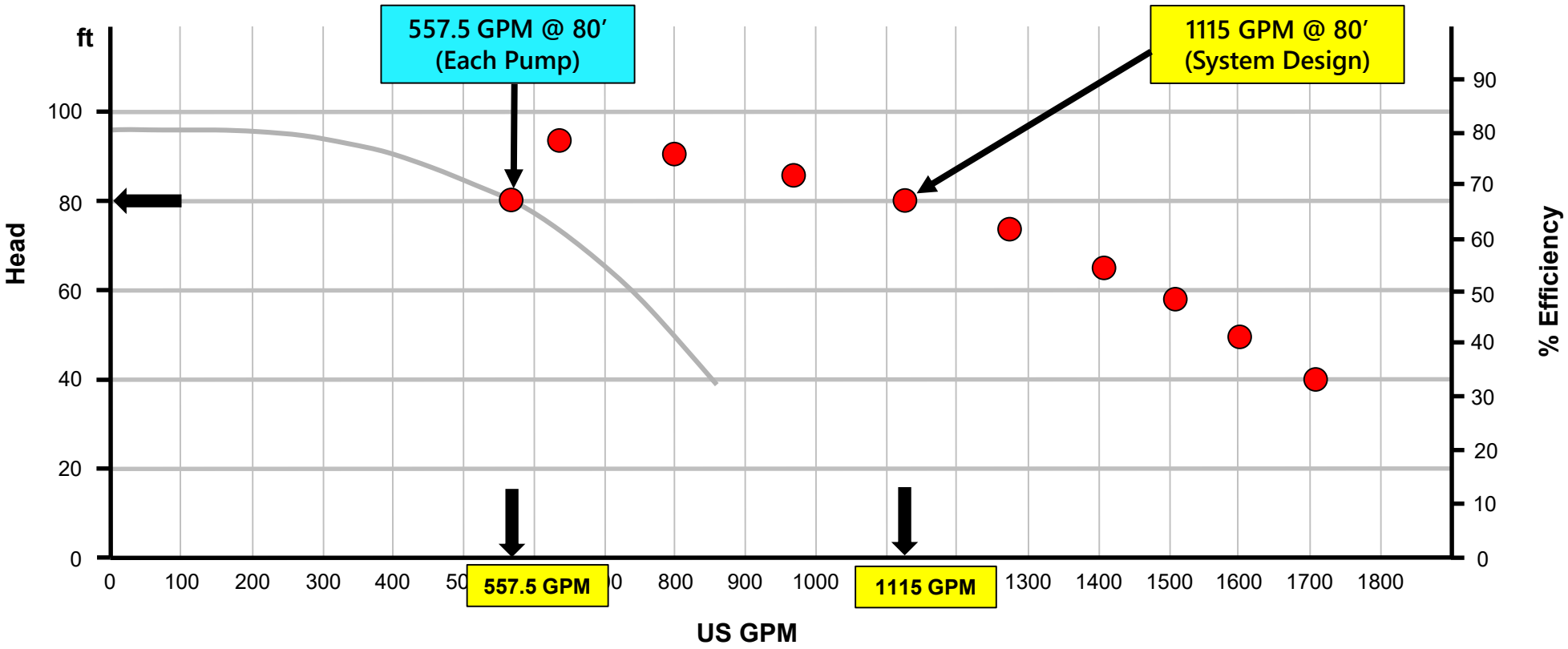

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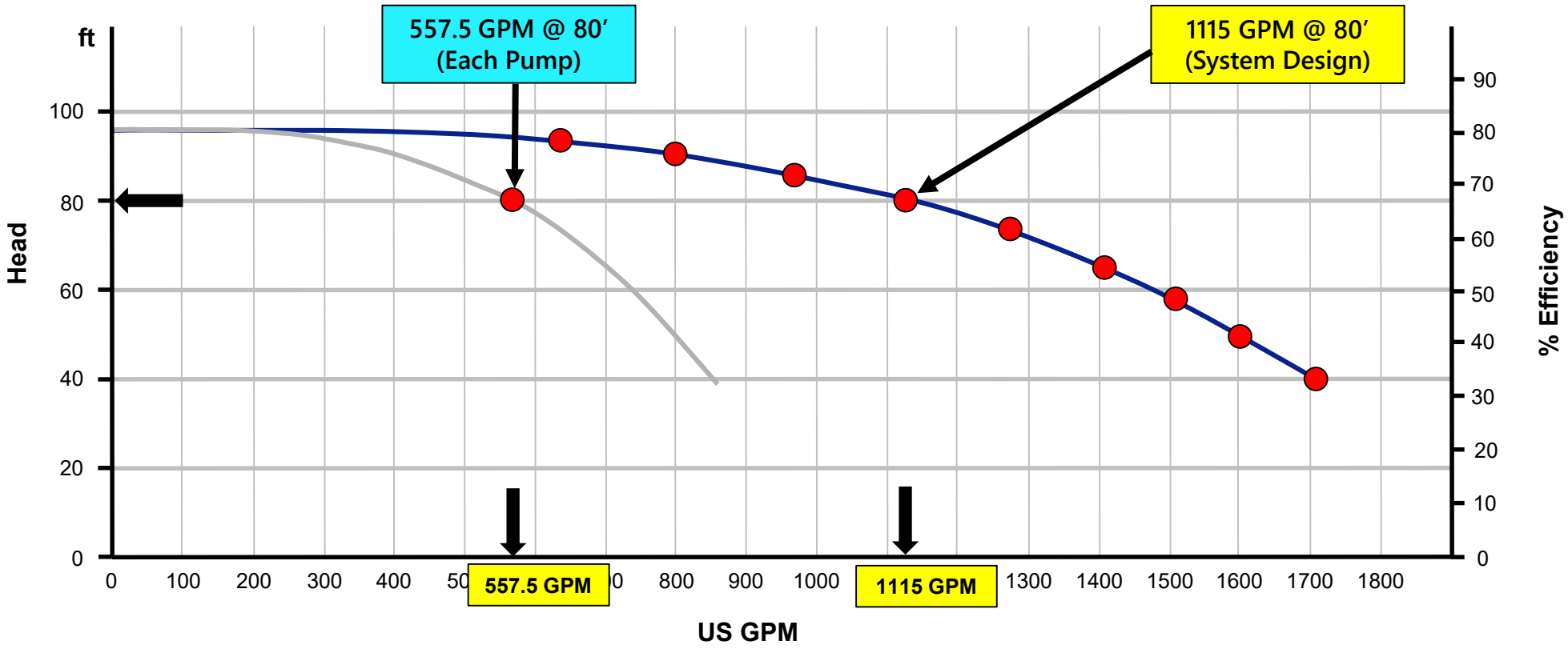

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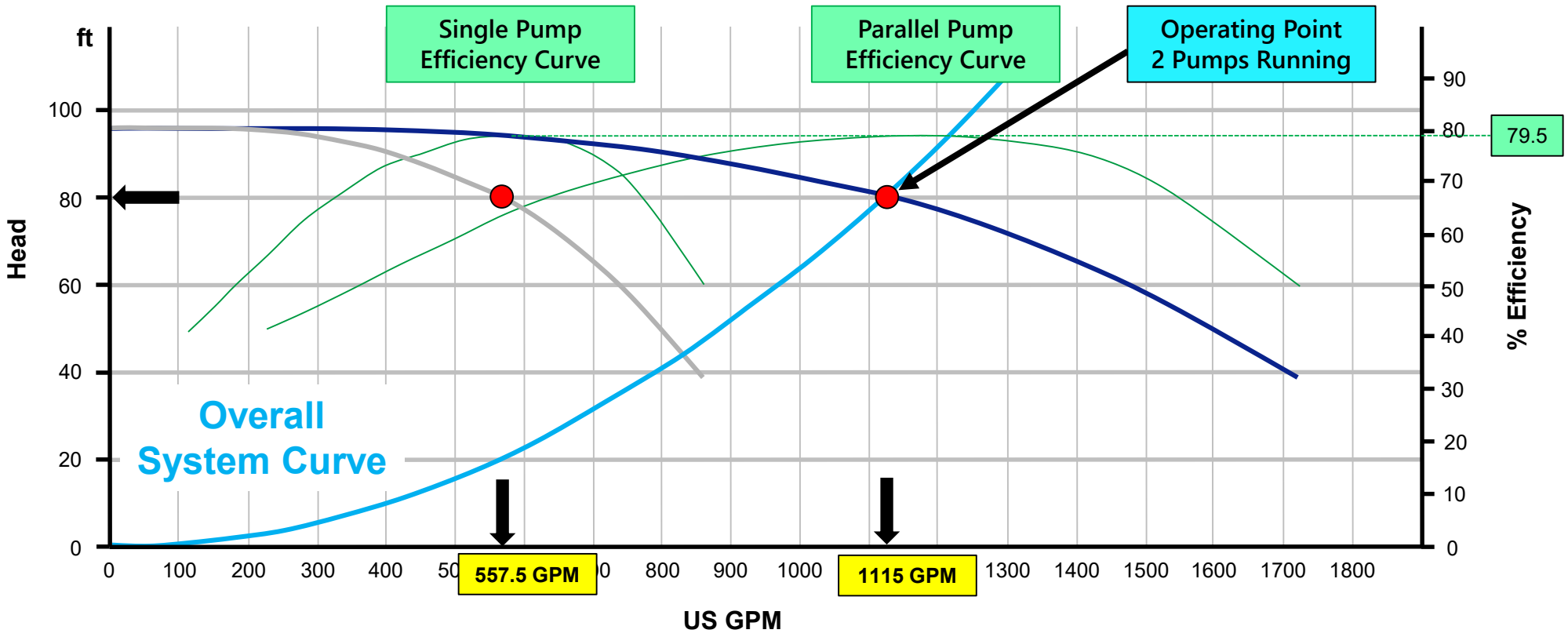

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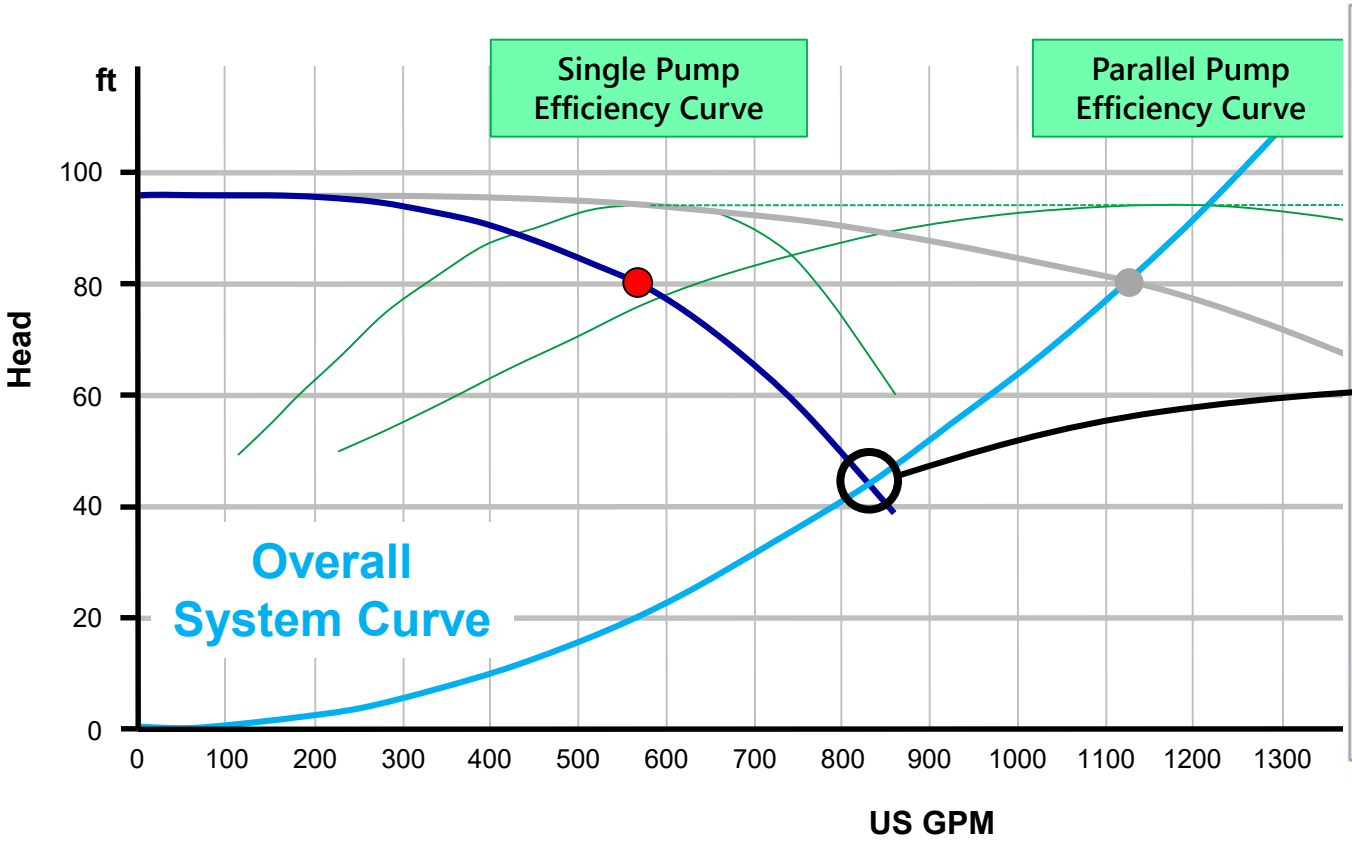

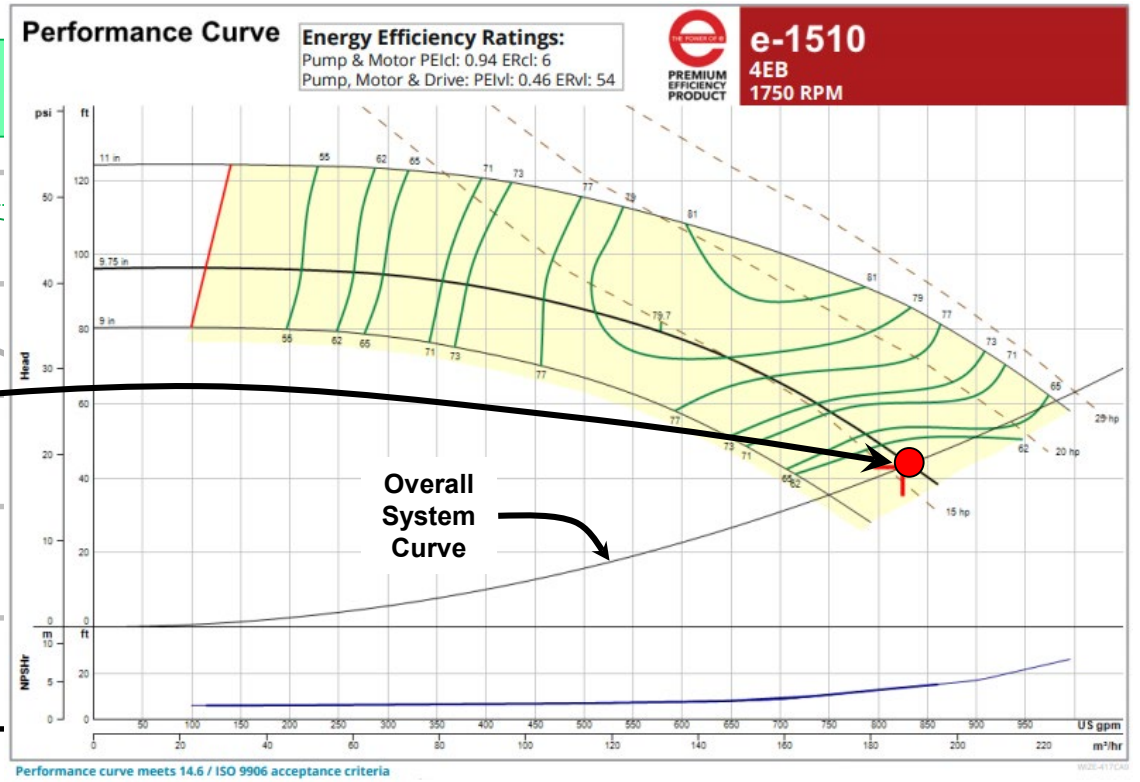

What happens when 1 pump is turned off?

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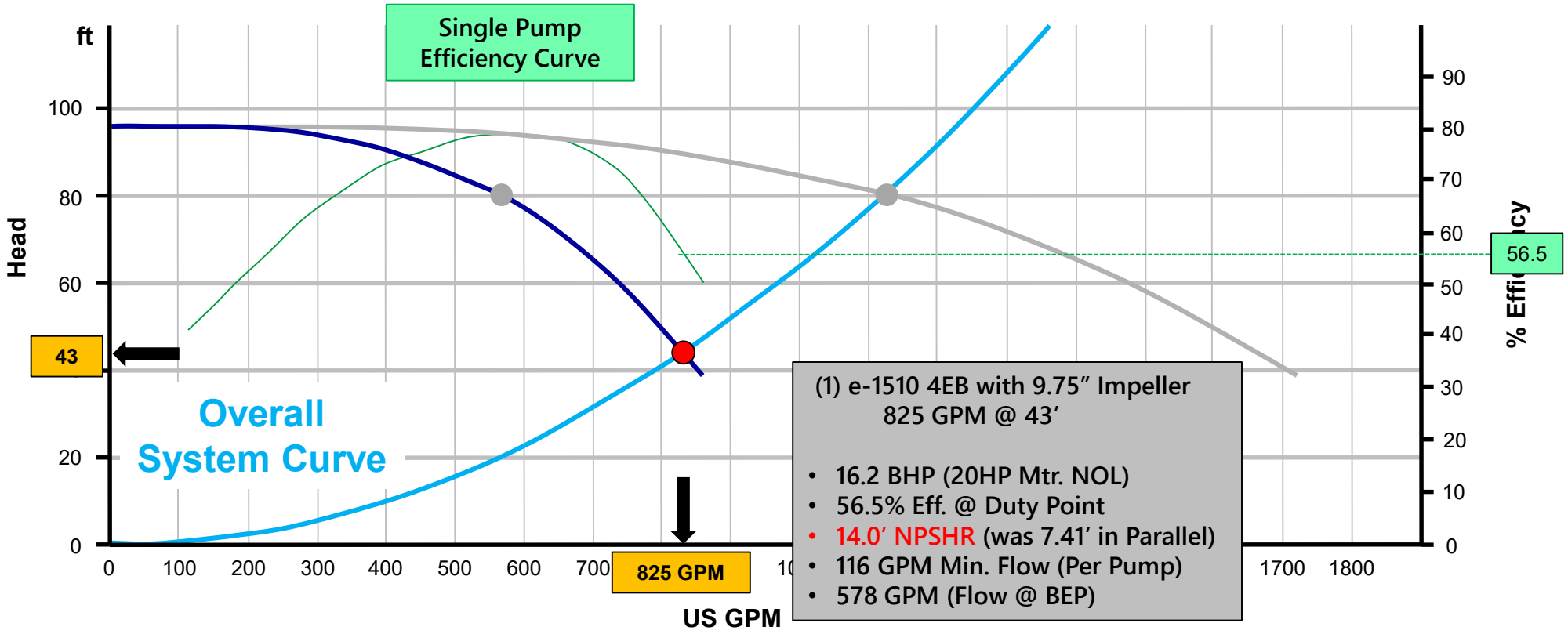

825 GPM/1115 GPM = 74%
Redundant Capacity

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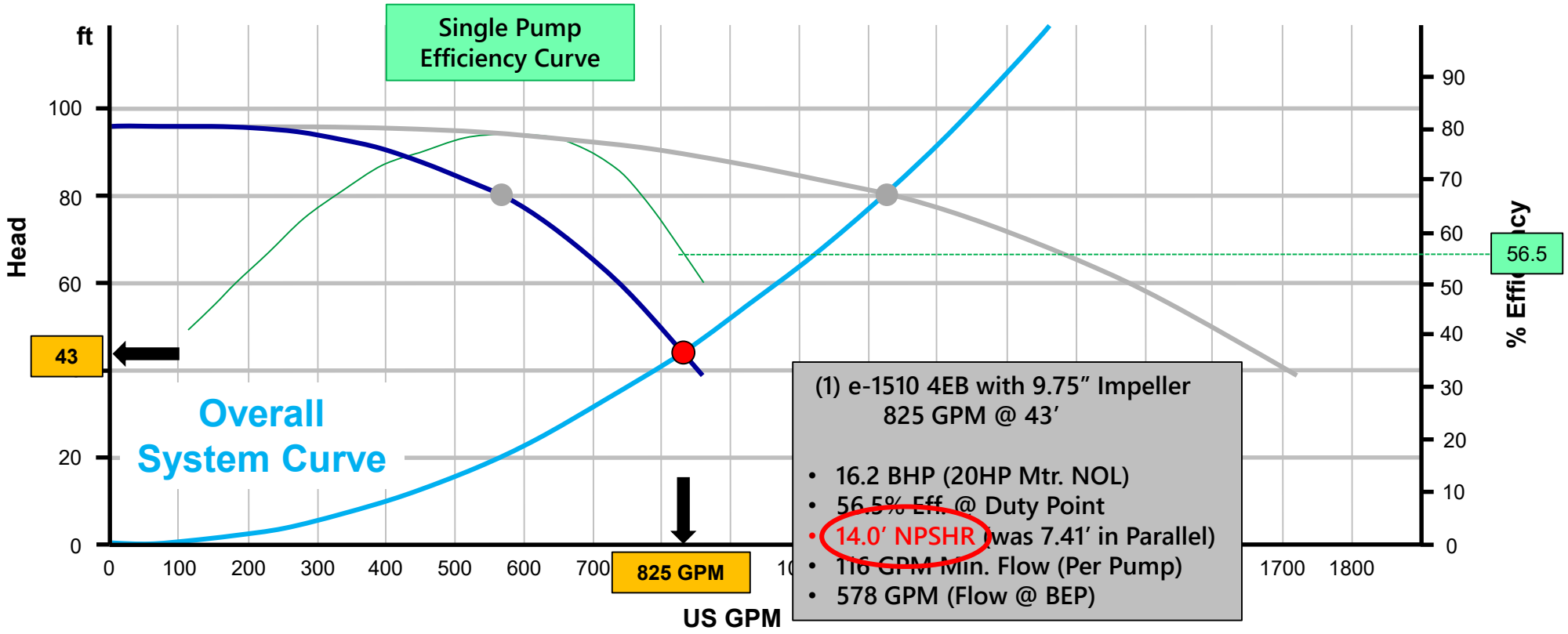

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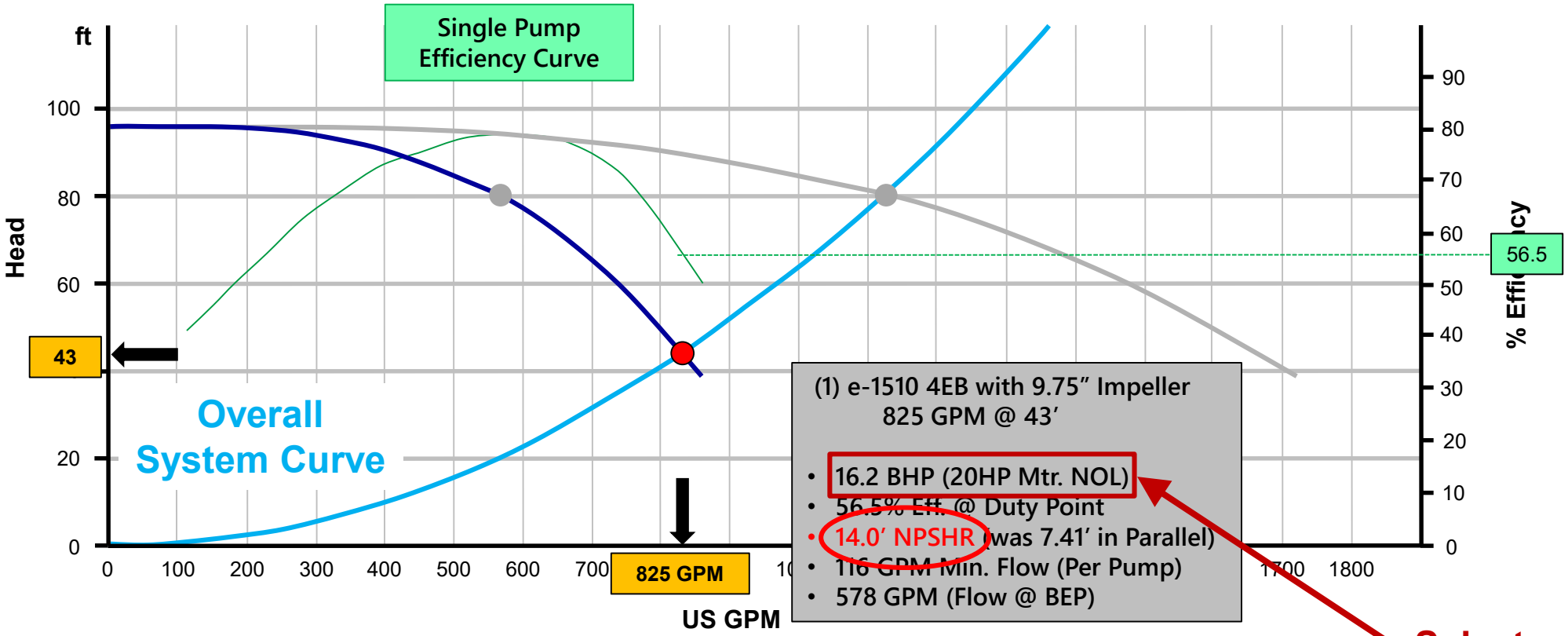
a xylem brand

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

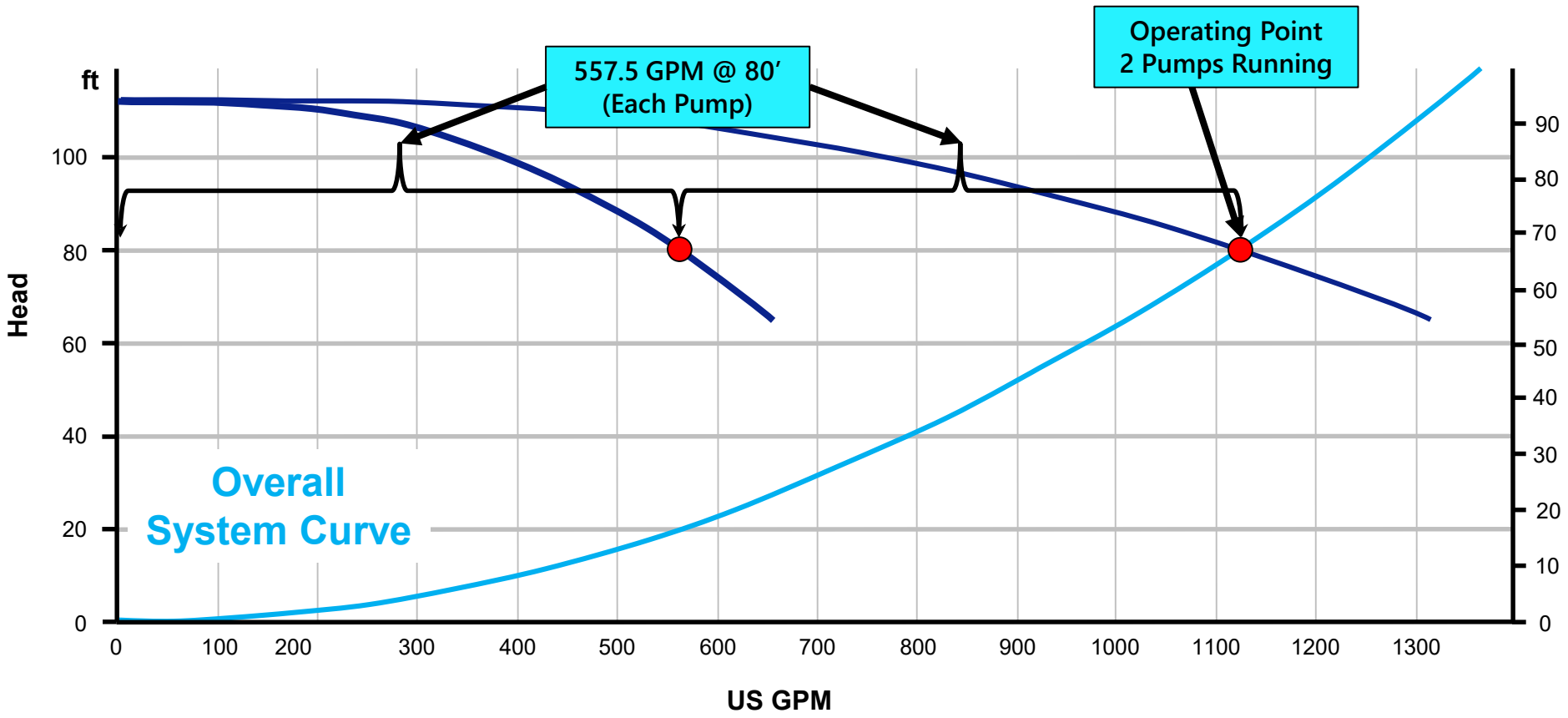


Select motor for single pump operation on Design Day System Curve

825 GPM/1115 GPM = 74%
Redundant Capacity

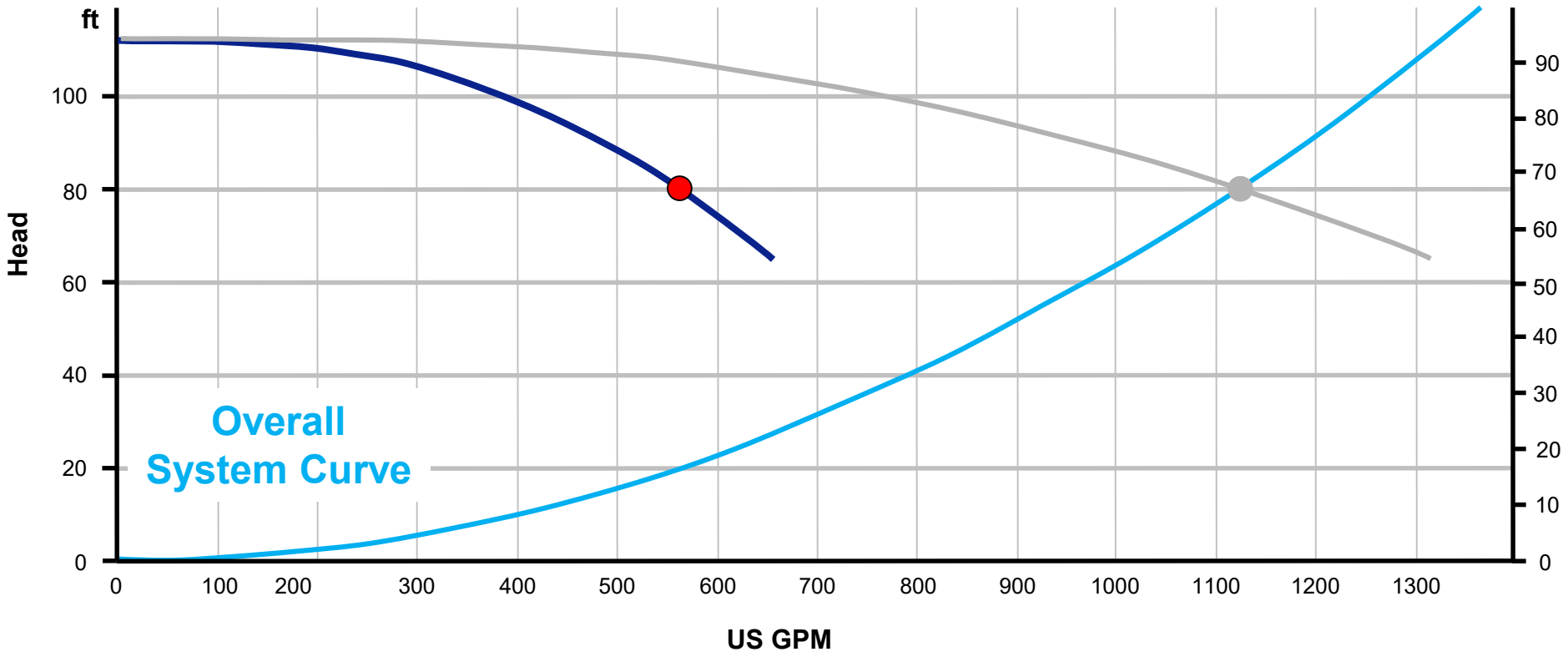
Bell & Gossett
a xylem brand

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



Bell & Gossett
a xylem brand

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



What happens when 1 pump is turned off?

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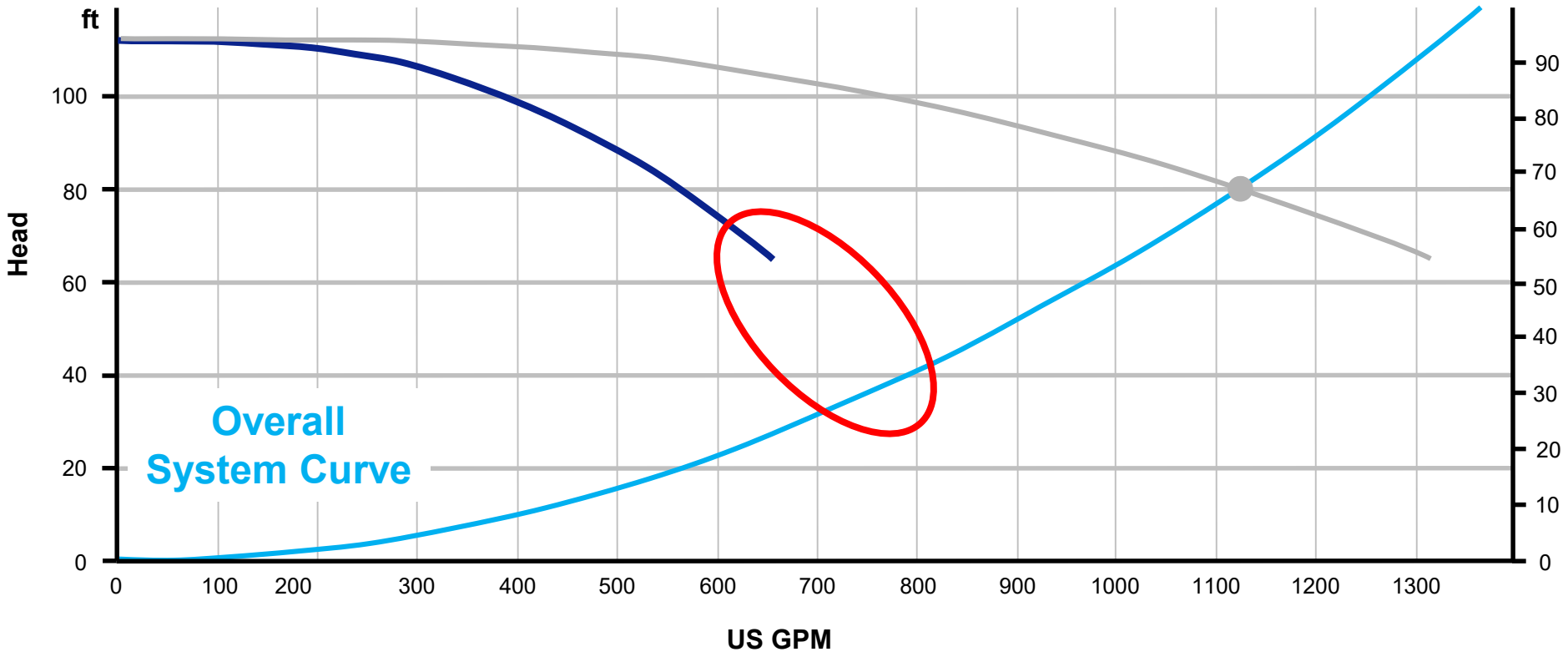
Parallel Pumping – 50% Duty Flow per Pump (No Standby) **Opt. A**



What happens when 1 pump is turned off?

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

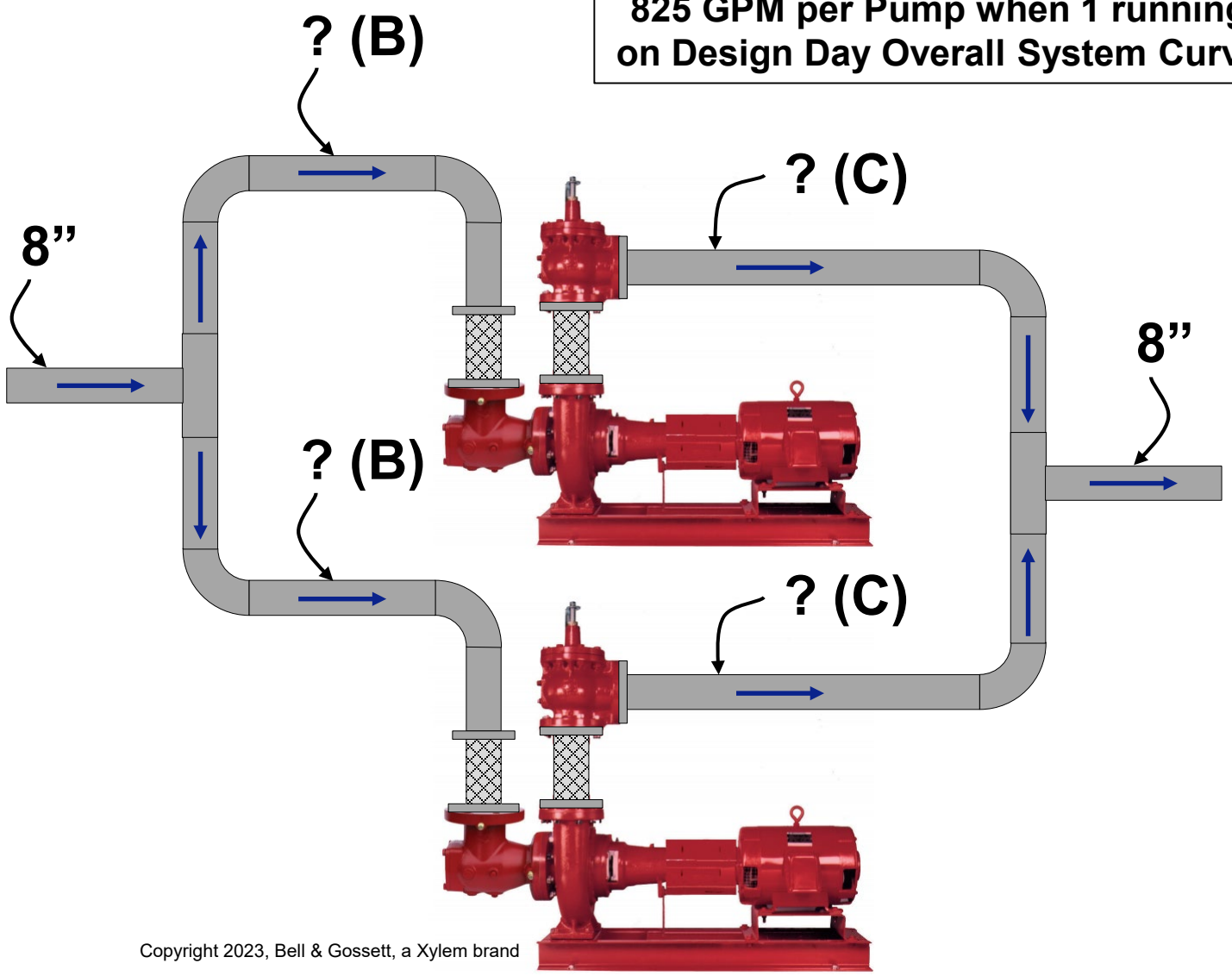
The "Golden Rule" of Parallel Pumping

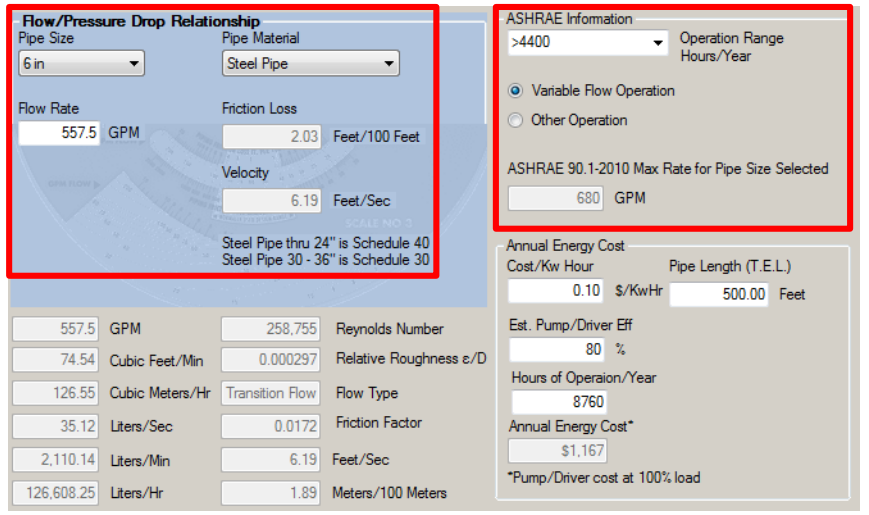
The Overall System Curve **must** intersect **all** pump curves
(Maximum to Minimum number of operating pumps possible)

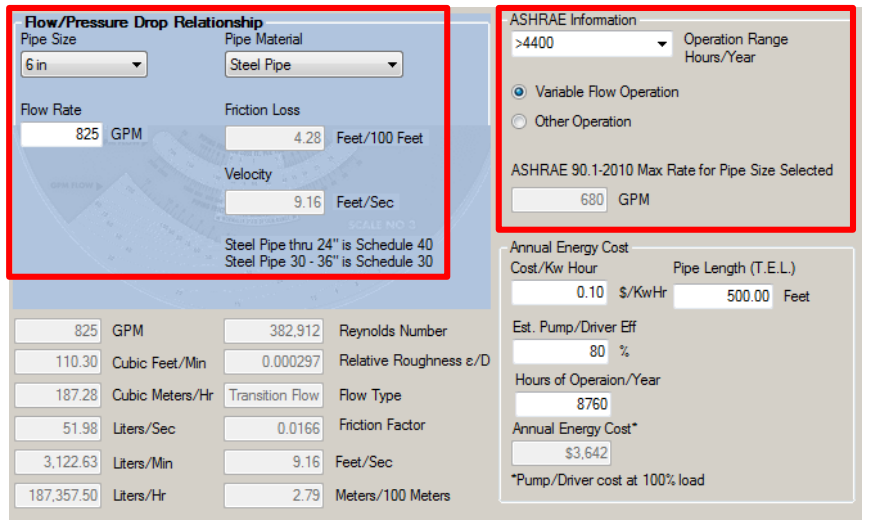
Parallel Pumping – Pipe Size Selection 50% Duty per Pump

in Parallel

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







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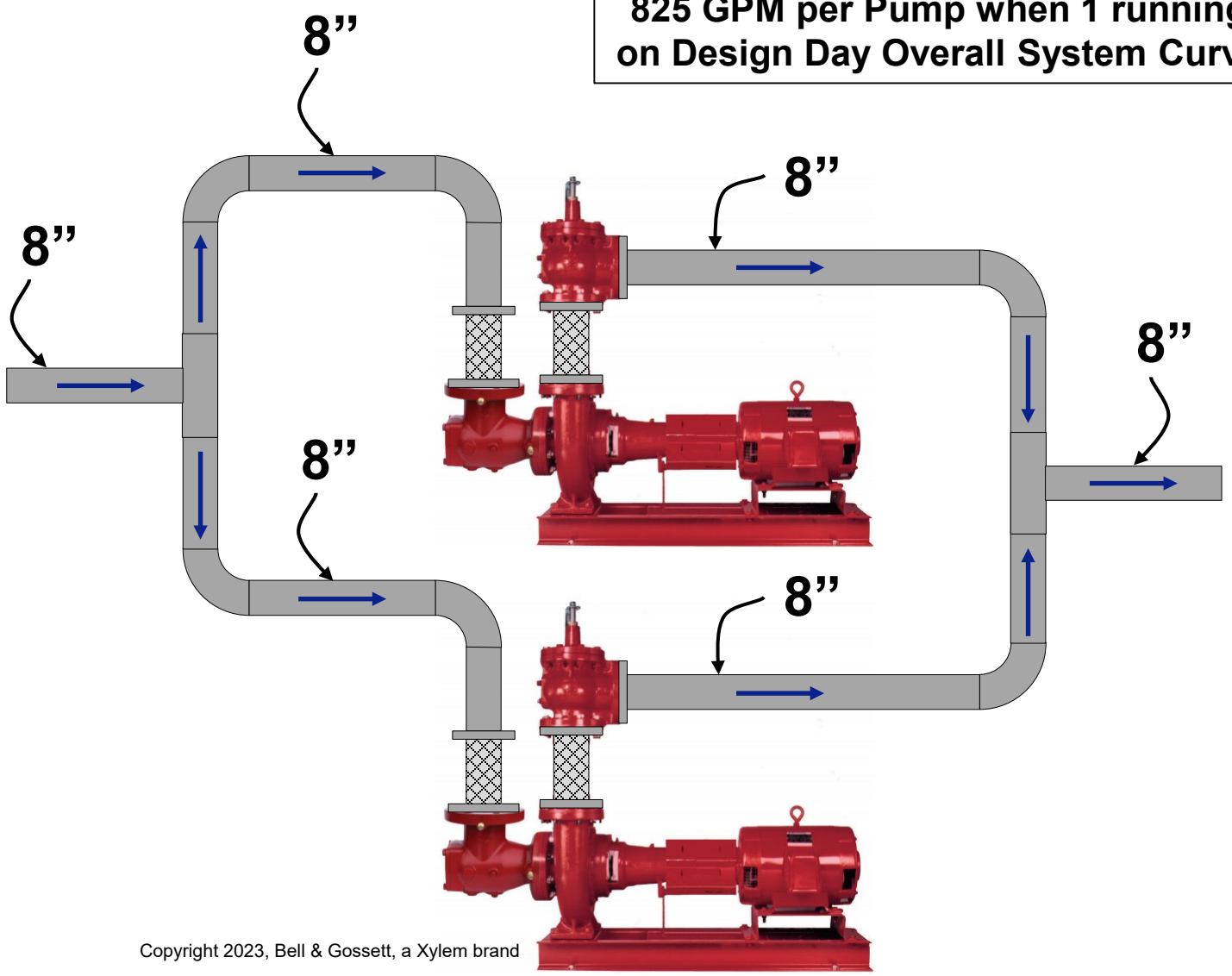
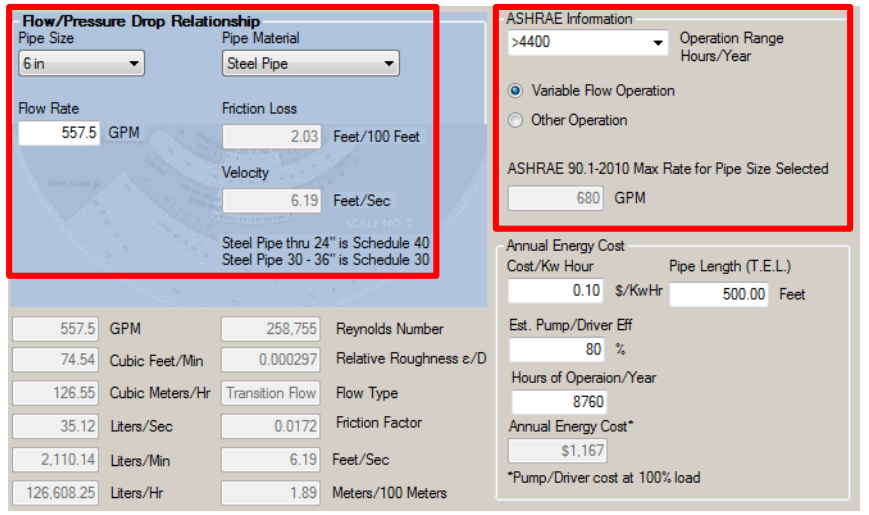
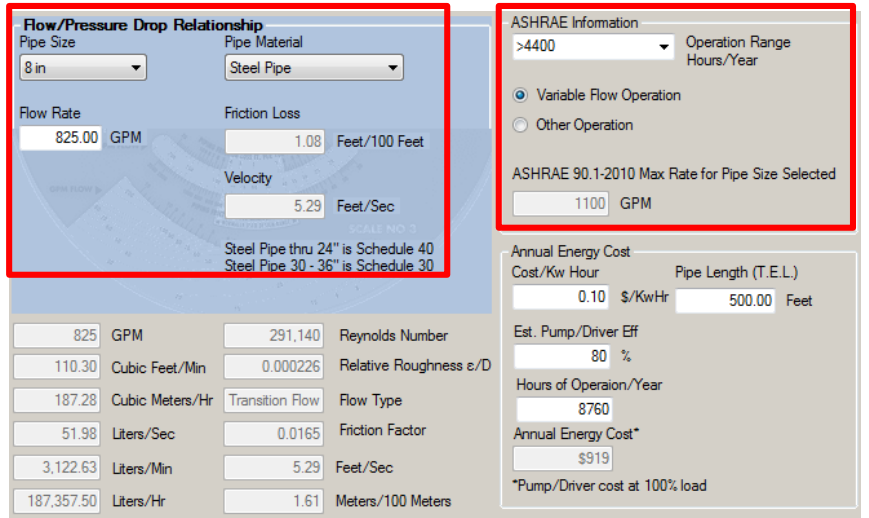
Parallel Pumping – Pipe Size Selection 50% Duty per Pump

in Parallel

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







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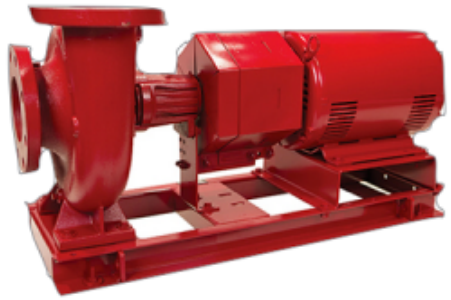
Advantage of Parallel Pumps – Reduced Footprint and Weight

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://bellgossett.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 ft²

811 Lbs. each
7.68 ft² x 2 = 15.36 ft²

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://bellgossett.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 ft²

610 Lbs. each
6.65 ft² x 2 = 13.30 ft²

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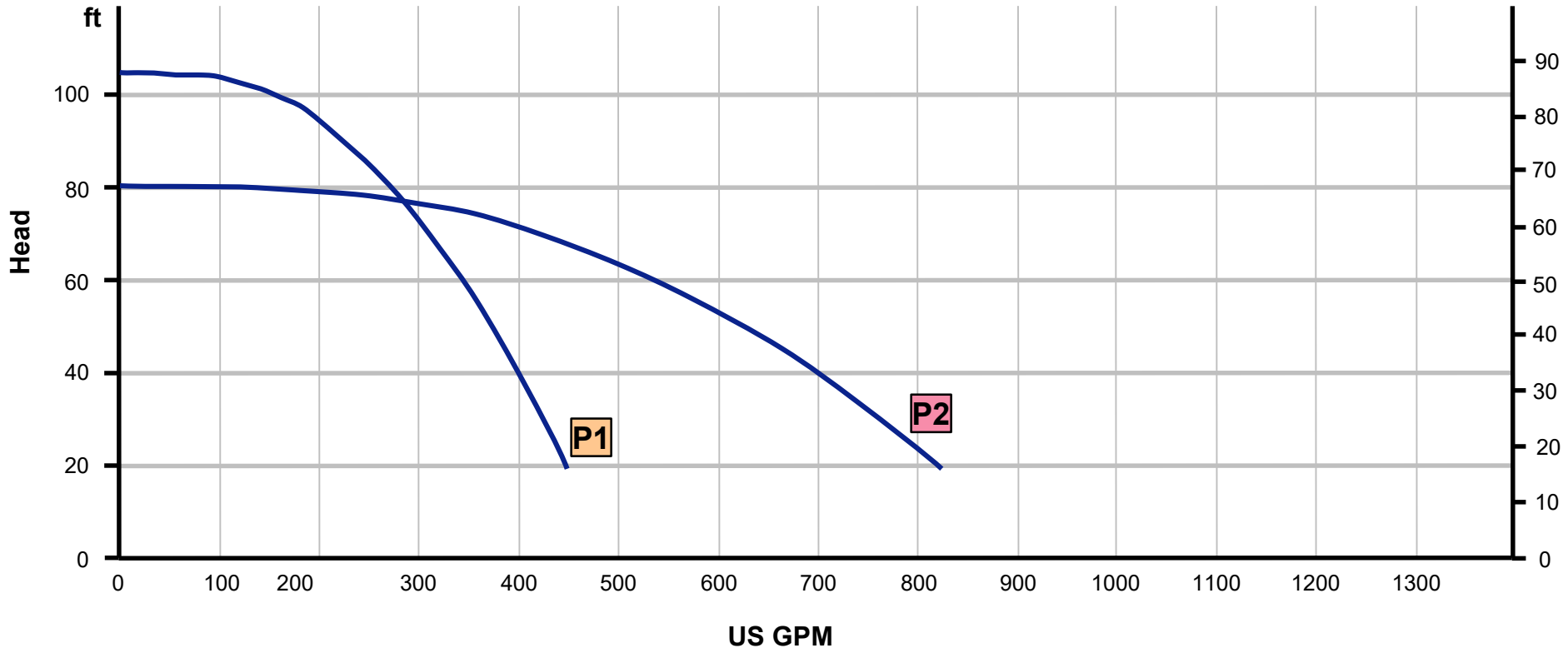
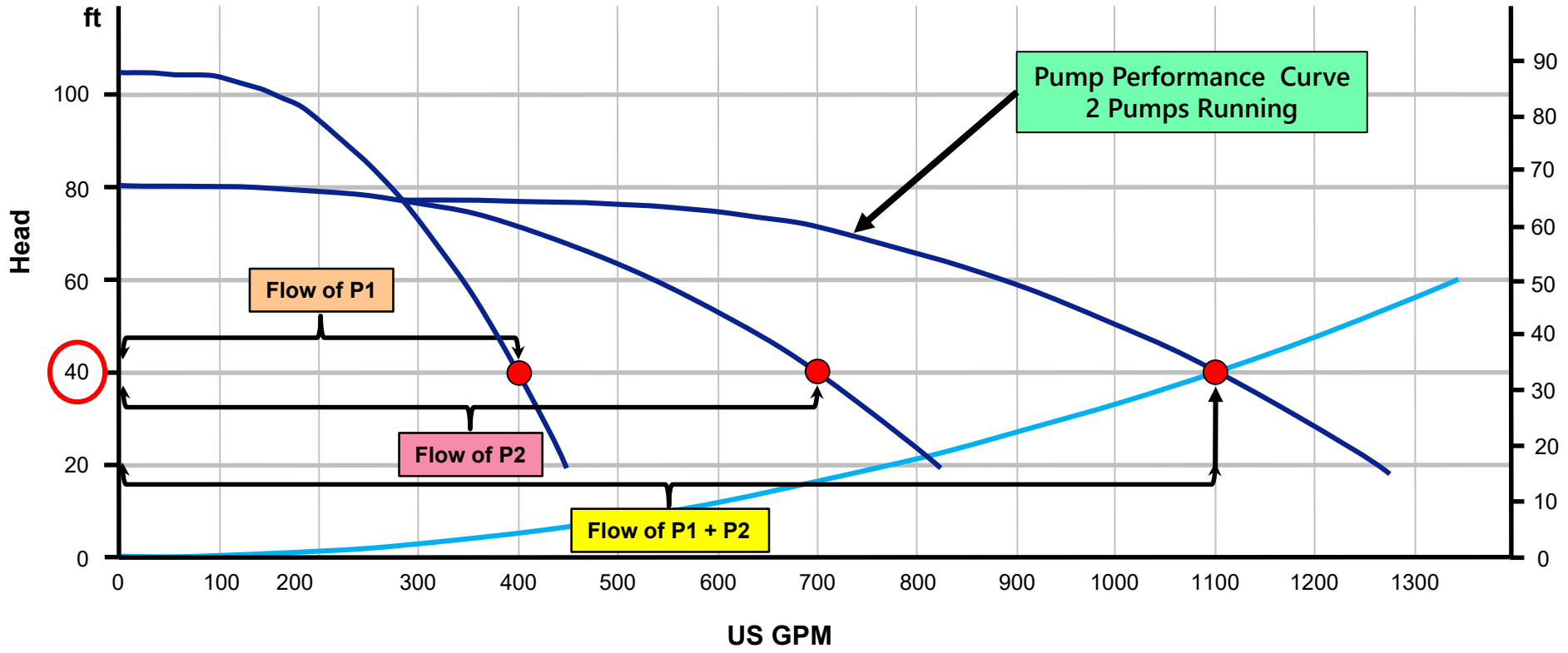
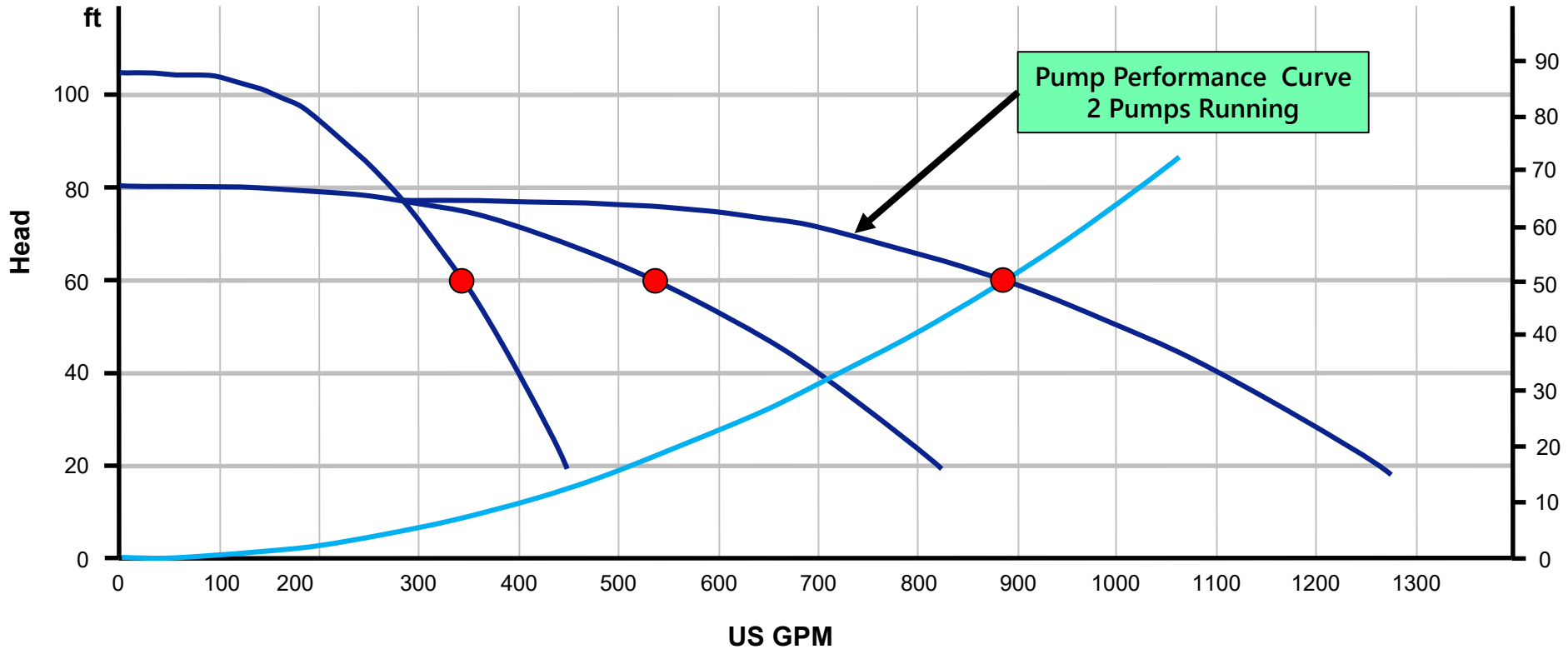


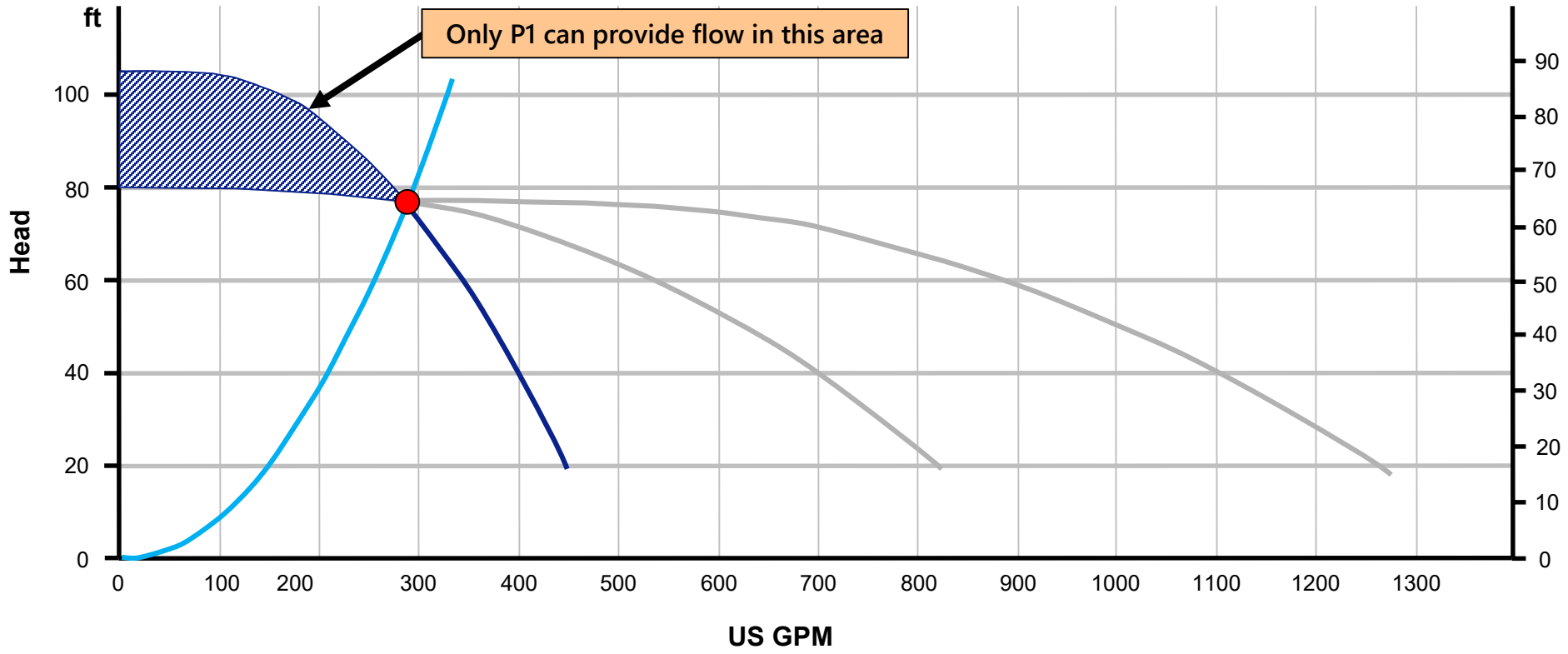
Bell & Gossett
a xylem brand



Bell & Gossett
a xylem brand



Bell & Gossett
a xylem brand



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xylem
Let's Solve Water

Series Pumping: Using Multiple Pumps simultaneously

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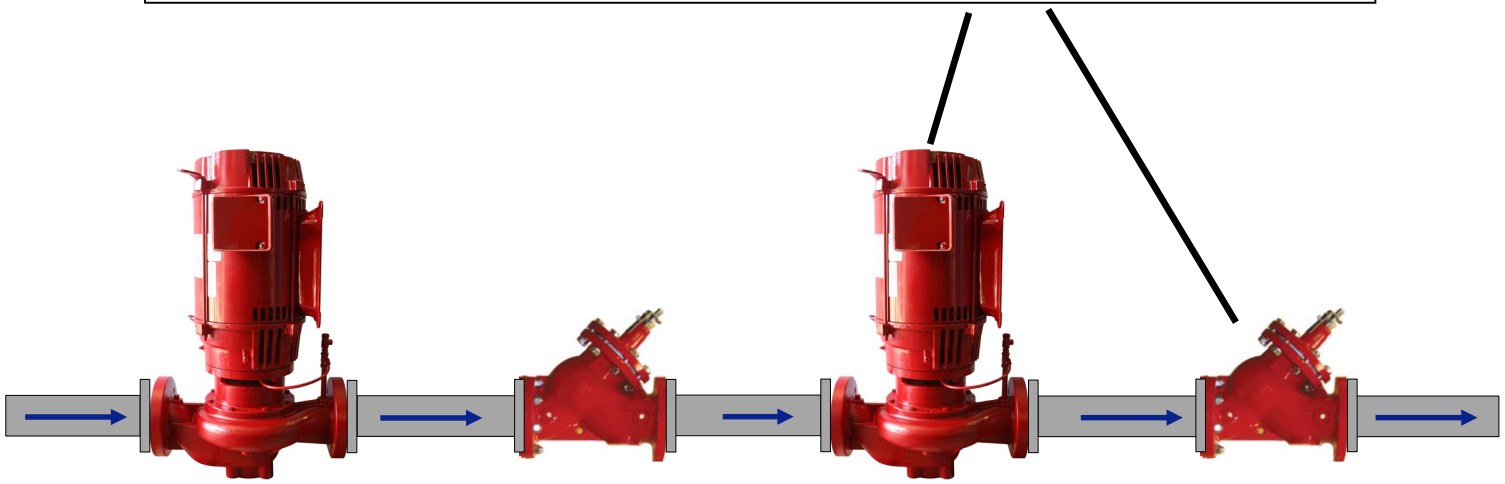
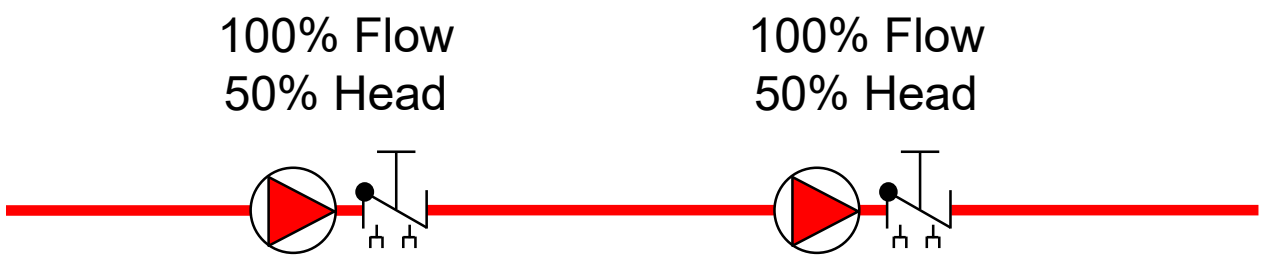
What is Series Pumping?

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





- 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

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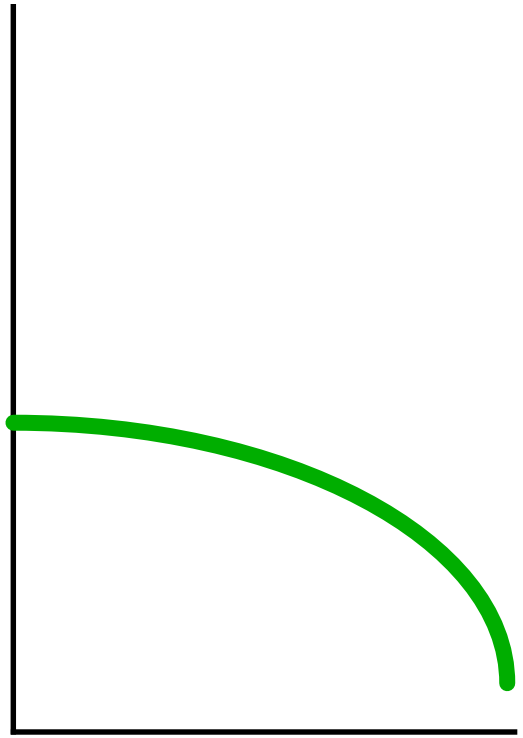
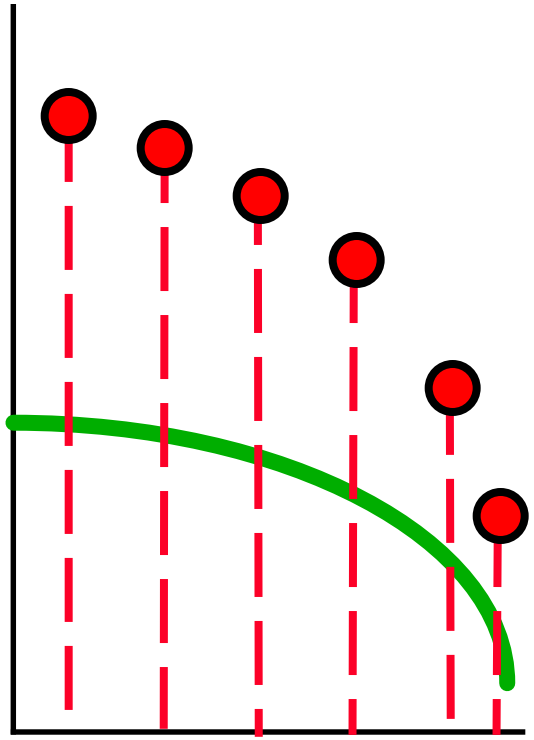
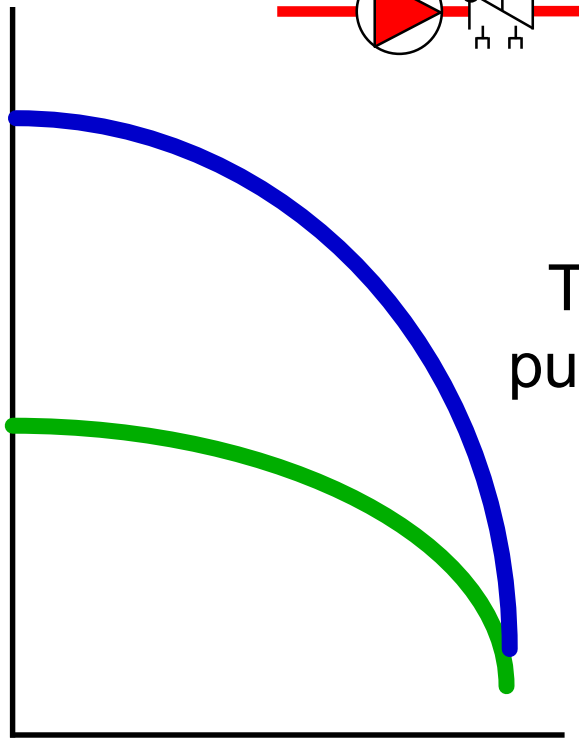


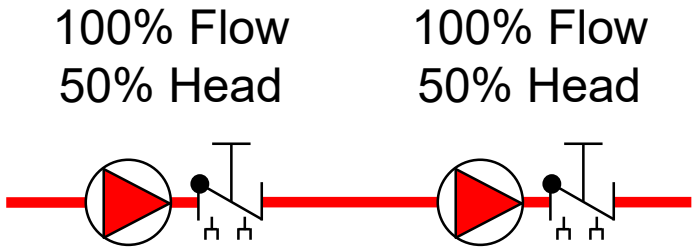
Single Pump Curve



Double the Head at Several Values of Flow

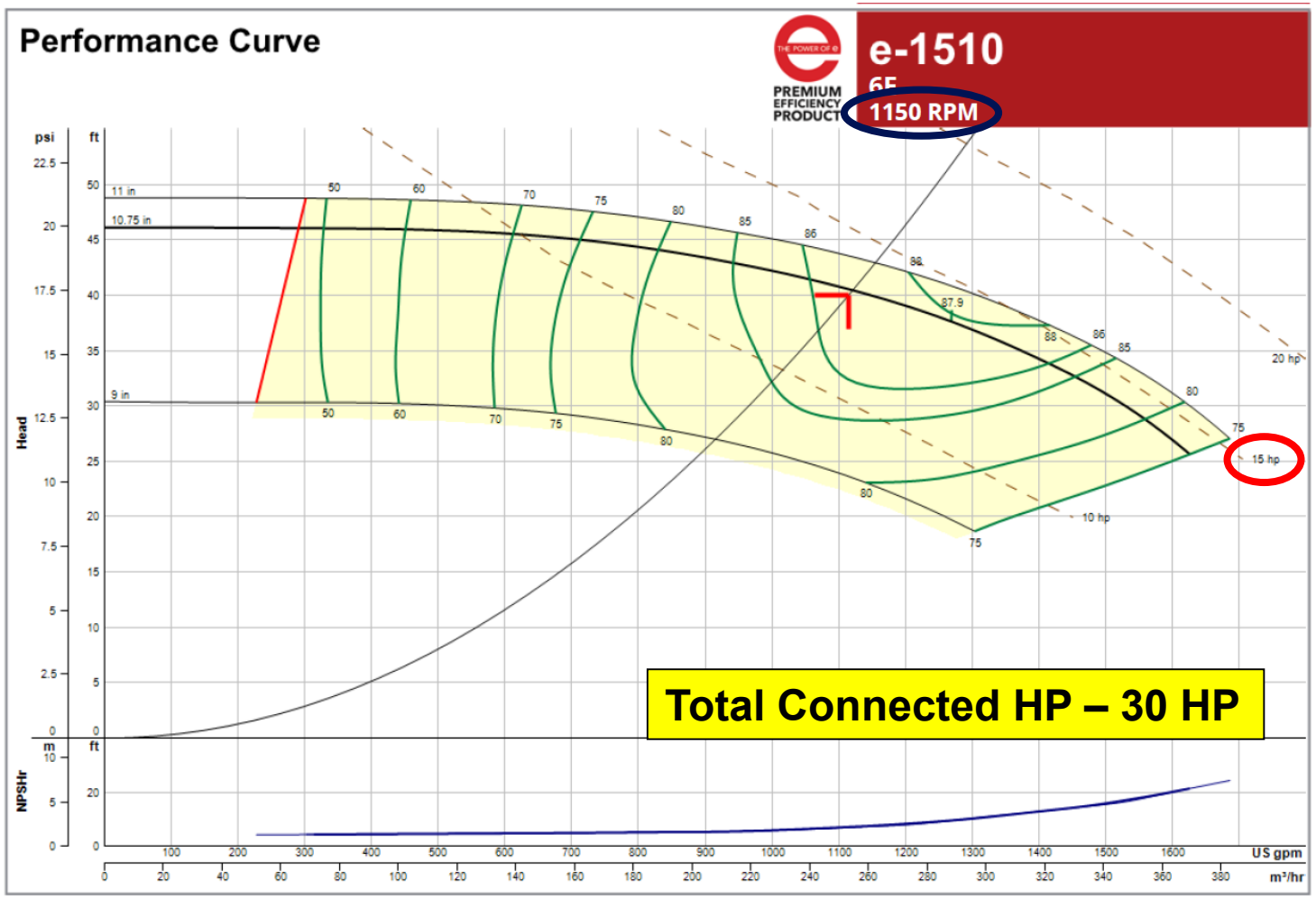


Connect the Points to Make the Series Curve



Two identical pumps in series

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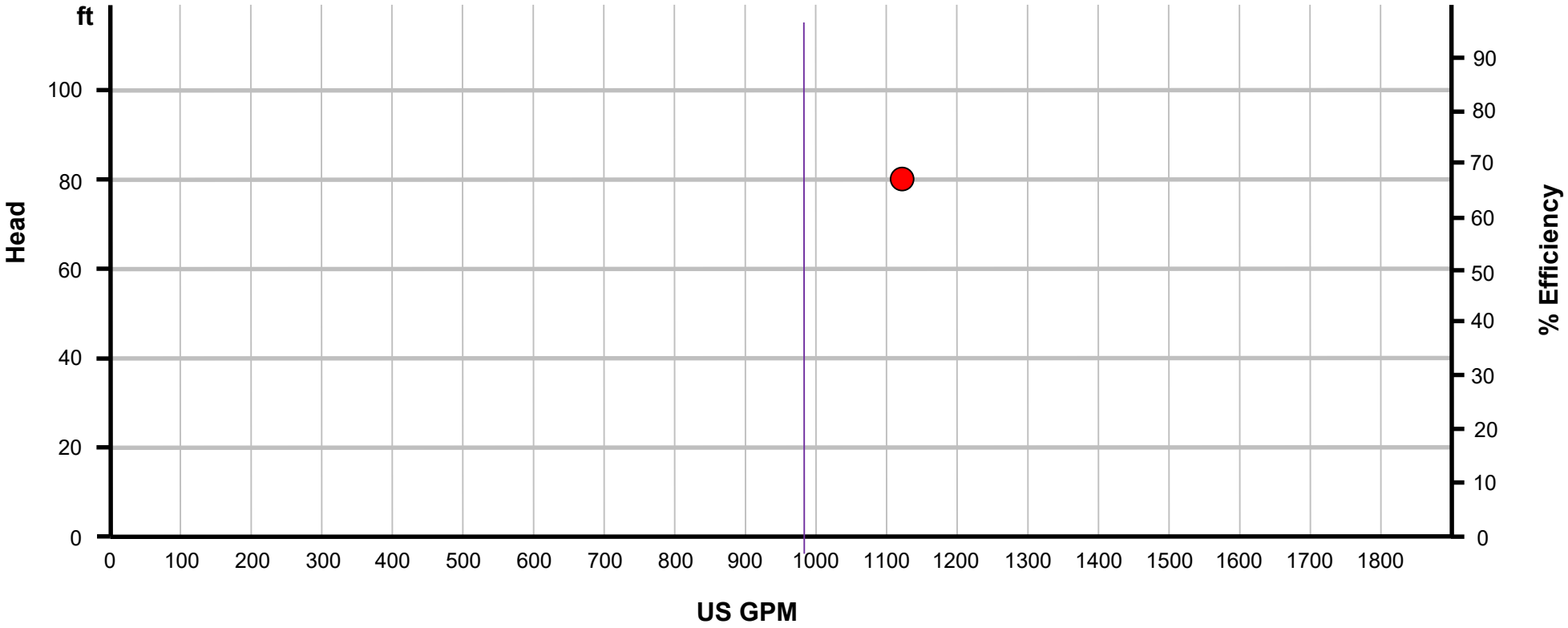
Series Pumping – 50% Duty Head per Pump (No Standby)



Bell & Gossett
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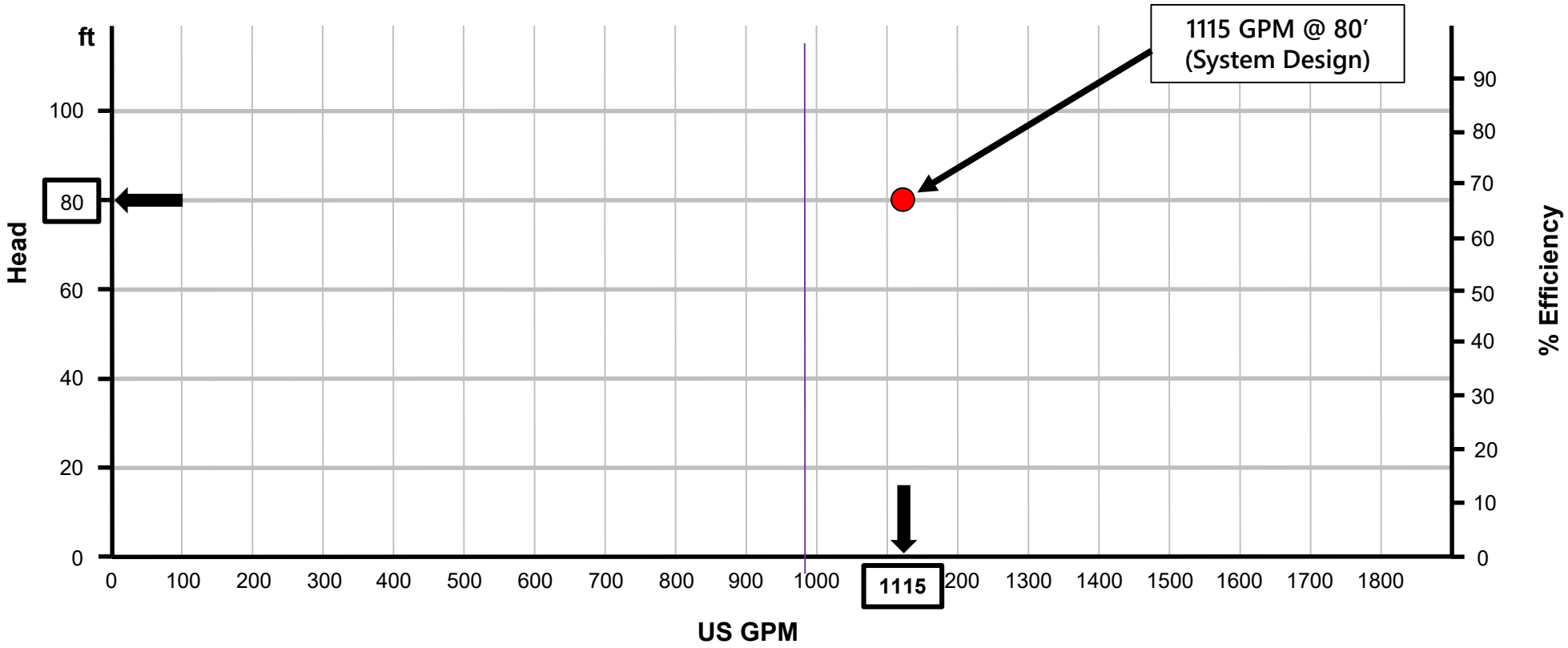
Series Pumping – 50% Duty Head per Pump (No Standby)



Bell & Gossett
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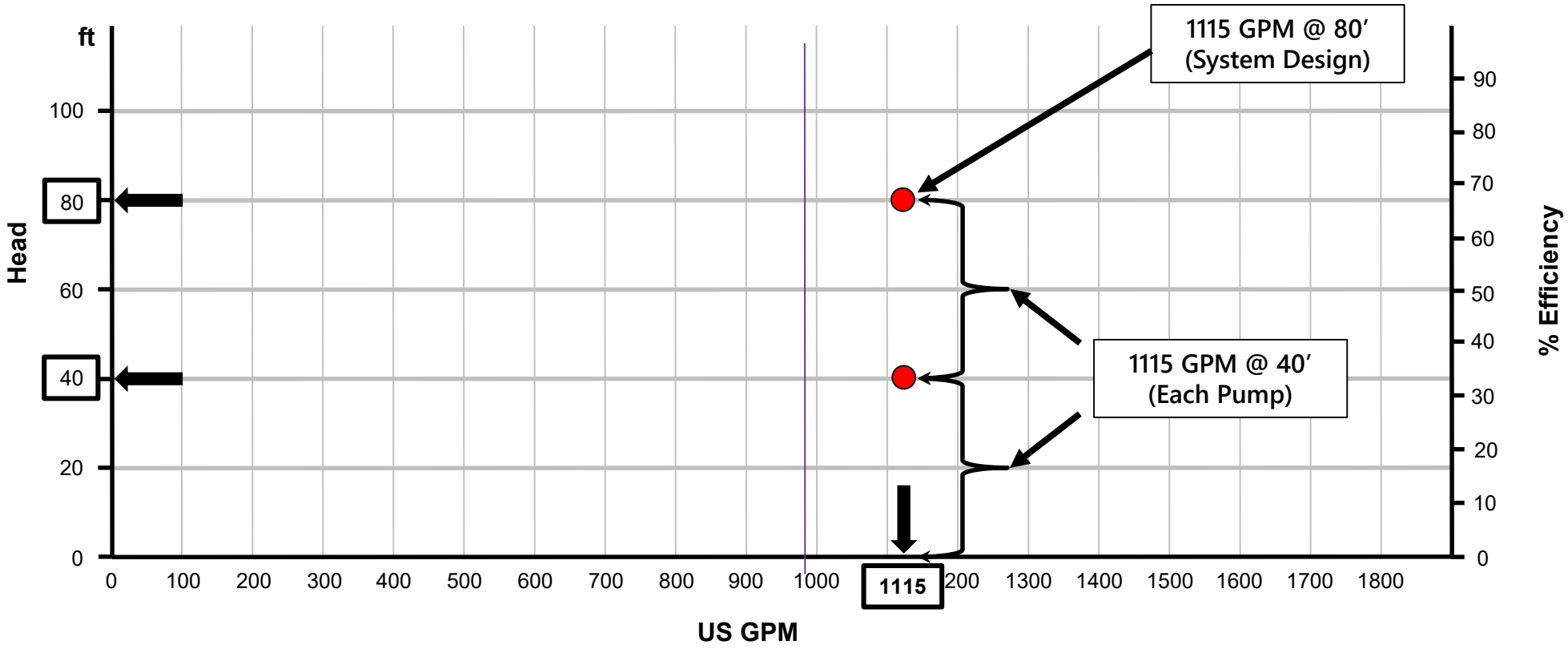
Series Pumping – 50% Duty Head per Pump (No Standby)



Bell & Gossett
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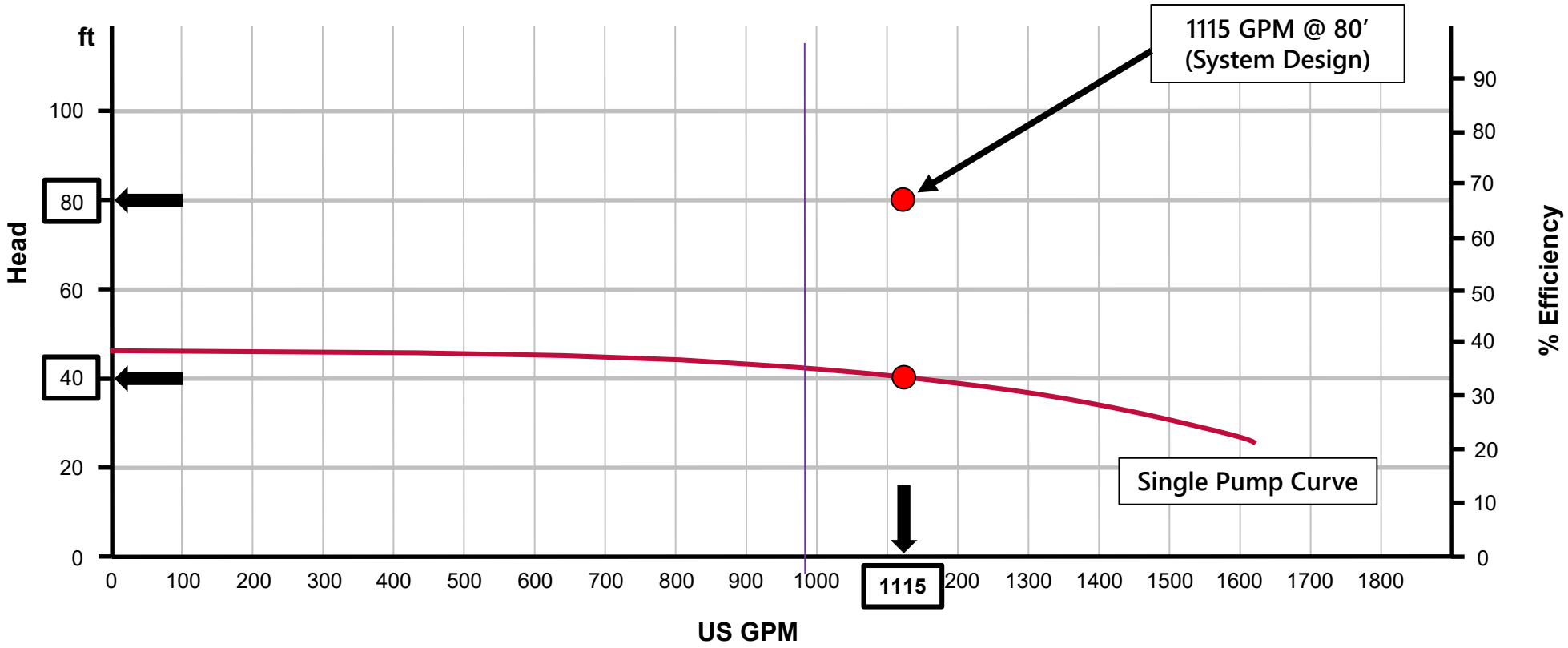
Series Pumping – 50% Duty Head per Pump (No Standby)



Bell & Gossett
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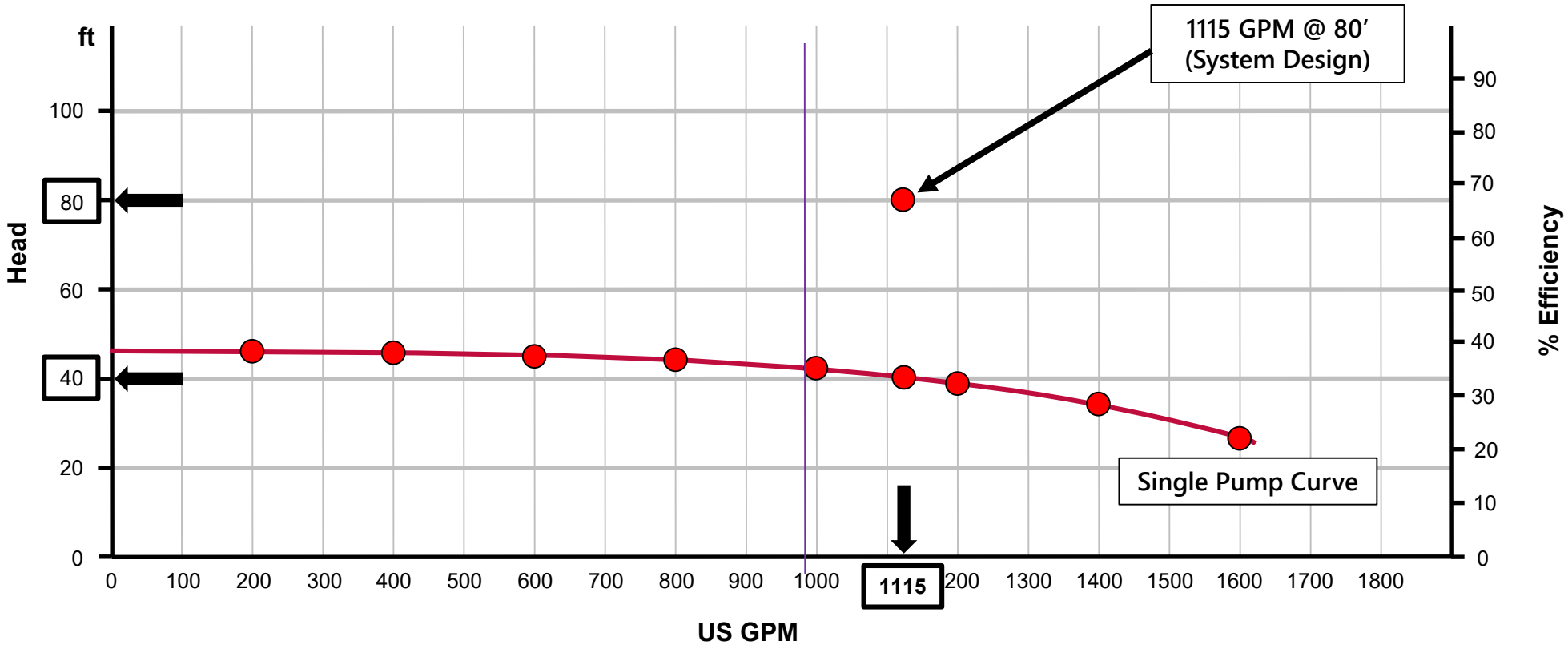
Series Pumping – 50% Duty Head per Pump (No Standby)



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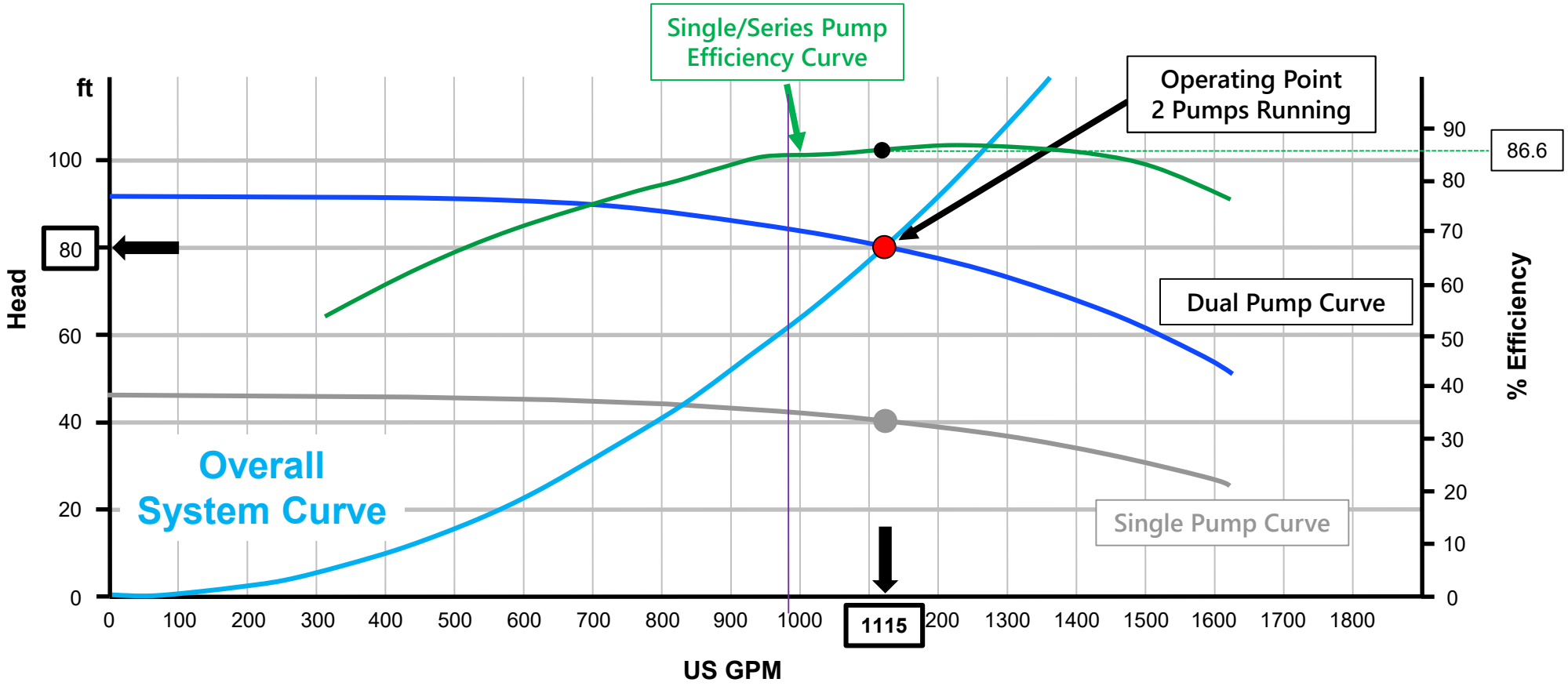
Series Pumping – 50% Duty Head per Pump (No Standby)



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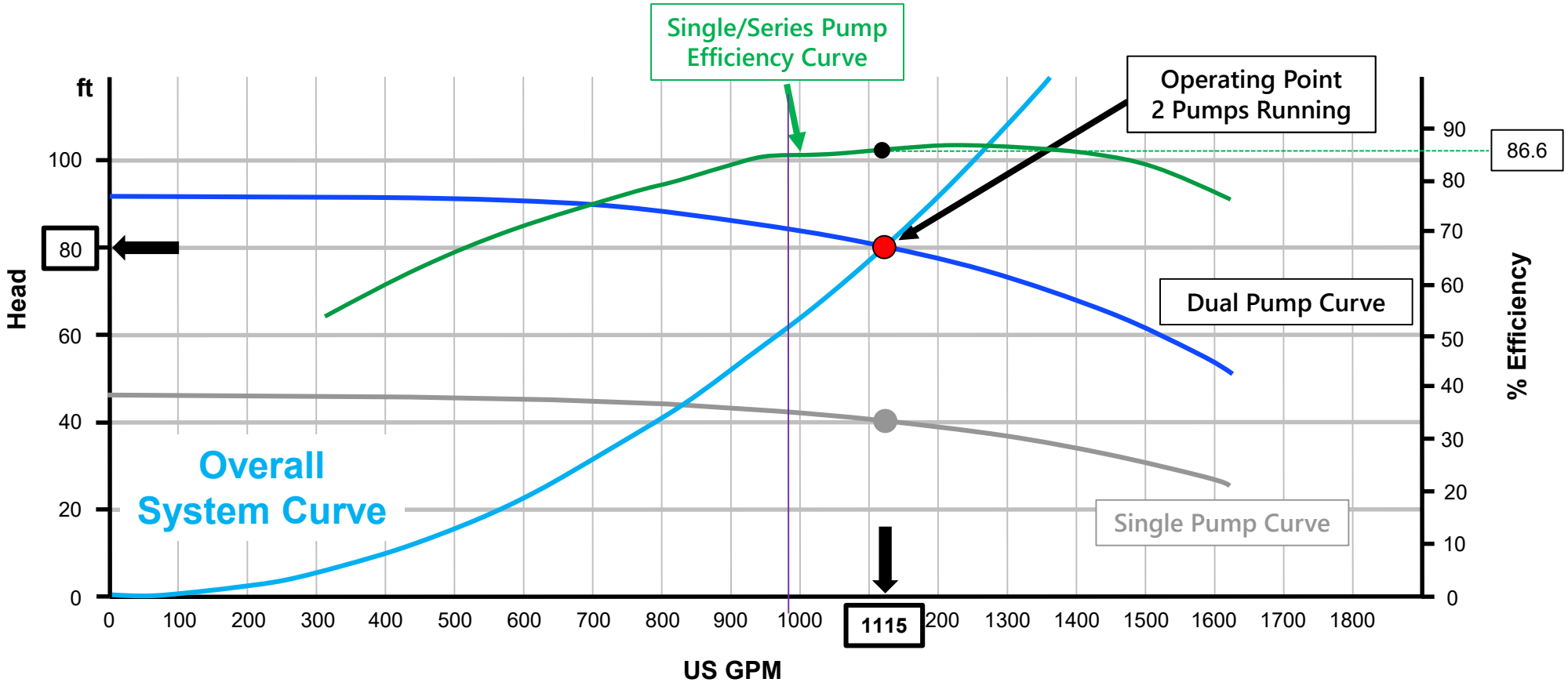
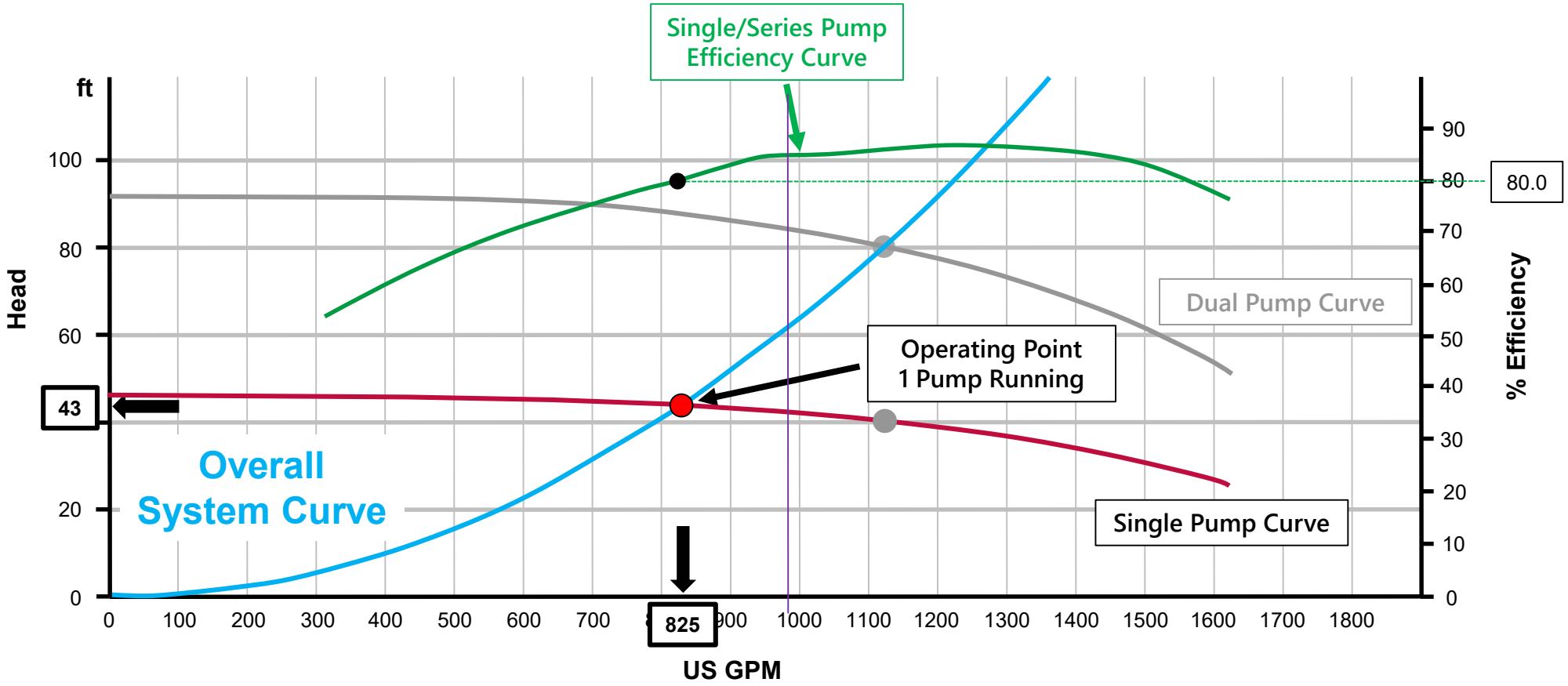
Series Pumping – 50% Duty Head per Pump (No Standby)



What happens when 1 pump is turned off?

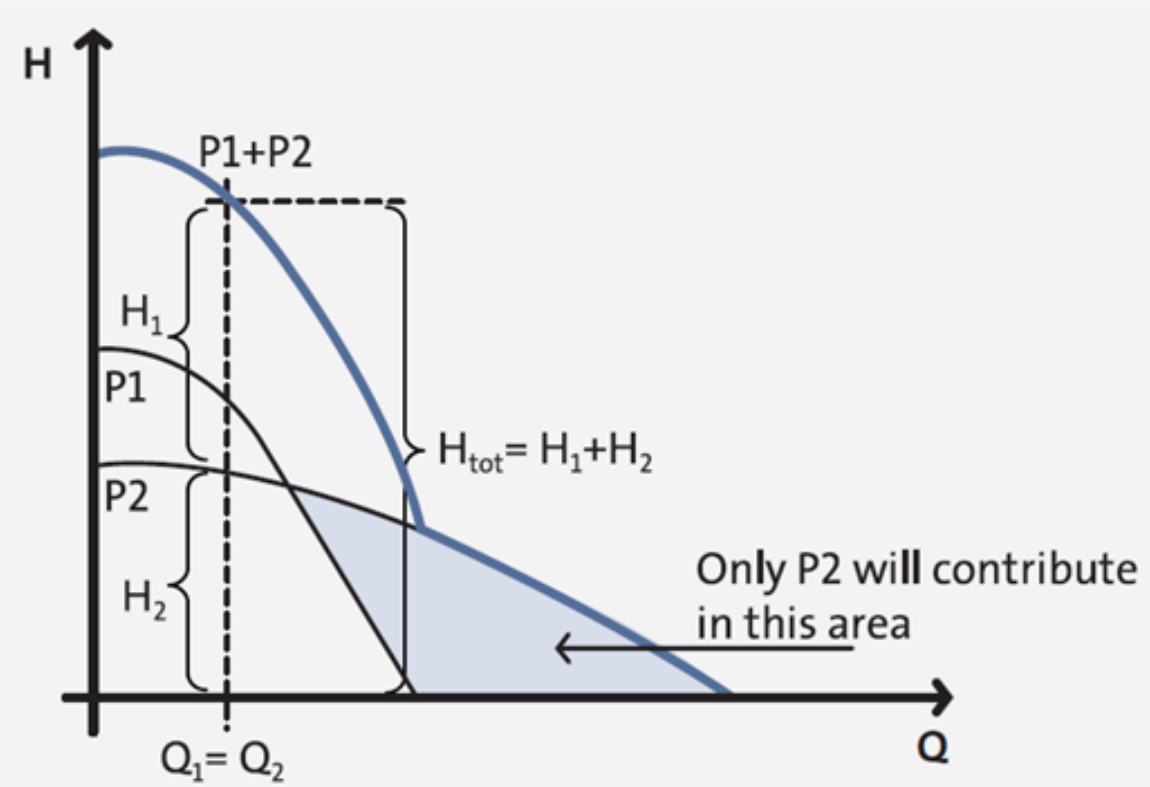
Series Pumping – 50% Duty Head per Pump (No Standby)



What happens when 1 pump is turned off?

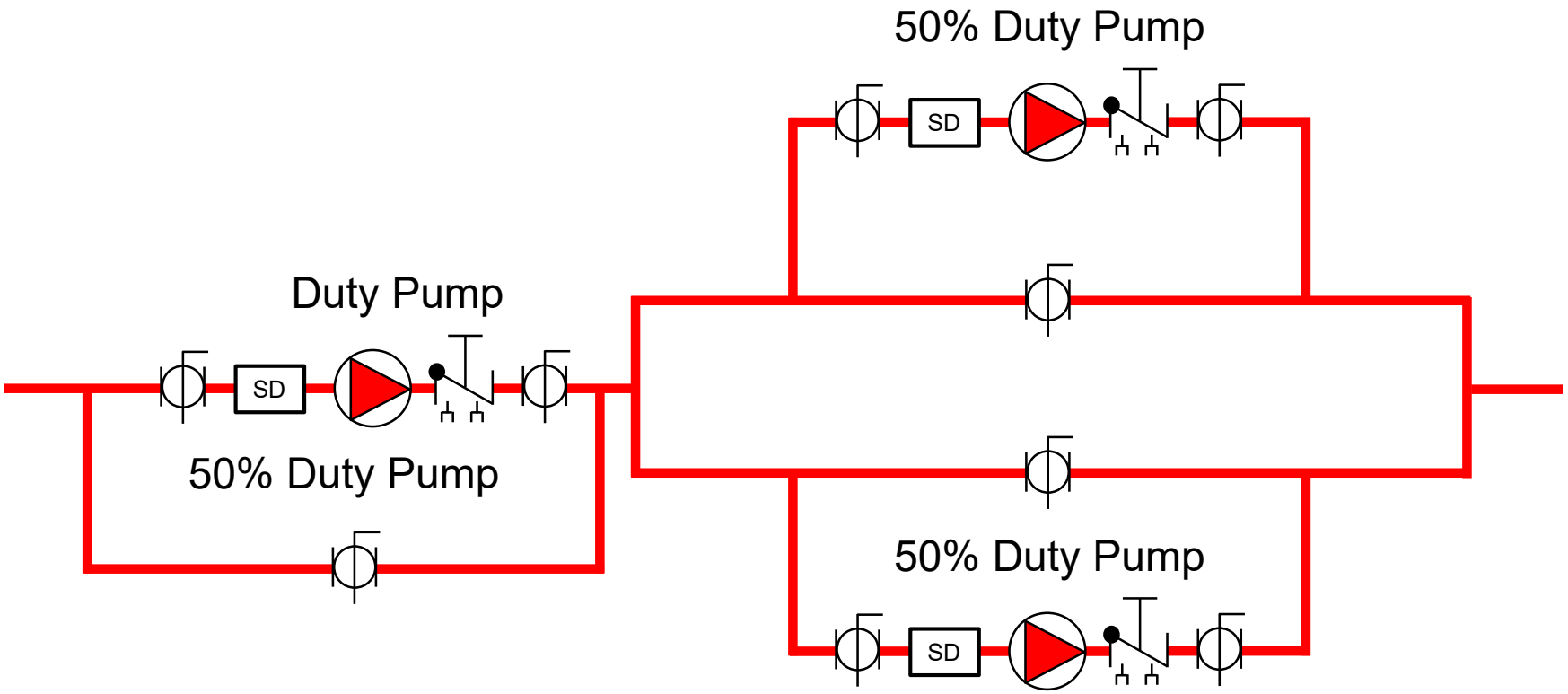
825 GPM/1115 GPM = 74%
Redundant Capacity

Series Pumping – Different Size Pumps

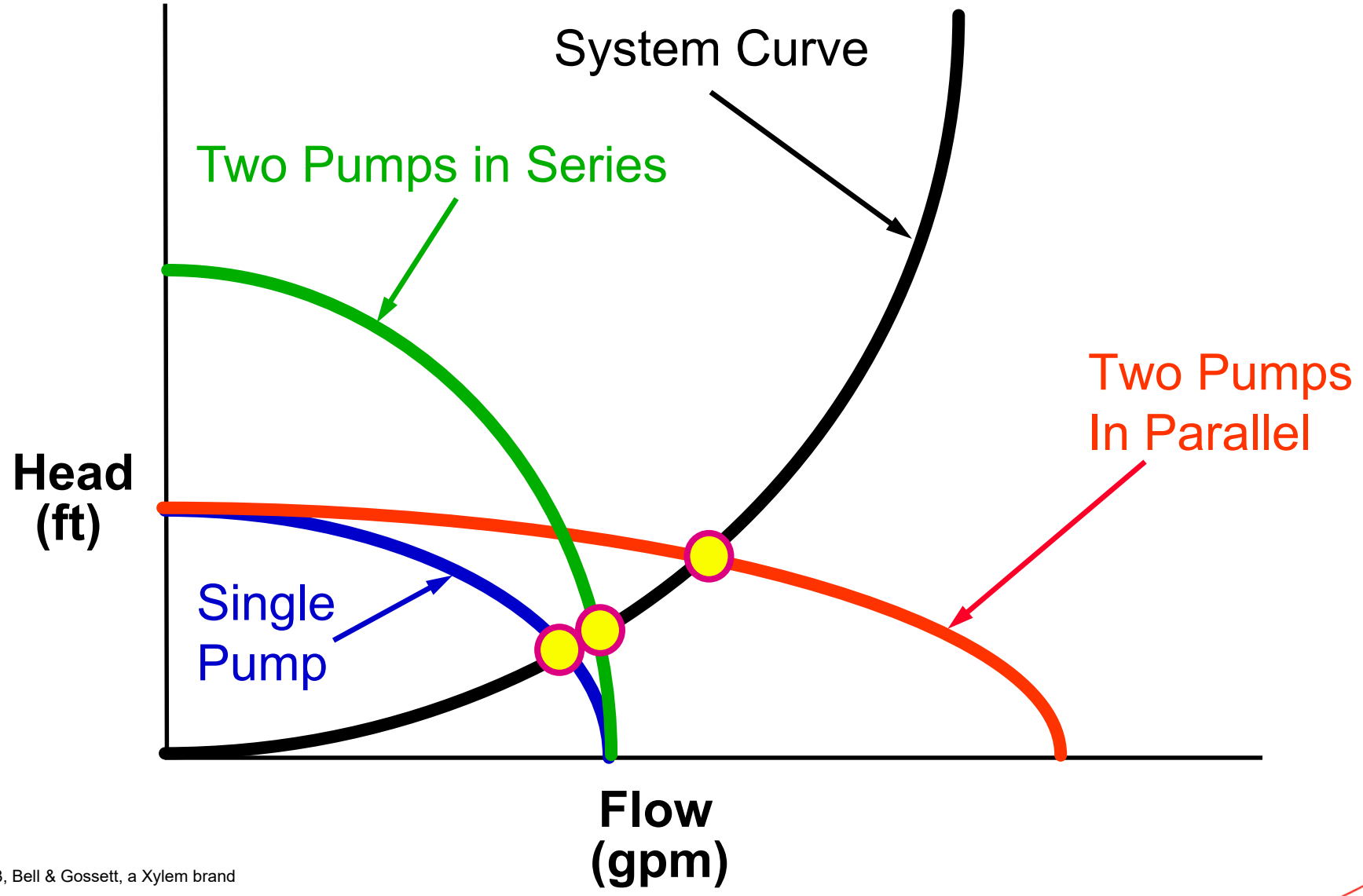


Two different sized pumps connected in series

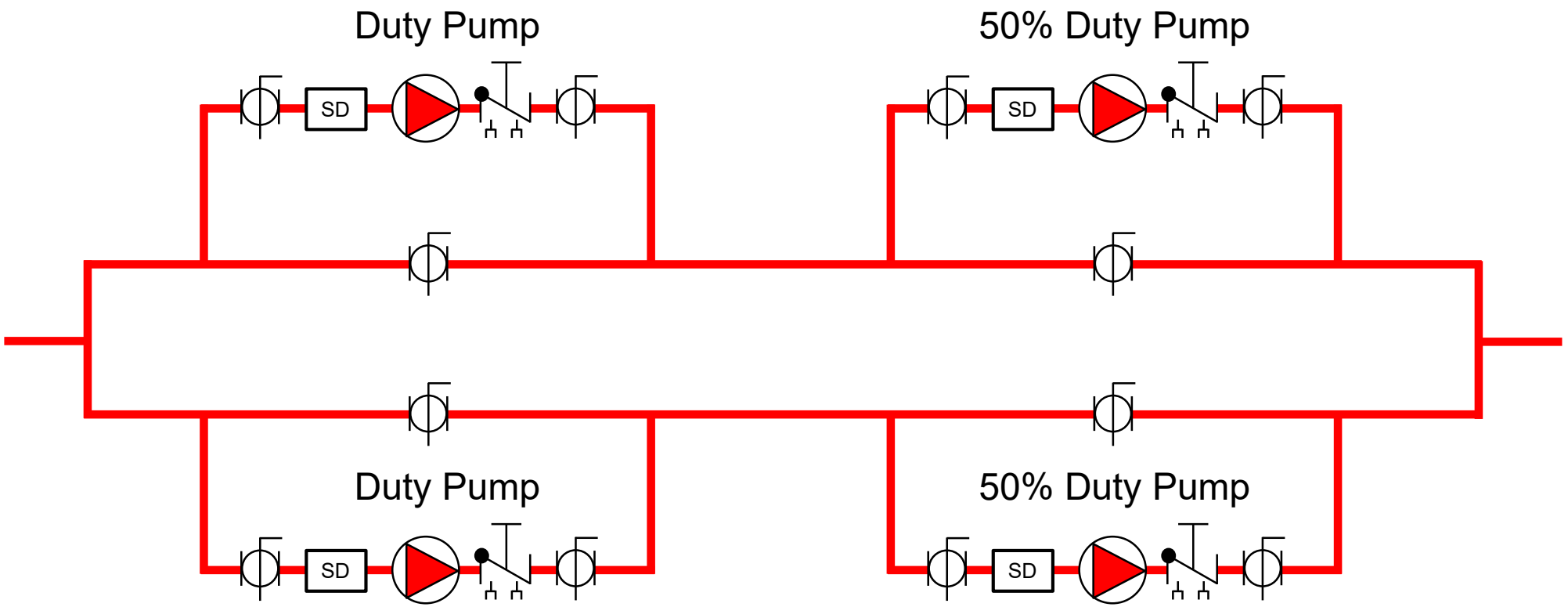
Combination Parallel & Series Pump Configuration



Combination Parallel & Series Pump Configuration



Combination Parallel & Series Pump Configuration



Combination Parallel & Series Pump Configuration