

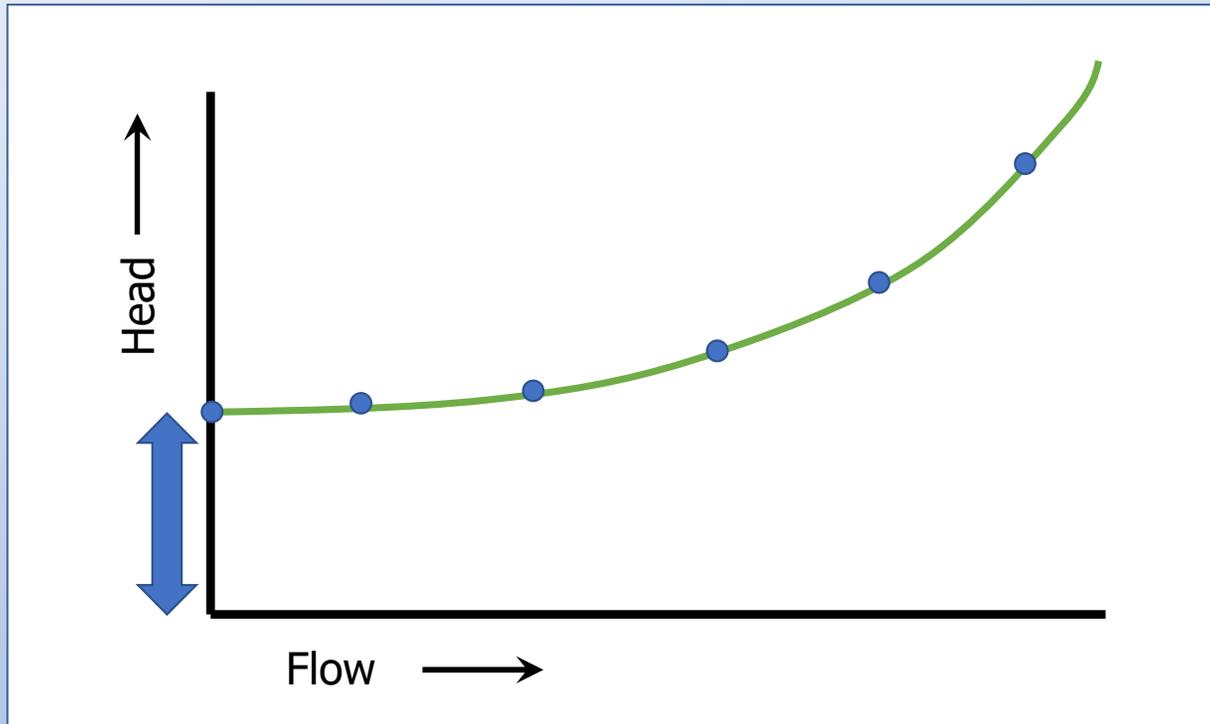
# Pumps and System Curves

Module 2

# Review

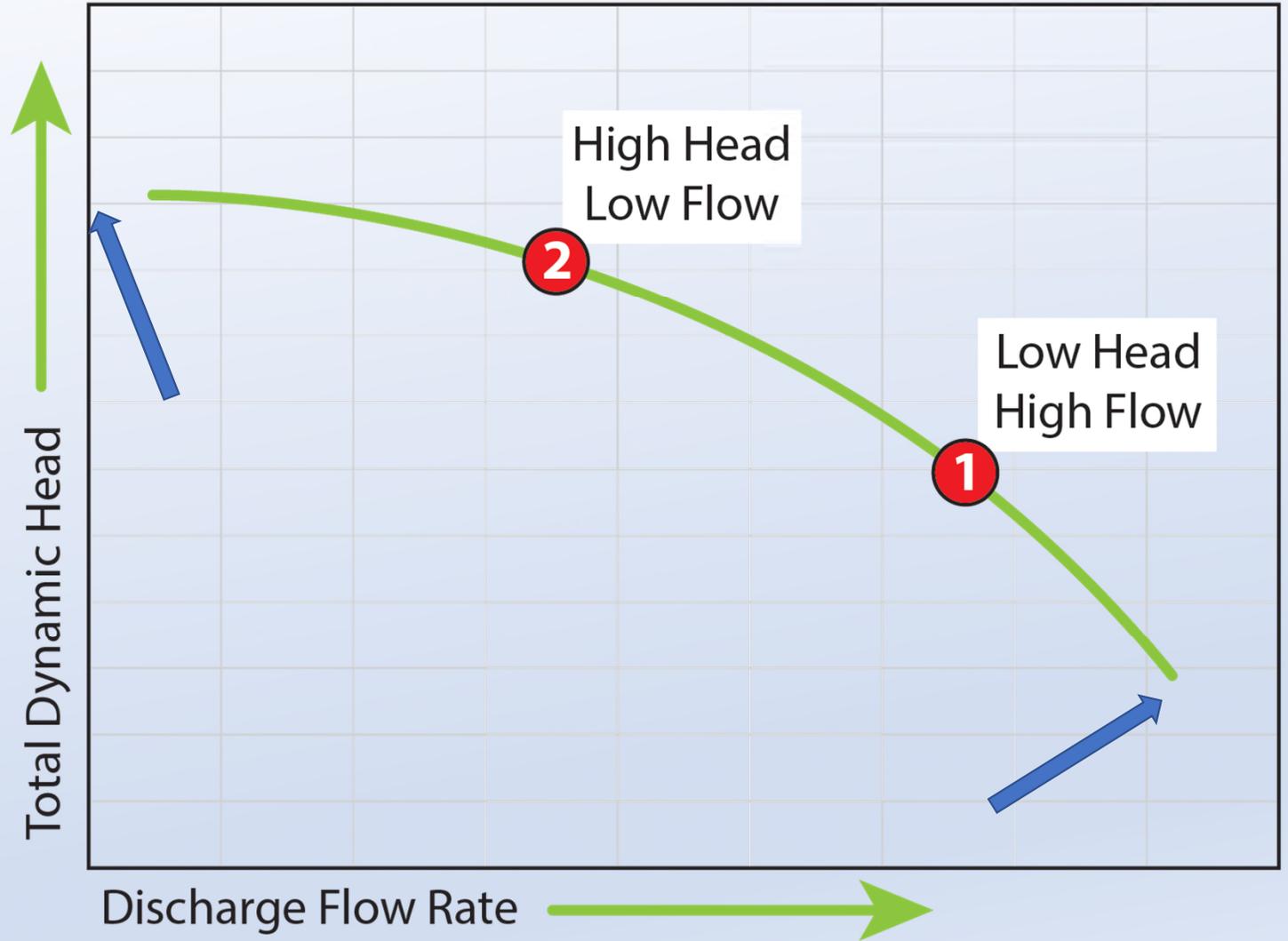
# Review

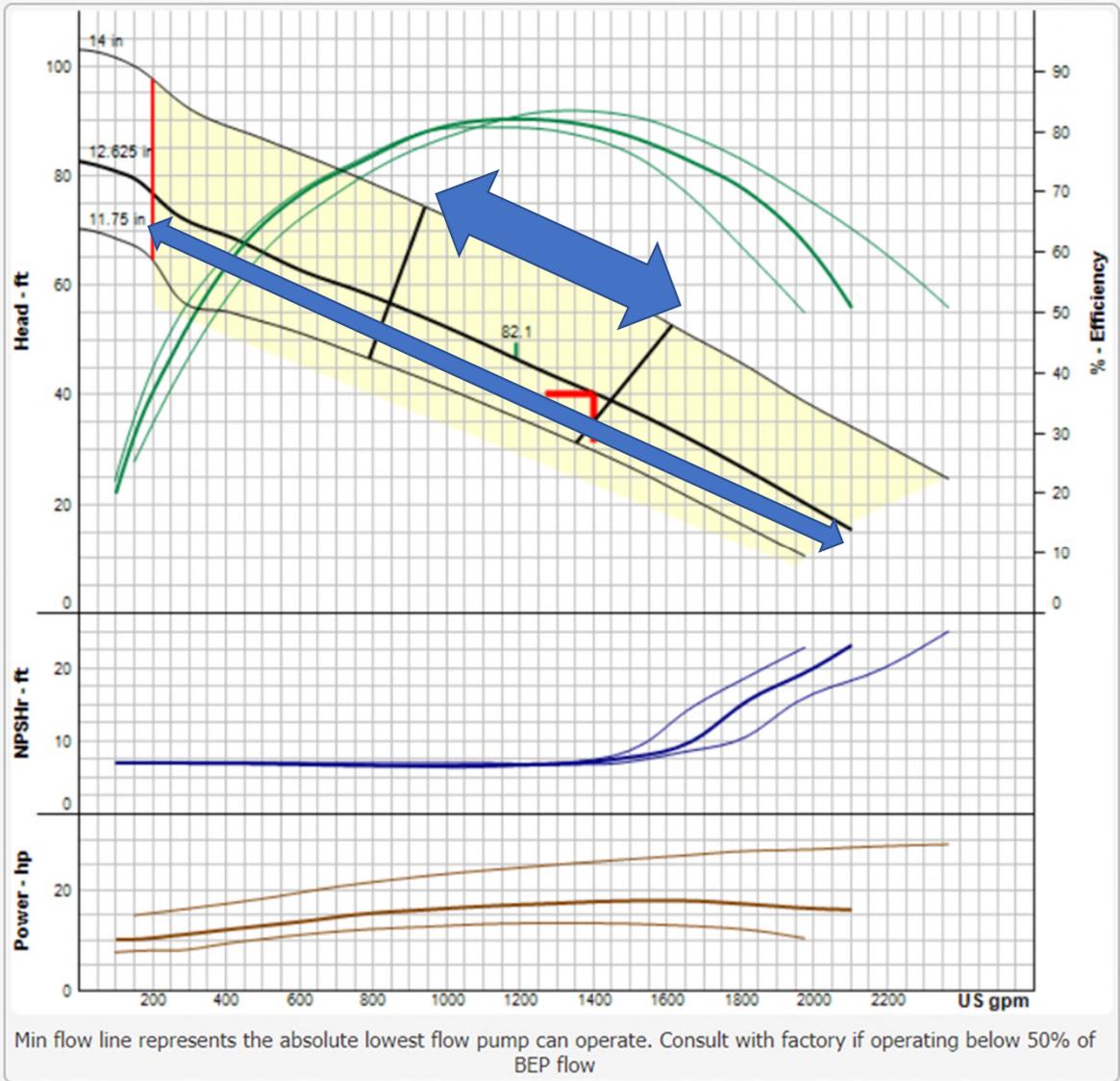
What?



# Review

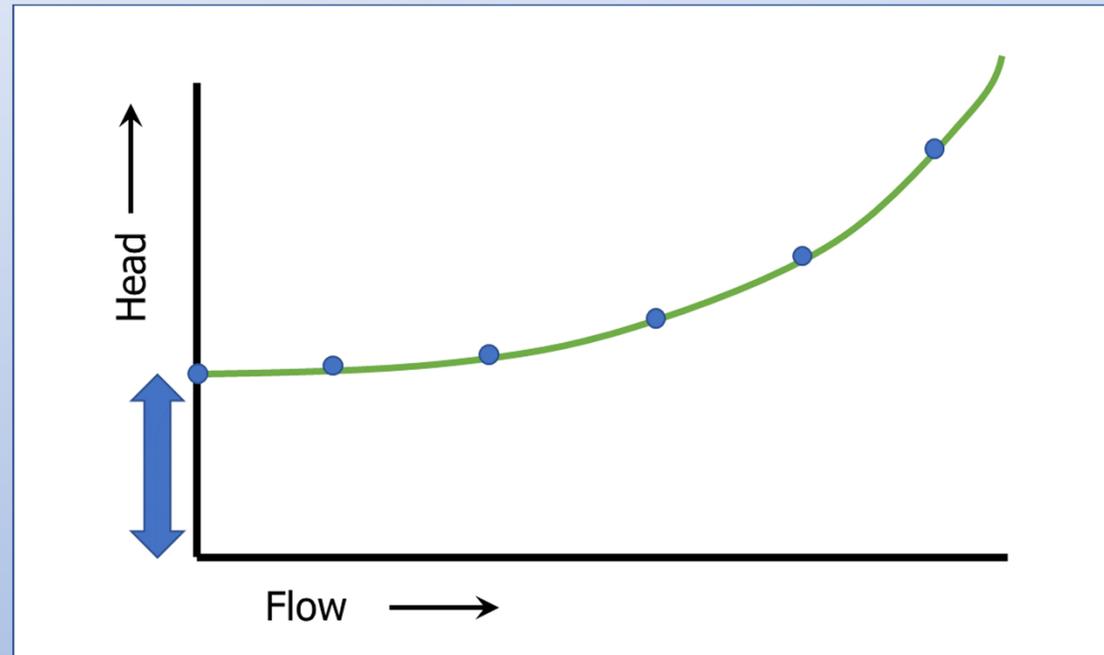
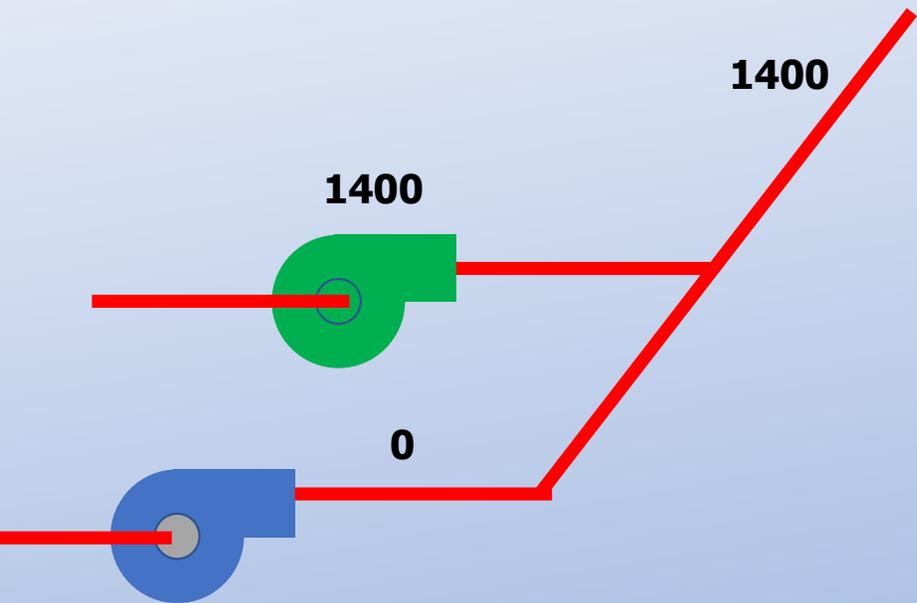
How?



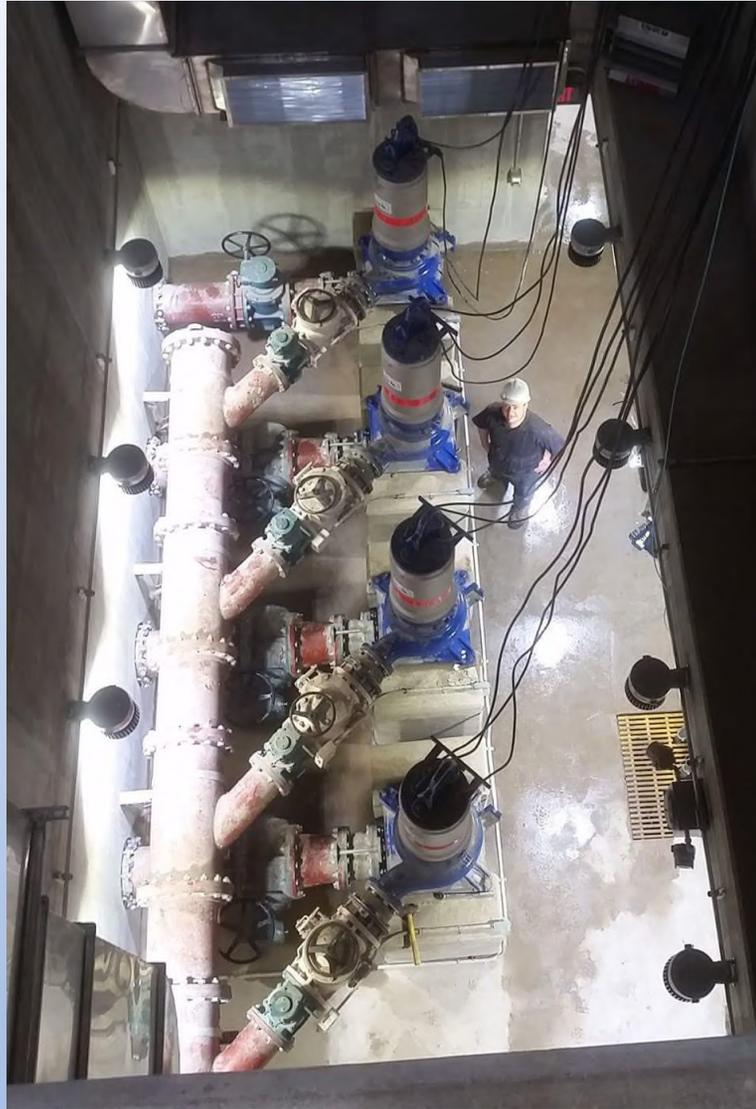




# Pumps in Parallel



# Pumps in Parallel



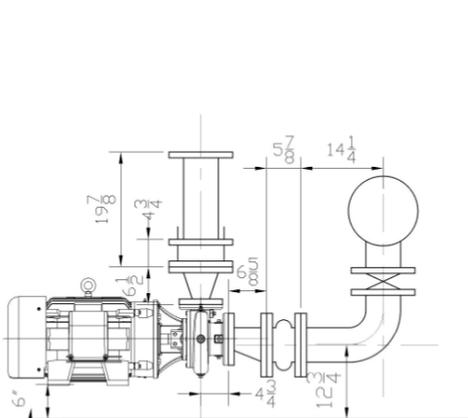
# Pumps in Parallel



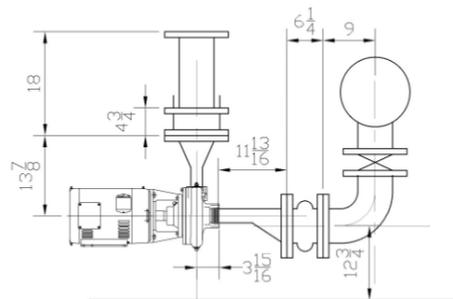
# Pumps in Parallel



FIELD MEASUREMENTS OF EXISTING PIPING AND PUMPS



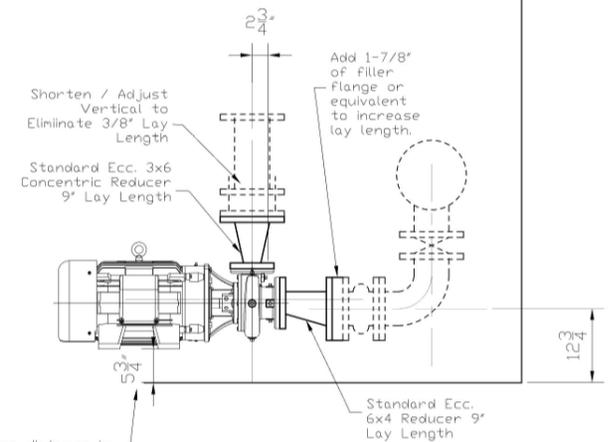
Existing 3WH36 30HP



Existing 2WH36 7.5HP

THIS IS THE RECOMMENDED CONFIGURATION -- SHOWN IN MODIFIED PIPING

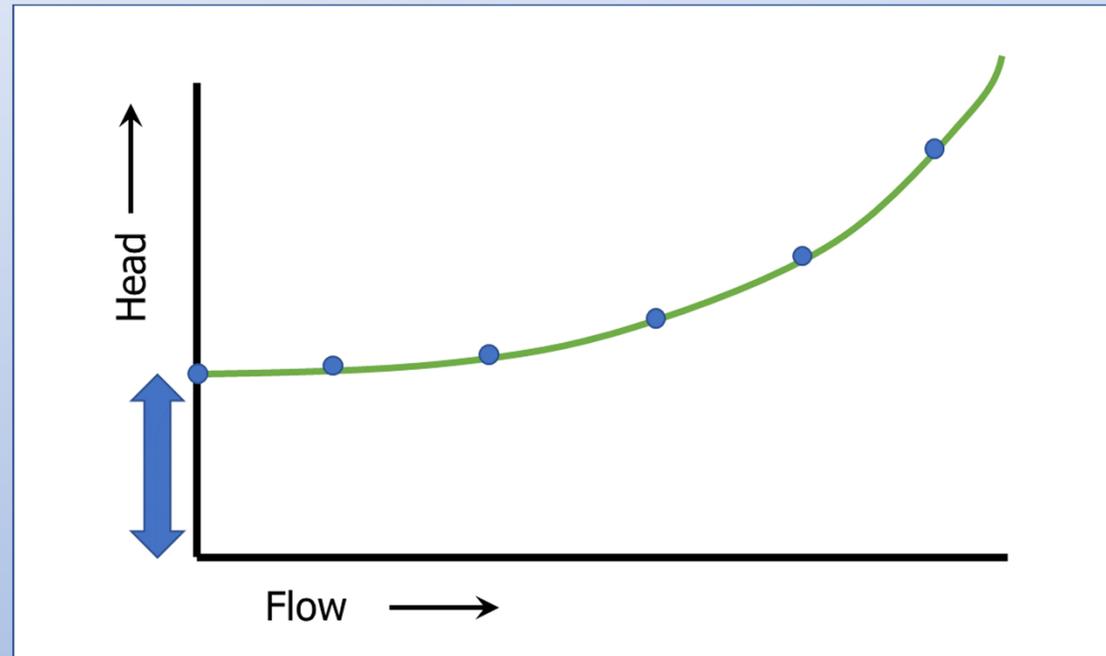
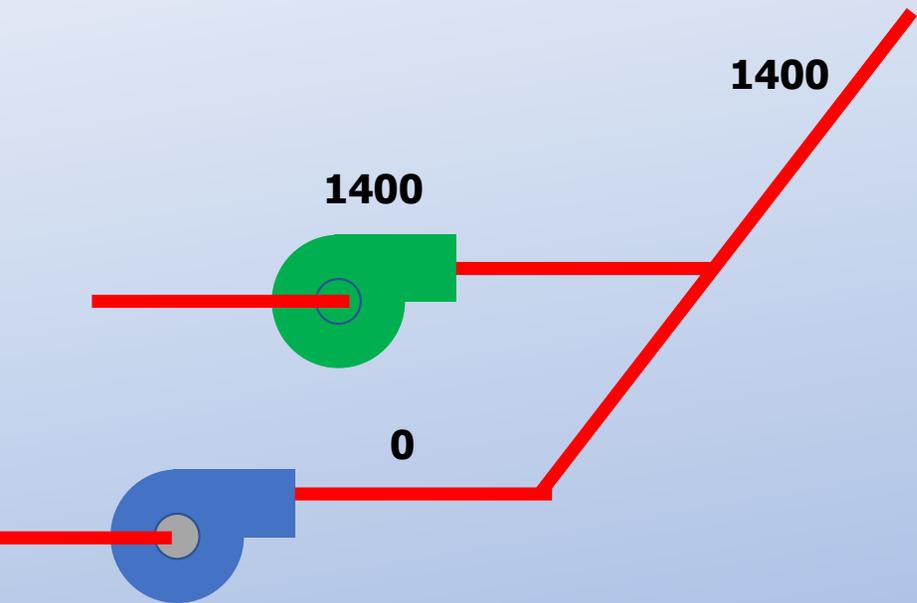
ONLY NEW FITTINGS/PIPE:  
2 REDUCERS + FILLER FLANGES.  
ONE PIPE MODIFIED.



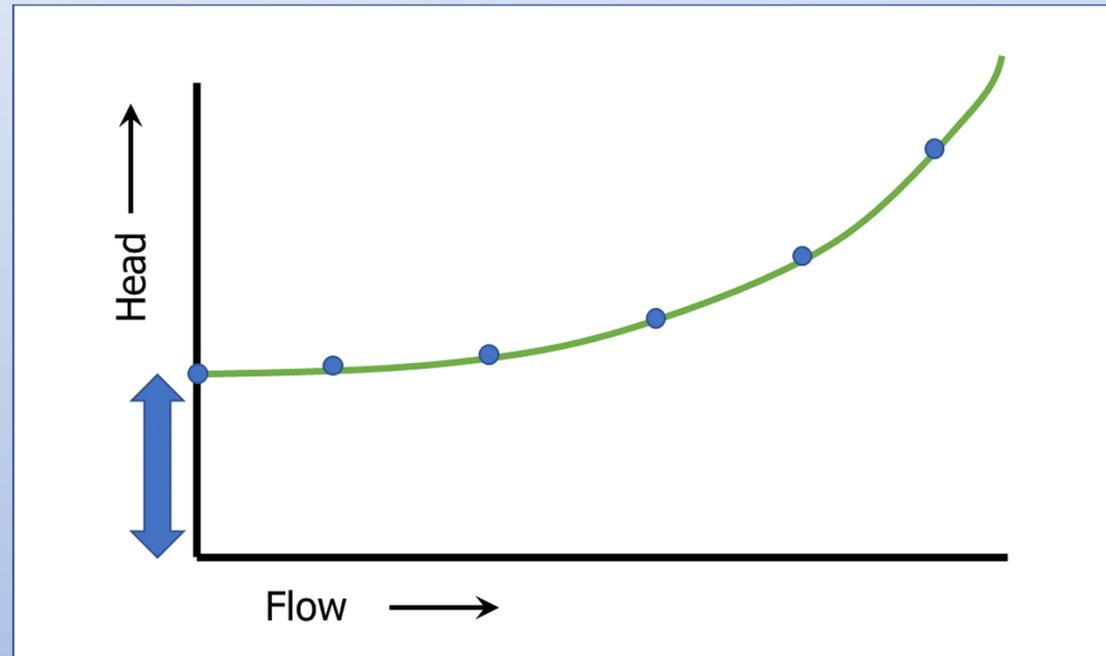
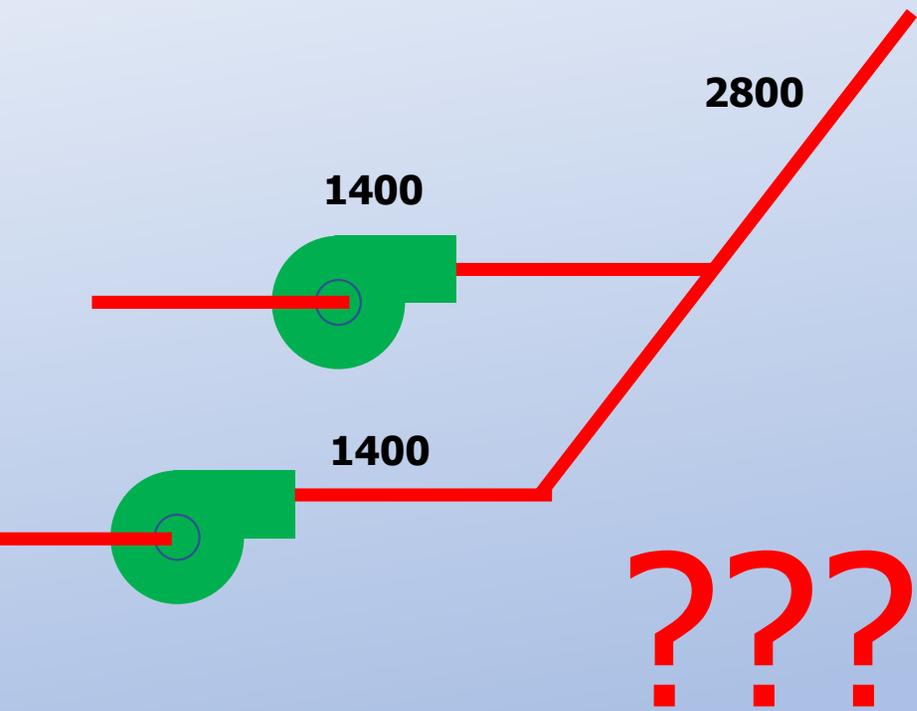
Resulting distance is LESS than C-channel dimension on existing 30 HP. Need to fab appropriate support for 5.75' (or slightly less and shim final)

NEW 30HP WHA in Spot of Existing 2WH36 7.5HP CORRECTED PIPING

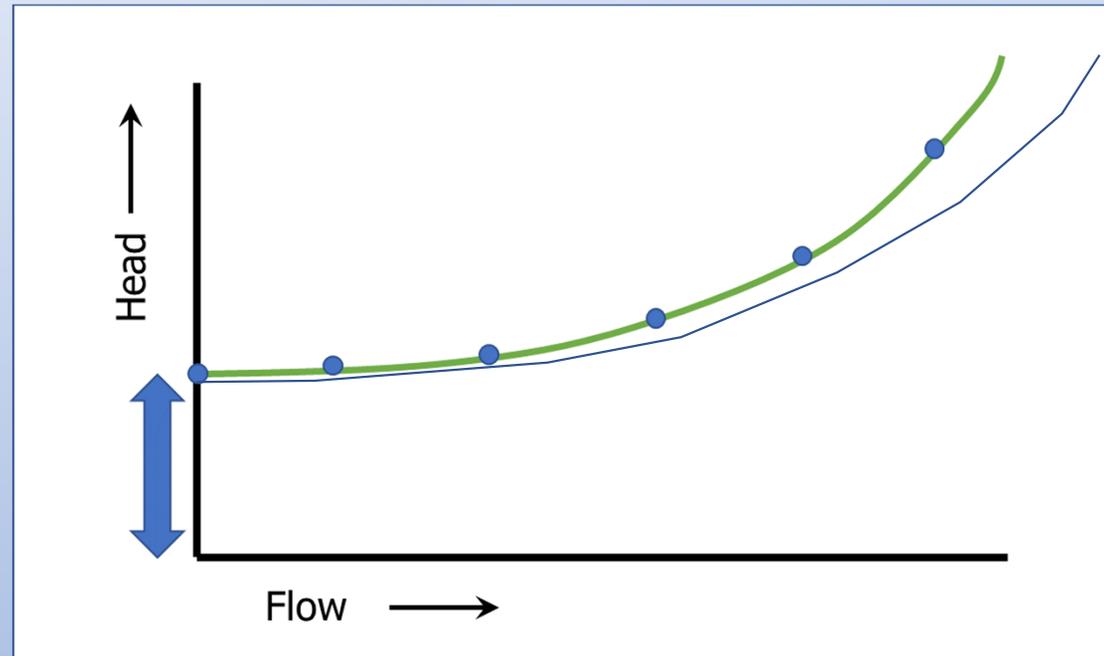
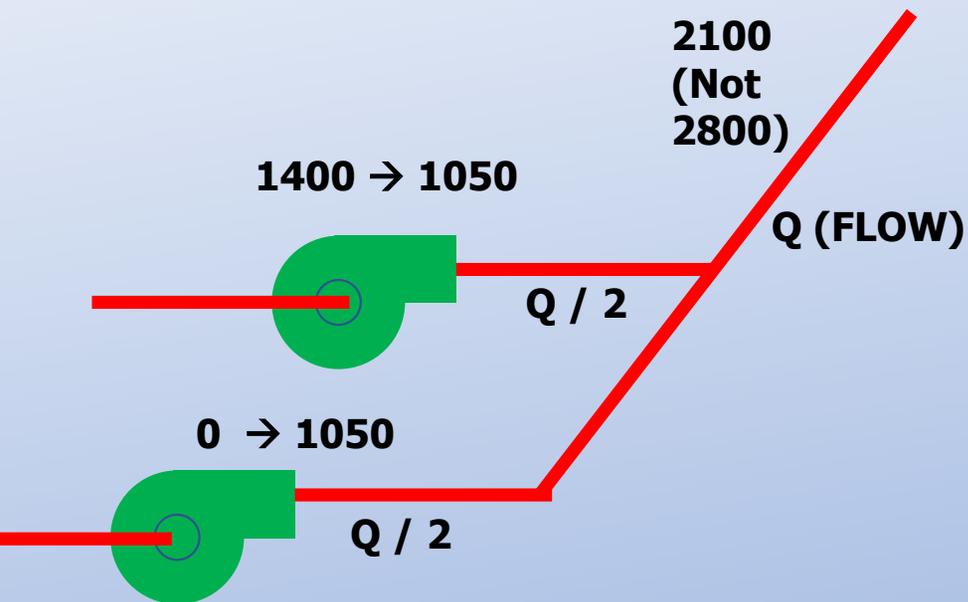
# Pumps in Parallel



# Pumps in Parallel

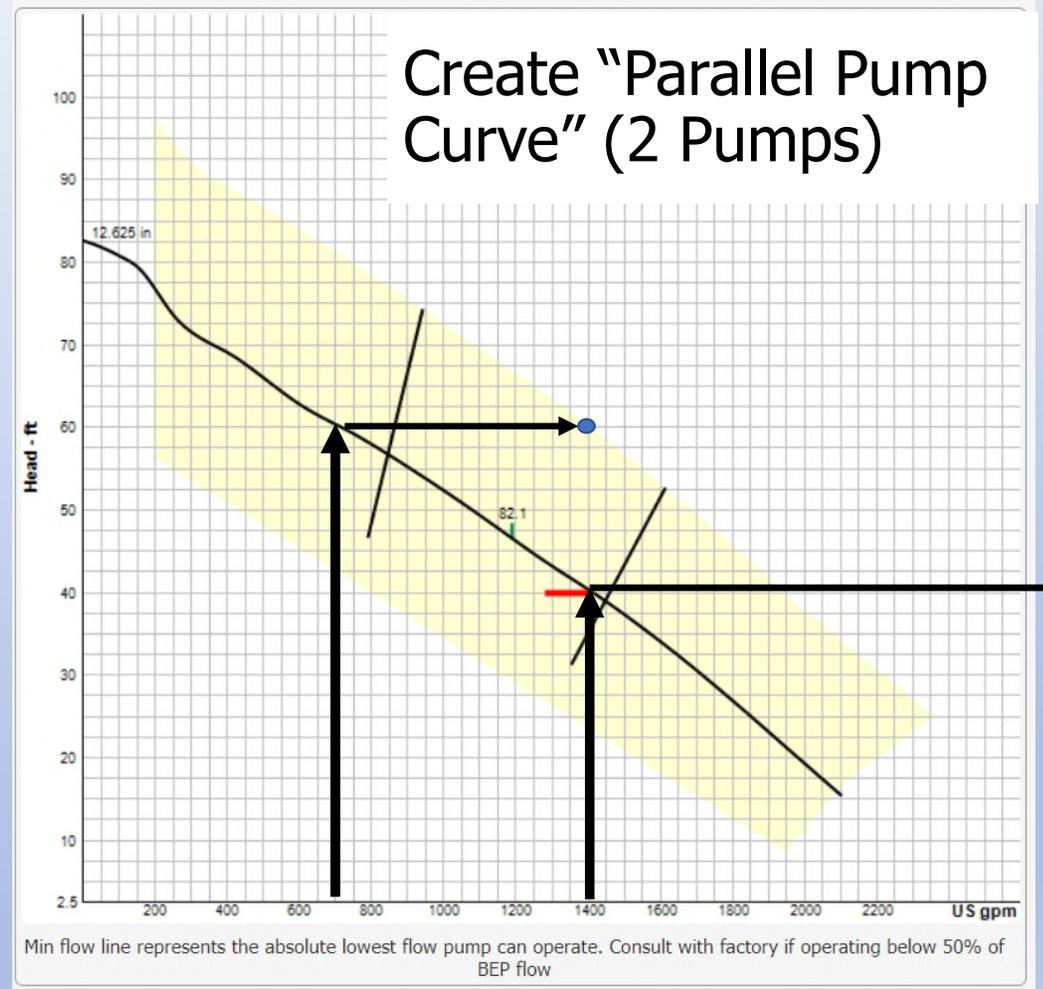
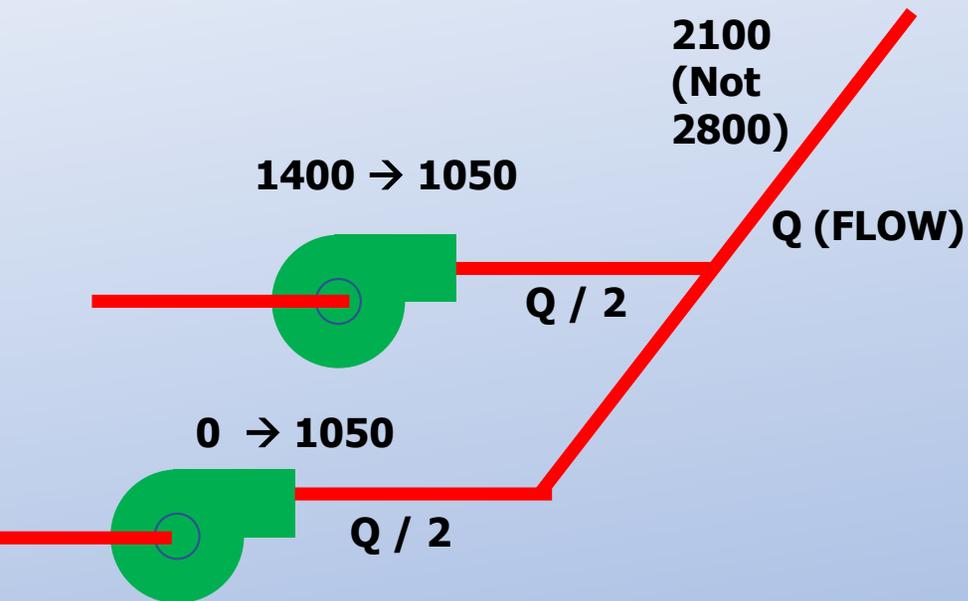


# Pumps in Parallel



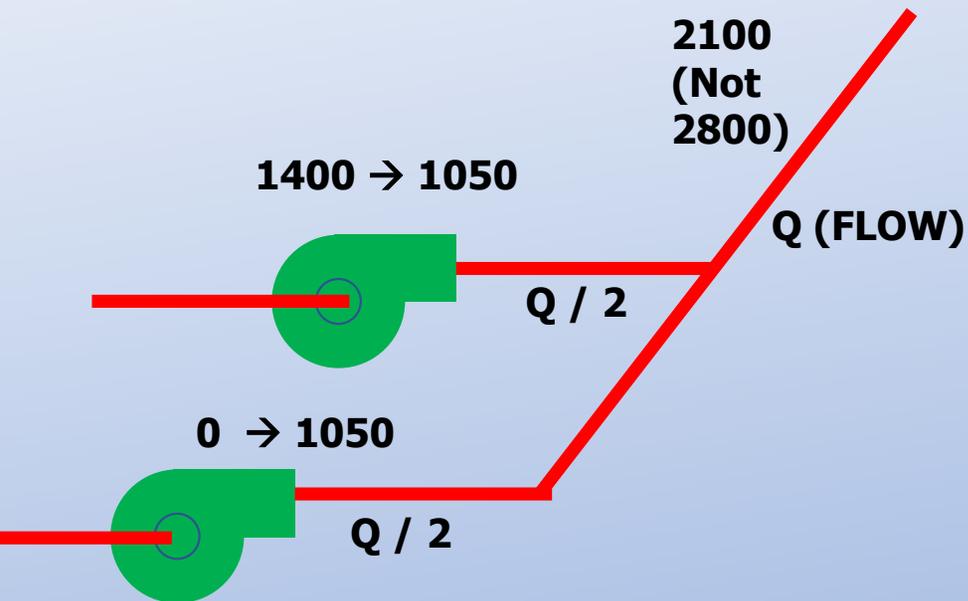
Assume for the moment System Curve doesn't change...

# Pumps in Parallel

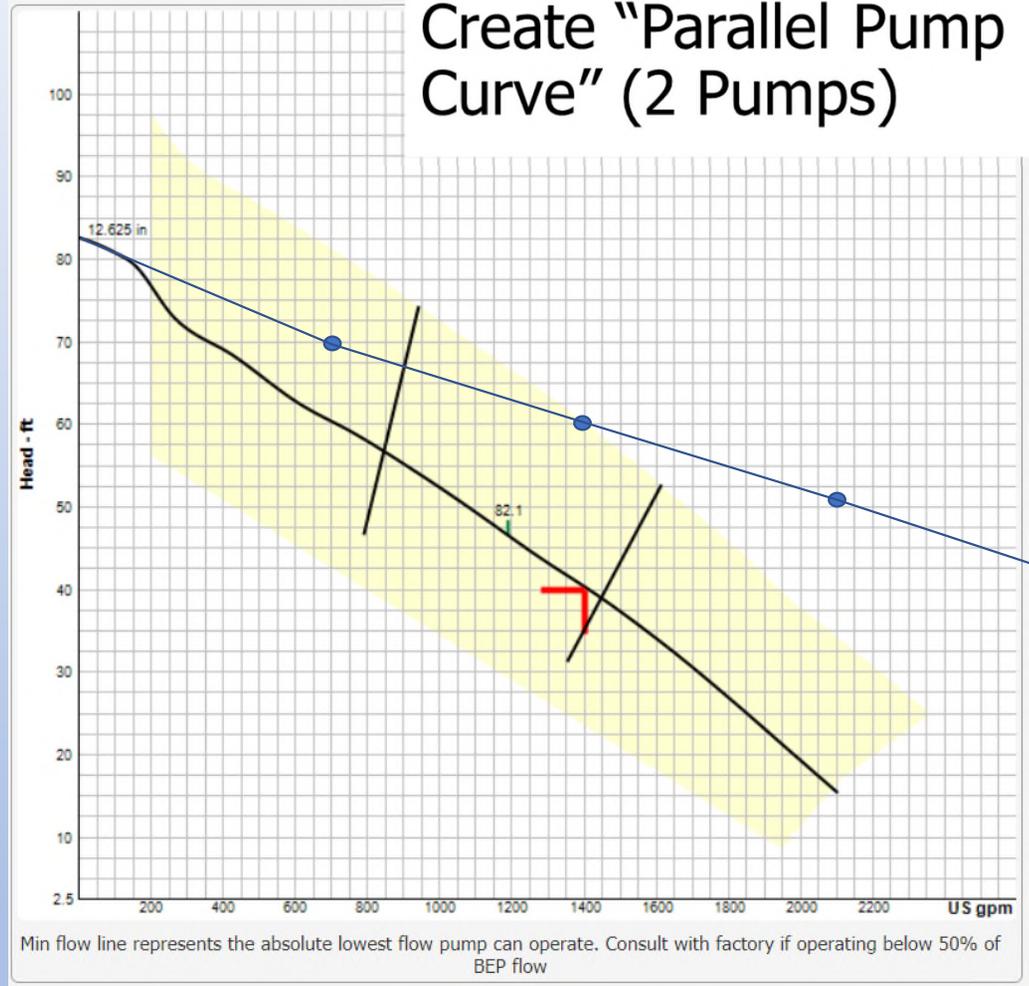


Q (FLOW)

# Pumps in Parallel

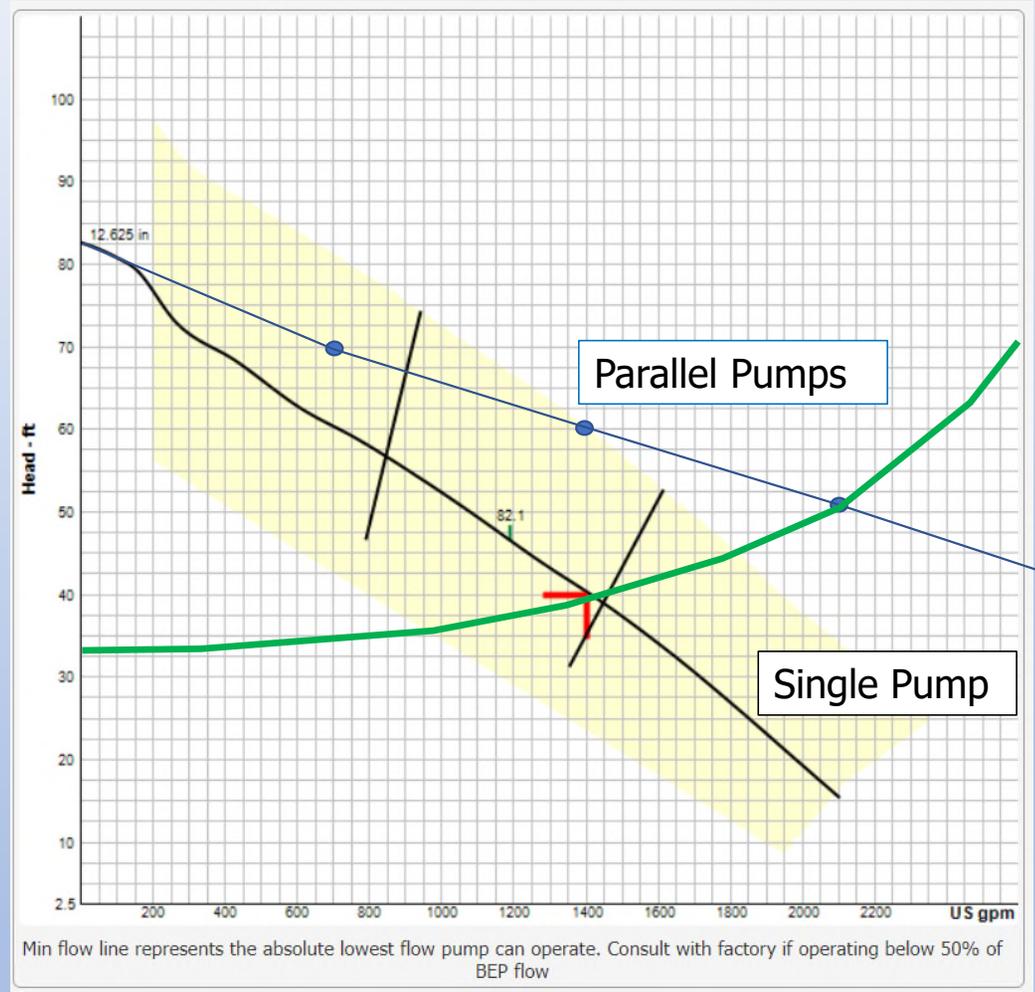
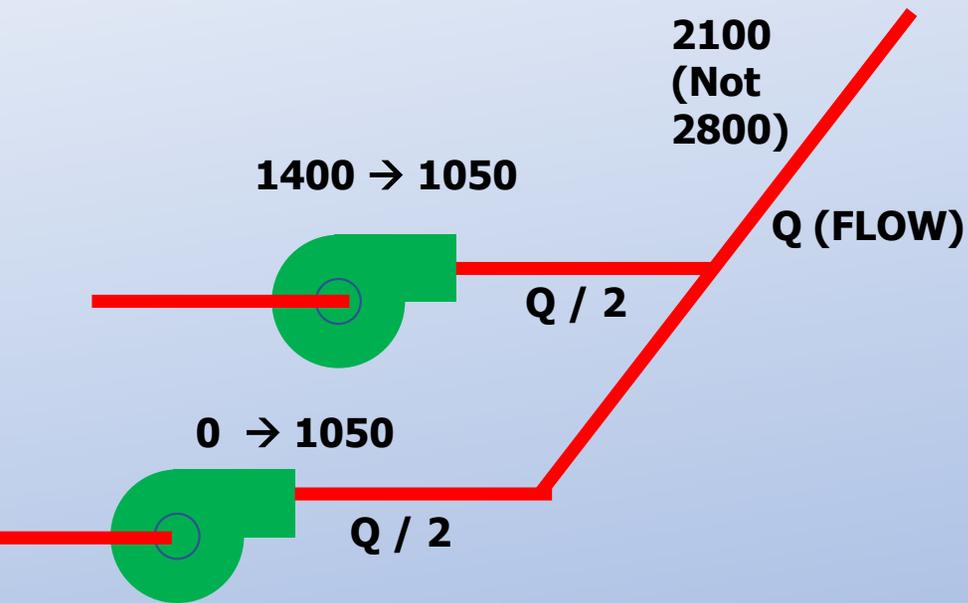


Create "Parallel Pump Curve" (2 Pumps)



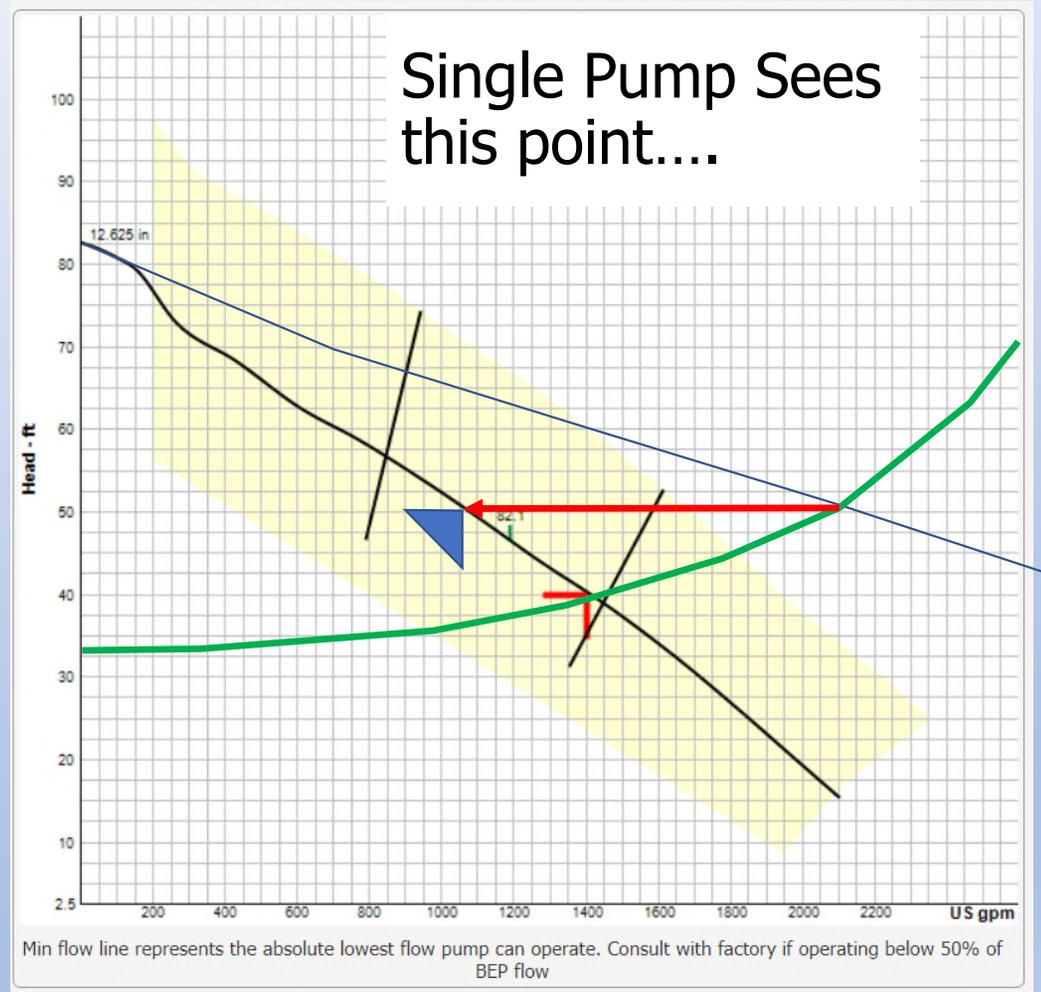
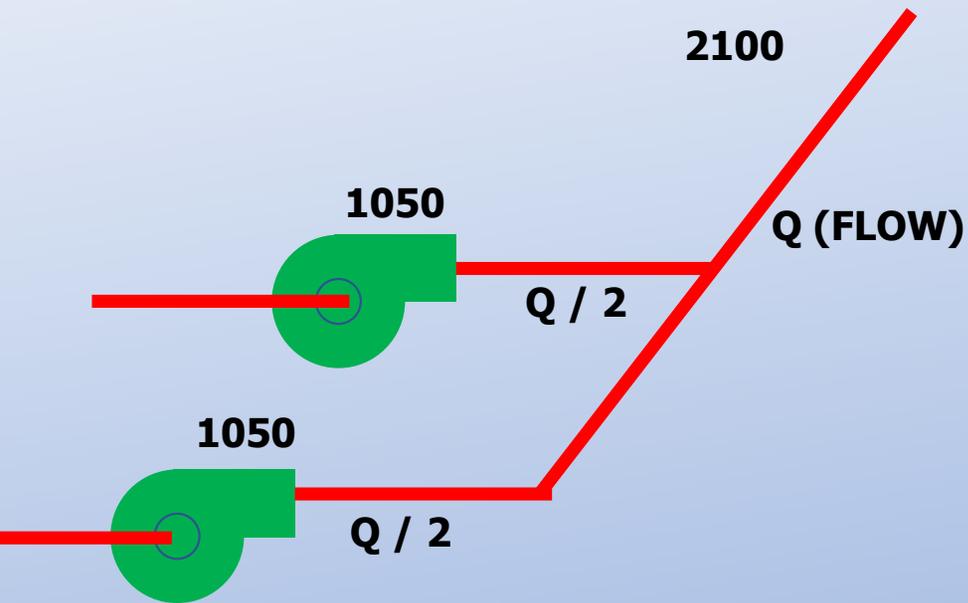
Q (FLOW)

# Pumps in Parallel



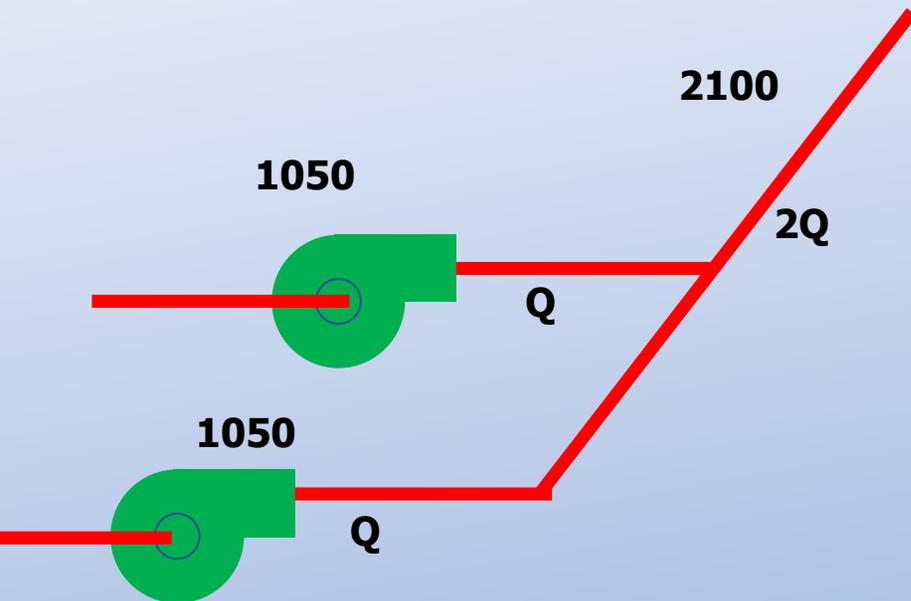
**Q (FLOW)**

# Pumps in Parallel

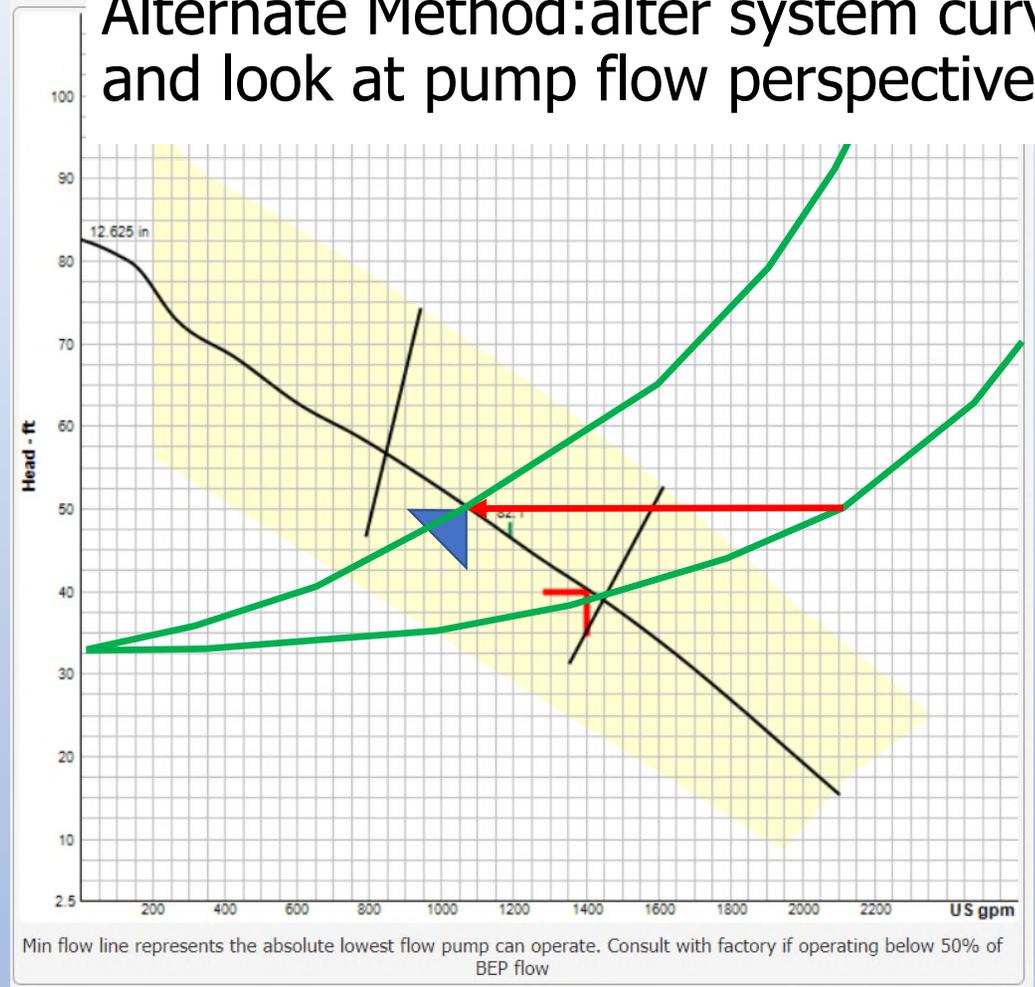


**Q (FLOW)**  
**(FROM ALL PUMPS)**

# Pumps in Parallel

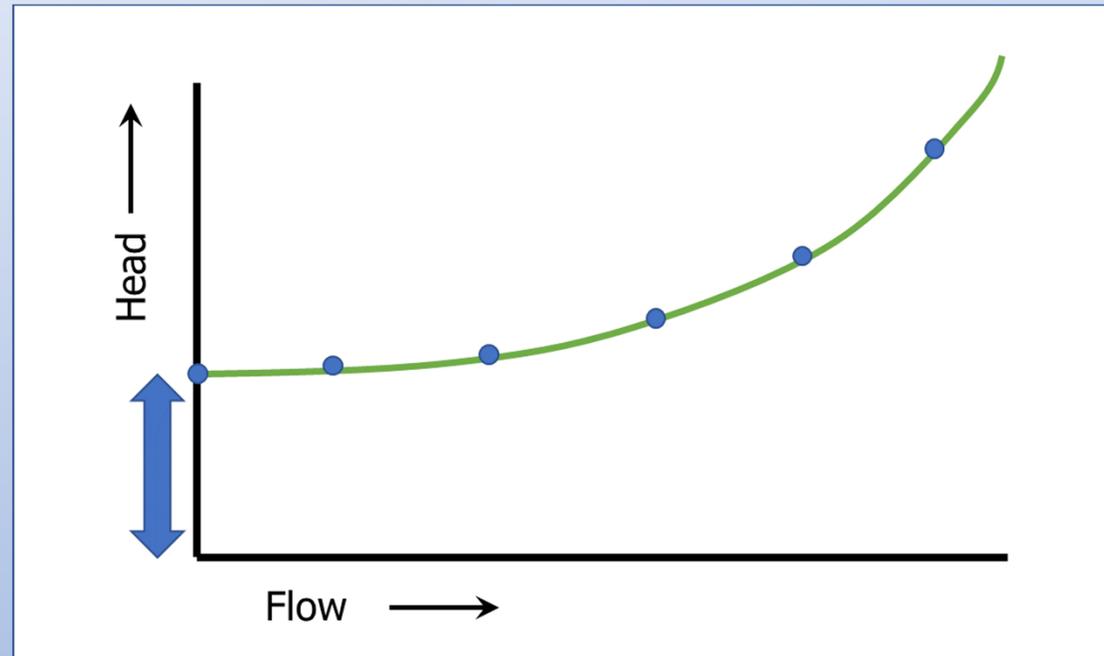
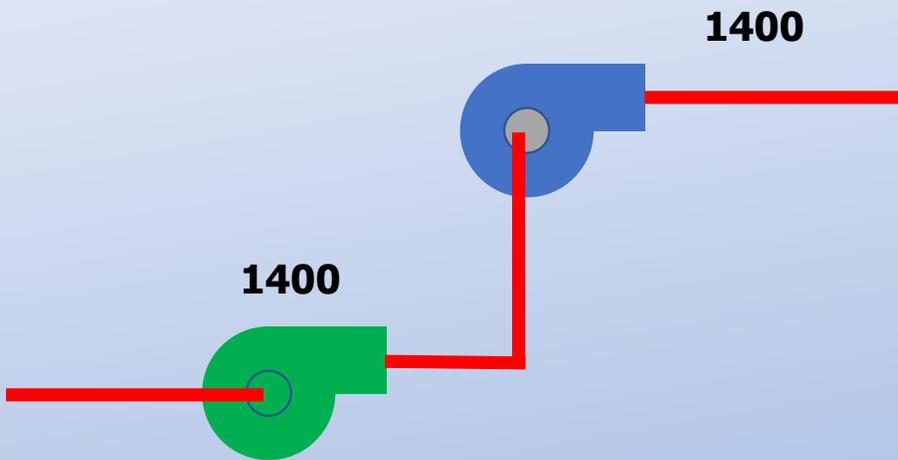


Alternate Method: alter system curve and look at pump flow perspective.

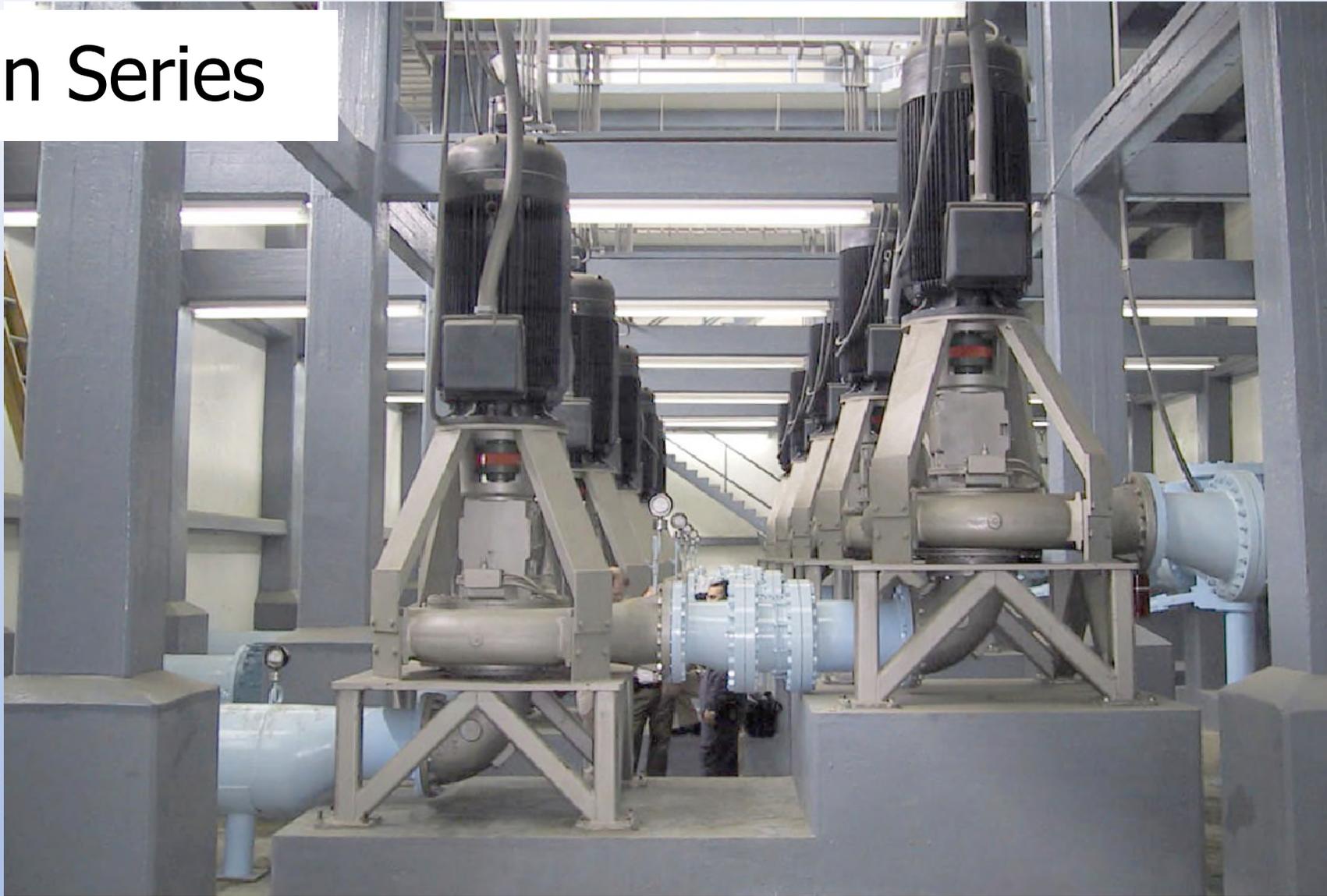


**Q (FLOW\_ (THRU ONE PUMP))**

# Pumps in Series



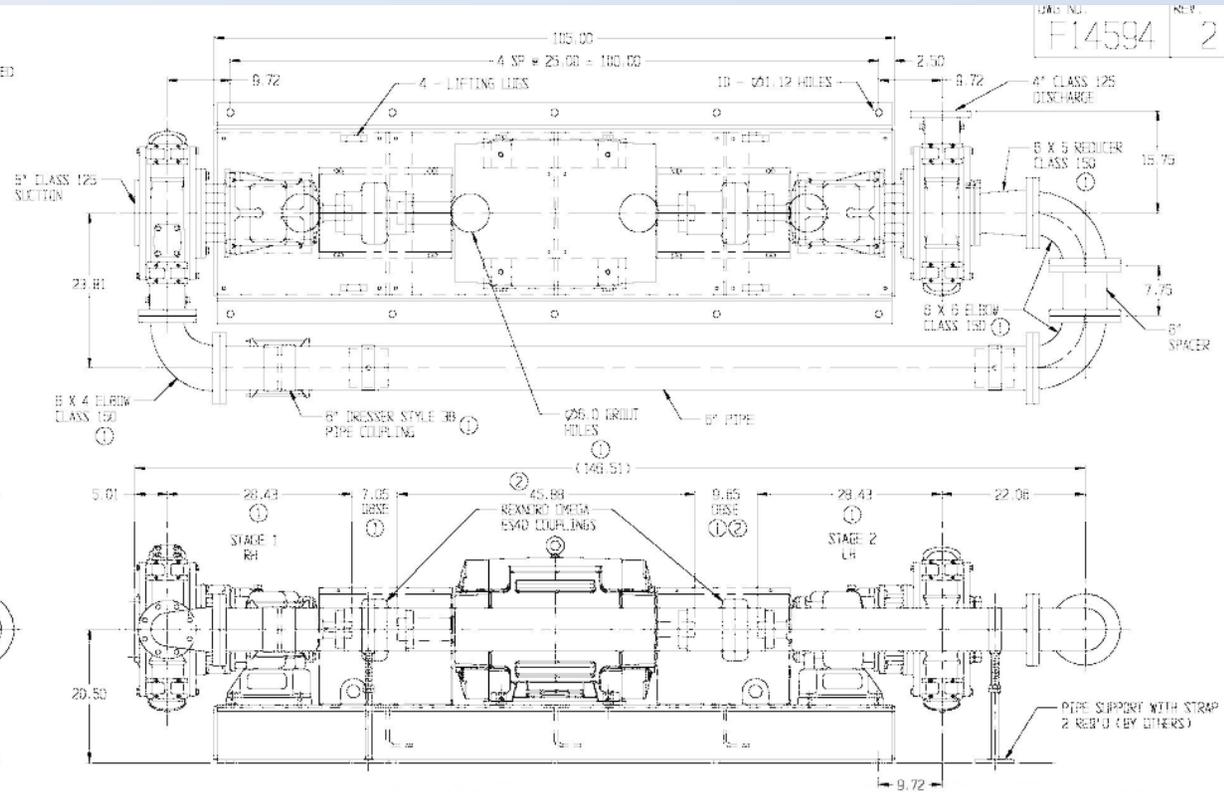
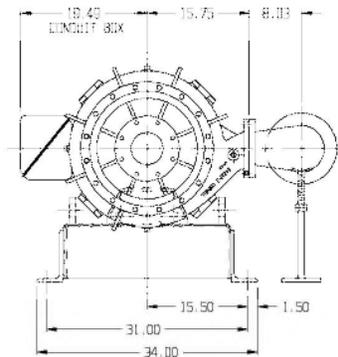
# Pumps in Series



# Pumps in Series

- NOTE:
1. OVERALL DIMENSIONS CAN VARY ±.12 INCHES
  2. DO NOT USE FOR CONSTRUCTION UNLESS CERTIFIED
  3. STAGE 1: 4NHTB-F180B, RIGHT HAND
  4. STAGE 2: 4NHTB-F180B, LEFT HAND
  5. REF: 101180H-S

CERTIFIED CORRECT BY  
**CORNELL PUMP CO.**  
 REV: Dale Timmons  
 DATE: 1/16/17

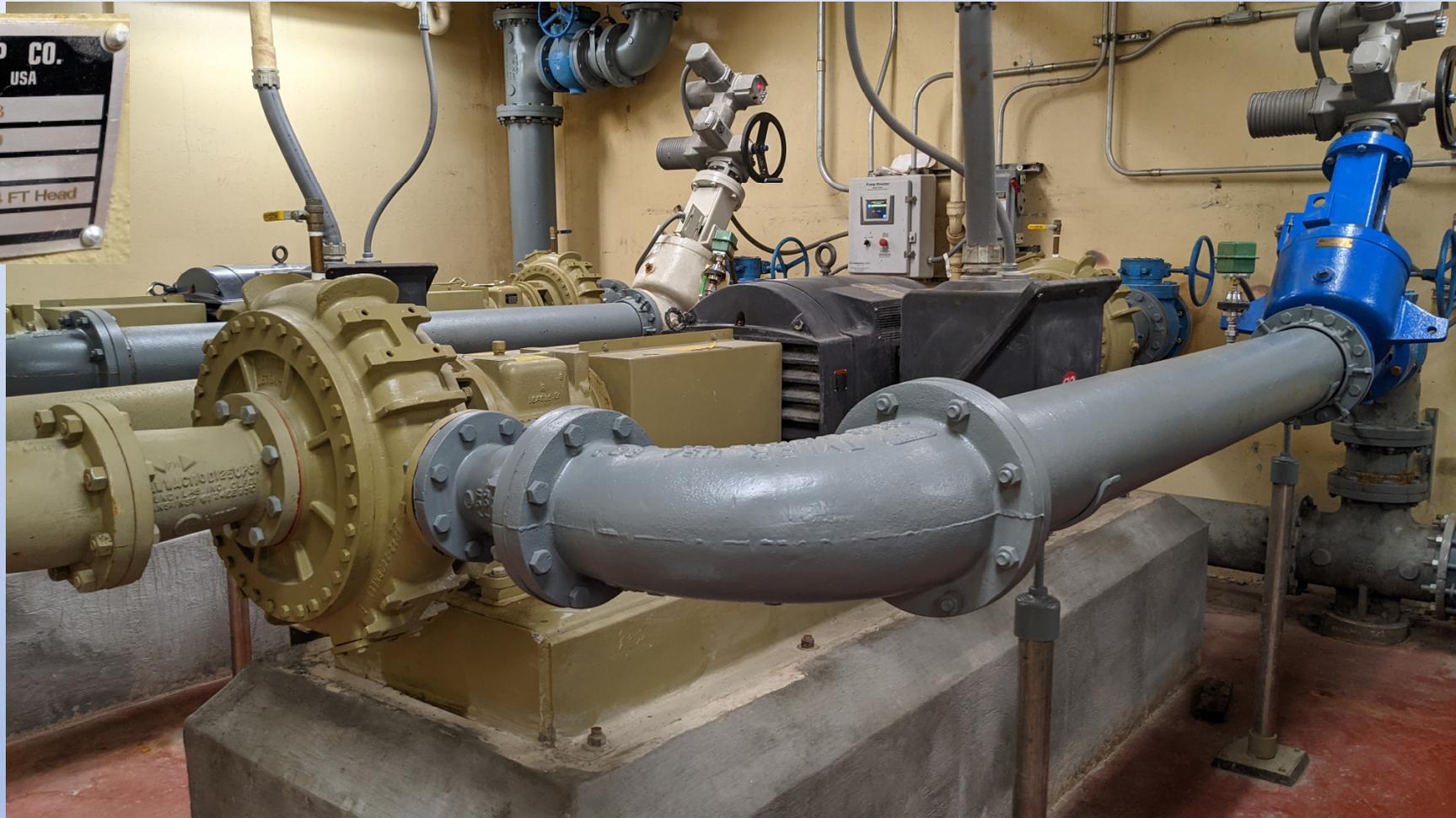
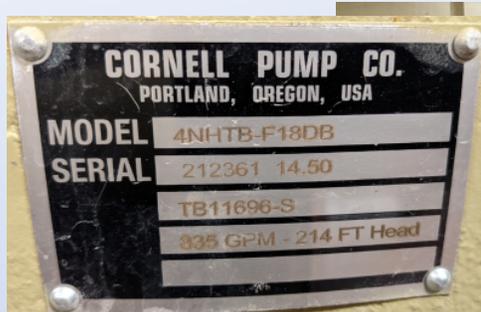


CUSTOMER: TOTAL EQUIPMENT COMPANY  
 P.O. NO.: 3144076  
 S.O. NO.:  
 PROJECT NAME: GLADE RUN PUMP STATION  
 MOTOR MANUF.: U.S. MOTORS HP: 200  
 FRAME SIZE: 445 RPM: 1800  
 ENCLOSURE: ODP

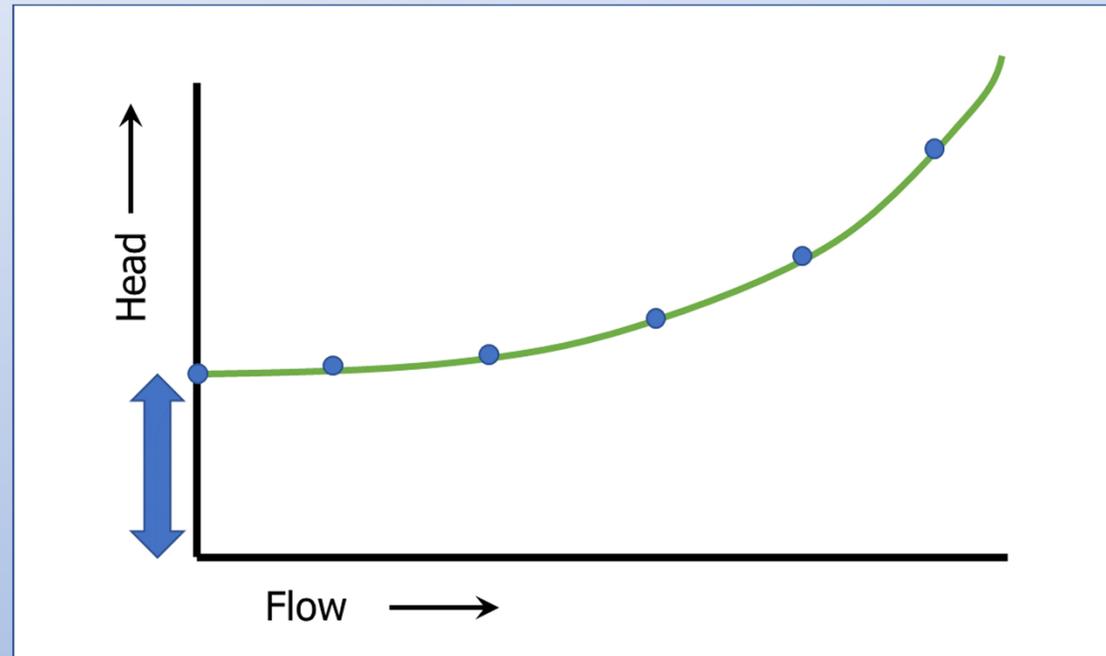
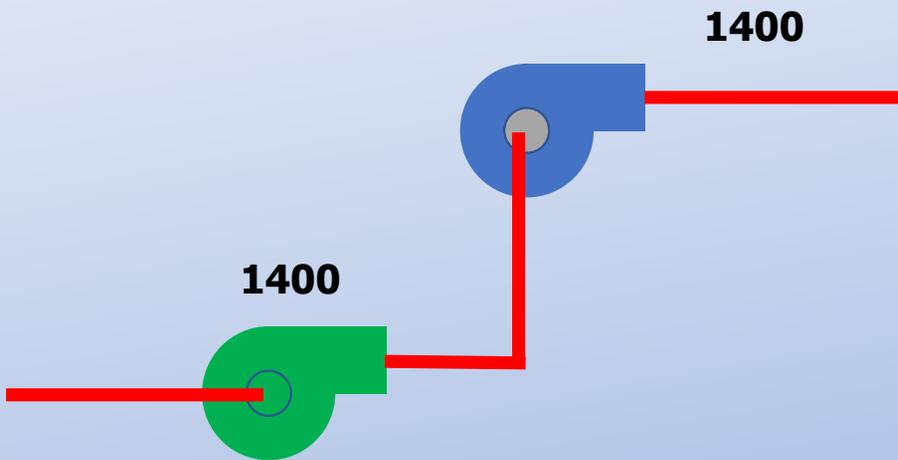
②	45.88 WAS 48.55, 9.65 WAS 6.98, ADDED CERTIFIED CORRECT, DELETED PRELIMINARY	1-16-17	KHL/DT
①	CORRECTED ROTATIONS, DRESSER COUPLING WAS COUPLER W/STAY BOLTS, (146.51) WAS (146.54), 28.43 WAS 28.45 & 28.47, 7.05 & 6.98 WAS 7.00, CLASS 150 WAS 125	7-7-16	KHL/DT
REV. NO.	DESCRIPTION	DATE	BY

FOUNDATION PRINT 4NHTB-F180B DUPLEX PUMPS				PATT. NO.	
DR. KHL CHECKED DT DATE 7-7-16 SCALE TO SCALE				JOB NO.	
CORNELL PUMP COMPANY PORTLAND, OREGON				DWG NO. F14594	
				REV. 2	

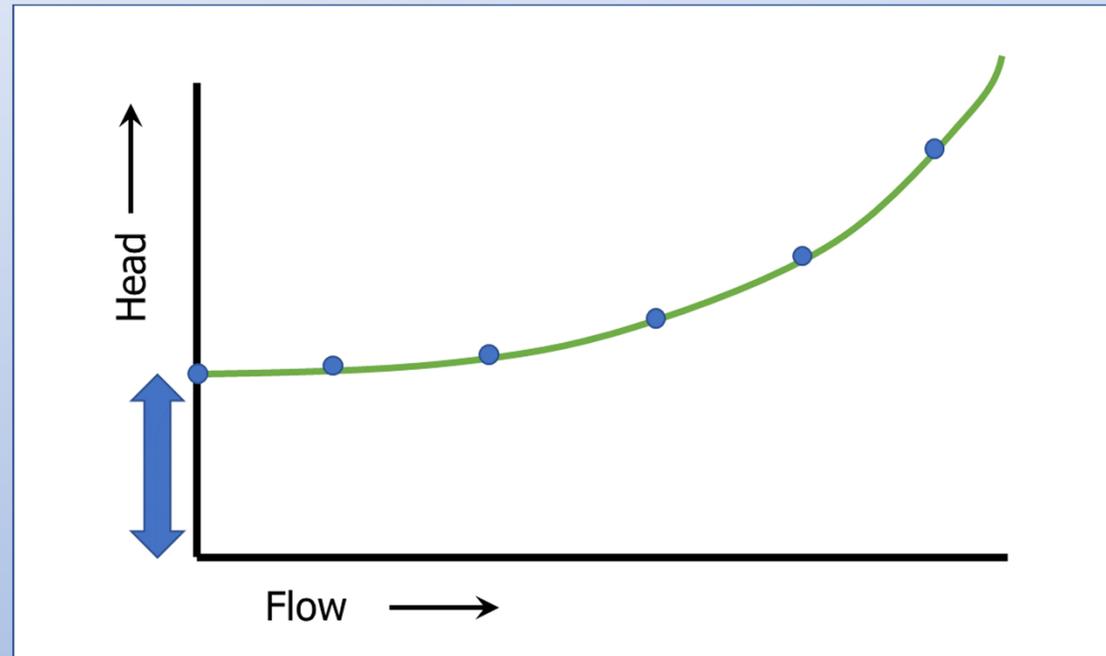
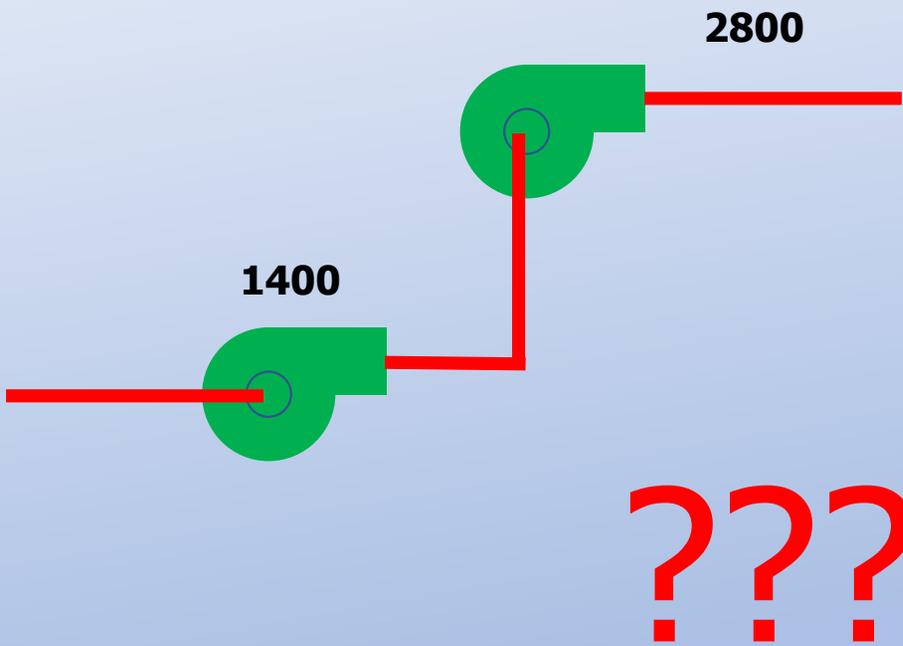
# Pumps in Series



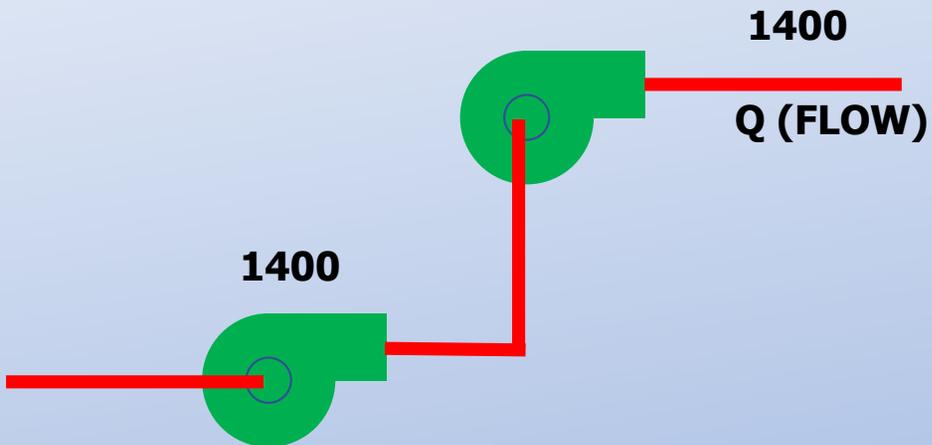
# Pumps in Series



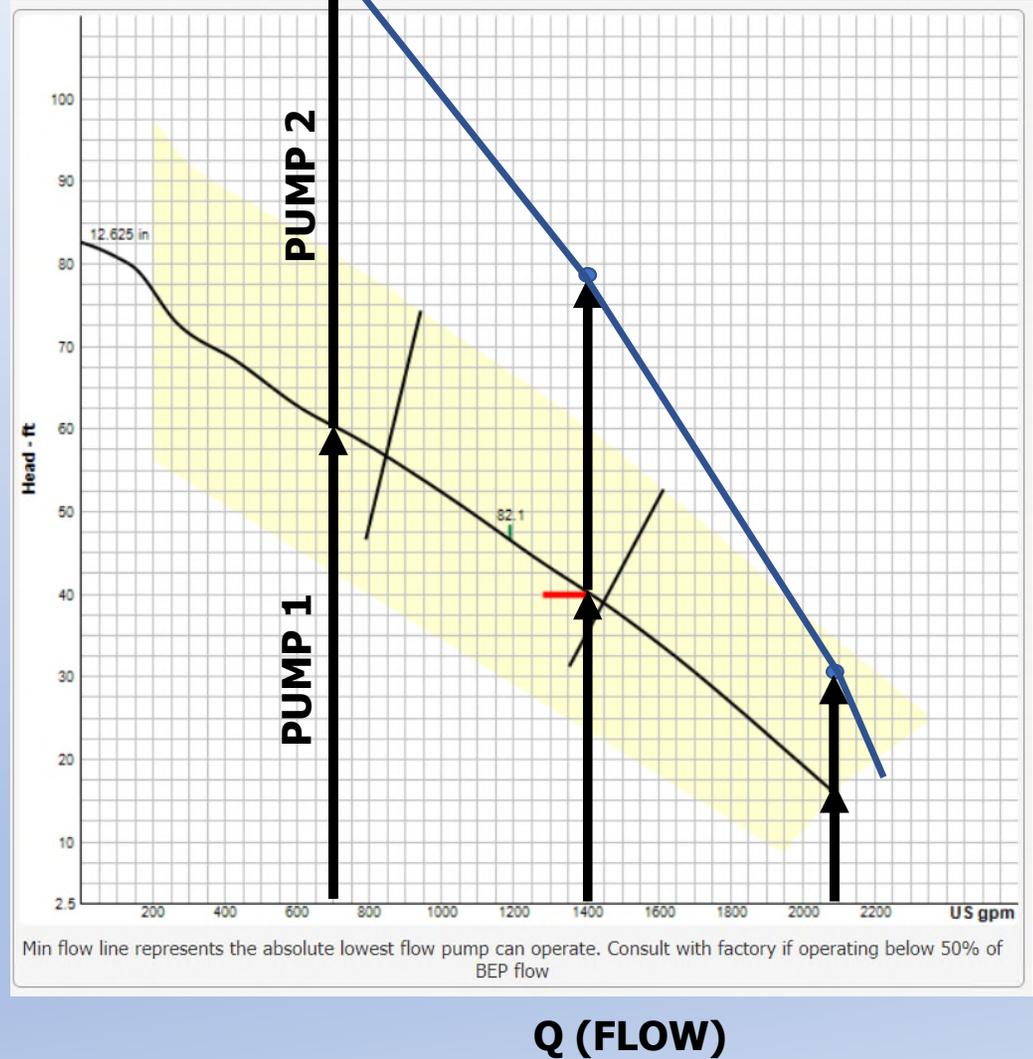
# Pumps in Series



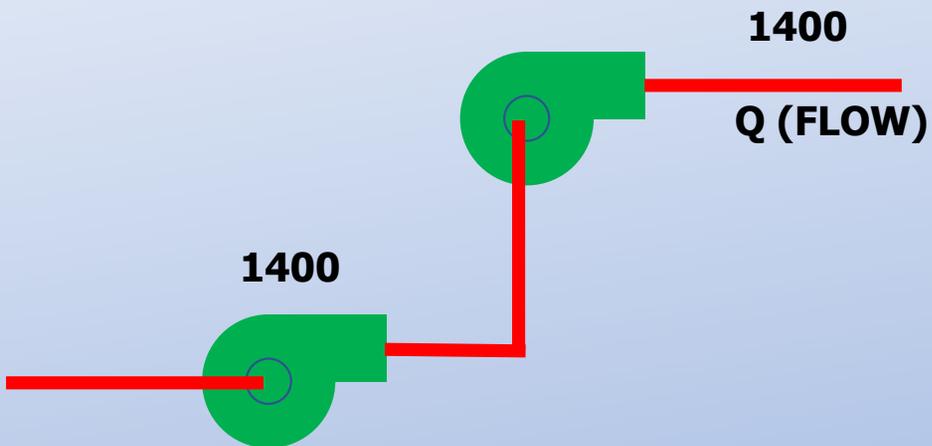
# Pumps in Parallel



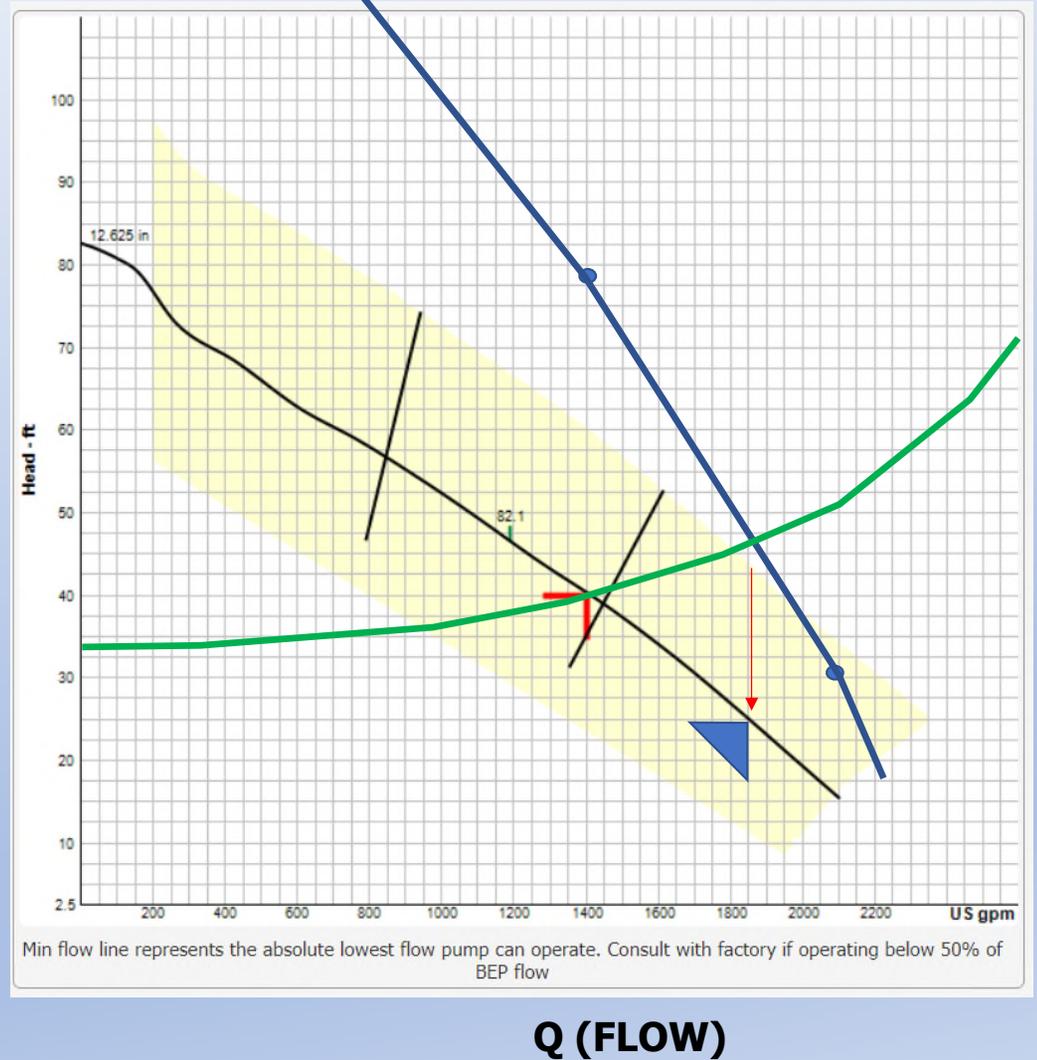
Create "Series Pump Curve" (2 Pumps)



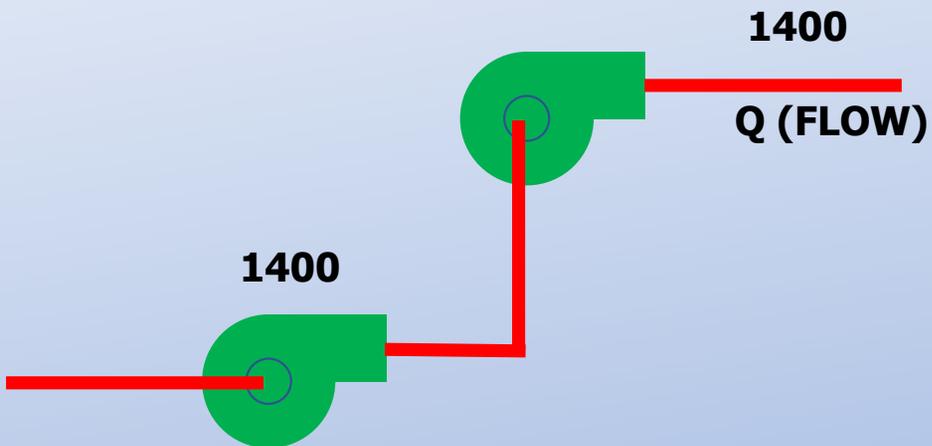
# Pumps in Series



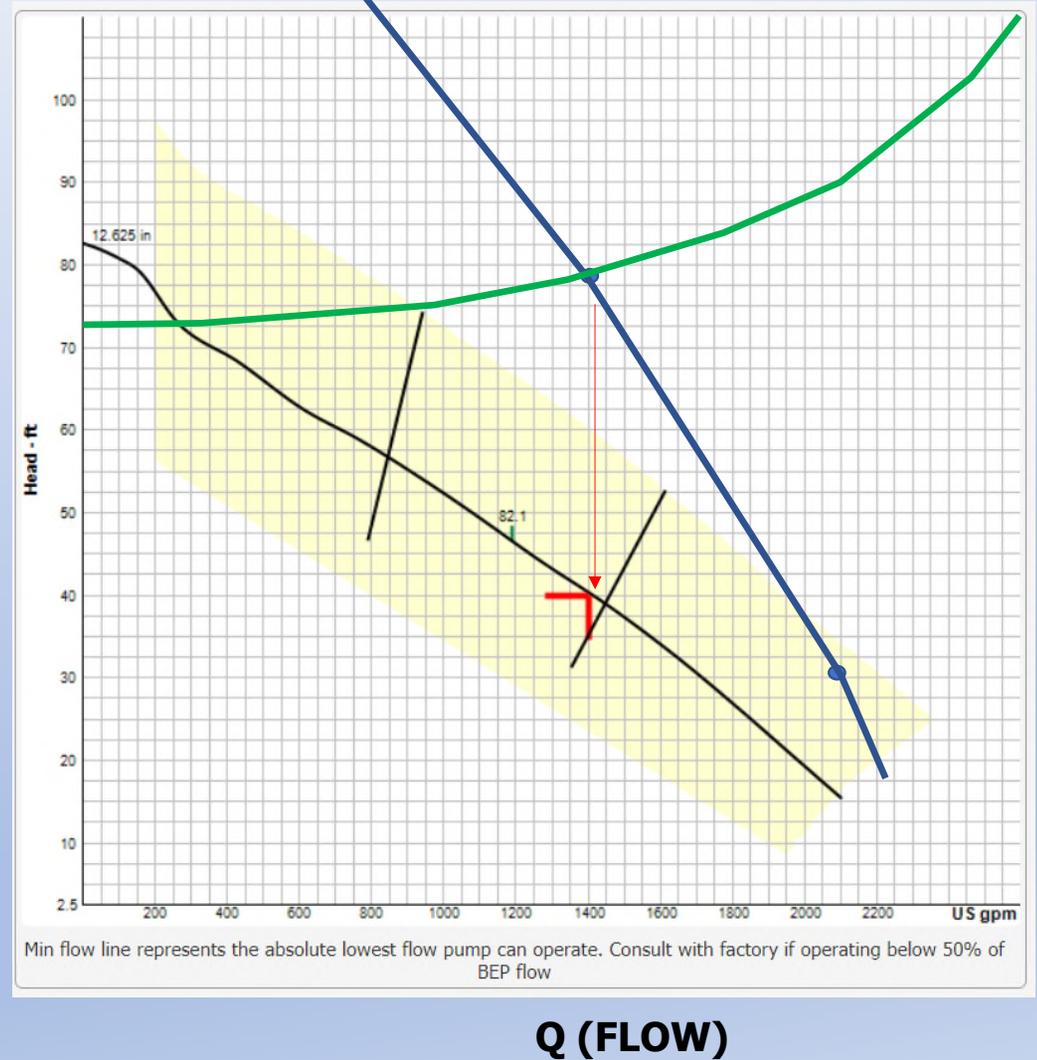
Not much reason with this system curve....



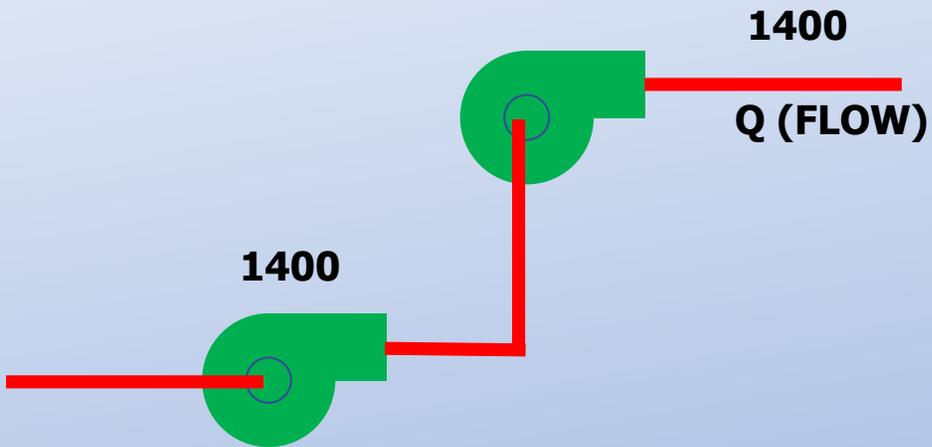
# Pumps in Series



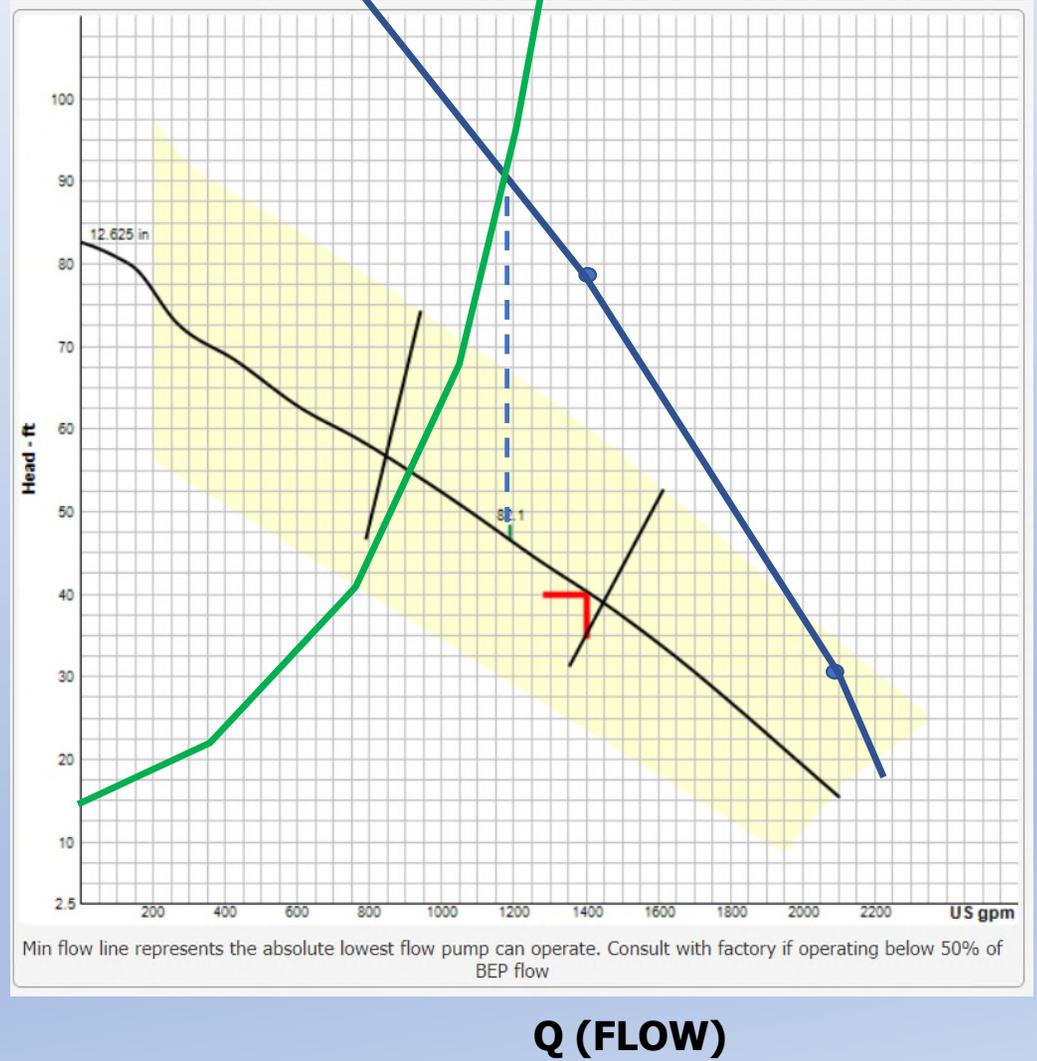
If I have to get over a hill....  
(yeh, what's a hill????)



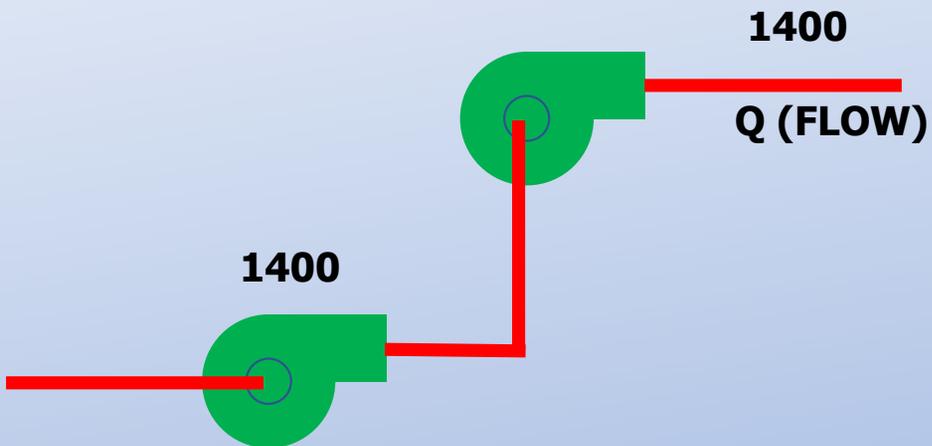
# Pumps in Series



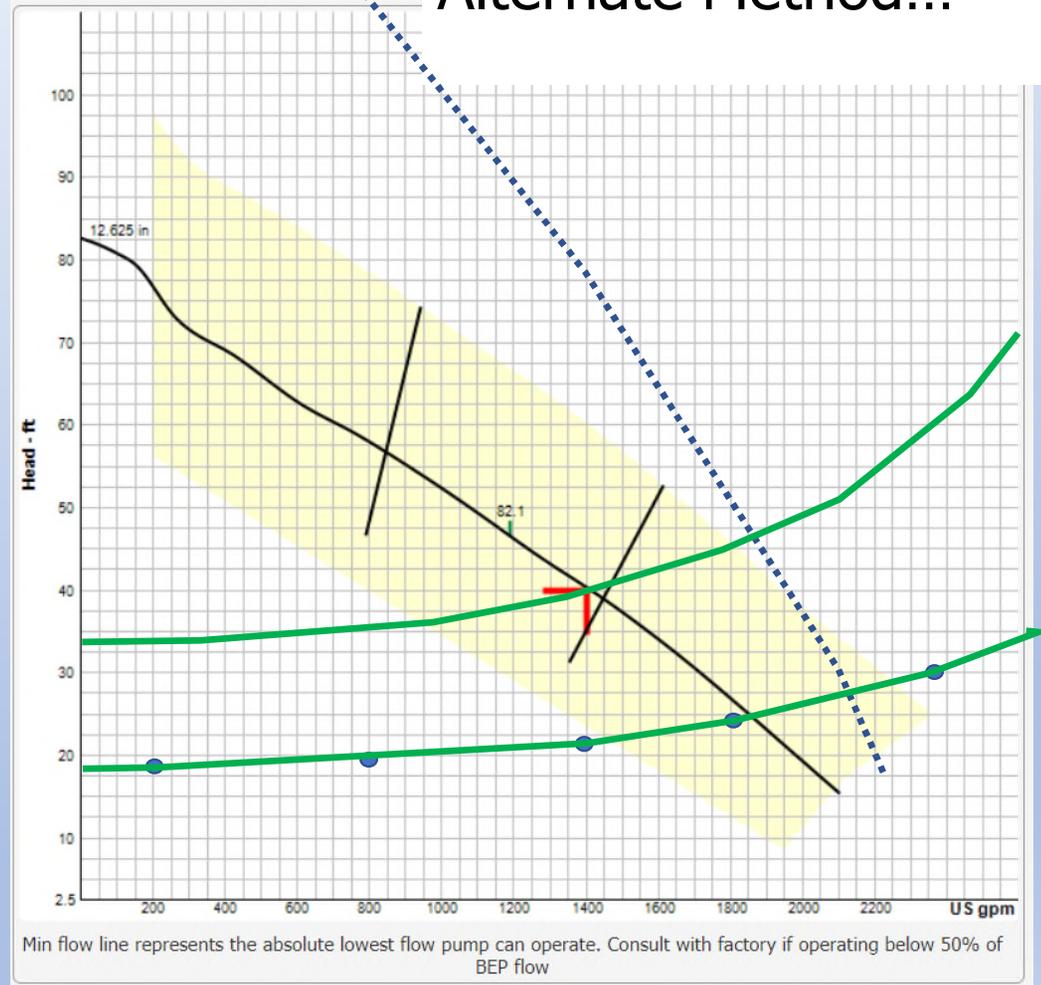
Or if I have high friction loss...



# Pumps in Series

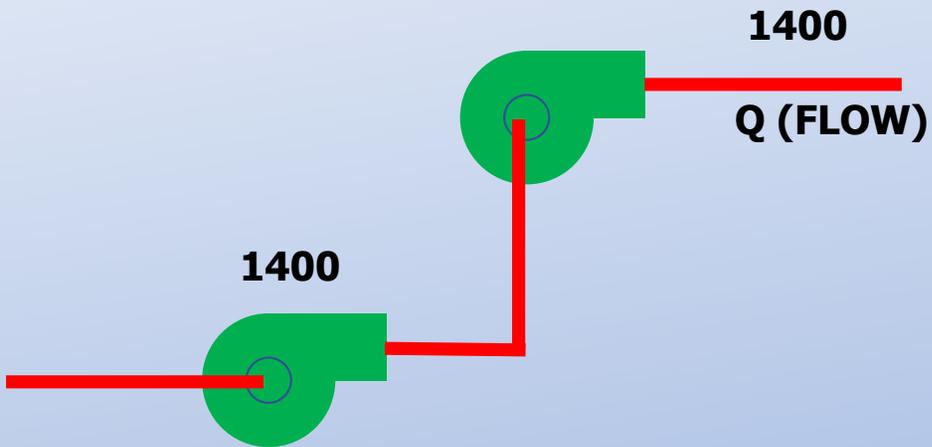


Alternate Method...

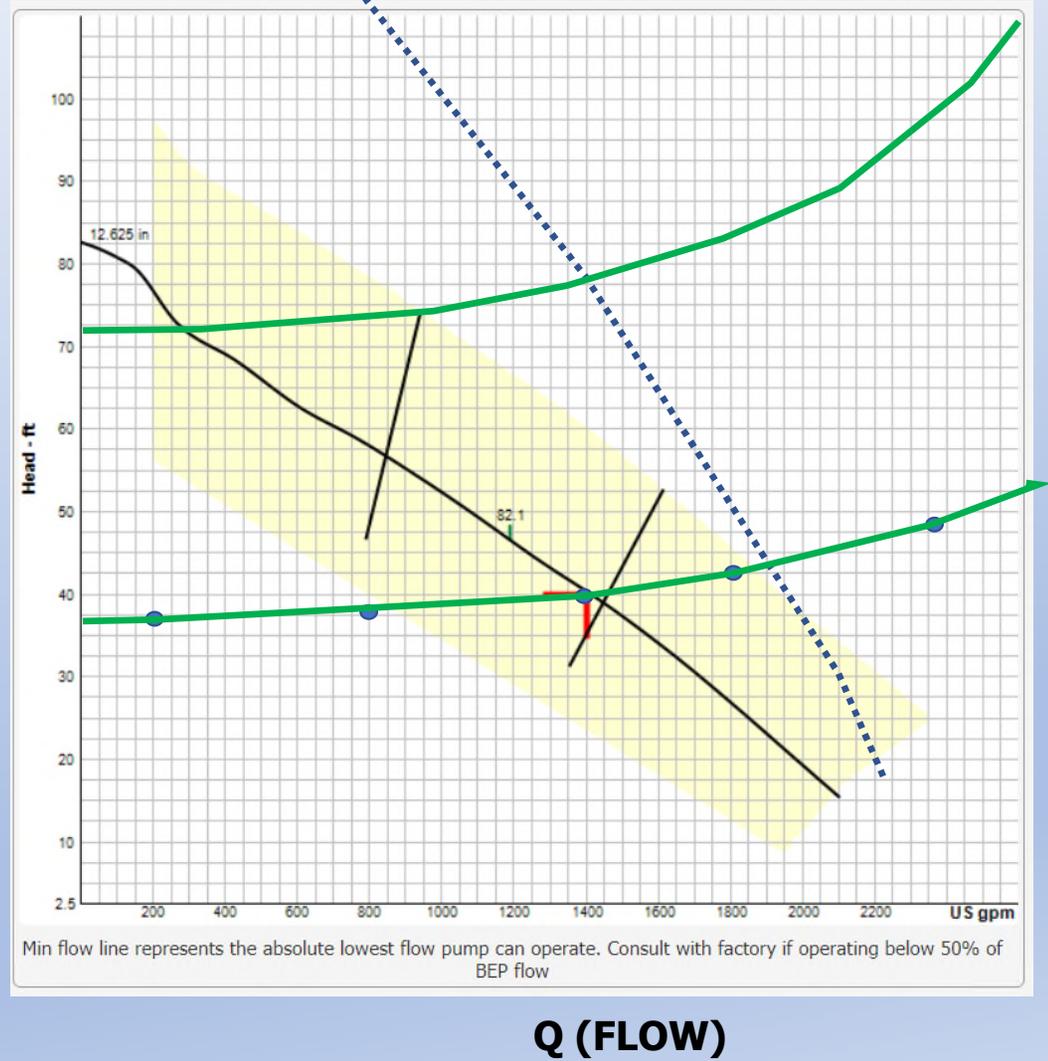


Q (FLOW)

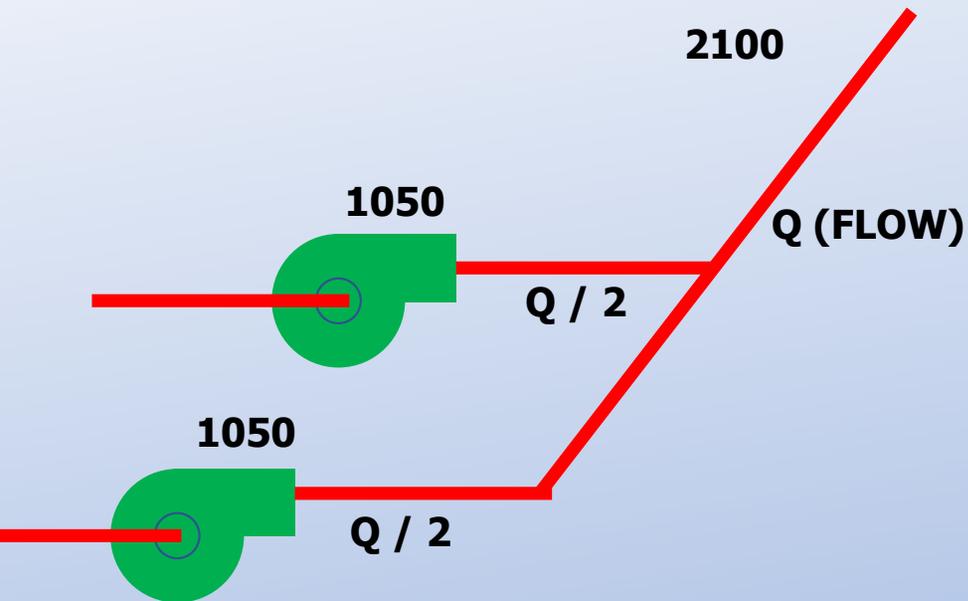
# Pumps in Series



Alternate Method...  
Hill example

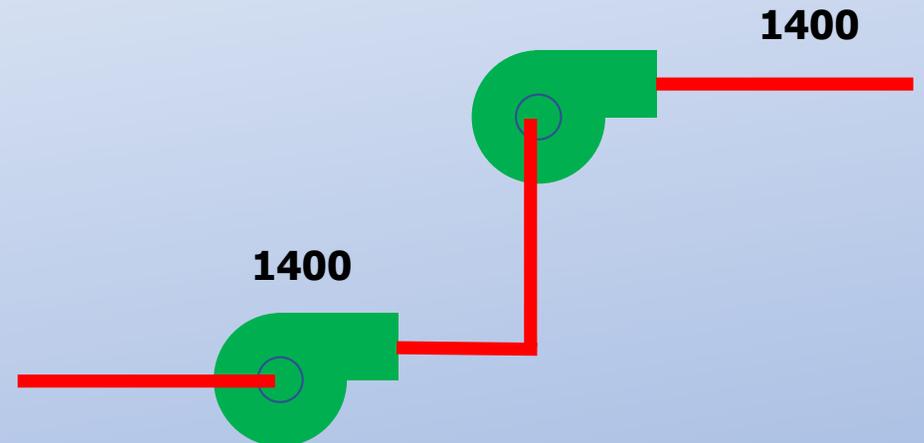


## Pumps in Parallel



Pump sees HALF the flow at same head.

## Pumps in Series



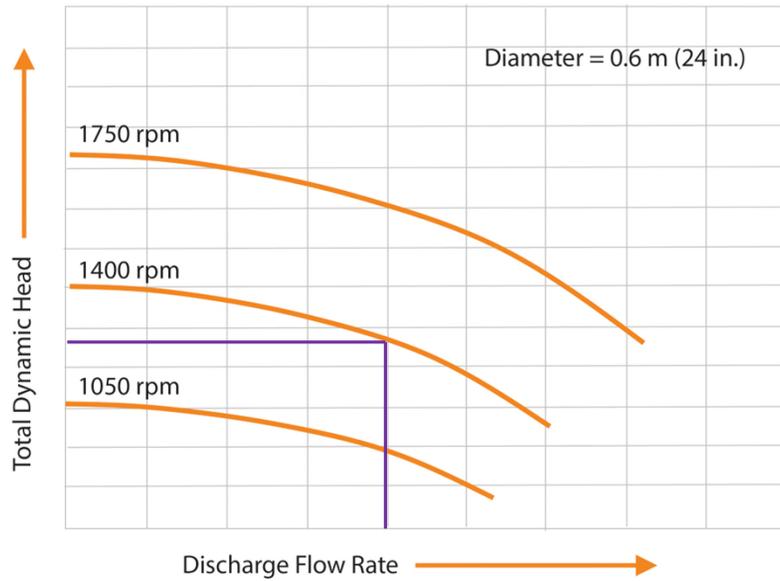
Pump sees HALF the head at same flow.

Stretch Break...

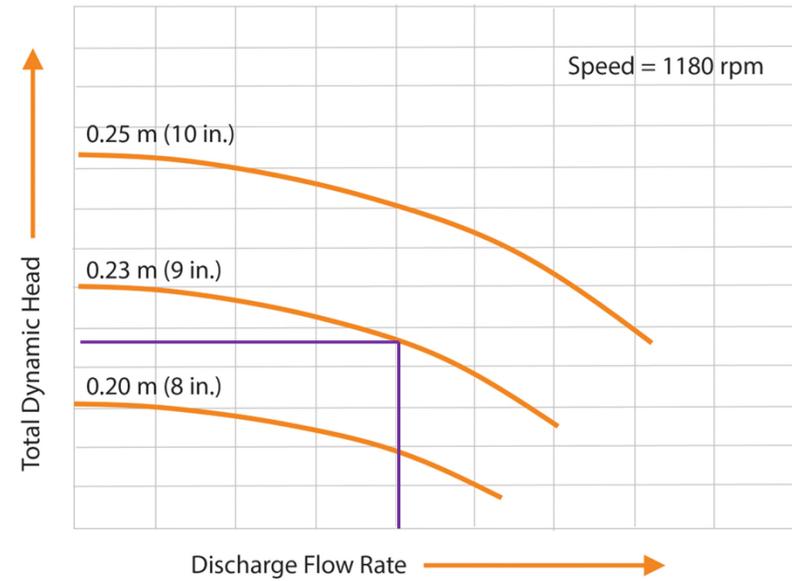
Real Quick (<2 min)

# Variable Speed Operation

## Variable Speed

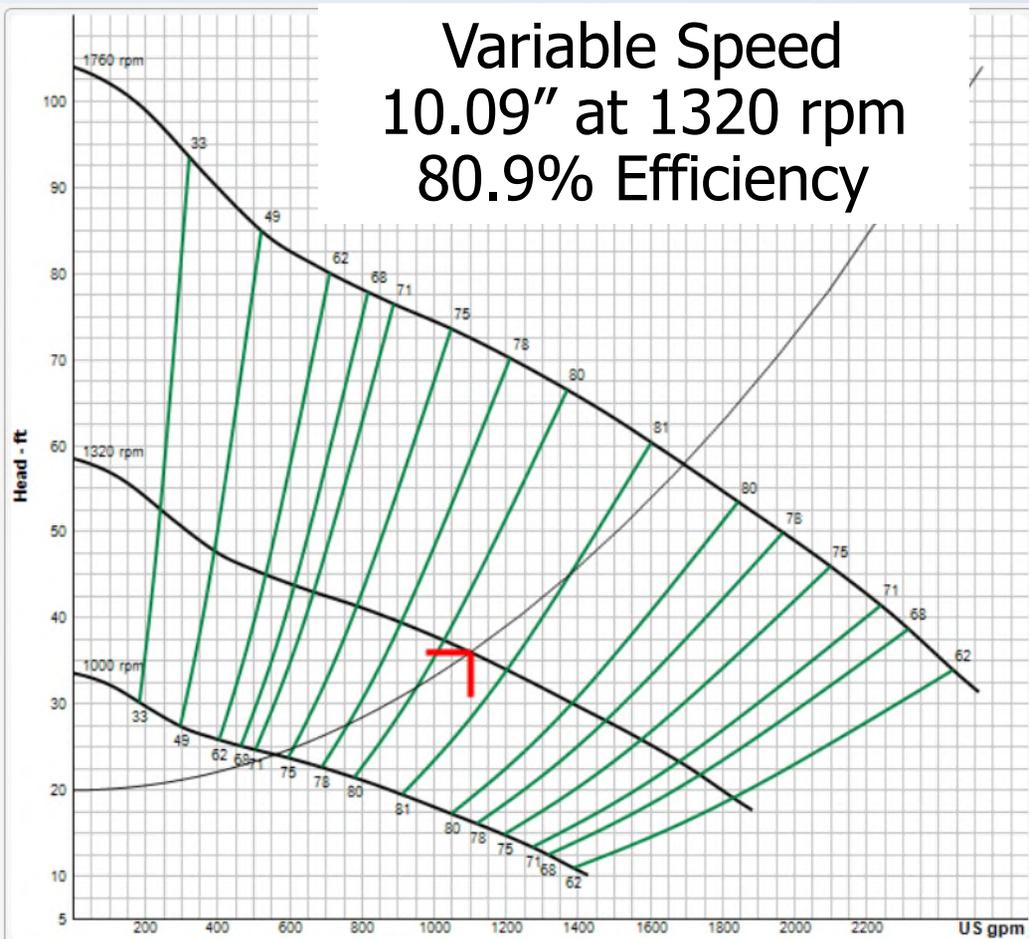


## Trimmed Impeller

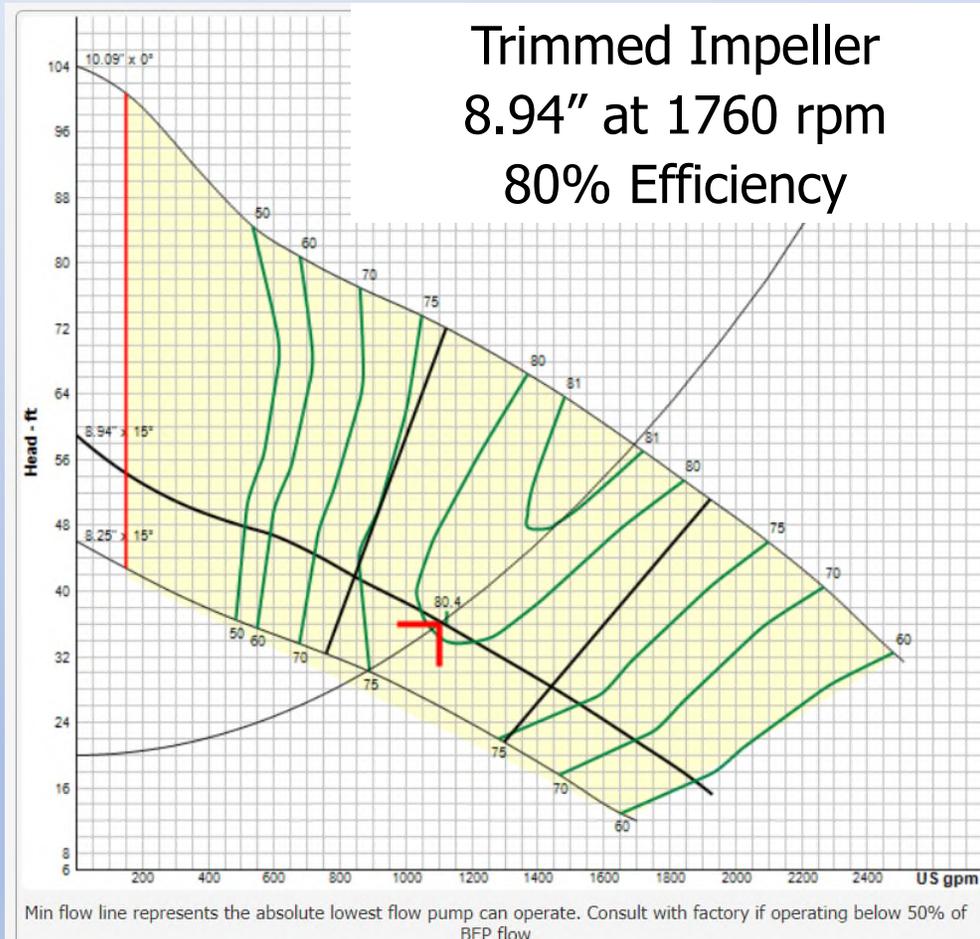


# Variable Speed Operation

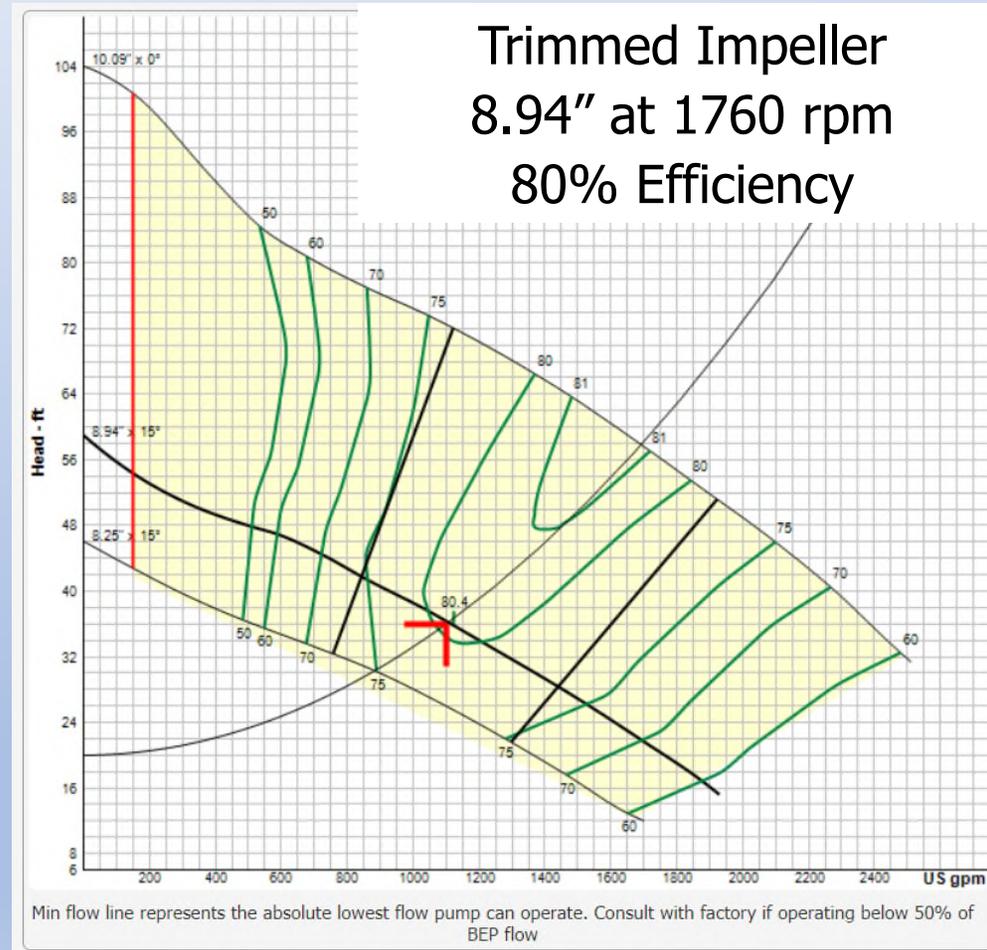
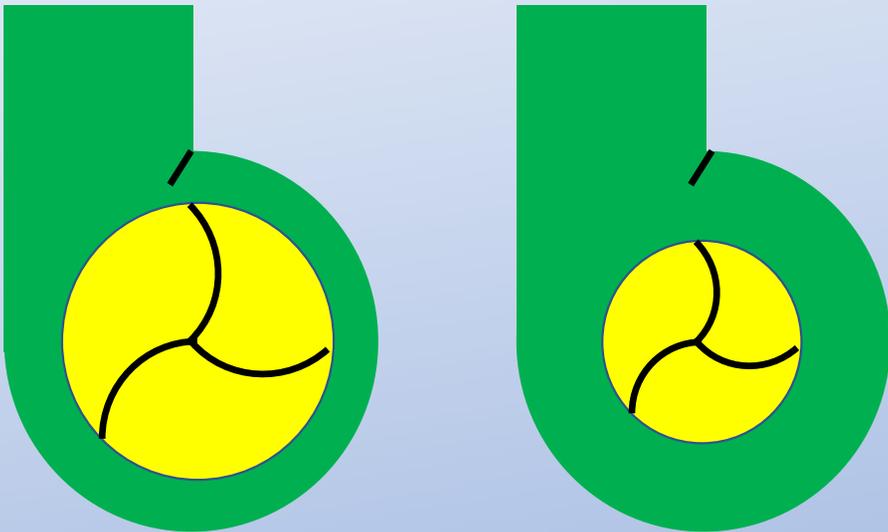
Variable Speed  
10.09" at 1320 rpm  
80.9% Efficiency



Trimmed Impeller  
8.94" at 1760 rpm  
80% Efficiency

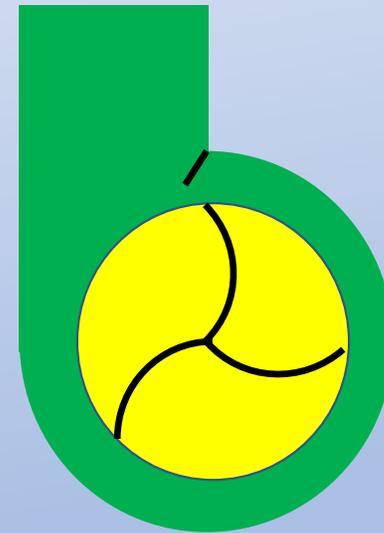
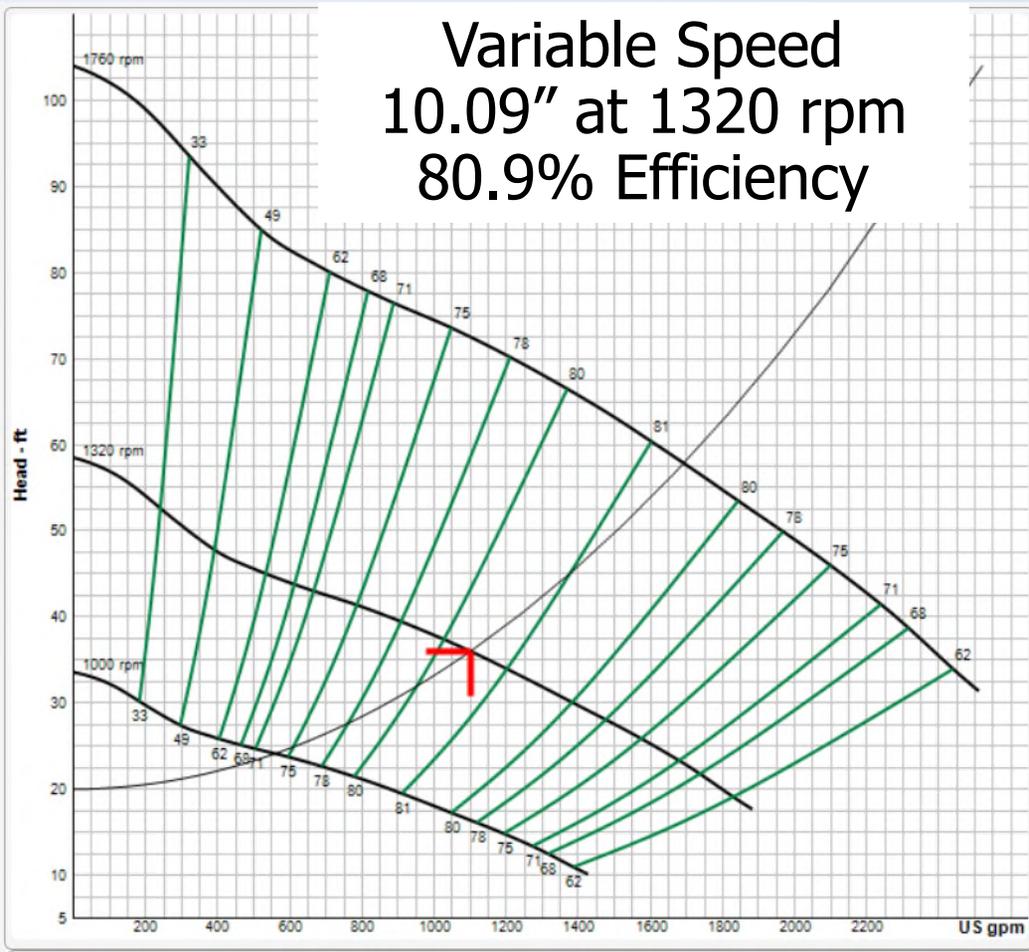


# Efficiency Decreases with Trimmed Impeller



# Efficiency Holds with Speed Reduction

Variable Speed  
10.09" at 1320 rpm  
80.9% Efficiency



BUT, Max power on curve dictates motor size...

# Variable Speed Operation

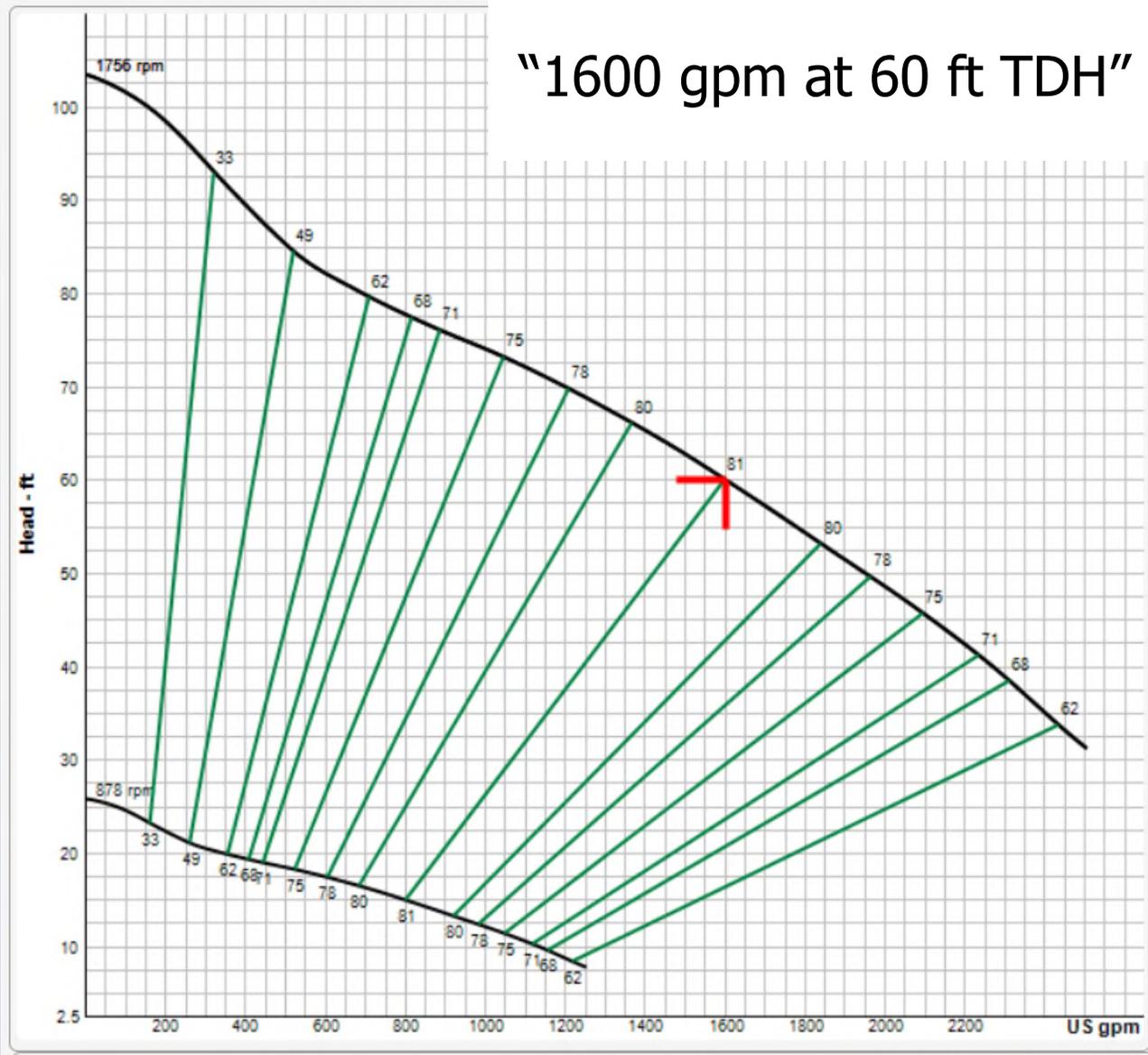
What's the limit?

Consider "1600 gpm at 60 ft TDH"

Full Speed (60 Hz) = 1765 rpm

Red. Speed (30 Hz) = 878 rpm

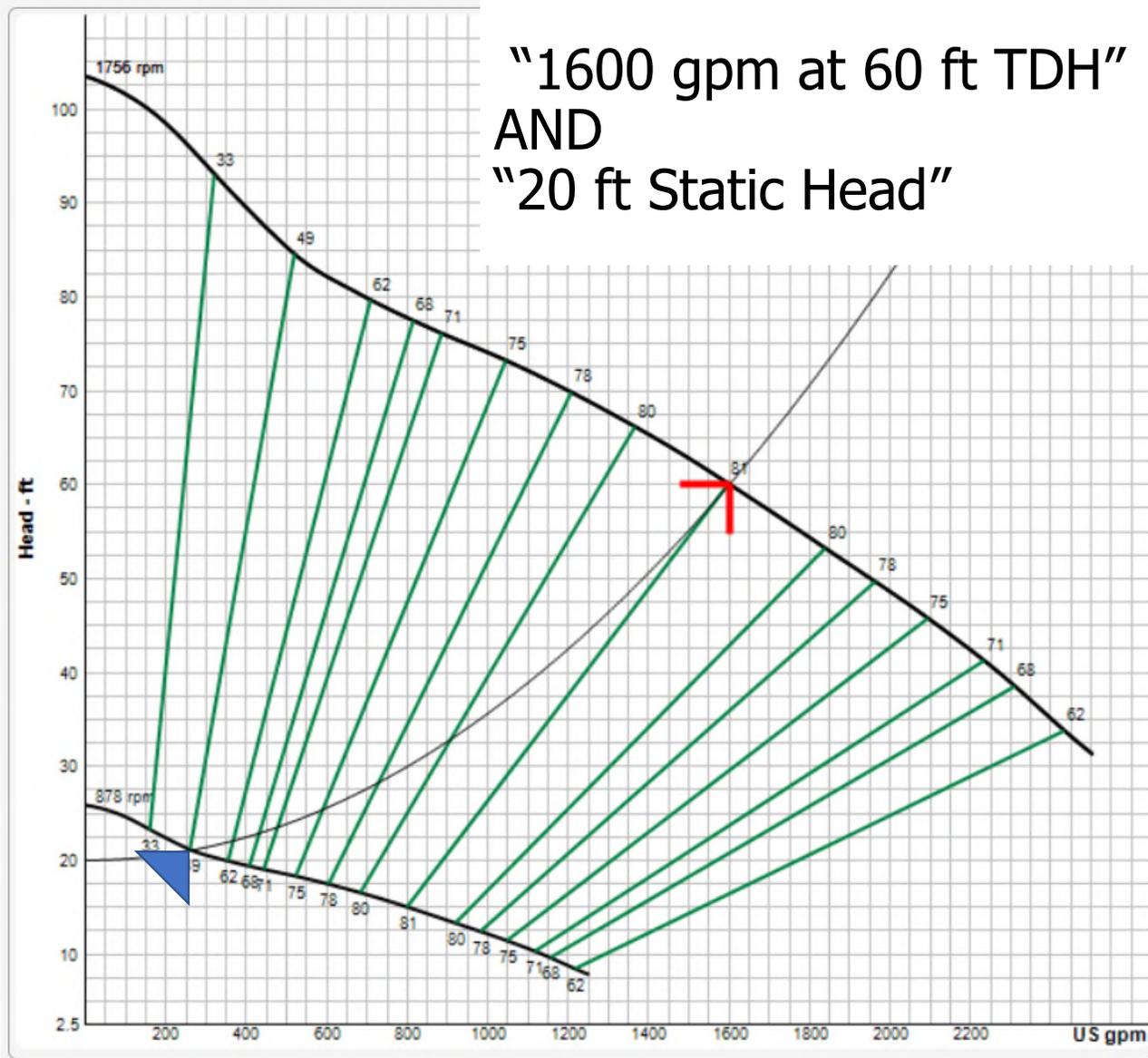
Acceptable to Operate at 30 Hz?????



Full Speed (60 Hz) =  
1765 rpm

Red. Speed (30 Hz) =  
878 rpm

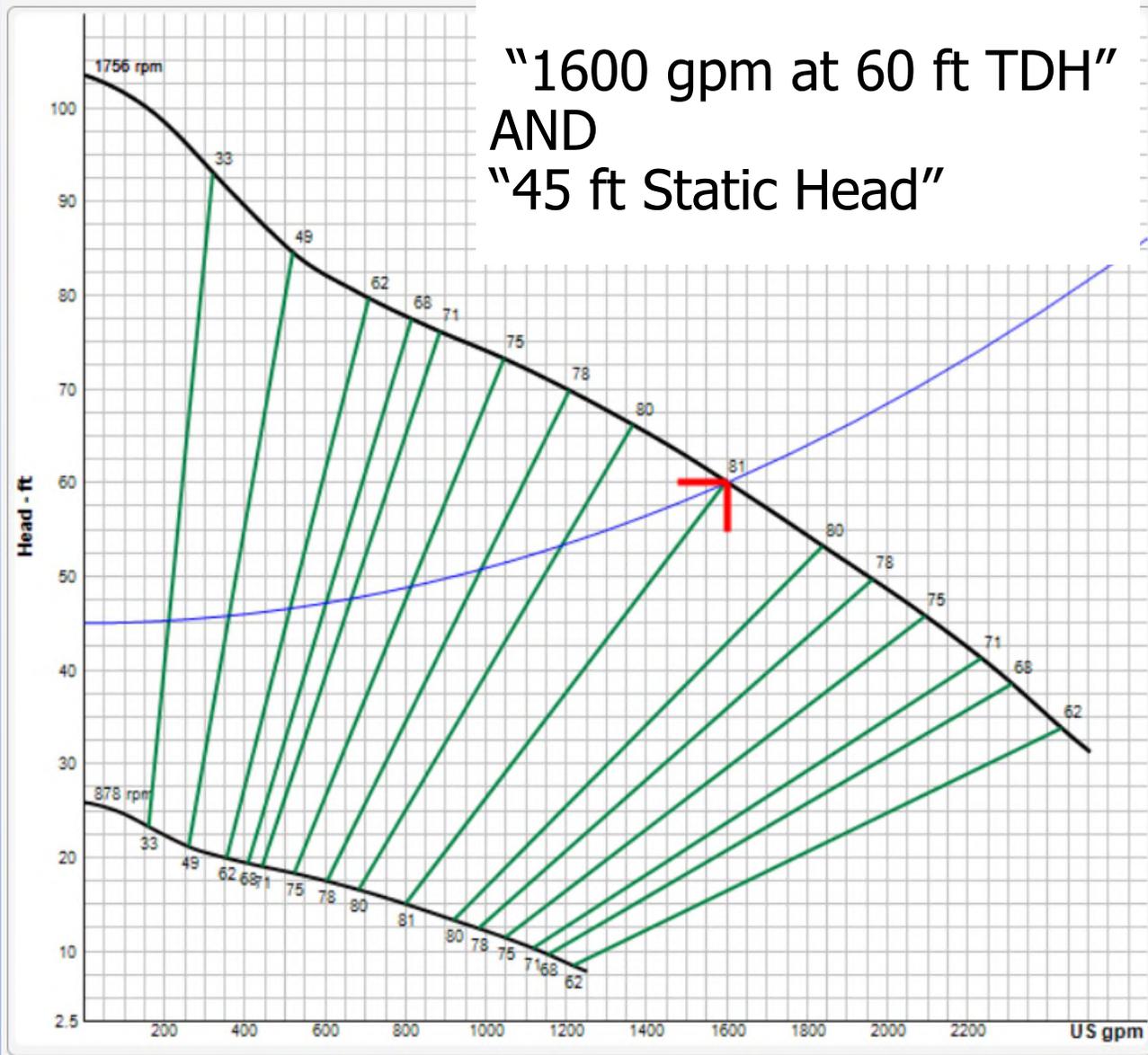
Acceptable to Operate at  
30 Hz?????



Full Speed (60 Hz) =  
1765 rpm

Red. Speed (30 Hz) =  
878 rpm

Acceptable to Operate at  
30 Hz?????



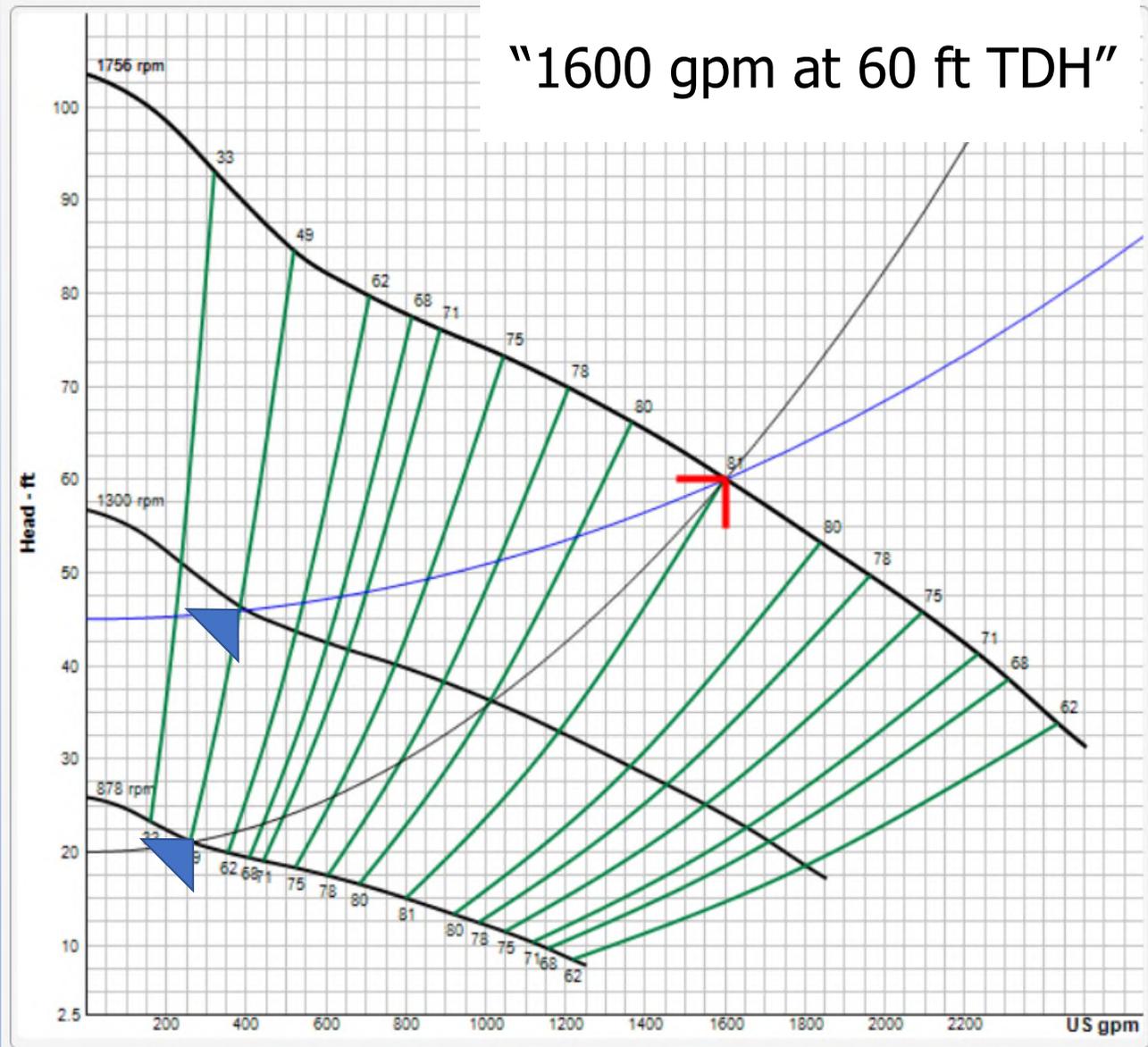
“1600 gpm at 60 ft TDH”  
AND  
“45 ft Static Head”

Full Speed (60 Hz) =  
1765 rpm

Red. Speed (44 Hz) =  
1300 rpm

Red. Speed (30 Hz) =  
878 rpm

Acceptable to Operate at  
30 Hz.... **DEPENDS!!!!**

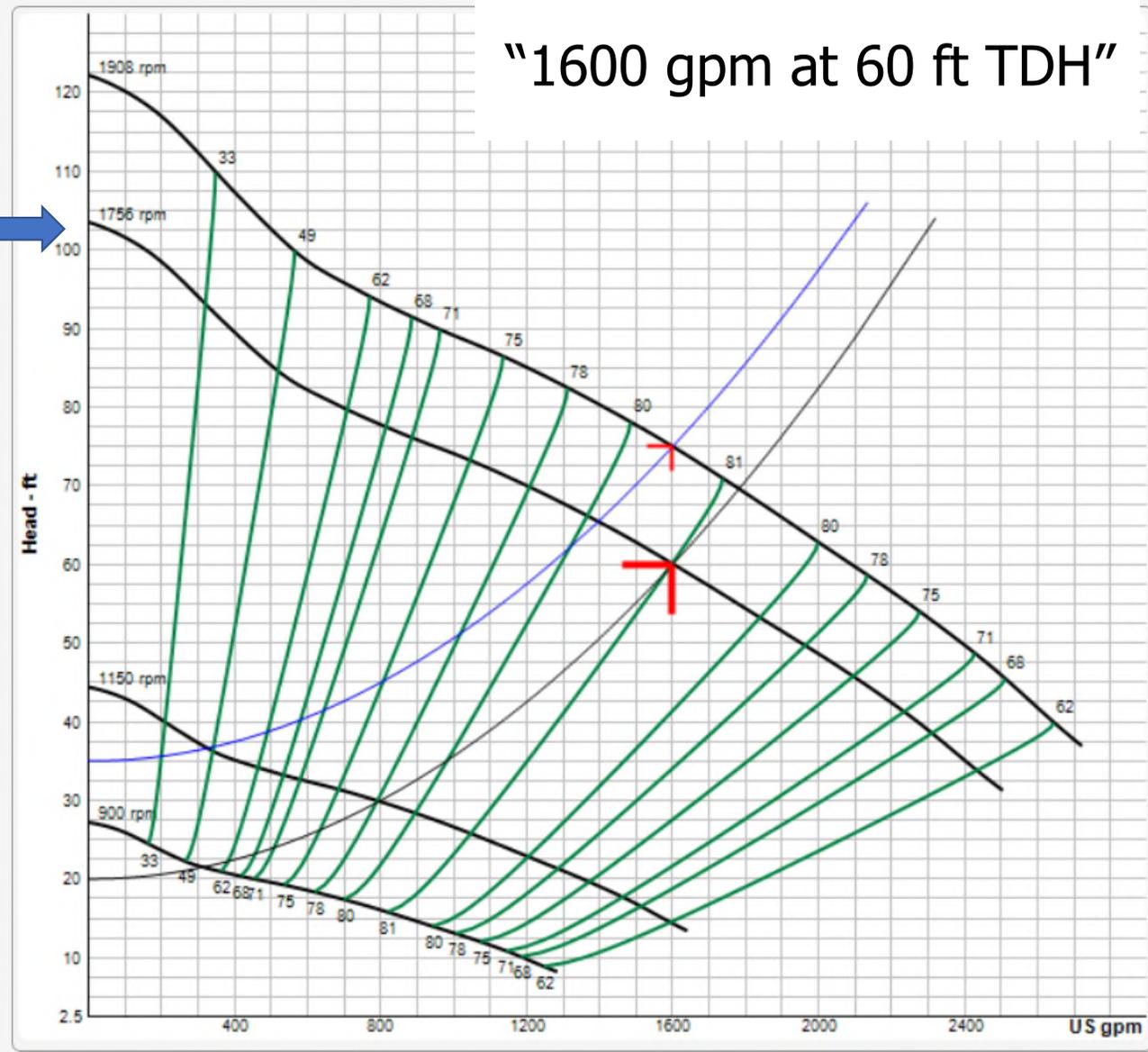


Full Speed (60 Hz) = 1765 rpm

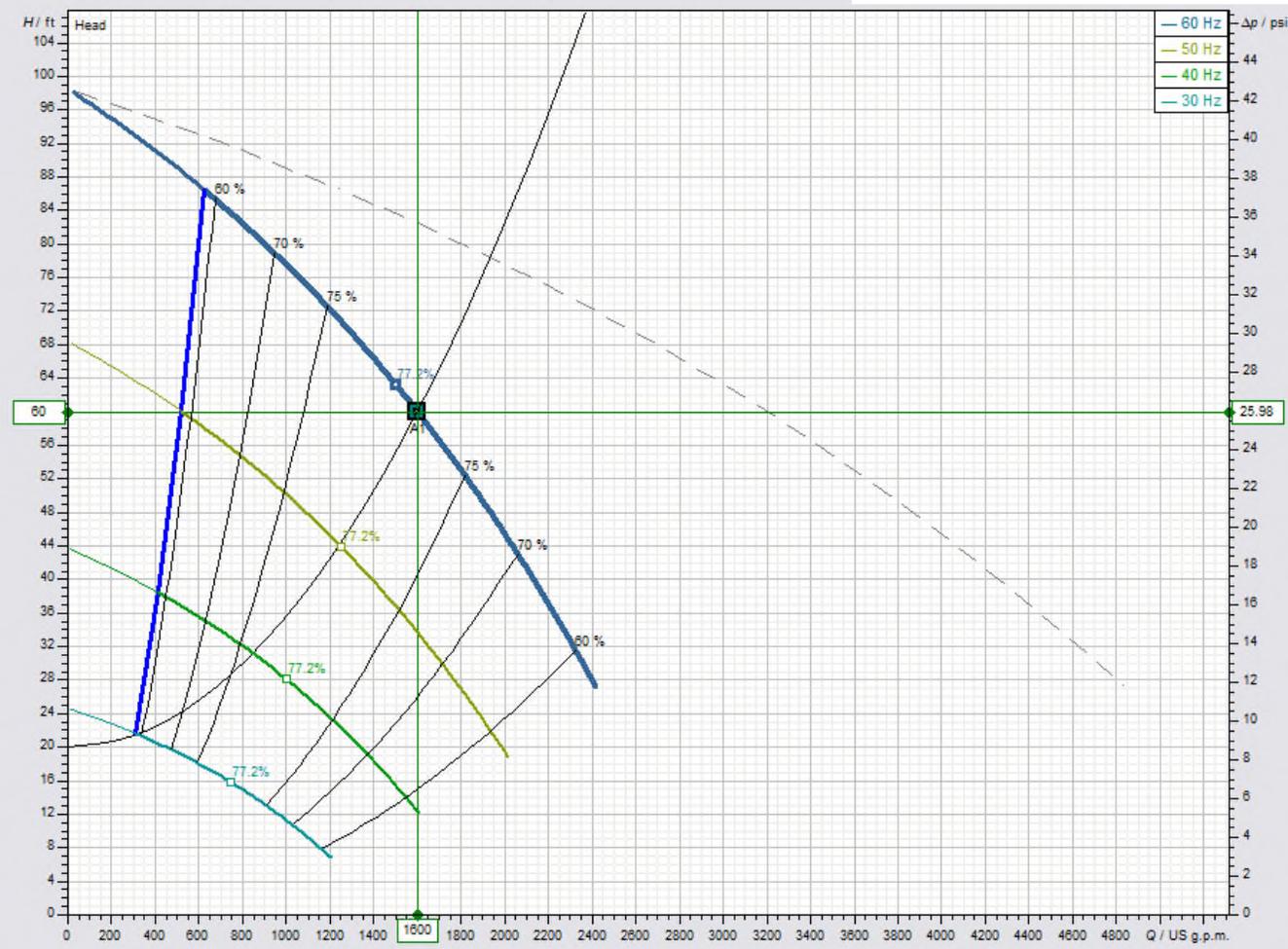
If VFD set for 380 gpm at 900 rpm, but then wet well pumps down...

1150 rpm

900 rpm

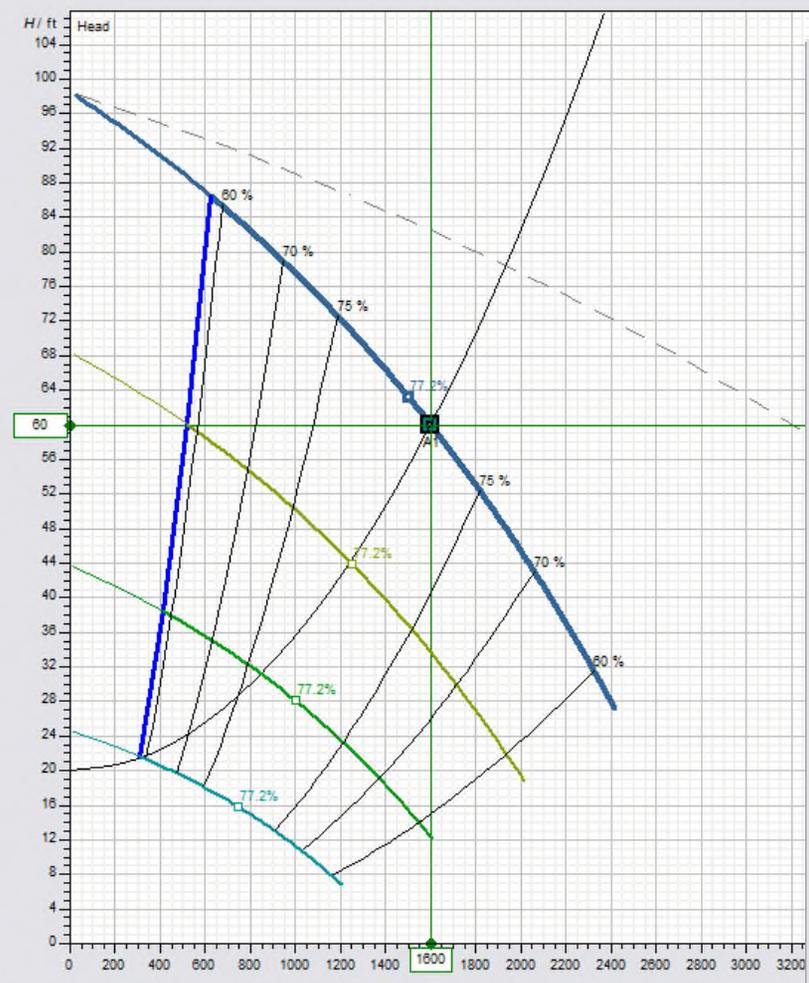


1600 gpm at 60 ft TDH  
 Two pumps in Parallel



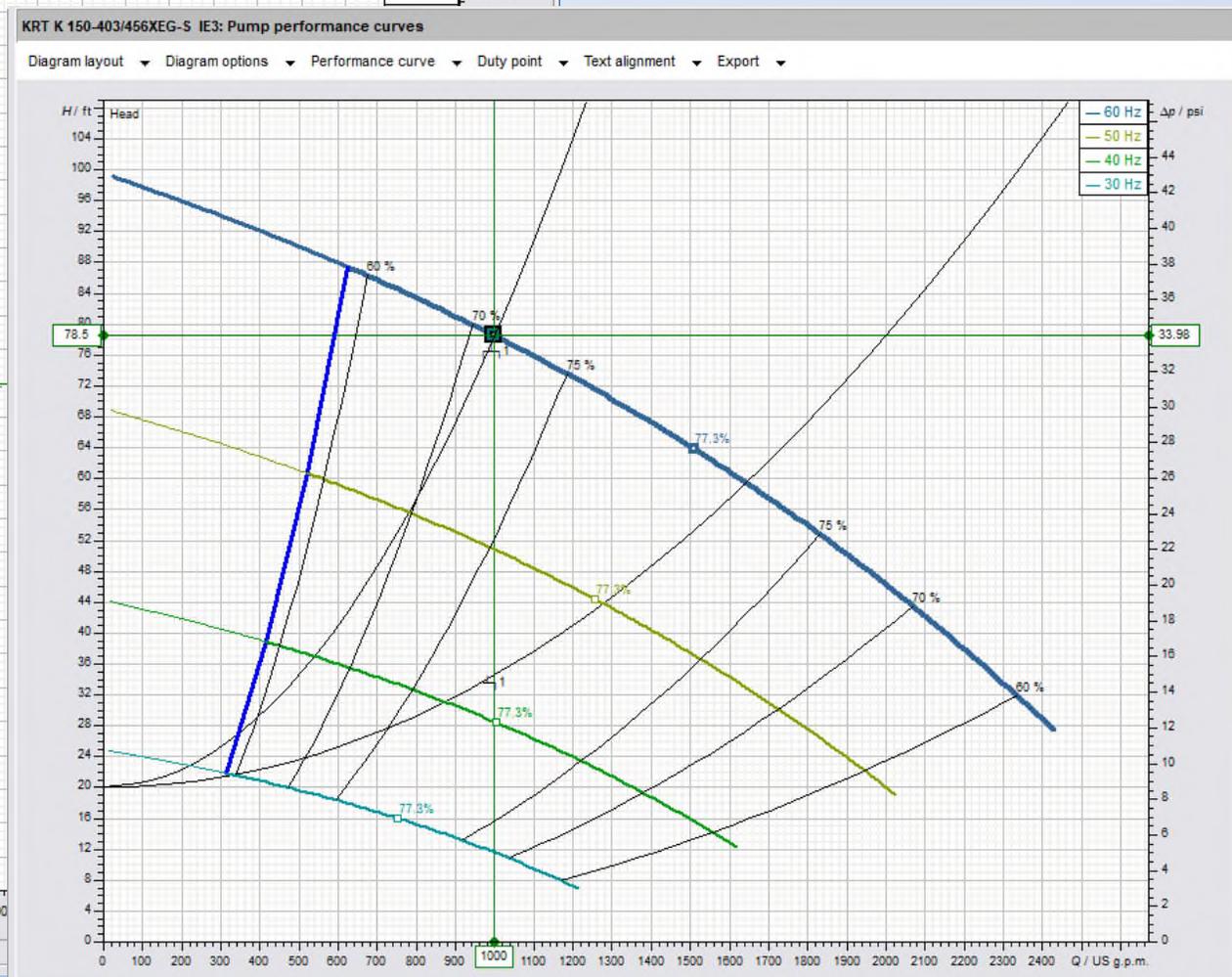
Variable Speed Operation  
 Pumps in Parallel

# 1600 gpm at 60 ft TDH Two pumps in Parallel



Submersible motor pump with non-clogging impeller\_L\_ArexK\_150-403\_###K###\_KA\_22\_Wire\_sB\_sE

60 Hz Δp / psi



Submersible motor pump with non-clogging impeller\_L\_ArexK\_150-403\_###K###\_KA\_22\_Wire\_sB\_sE Motor safety: Req.1.00 av.1.44

# Variable Speed Operation

What else should I consider?

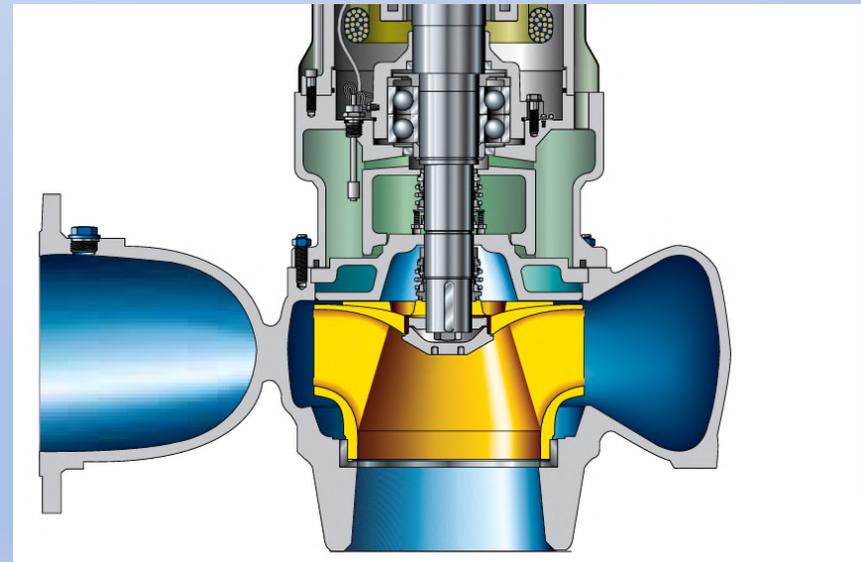
- Solids handling
- Startup Torque/Amps
- Variable System Curves
- Control System Settings/Programming



# Variable Speed Operation

What else should I consider?

- Solids handling



# Variable Speed Operation

What else should I consider?

- **Startup Torque/Amps**
  - Across the Line
  - Constant power (Variable Torque)
  - Constant torque



# Variable Speed Operation

What else should I consider?

- Variable System Curves



# Variable Speed Operation

What else should I consider?



- **Control System Settings/Programming**
  - PLC/HMI Settings, VFD Settings (range, %, Hz, low, high)
  - Doublechecking
  - Operator knowing what is where

# Variable Speed Operation

Lessons learned the hard way...

- RAS Pumps – Bearing Fail



# Variable Speed Operation

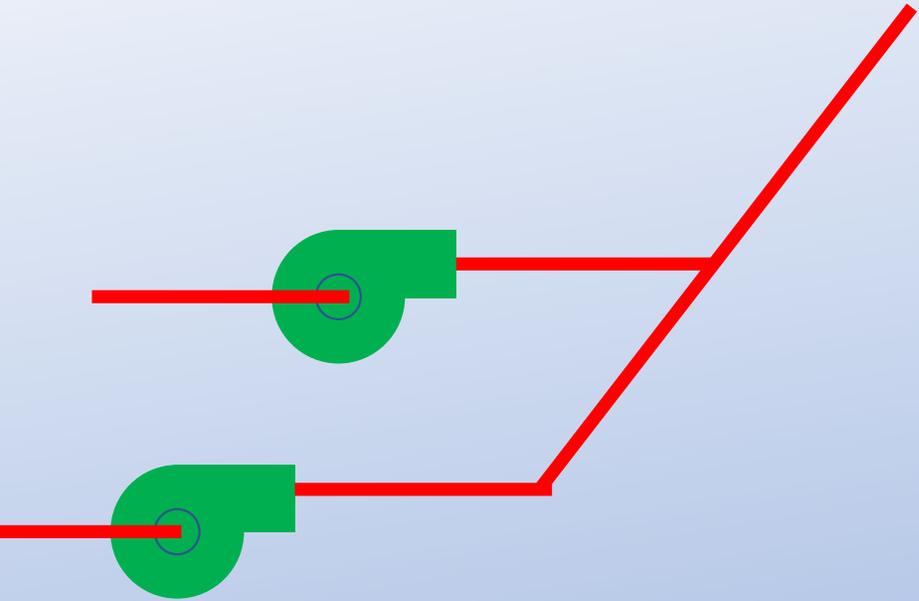
Lessons learned the hard way...

- Pump Cost vs. Control Cost  
(vs. Plant Complexity)



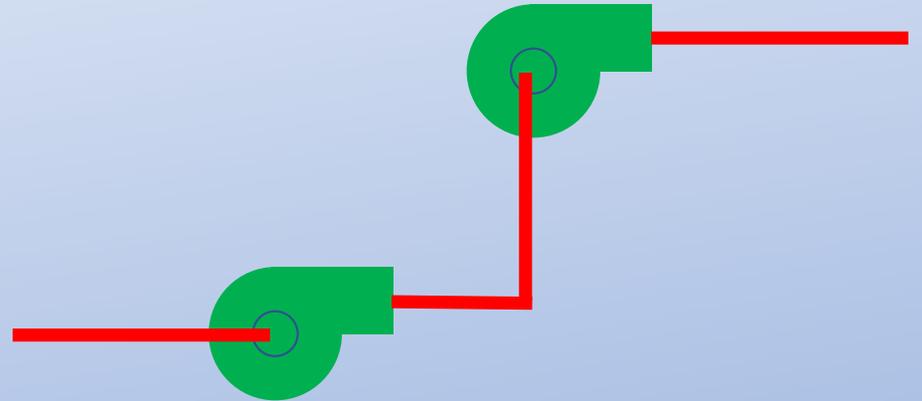
# Review/Quiz

## Pumps in Parallel



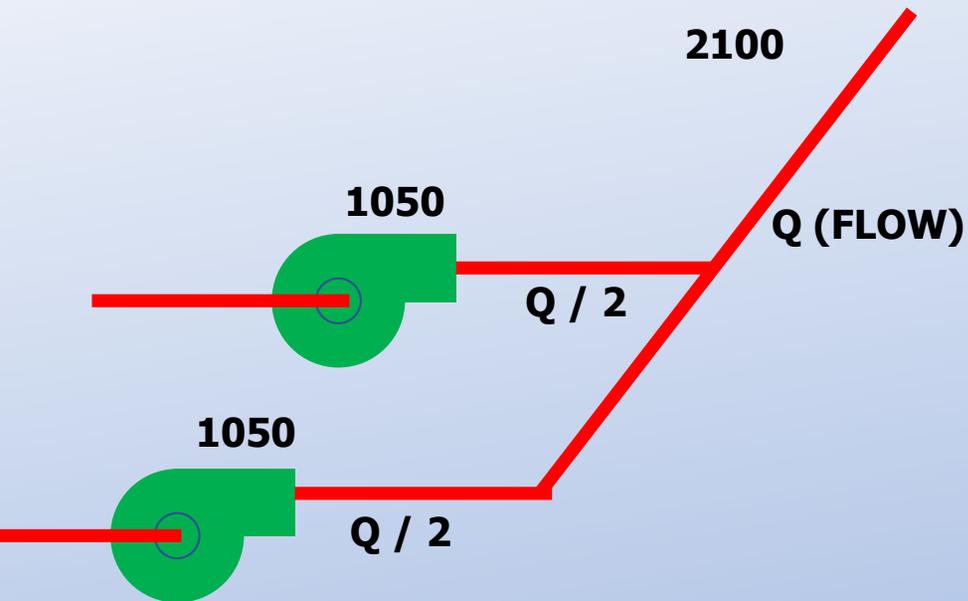
Pump sees HALF the  
\_\_\_\_\_ at same \_\_\_\_\_.

## Pumps in Series



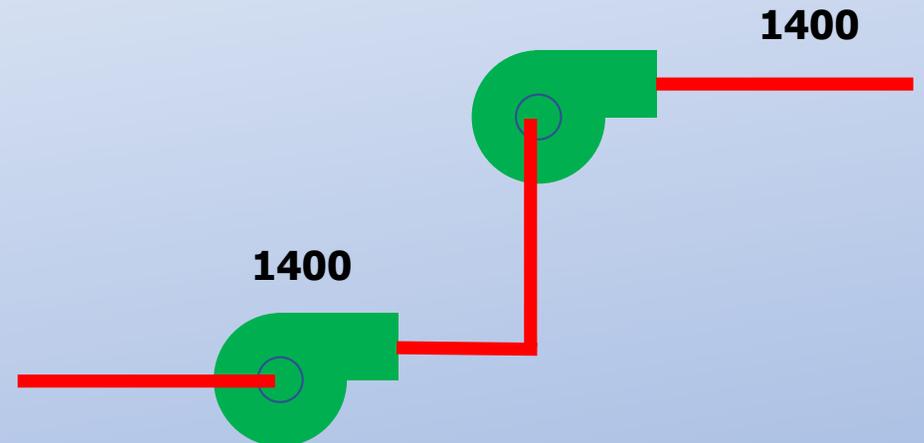
Pump sees HALF the  
\_\_\_\_\_ at same \_\_\_\_\_.

## Pumps in Parallel



Pump sees HALF the flow at same head.

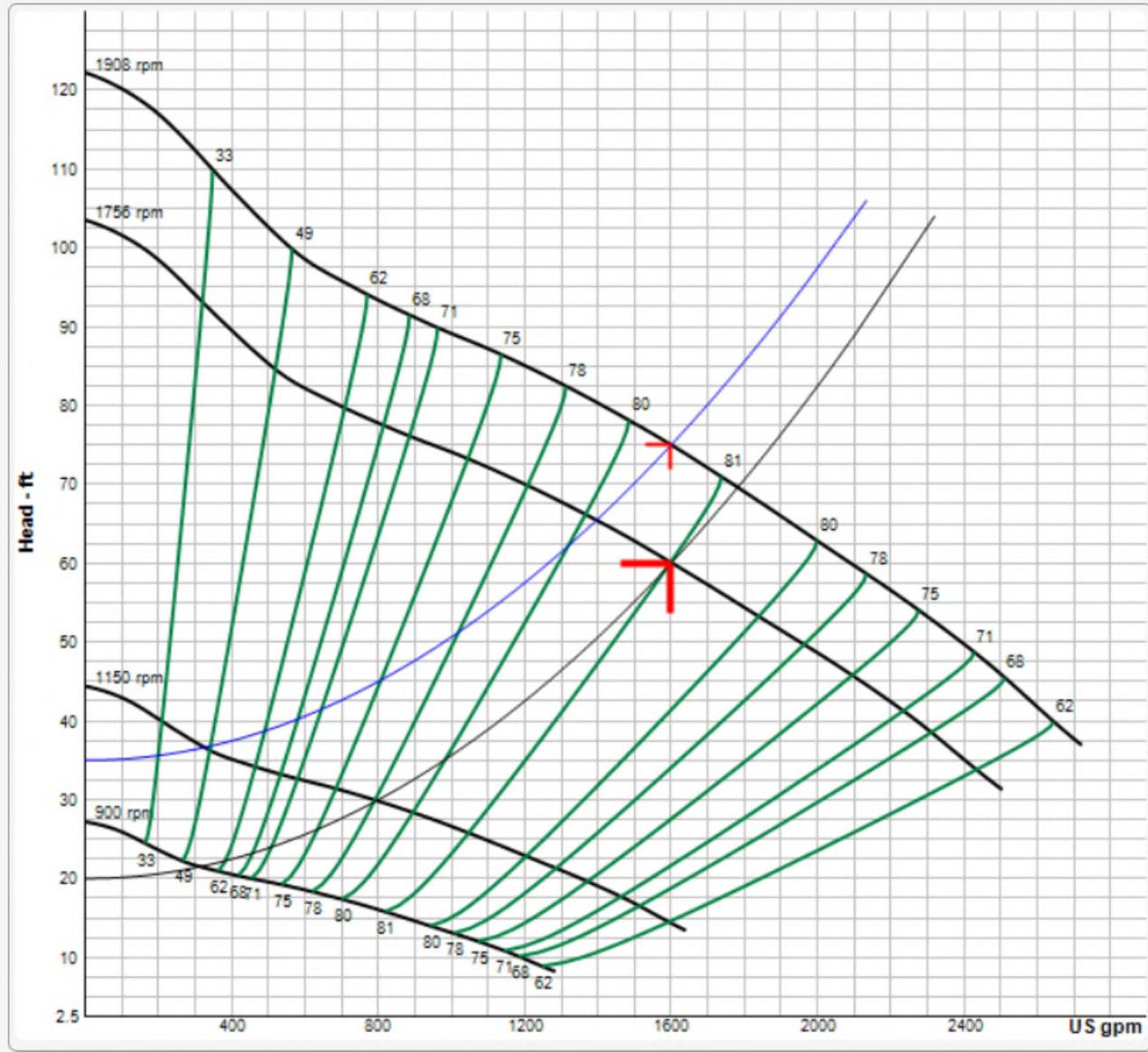
## Pumps in Series



Pump sees HALF the head at same flow.

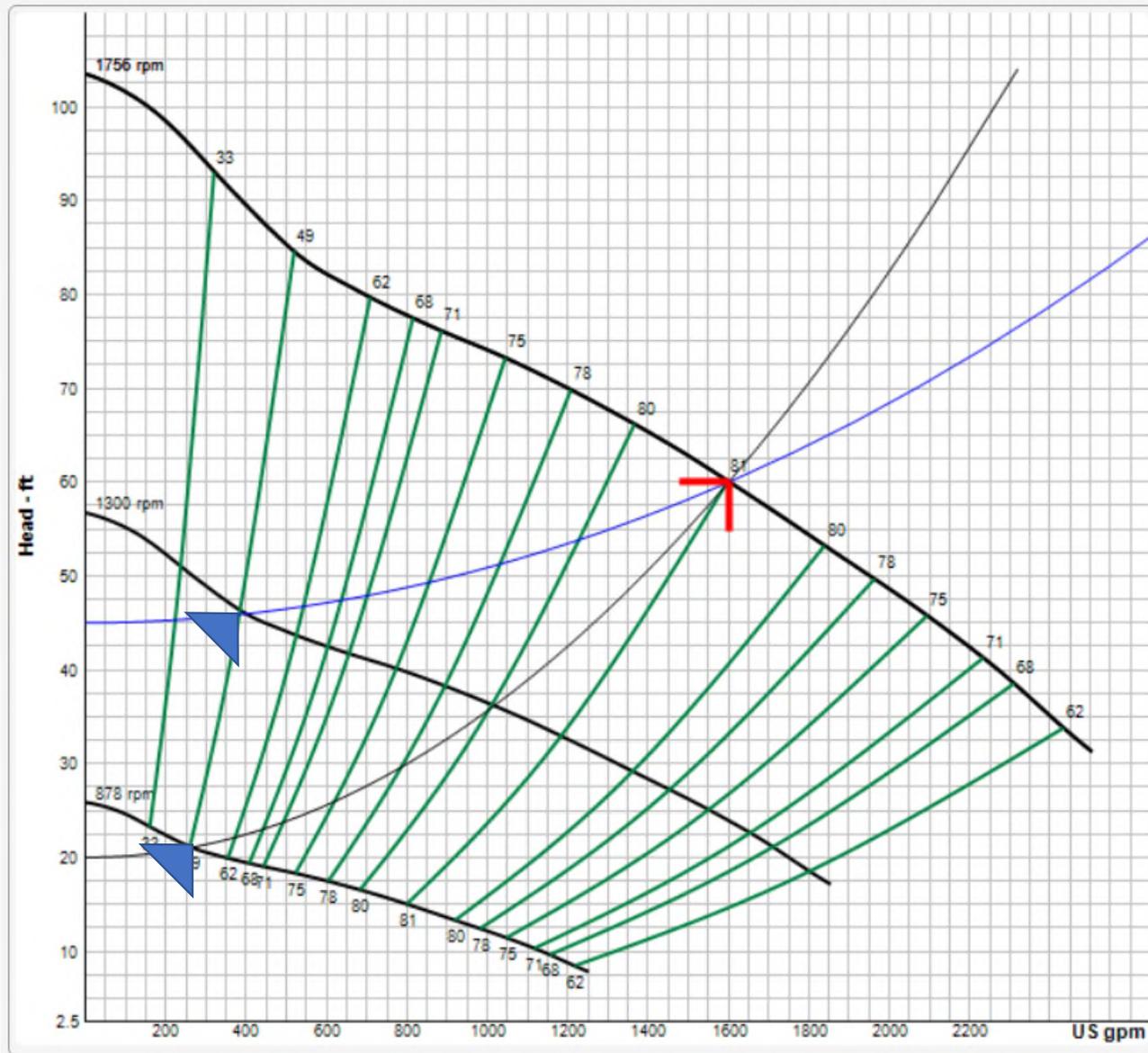
When setting up a VFD, the settings must take in the changes in the wet well because as the wet well level decreases the system curve moves

- a. Upwards
- b. Downwards
- c. Sideways



In this graph, there are two system curves. The design point is the same, but the \_\_\_\_\_ is different.

(Engineers often forget to specify / consider this in pump selection and system control.)



You made it!!!!

Thanks for stretching  
your mind a little  
with me....