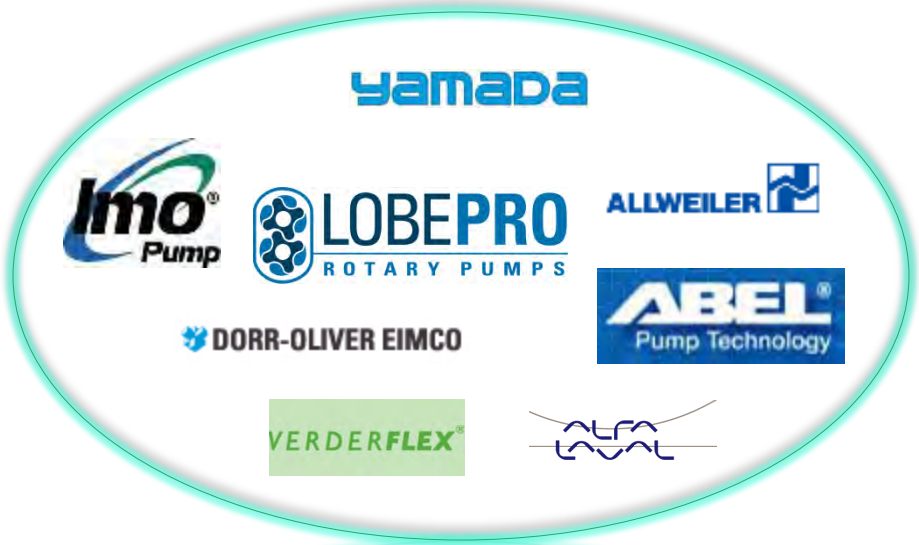
PumpTech Customer Education

http://www.Pumptechnw.com

Bellevue Moses Lake Canby

PumpTech Product Lines



PumpTech inc.

Two full time Mechanical Engineers
Licensed in OR & WA

SolidWorks & E-Drawings Viewer

AutoCad Compatible Drawings

All Systems UL QCZJ Listed

Designed to HI Standards

HYDRONIX

METERMAN
Pump Systems
"For The Best In Flow Technology"

PumpTech inc.

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Manufacturing Facility Canby, OR

METERMAN
Pump Systems
"For The Best In Flow Technology"

Pump ED 101

Centrifugal Pump Training Series

The Long & Short Term Cost of System Efficiency

Joe Evans, Ph.D

http://www.PumpEd101.com

http://www.Pump-Zone.com

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Pumping System Efficiency

The System

Motors

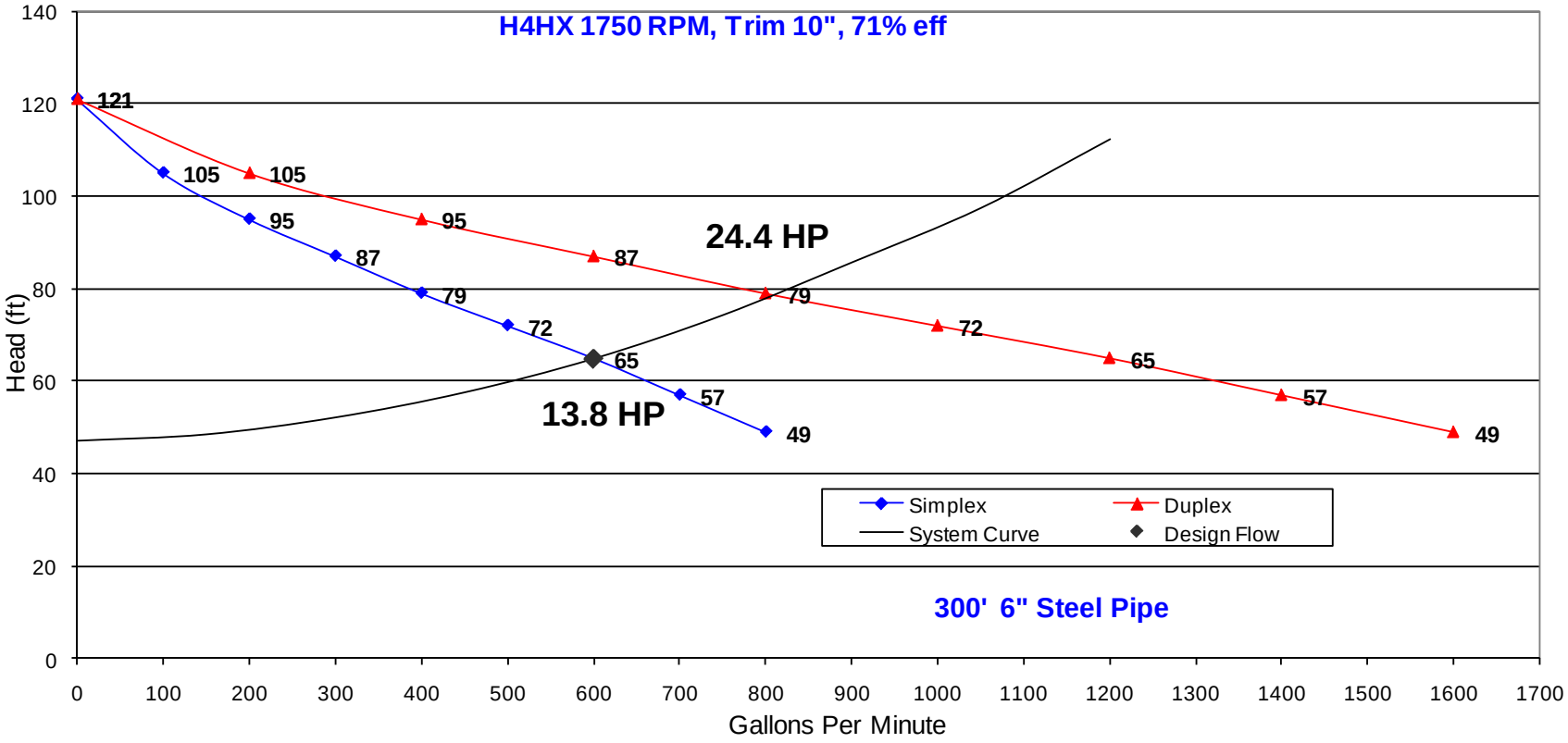
Pumps

Control

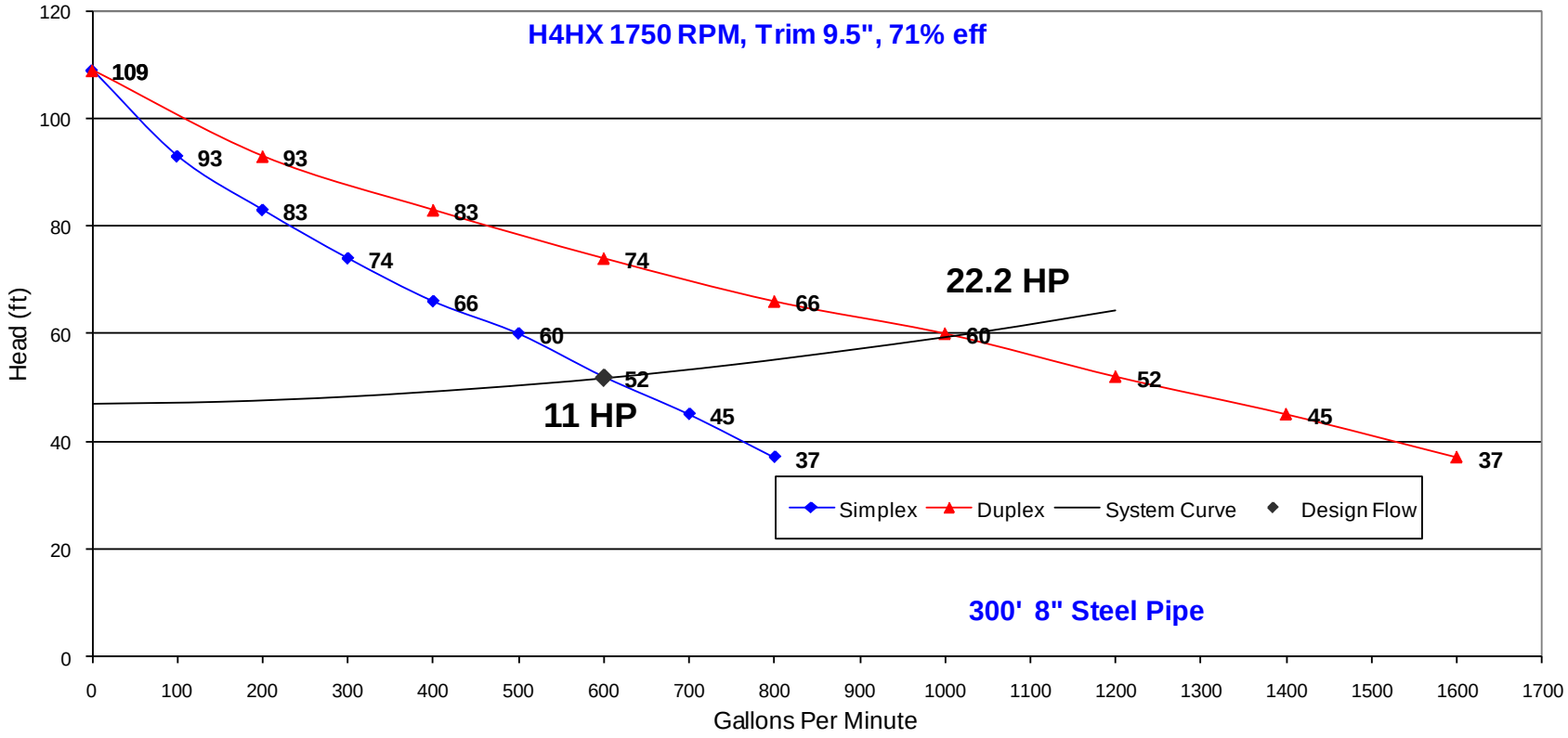
PumpTech Inc.

Pump ED 101

The System Curve



The System Curve



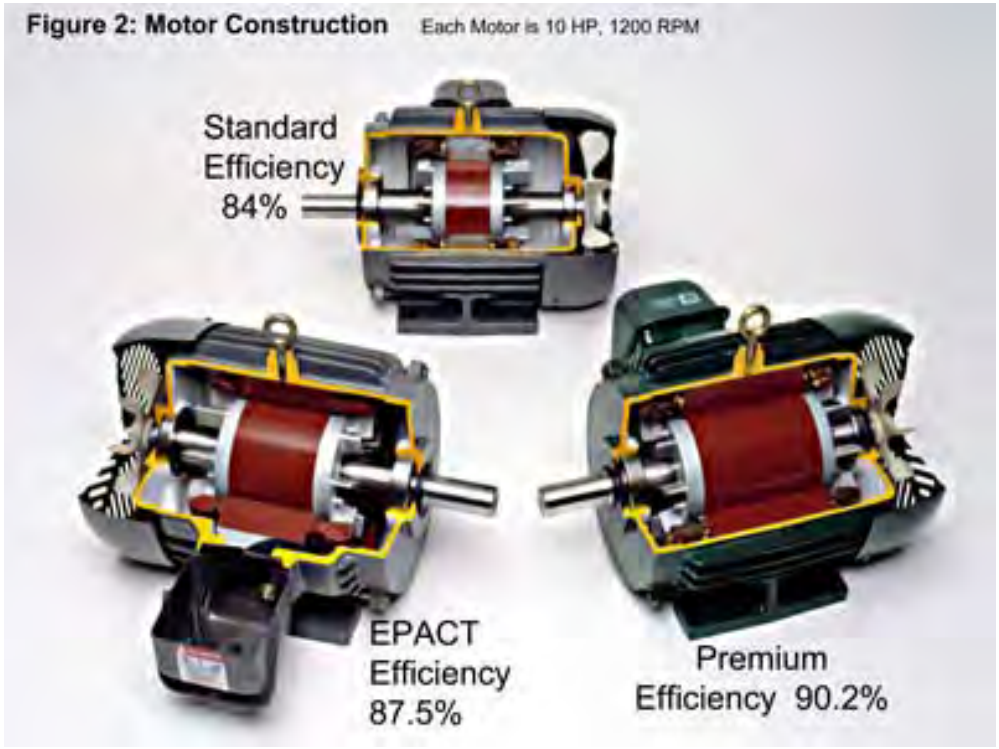
Pump ED 101

Motor Efficiency

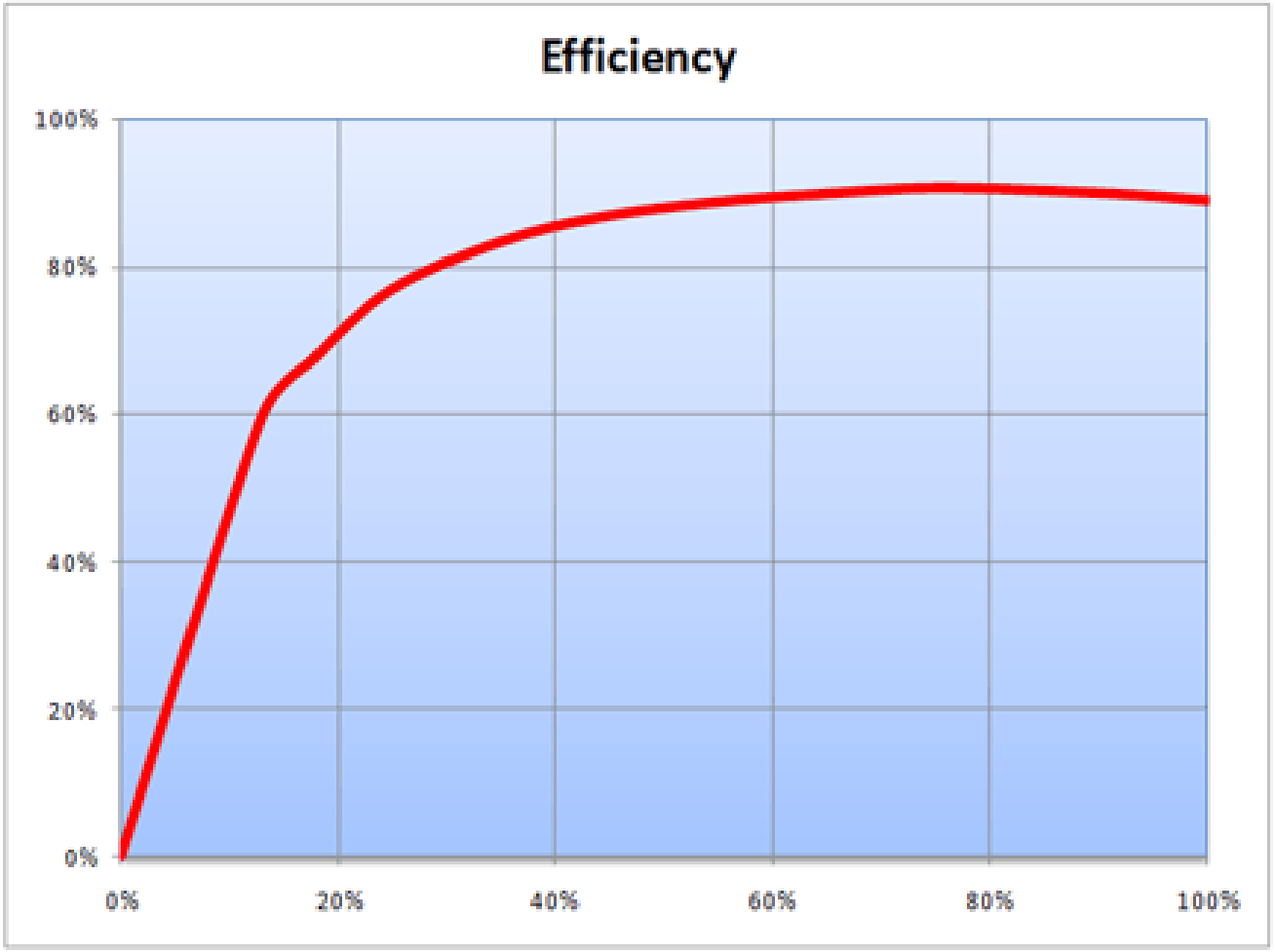
Energy Policy Act (EPACT)
Oct 1997 1 - 200 HP
EPACT Efficiency
NEMA MG1, Table 12-11

Energy Independence and Security Act (EISA)
Dec 19, 2010 1 – 500 HP
Premium Efficiency
NEMA MG1 Table 12-12

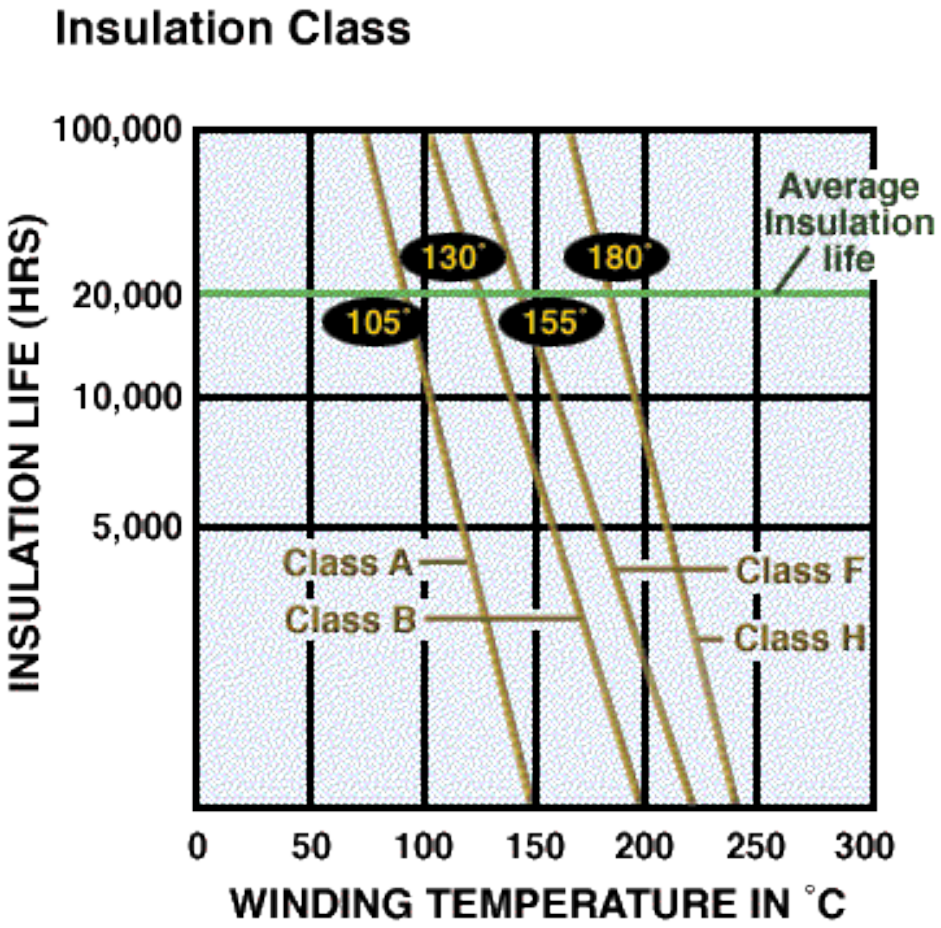
Motor Efficiency



Motor Efficiency versus Load



Insulation Life



Centrifugal Pump Efficiency

Ef = Ef mechanical x Ef volumetric x Ef hydraulic

Ef mechanical = Bearing, Seals etc

Ef volumetric = Leakage

Ef hydraulic = Friction

Also speed and specific speed

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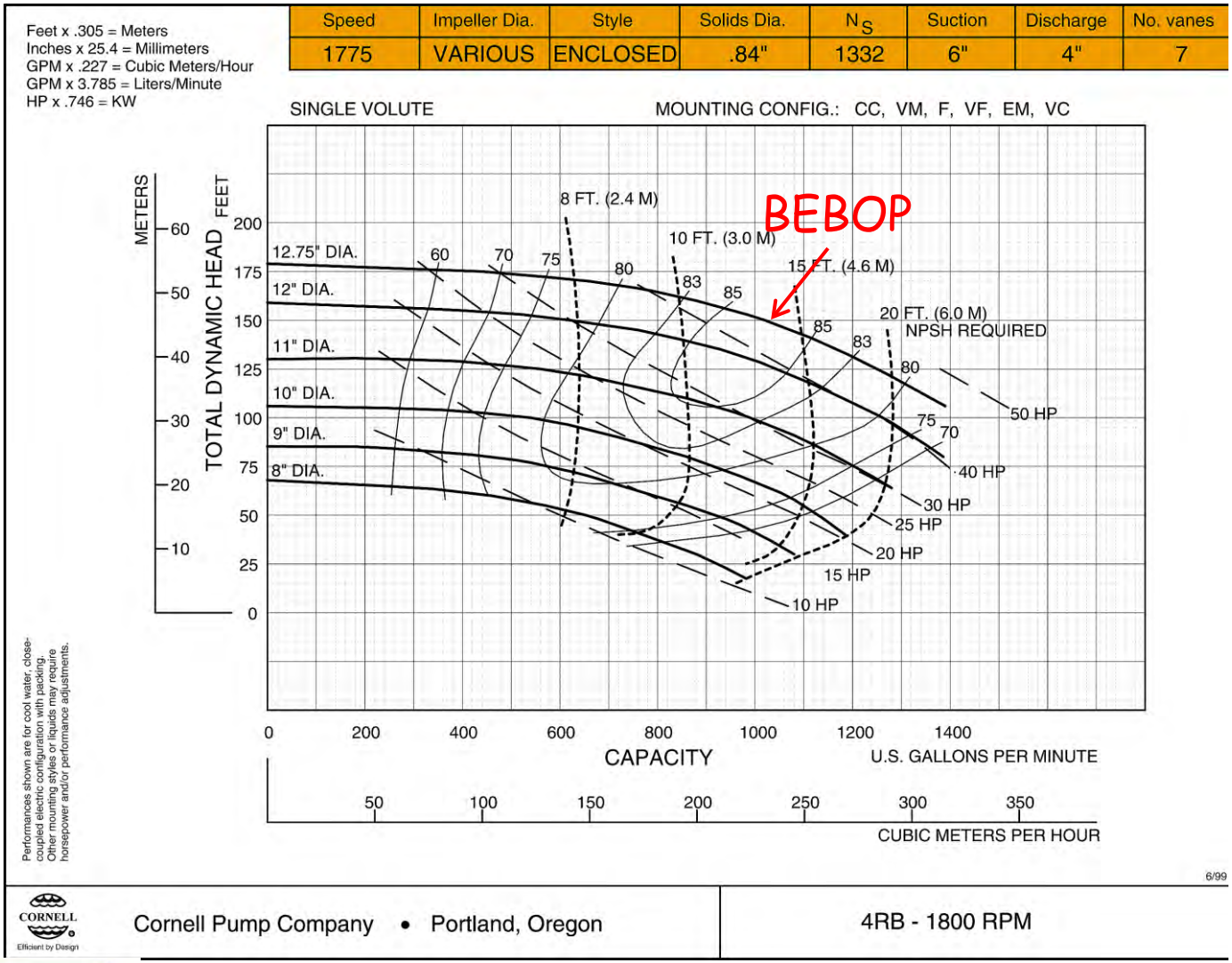
The Performance Curve



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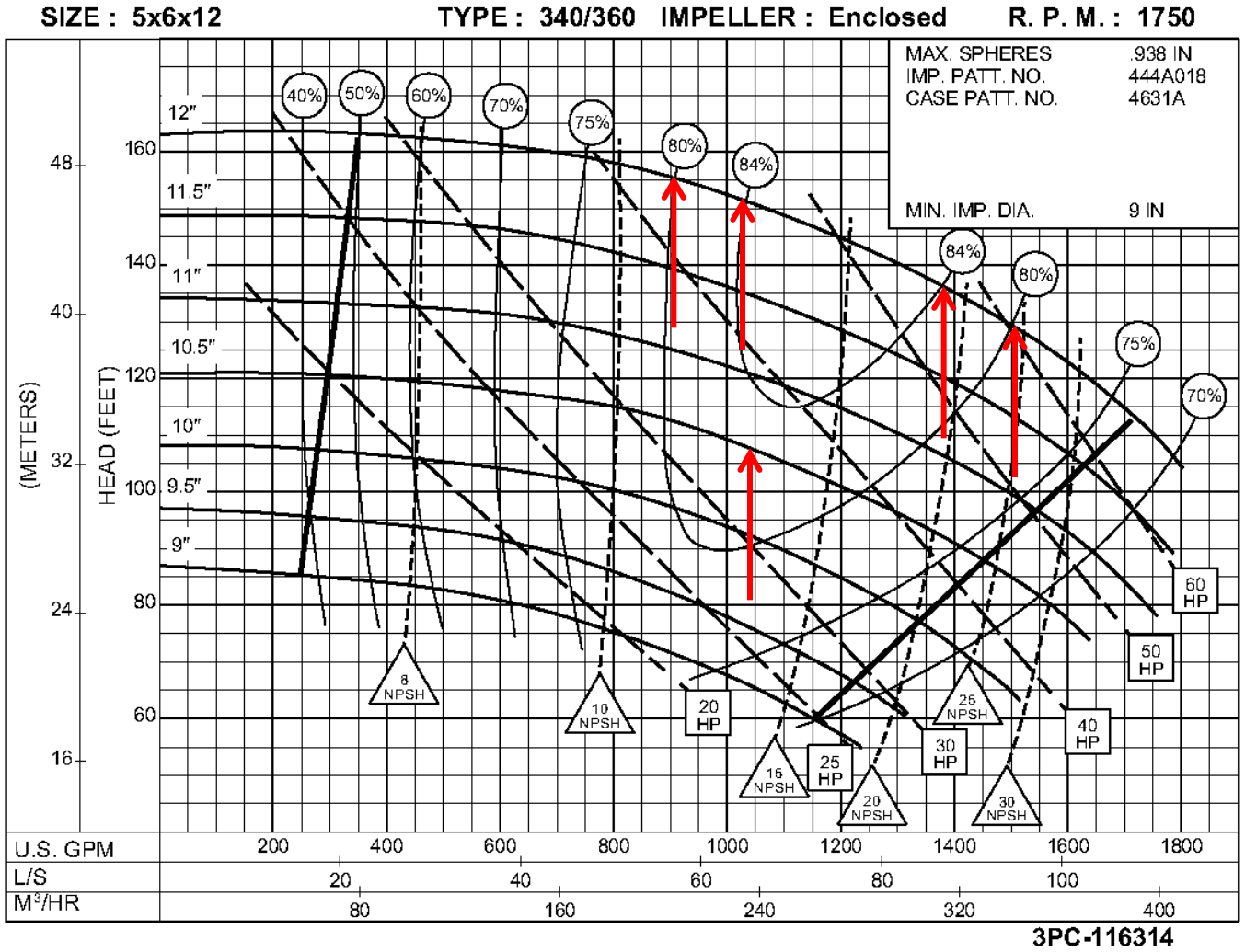
Wide Efficiency Range



3PC-116314

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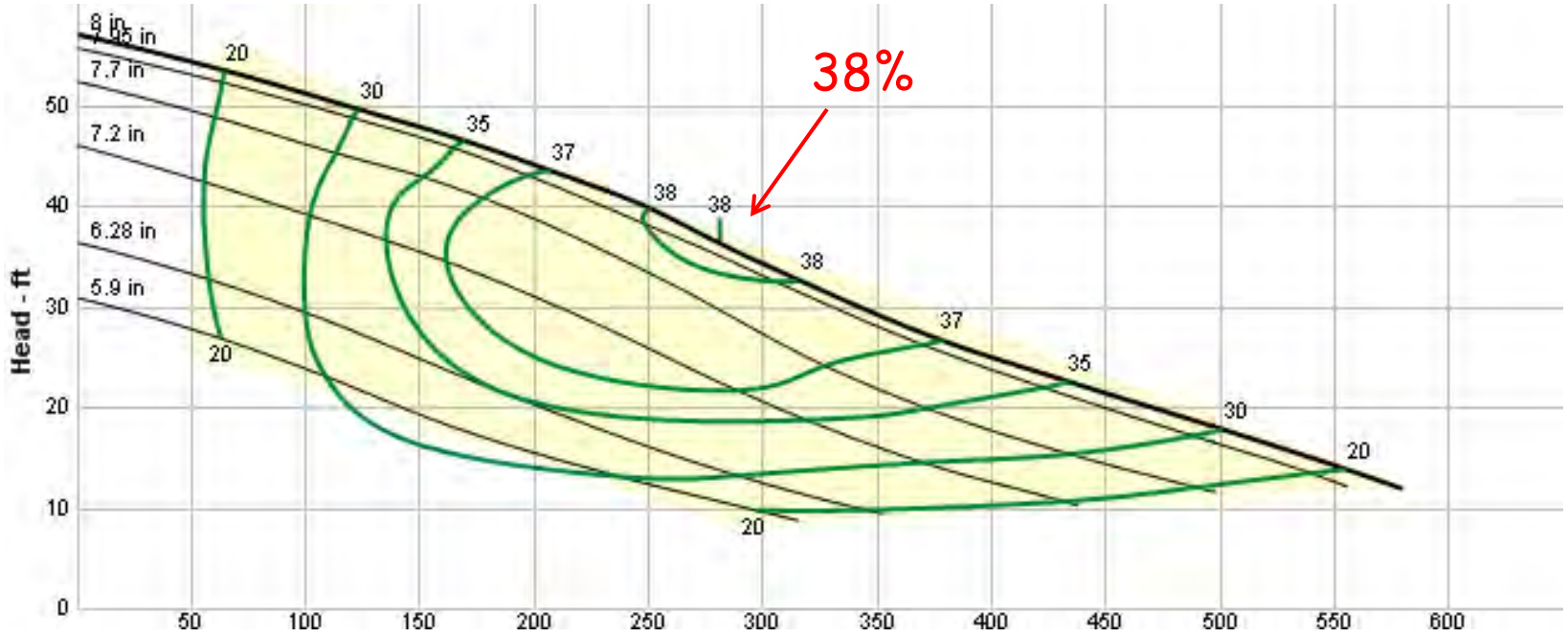
Would You Select This Pump ?



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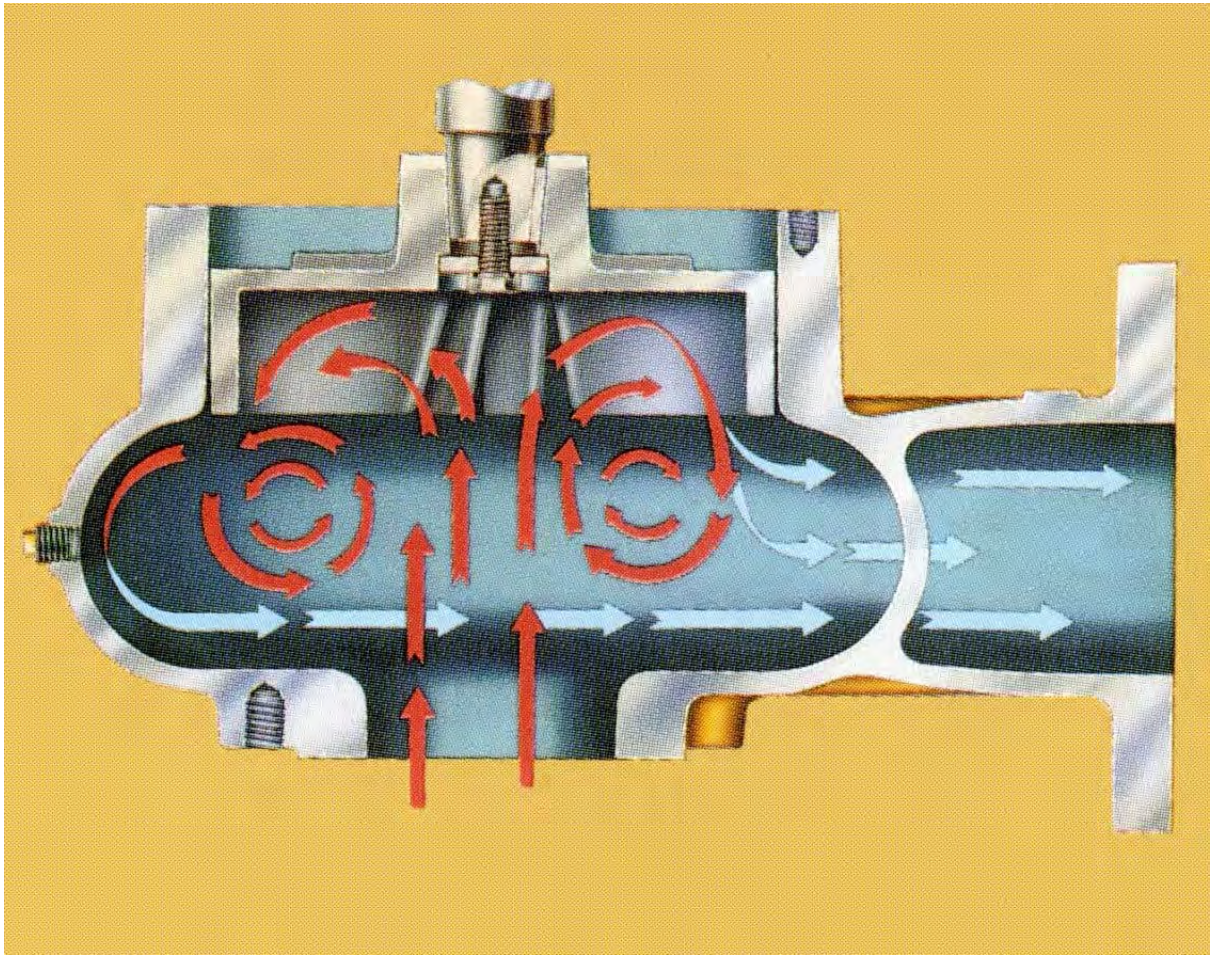
Vortex Action



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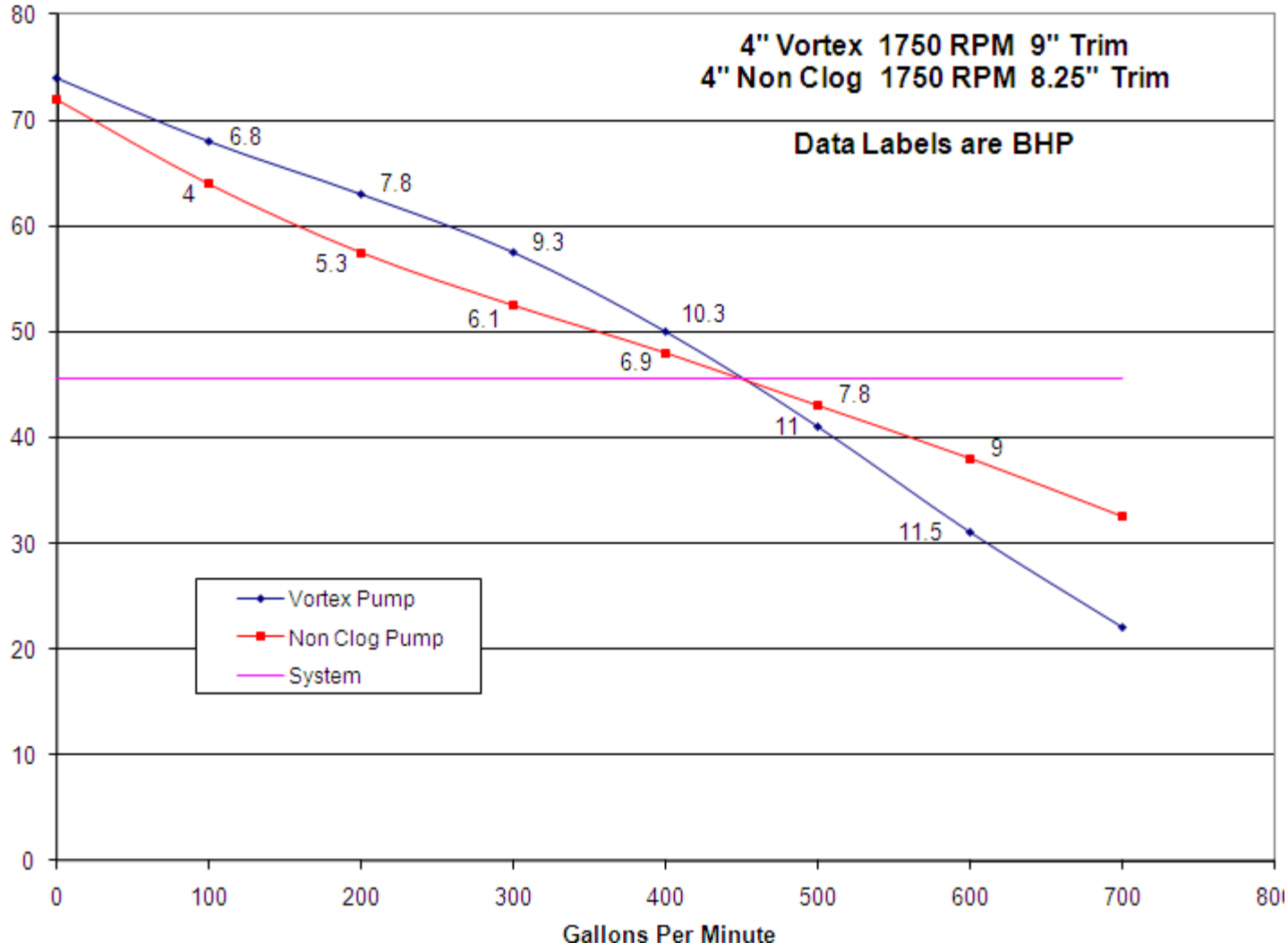
Vortex vs Non Clog



Pump ED 101

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Motor & Pump Efficiency

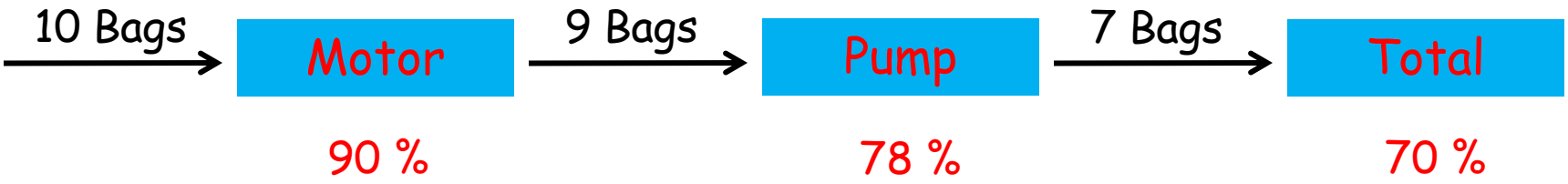
Motor Efficiency = Mechanical Power / Electrical Power

Pump Efficiency = Fluid Power / Mechanical Power

Total Efficiency = Pump Efficiency X Motor Efficiency

Motor & Pump Efficiency

Total Efficiency = Pump Efficiency X Motor Efficiency



0.90 X 0.78 = 0.70 = 70%

Wire to Water Energy Calculator

	REQUIRED DATA	PUMP 1	PUMP 2
4	Pump Operation - Hours / Day	8	8
5	Pump Operation - Days / Year	365	365
6	Pump Flow - GPM	1000	1000
7	Pump Head - Feet	150	150
8	Pump Efficiency - %	85%	75%
9	Motor Efficiency - %	94.1%	94.1%
10	Energy Cost in $/KWH	$0.11	$0.11
11			
12	**RESULTS**		
13	BHP At Design Point	44.6	50.5
14	Wire to Water Efficiency - %	80%	71%
15	Annual Energy Cost	$11,347.54	$12,860.55
16	KW Per 1000 Gallons Pumped	0.589	0.667
17	Cost Per 1000 Gallons Pumped	$0.065	$0.073
18			
19	**PAYBACK**		
20	Annual Savings - $$	$1,513.01	
21	Annual Savings - %	11.76%	
22	Cost of Pump 1	$9,000.00	
23	Cost of Pump 2	$7,200.00	
24	Payback - Years	1.2	

Note: When comparing two pumps, place the lower efficiency pump/motor in the Pump 2 column.

Sheet1 Sheet2 Sheet3

PumpTech inc.

12020 SE 32nd Street #2
Bellevue, WA 98005
888-644-6686

2425 SE Ochoco Street
Portland, OR 97222
503-659-6230

209 S Hamilton Road
Moses Lake, WA 98837
509-766-6330

F4 | Steel Pipe

System Energy Calculator

REQUIRED DATA	Option 1	Option 2
System Condition:	Steel Pipe	Steel Pipe
	8" 600'	6" 600'
Pump Operation - Hours / Day	8	8
Pump Operation - Days / Year	365	365
Pump Flow - GPM	600	600
Pump Head - Feet	50	65
Pump Efficiency - %	71%	71%
Motor Efficiency - %	82.0%	82.0%
Energy Cost in $/KWH	$0.11	$0.11
RESULTS		
BHP At Design Point	10.7	13.9
Wire to Water Efficiency - %	58%	58%
Annual Energy Cost	$3,117.94	$4,053.33
KW Per 1000 Gallons Pumped	0.270	0.351
Cost Per 1000 Gallons Pumped	$0.030	$0.039

12020 SE 32nd Street #2
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Portland, OR 97222
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209 S Hamilton Road
Moses Lake, WA 98837
509-766-6330

PAYBACK	
Annual Savings - $$	$935.38
Annual Savings - %	23.08%
Cost of Option 1	$12,000.00
Cost of Option 2	$9,000.00
Payback - Years	3.2

Note: When comparing two options, place the lower efficiency option in the Option 2 column. If the pump or parallel pumps in Option 2 cannot meet the flow of of Option 1, increase the Hours / Day of operation to make up the difference. Be sure to correct the overall hydraulic efficiency when pumps are running in parallel.

*

Multiple Pump Energy Calculator

REQUIRED DATA	PUMP 1	PUMP 2	PUMP 3	PUMP 4	PUMP 5
Pump Operation - Hours / Day	12	12	4	2	1
Pump Operation - Days / Year	365	365	365	365	365
Pump Flow - GPM	3000	2000	1000	1000	1000
Pump Head - Feet	88	88	88	88	88
Pump Efficiency - %	85%	80%	75%	75%	75%
Motor Efficiency - %	95.0%	95.0%	94.1%	94.1%	94.1%
Energy Cost in $/KWH	$0.12	$0.12	$0.12	$0.12	$0.12
Single Pump Calculations					
BHP At Design Point	78.4	55.6	29.6	29.6	29.6
Wire to Water Efficiency - %	81%	76%	71%	71%	71%
Annual Energy Cost	$32,371.32	$22,929.68	$4,115.38	$2,057.69	$1,028.84
KW Per 1000 Gallons Pumped	0.342	0.364	0.391	0.391	0.391
Cost Per 1000 Gallons Pumped	$0.041	$0.044	$0.047	$0.047	$0.047

Multiple Pump Calculations	Ave BHP	Ave WW Eff	Ave KW/1000	Ave $$/1000	Annual Flow	Annual Cost
Pumps 1 & 2	67.0	78.4%	0.353	$0.042	21,900,000	$55,301.00
Pumps 1, 2 & 3	61.7	77.3%	0.358	$0.043	23,360,000	$59,416.38
Pumps 1, 2, 3 & 4	59.5	76.8%	0.361	$0.043	24,090,000	$61,474.07
Pumps 1, 2, 3, 4 & 5	58.6	76.6%	0.362	$0.044	24,455,000	$62,502.91

Sheet1 Sheet2 Sheet3

PumpTech inc.

12020 SE 32nd Street #2
Bellevue, WA 98005
888-644-6686

321 S Sequoia Parkway
Canby, OR 97013
503-659-6230

209 S Hamilton Road
Moses Lake, WA 98837
509-766-6330

*

Pump Control

Fixed Speed

Variable Speed

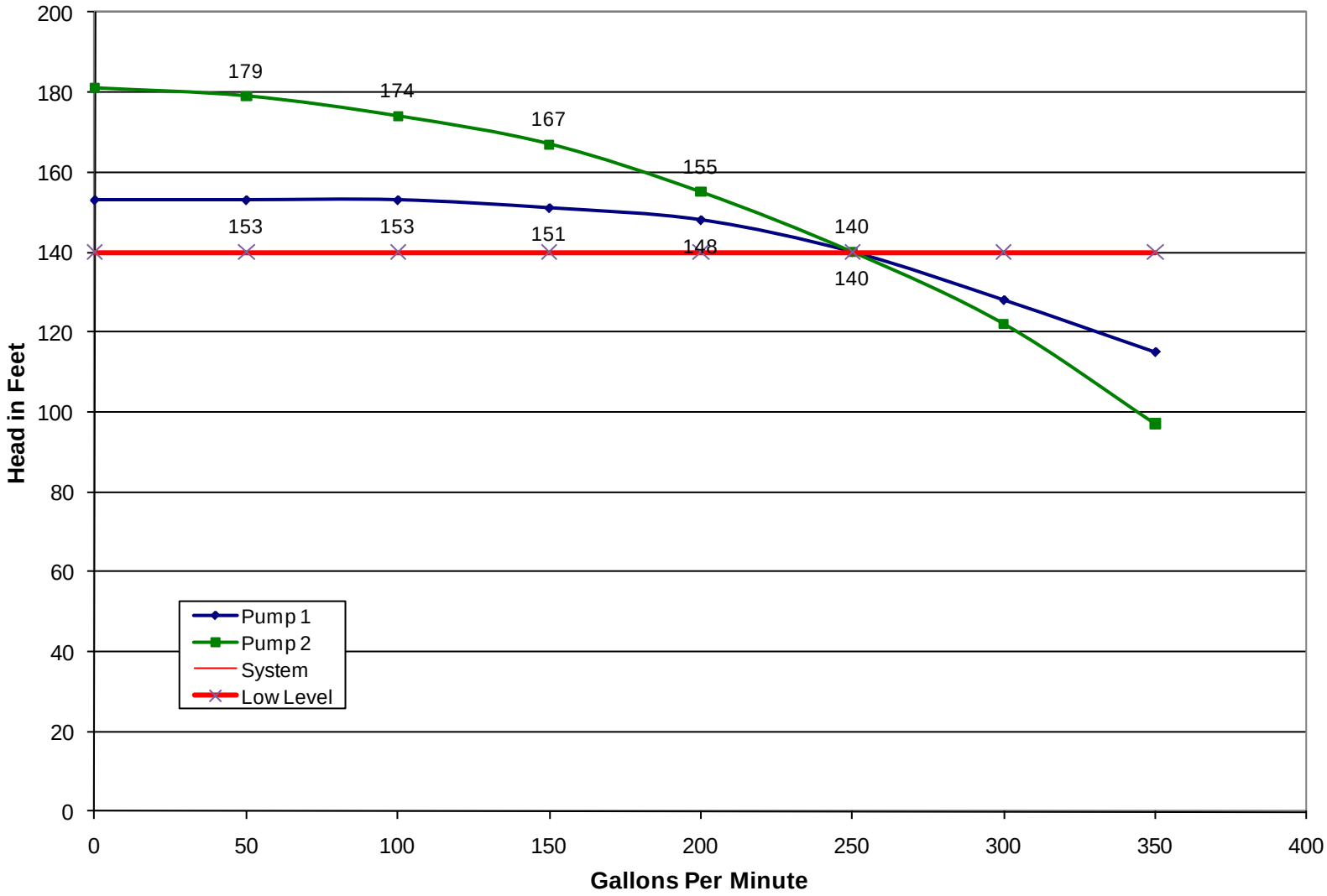
*

Curve Shape

The shape and slope of the performance curve can have a significant effect upon pump selection.

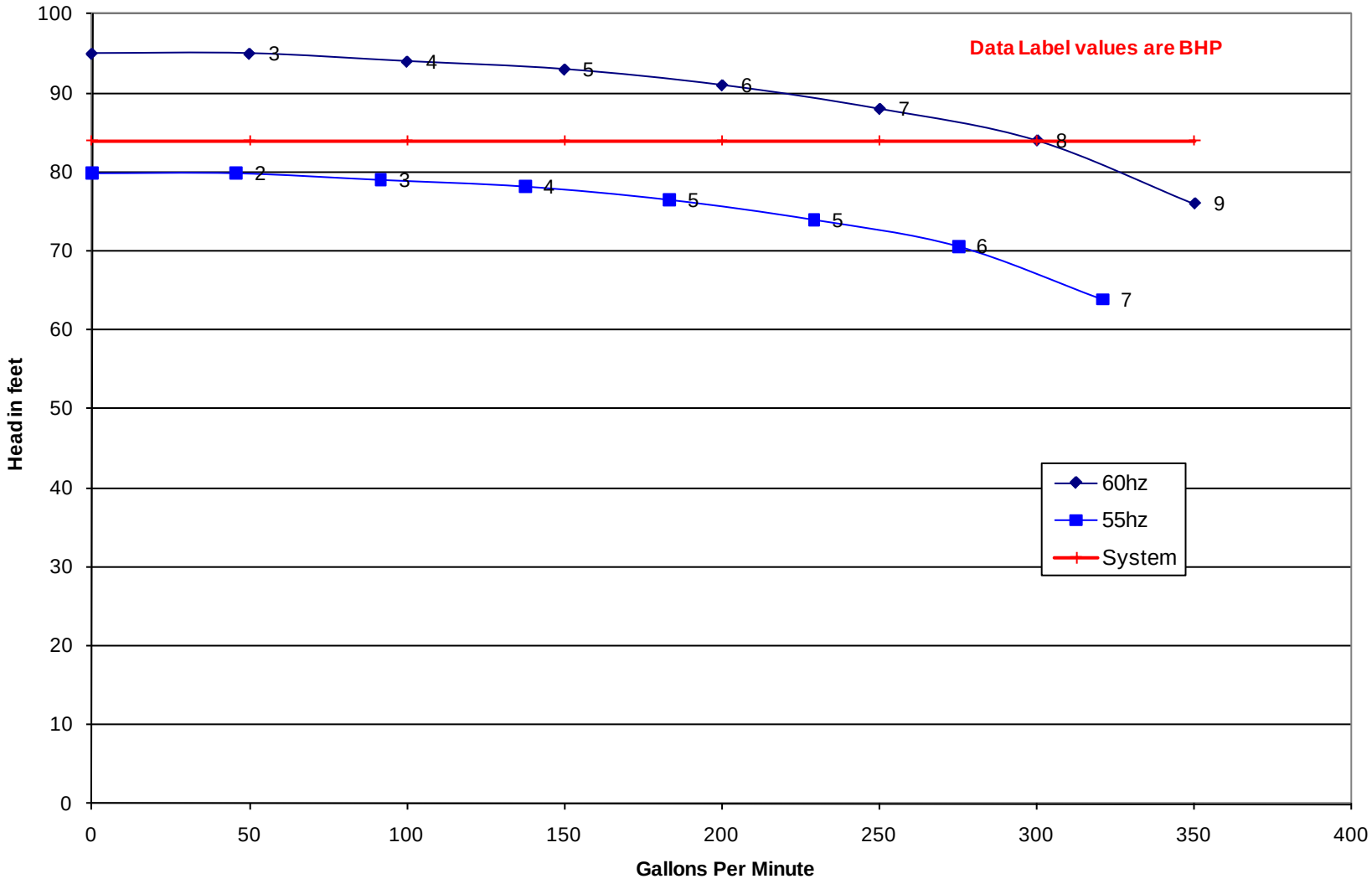
*

PRV Control


200
180
160
140
120
100
80
60
40
20
0
Head in Feet
179
174
167
155
153
153
151
148
140
140
Pump 1
Pump 2
System
Low Level
0
50
100
150
200
250
300
350
400
Gallons Per Minute

*

VFD Control Flat



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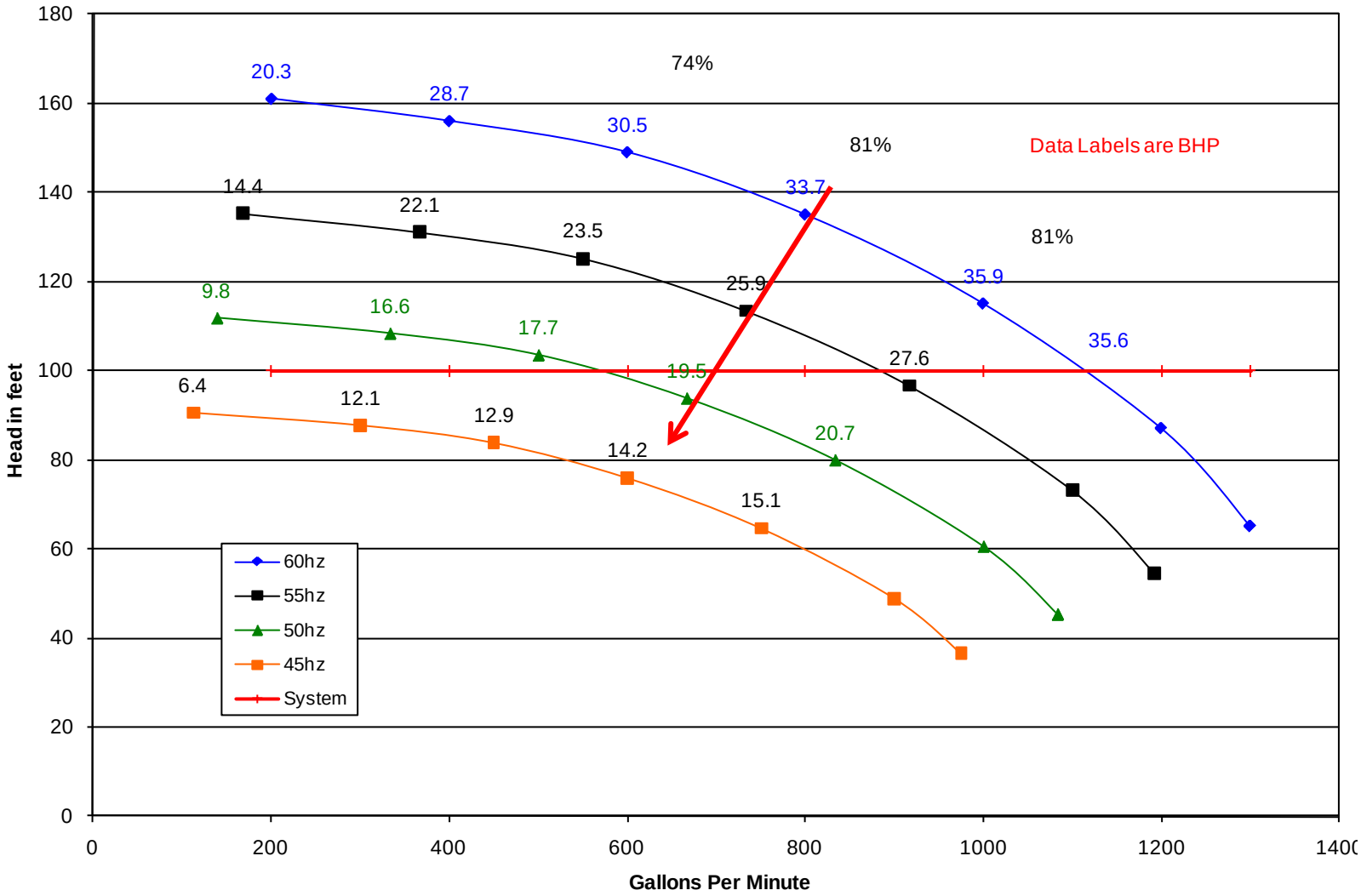
VFD Control Steep



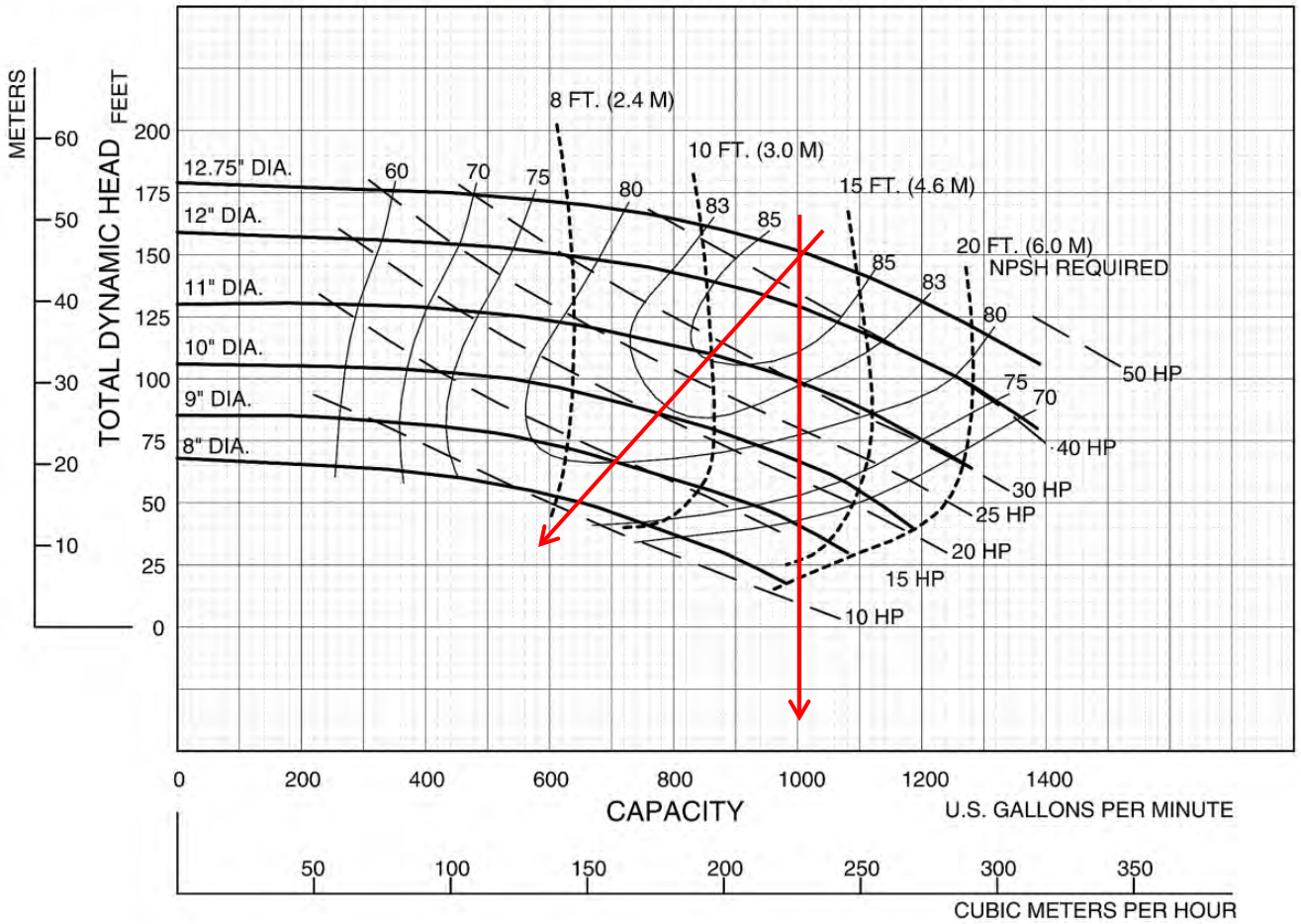
*

Feet x .305 = Meters
Inches x 25.4 = Millimeters
GPM x .227 = Cubic Meters/Hour
GPM x 3.785 = Liters/Minute
HP x .746 = KW

Speed	Impeller Dia.	Style	Solids Dia.	N_S	Suction	Discharge	No. vanes
1775	VARIOUS	ENCLOSED	.84"	1332	6"	4"	7

SINGLE VOLUTE

MOUNTING CONFIG.: CC, VM, F, VF, EM, VC



Performances shown are for cool water, close-coupled electric configuration with packing. Other mounting styles or liquids may require horsepower and/or performance adjustments.

6/99

CORNELL
Efficient by Design

Cornell Pump Company • Portland, Oregon

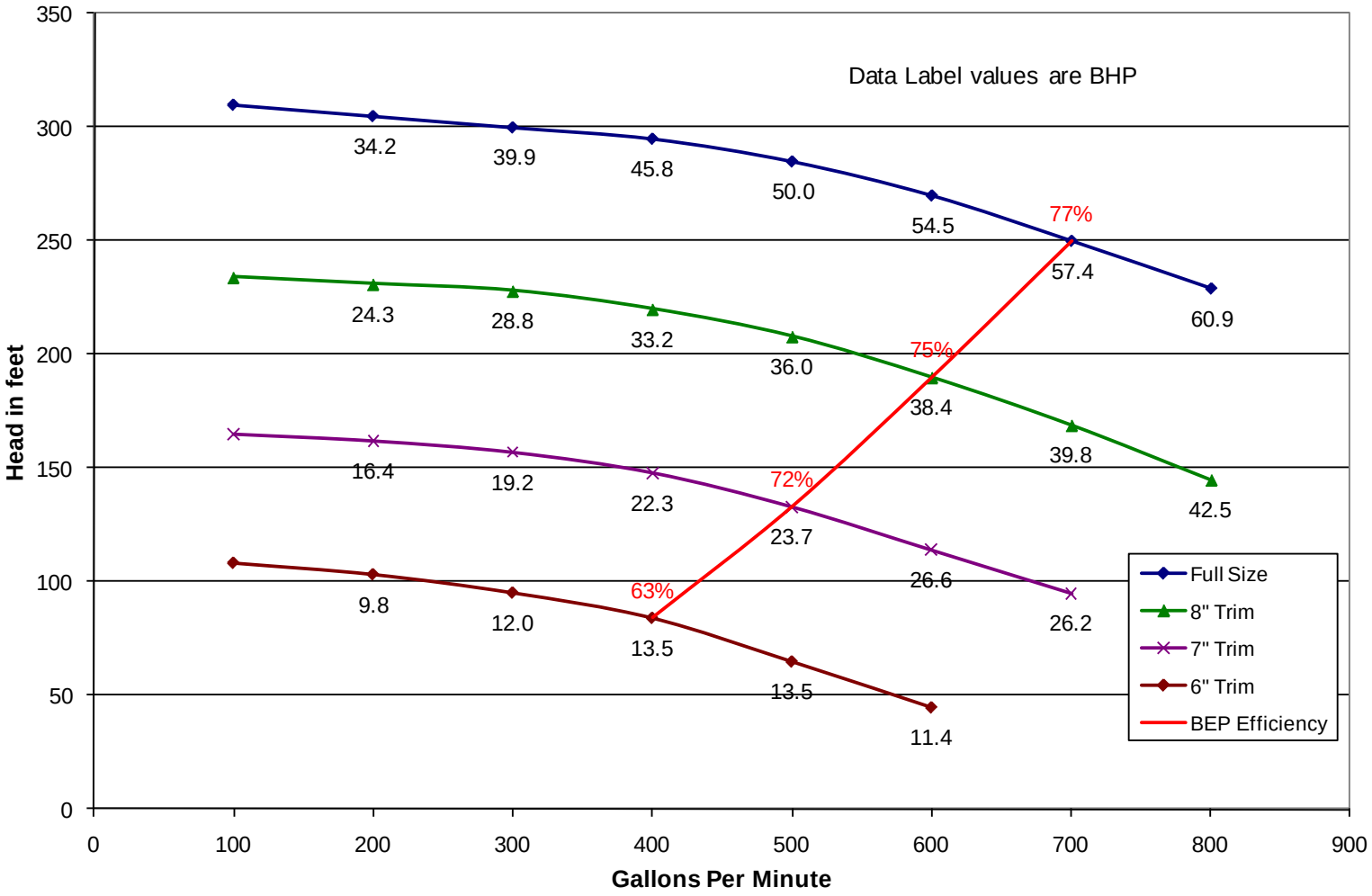
4RB - 1800 RPM

PumpTech inc.

Pump ED 101

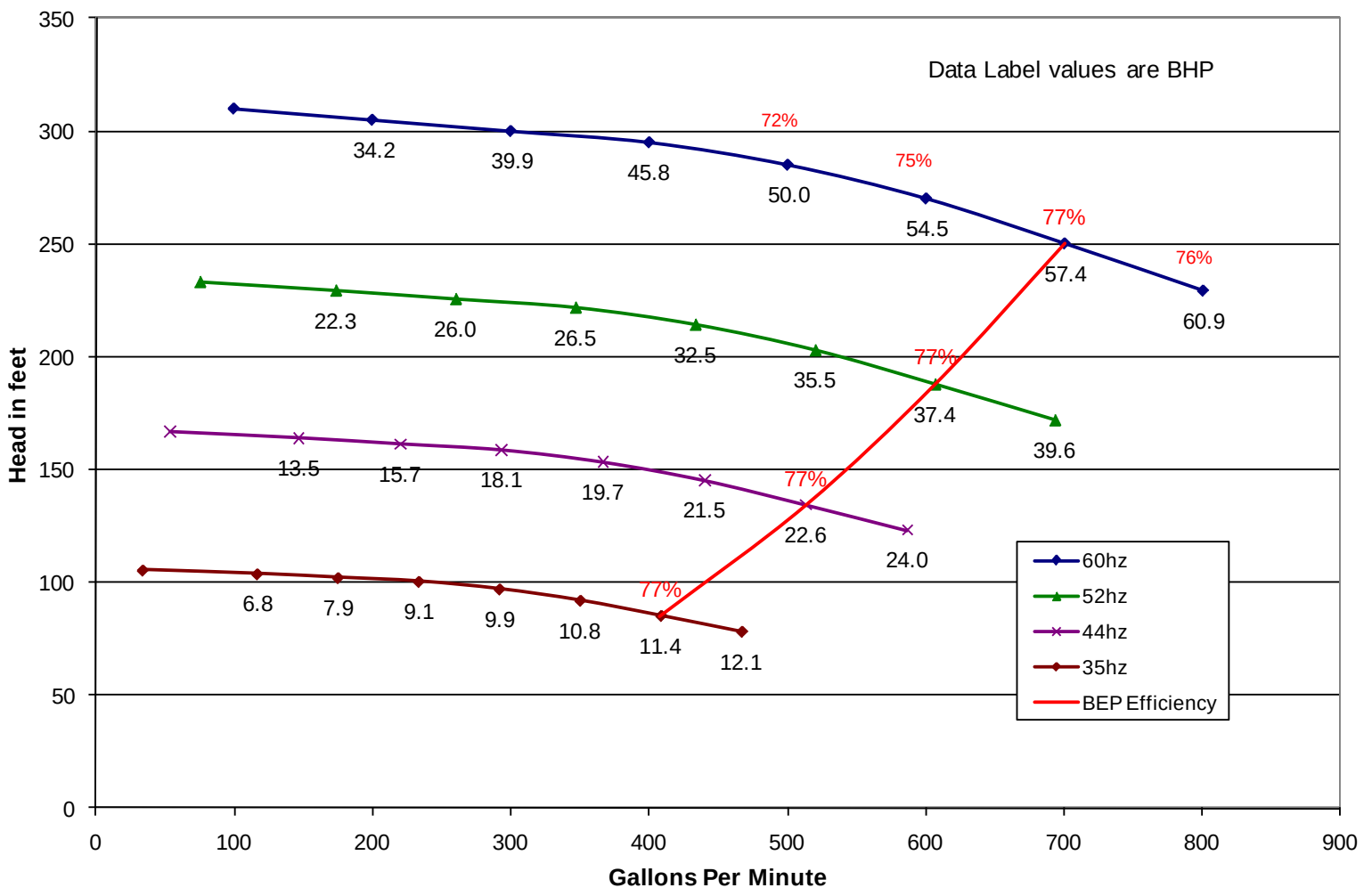
Preservation of Efficiency

3X4X9A 9" Impeller 3500 RPM



HP = (GPM X H) / (3960 X EFF)

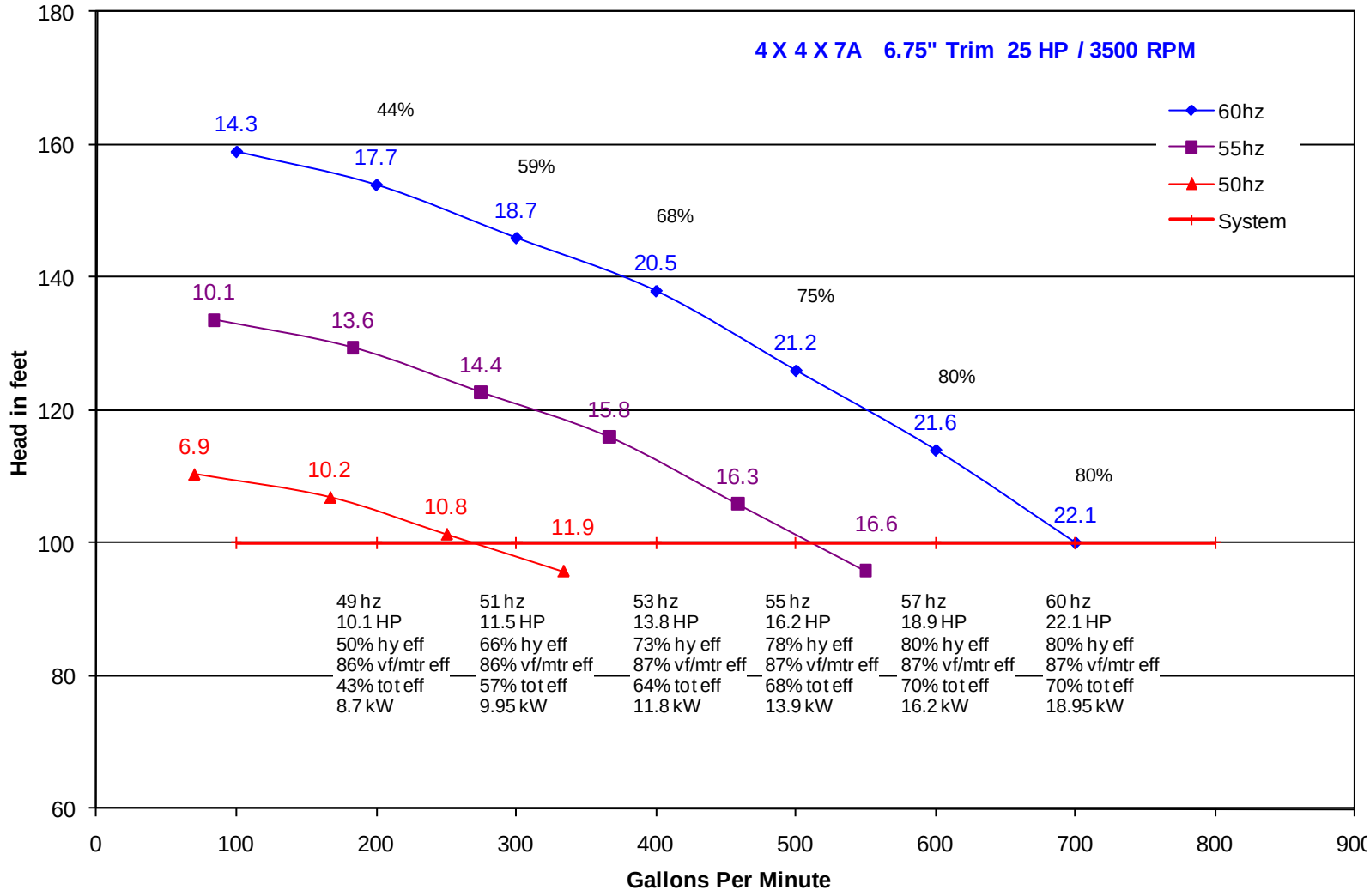
Preservation of Efficiency



HP = (GPM X H) / (3960 X EFF)

Pump ED 101

VFD Control – Power Savings



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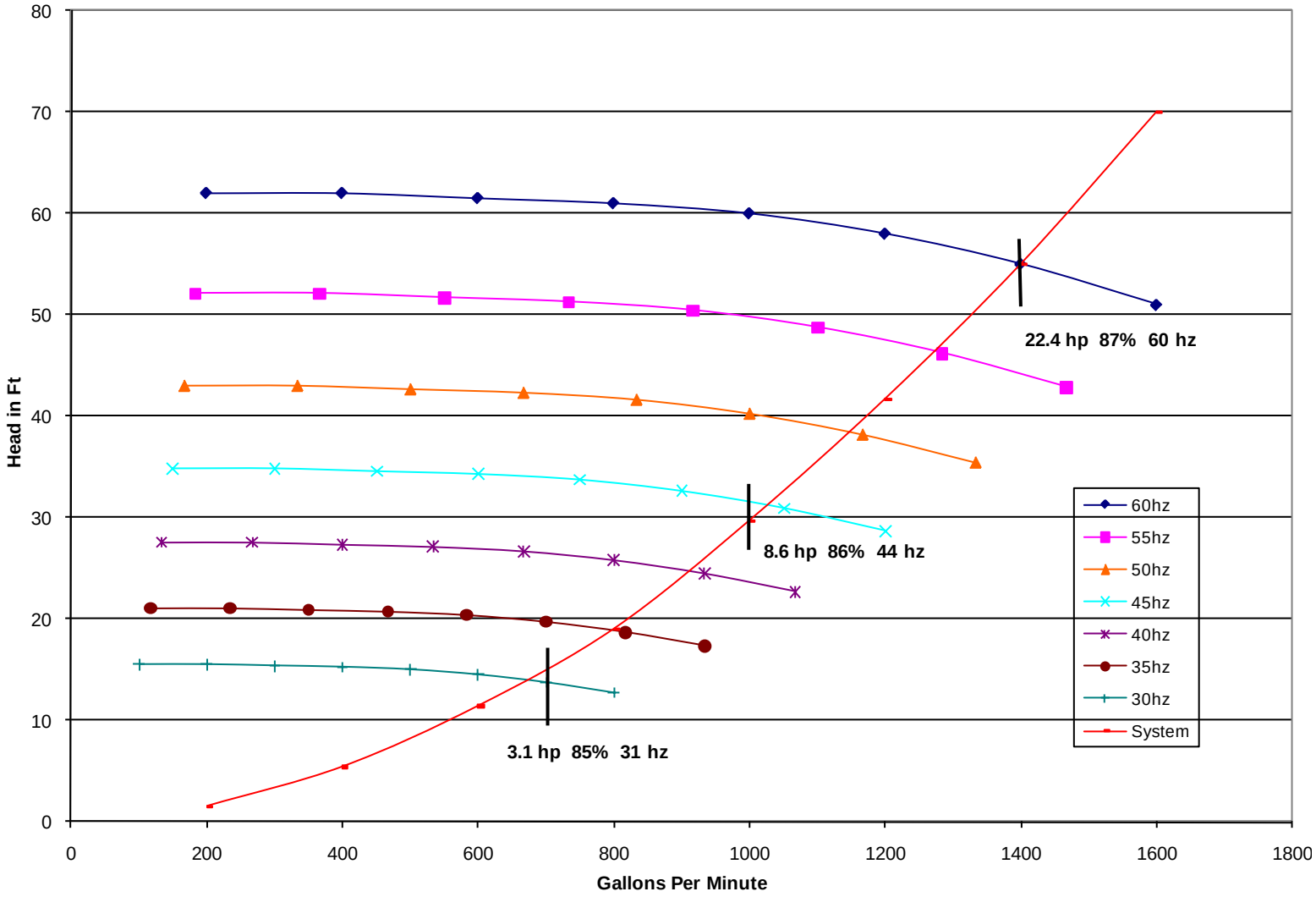
VFD Control Circulation



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*

Variable Speed Pump Analysis (VSPAnalysis) - with Autoplot

Joe Evans, Ph.D 10/1/2010 http://www.PumpEd101.com http://www.PumpTechnw.com

Follow the steps below to view the operating characteristics and potential power savings of a centrifugal pump under VFD control.
Scroll down for more detailed instructions and an explaination of the included example.

1) Enter the pump description in the yellow box to the right: Cornell 5RB 1780 RPM 13.5" Trim

2) Enter eight 60 hertz flows In Q1 - Q8
See instructions for fewer than eight points

Enter the corresponding heads (in ft) in H1 - H8

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
500	750	1000	1250	1500	1750	2000	2250
H1	**H2**	**H3**	**H4**	**H5**	**H6**	**H7**	**H8**
200	195	187	178	165	148	125	100

3) Enter the pump's hydraulic efficiencies (.xx) in Ef 1 - Ef 8 that correspond to the flows in Q1 - Q8.

Ef 1	Ef 2	Ef 3	Ef 4	Ef 5	Ef 6	Ef 7	Ef 8
0.60	0.72	0.80	0.84	0.86	0.86	0.83	0.74

4) Enter the design point flow, head & Ef (.xx) in Qd, Hd & Efd

Qd	Hd	Efd
1850	140	0.85

5) Enter BEP Q, H, Ef (.xx) & NPSHr in Qb, Hb, Efb & Nrb

Qb	Hb	Efb	Nrb
1700	154	0.86	14

6) Enter motor efficiency (.xx) in Efm, speed (RPM) in RPM and electrical power cost per kWH (.xxx) in $/kWH

Efm	RPM	$/kWH
0.90	1780	0.100

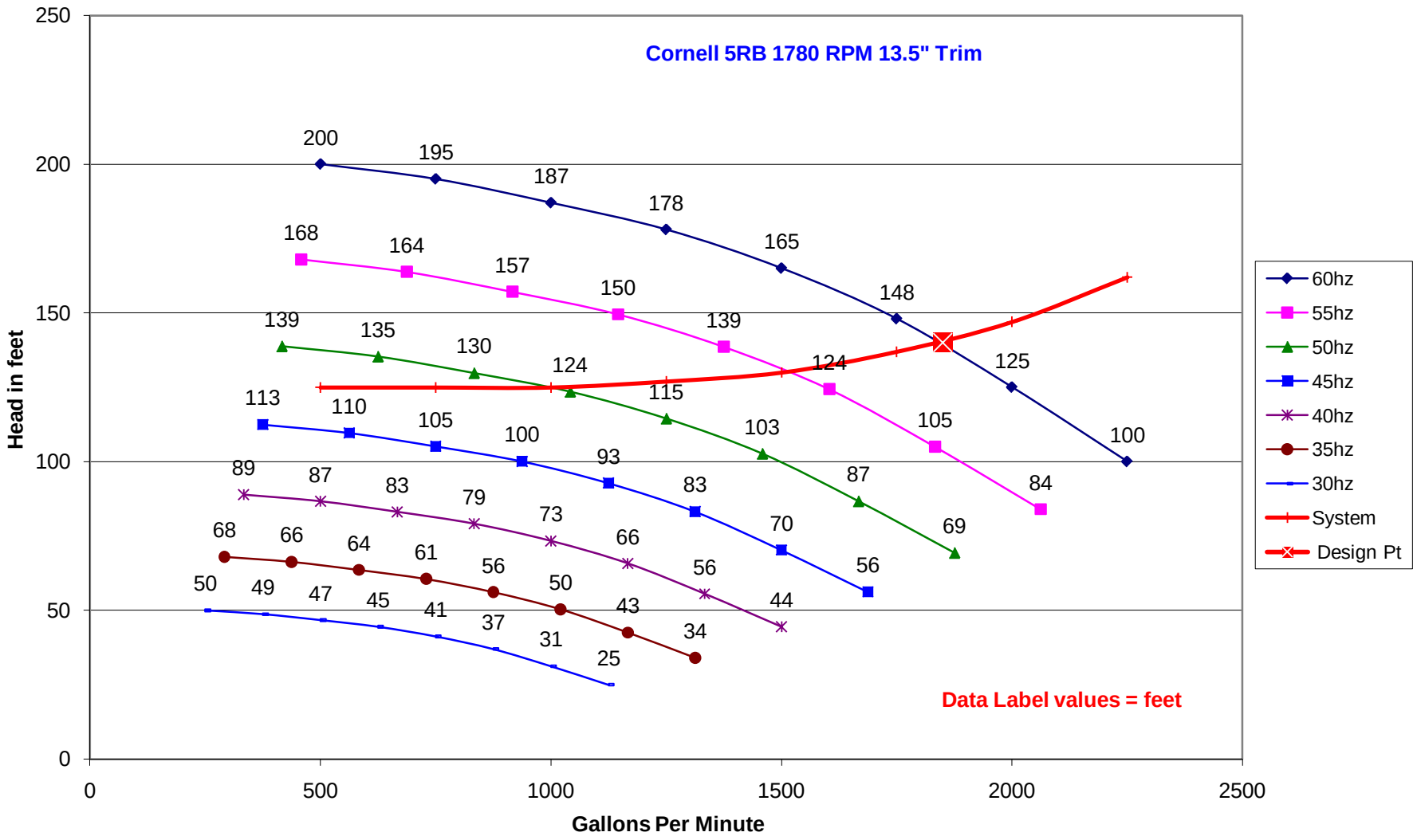
7) To plot a system or constant pressure curve, enter the system heads (in ft) in SH1 - SH8 that correspond to the flows in Q1 - Q8. (See Instructions below)

SH1	SH2	SH3	SH4	SH5	SH6	SH7	SH8
125	125	125	127	130	137	147	162

VSPA | Pump Head | Pump Efficiency | Pump BHP | kW per 1000 Gal | Cost per 1000 Gal | Useful Calculations

*

Pump Head vs System Head



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Pump ED 101

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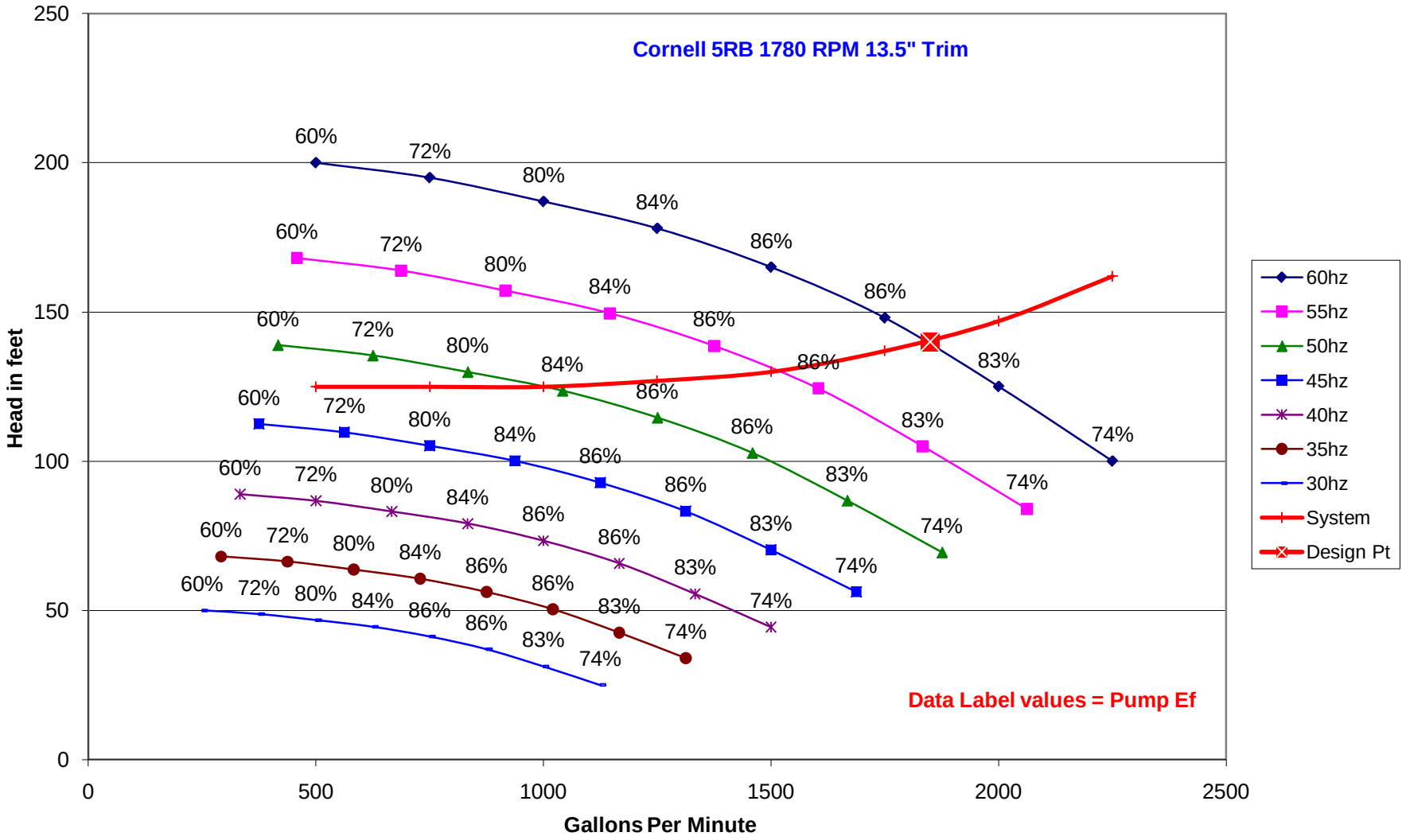
Pump Hydraulic Efficiency vs System Head



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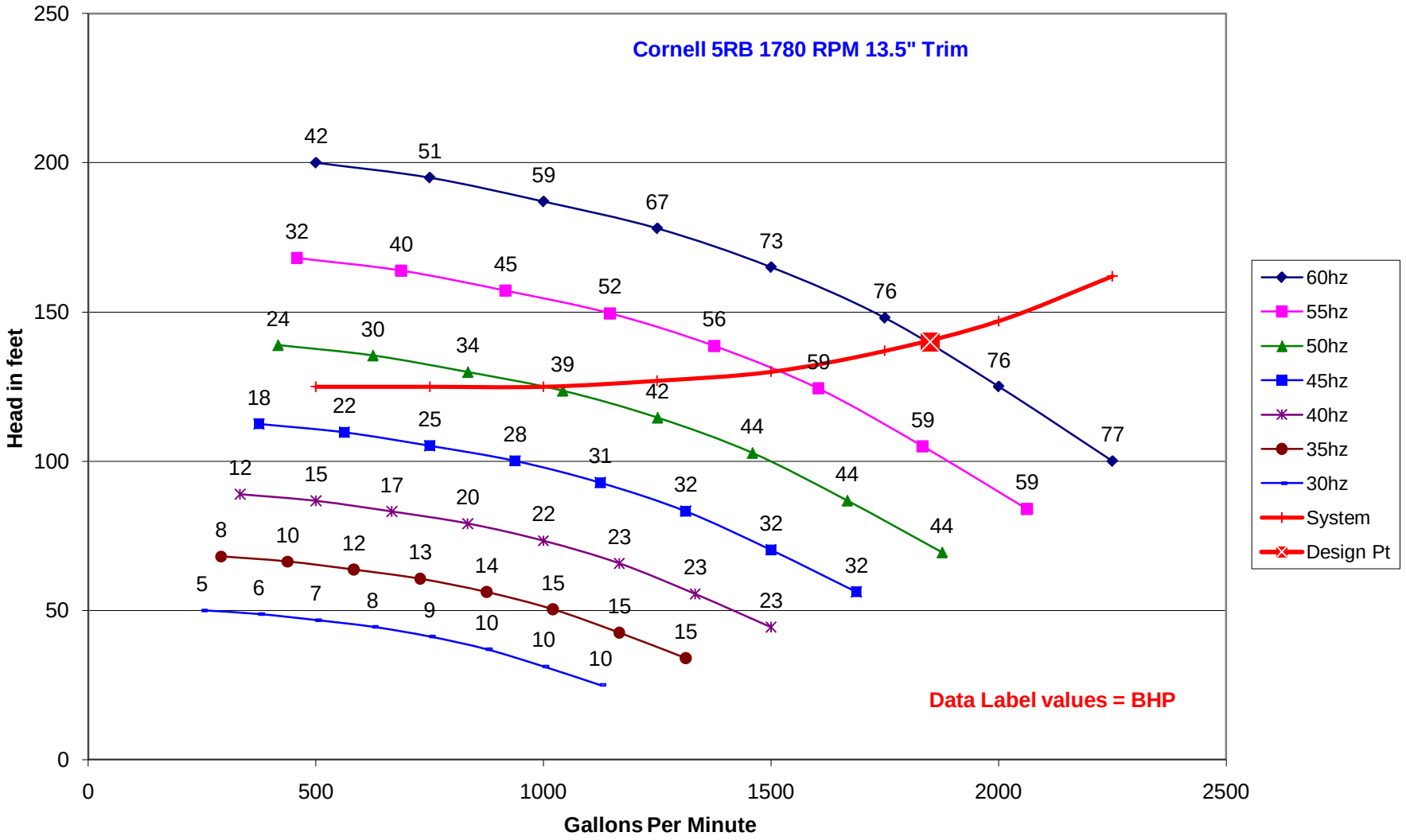
Pump BHP vs System Head



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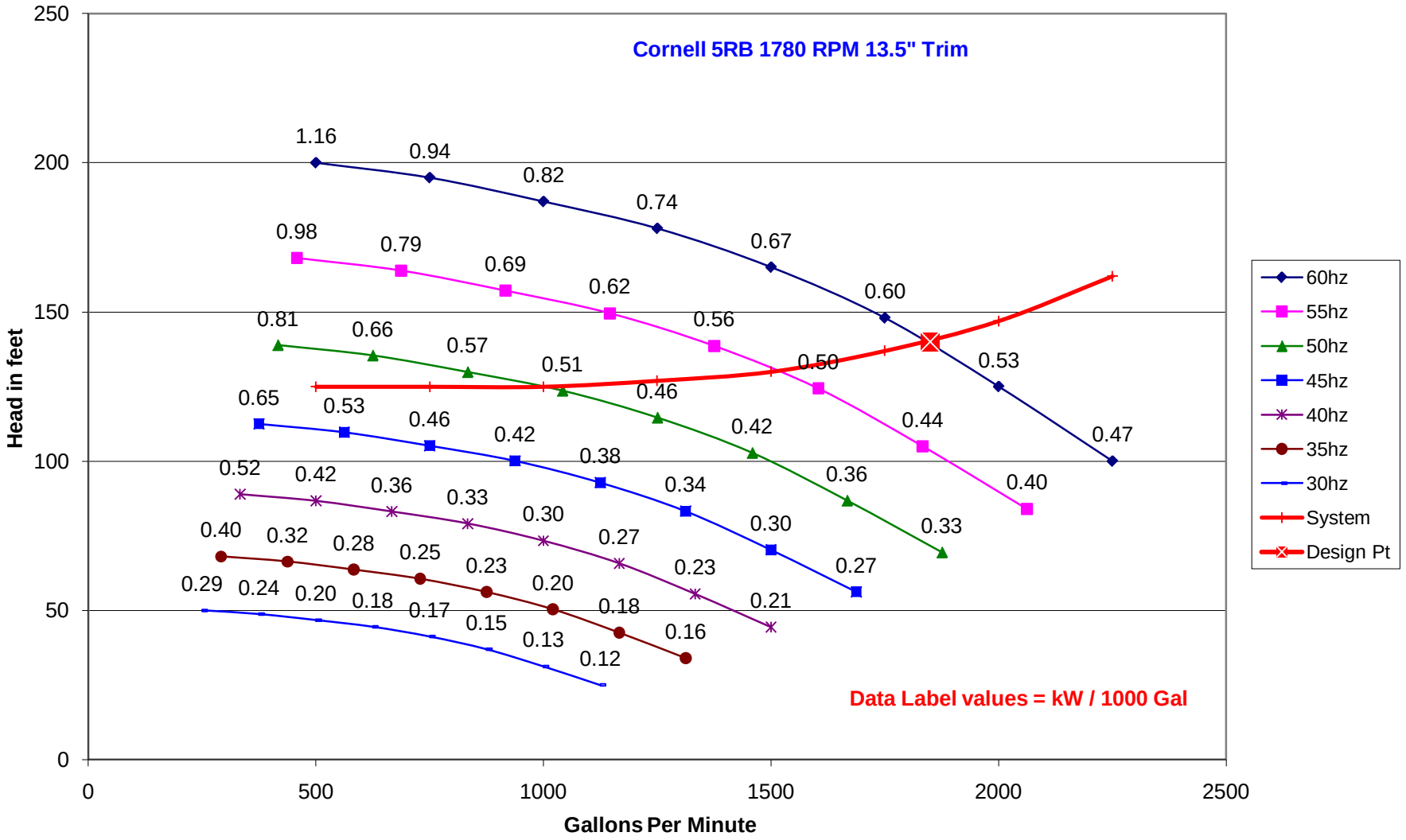
Power / 1000 Gallons Pumped



Pump ED 101

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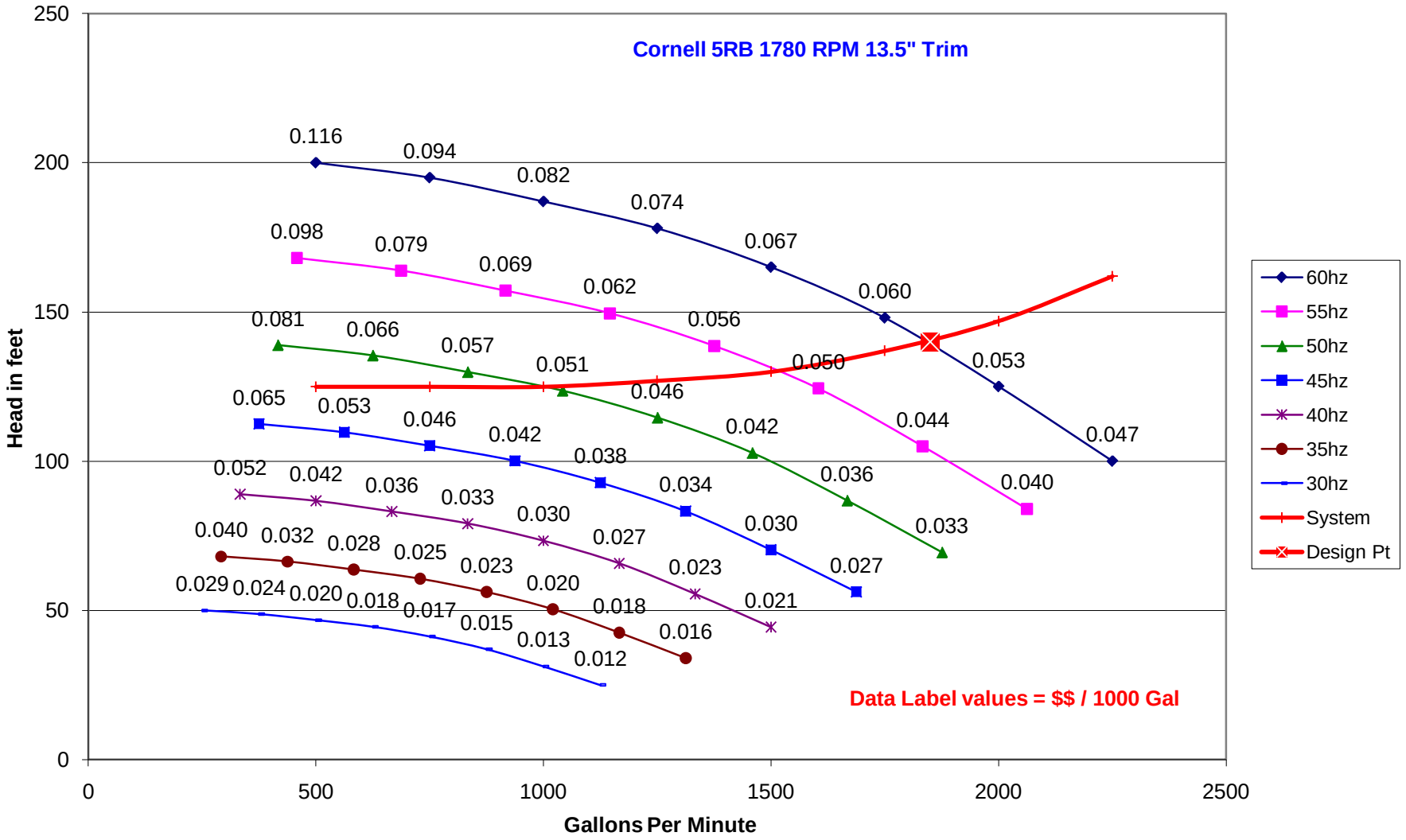
Cost / 1000 Gallons Pumped



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Pump ED 101

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Useful Calculations

General

Specific Speed (Ns)	1679
Suction Specific Speed (Nss)**	
60hz	10140
55hz	9816
50hz	9469
45hz	9103
40hz	8712
35hz	8283
30hz	7819

Suction Energy (SE)

Enter eye diameter in inches	7.2
60hz	129957376
55hz	115360936
50hz	101085255
45hz	87500427
40hz	74468732
35hz	61886397
30hz	50105418

** NPSHr estimation at reduced speeds is:
(RPM2 / RPM1)^1.5 = (NPSHr2 / NPSHr1)

BEP

Pump Efficiency	86.0%
Pump BHP	76.9
kW per 1000 Gallons Pumped	0.62
Cost per 1000 Gallons Pumped	$0.062

Design Point

Pump Efficiency	85.0%
Pump BHP	76.9
kW per 1000 Gallons Pumped	0.57
Cost per 1000 Gallons Pumped	$0.057

If eye diamater is not known it can be estimated as follows:

End Suction - Suction Diameter X 0.9
Split Case - Suction Diameter X 0.75

VSPA | Pump Head | Pump Efficiency | Pump BHP | kW per 1000 Gal | Cost per 1000 Gal | Useful Calculations

*

VFD Control – Multiple Pumps

2 Pumps – 1 Drive

2 Pumps – 1 Drive & Contactors

2 Pumps – 2 Drives

PumpTech Inc.

Pump ED 101

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Q12 | Vertical Multistage (25HP)

Variable Frequency Parallel Pump Analyzer (Beta)

Joe Evans, Ph.D 7/4/10 Customer Education PumpTech, Inc http://www.PumpEd101.com

Follow the five steps below to view the operation of two identical centrifugal pumps under VFD control.
Scroll down for more detailed instructions.

1) Enter the pump description in the yellow box to the right: Vertical Multistage (25HP)

2) Enter eight 60 hertz flows In Q1 - Q8 (Cells H20 - O20)
Enter the corresponding heads (in ft) in H1 - H8 (Cells P20 - W20)
(*See instructions below when entering fewer than eight points)

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	H1	H2	H3	H4	H5	H6	H7	H8
50	100	150	200	250	300	350	400	280	271	262	252	240	225	206	182

3) To plot a system curve (static), enter the head (in ft) in SH1 - SH8 (Cells P62 - W62). (See instructions below)

SH1	SH2	SH3	SH4	SH5	SH6	SH7	SH8
206	206	206	206	206	206	206	206

4) Enter the pump's hydraulic efficiencies in Ef 1 - Ef 8 (Cells P67 - W67) that correspond to the flows in Q1 - Q8
Enter as a decimal equivalent. (See instructions below)

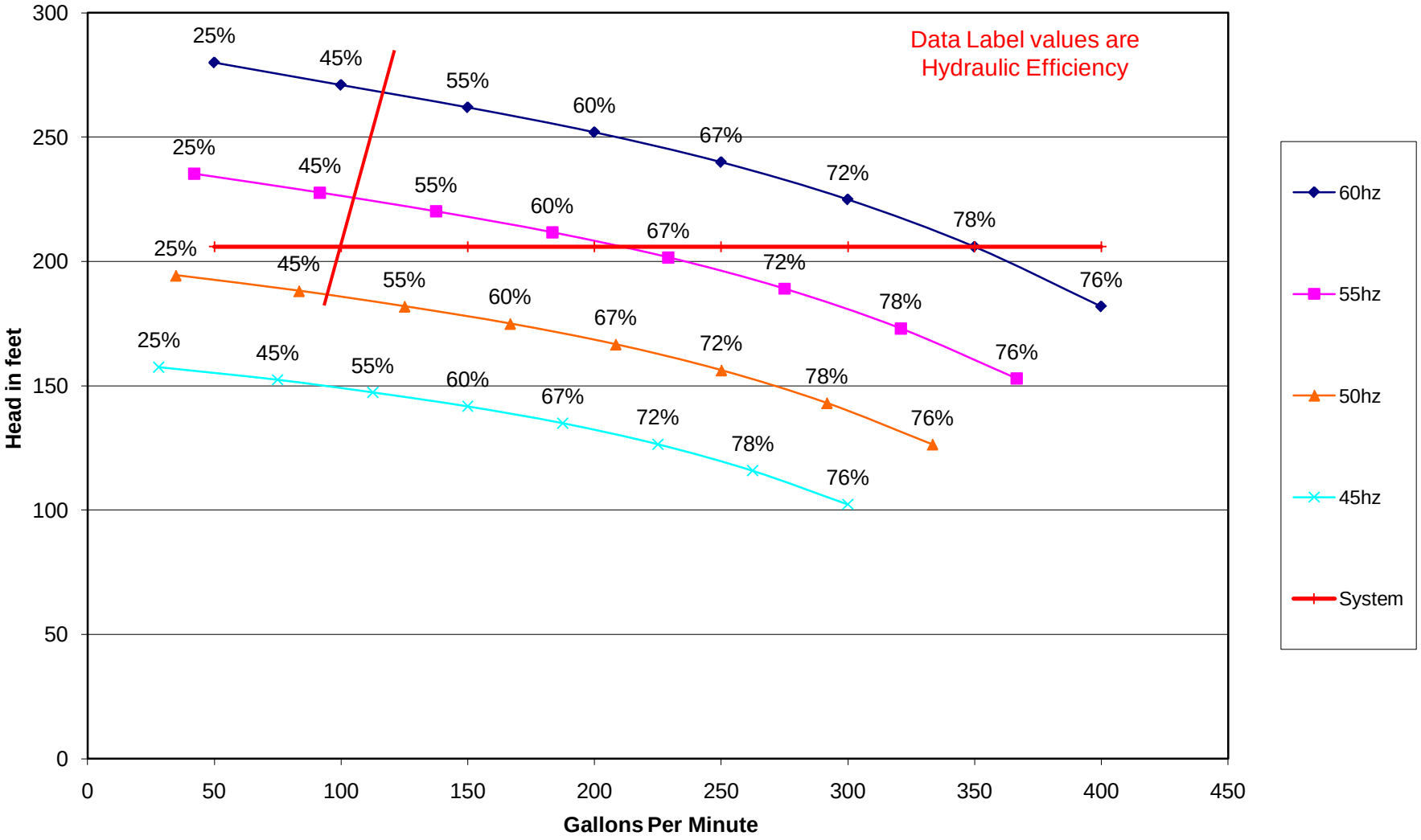
Ef 1	Ef 2	Ef 3	Ef 4	Ef 5	Ef 6	Ef 7	Ef 8
25%	45%	55%	60%	67%	72%	78%	76%

5) Click on the various tabs to view pump performance.

VFPPA Data Input | One Pump | Two Pumps | 45-60 Hz Curves | 55 & 60 Hz Curves | 50 & 55 Hz Curves | 45 & 50 Hz Curves

*

Vertical Multistage (25HP)



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Pump ED 101

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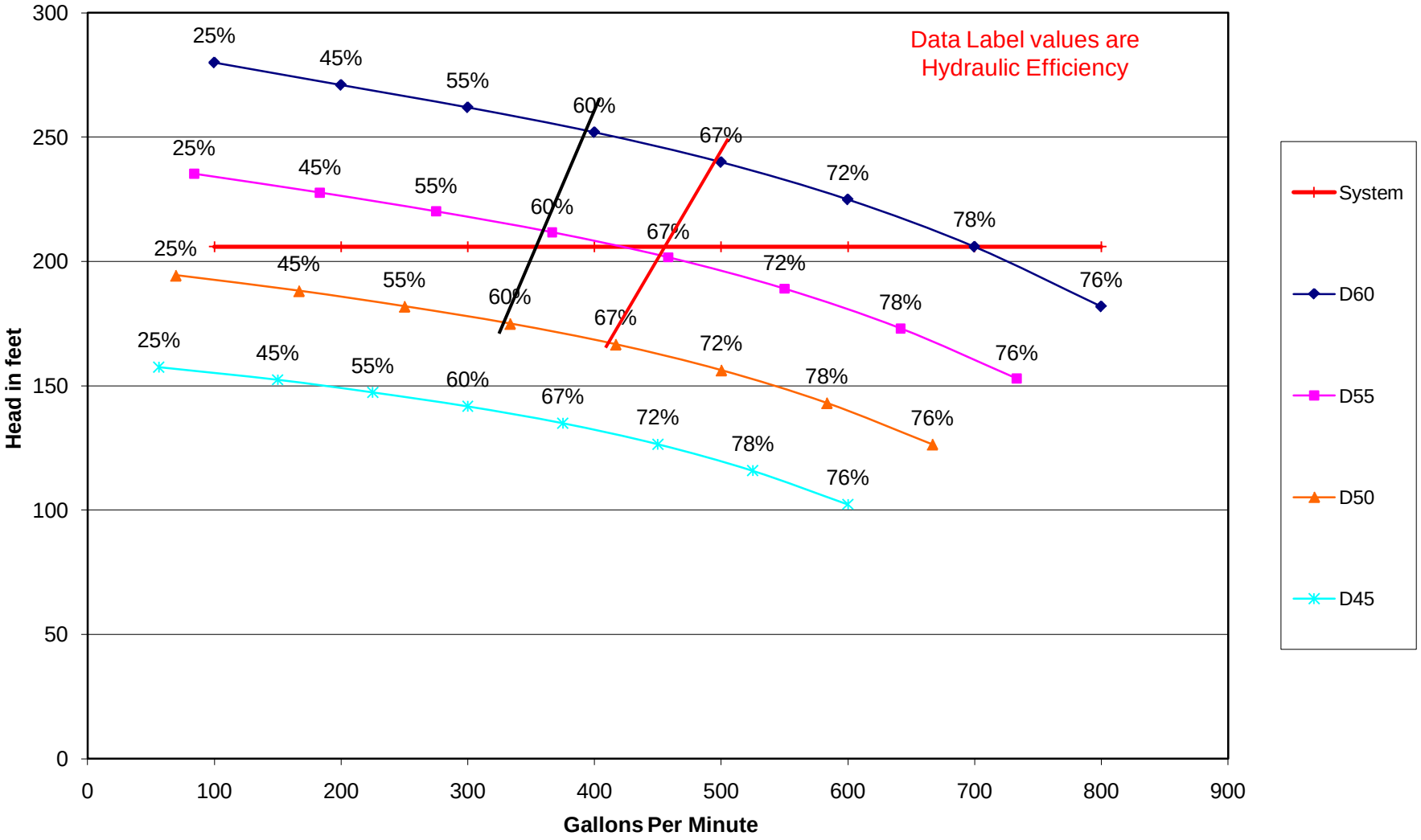
Vertical Multistage (25HP)



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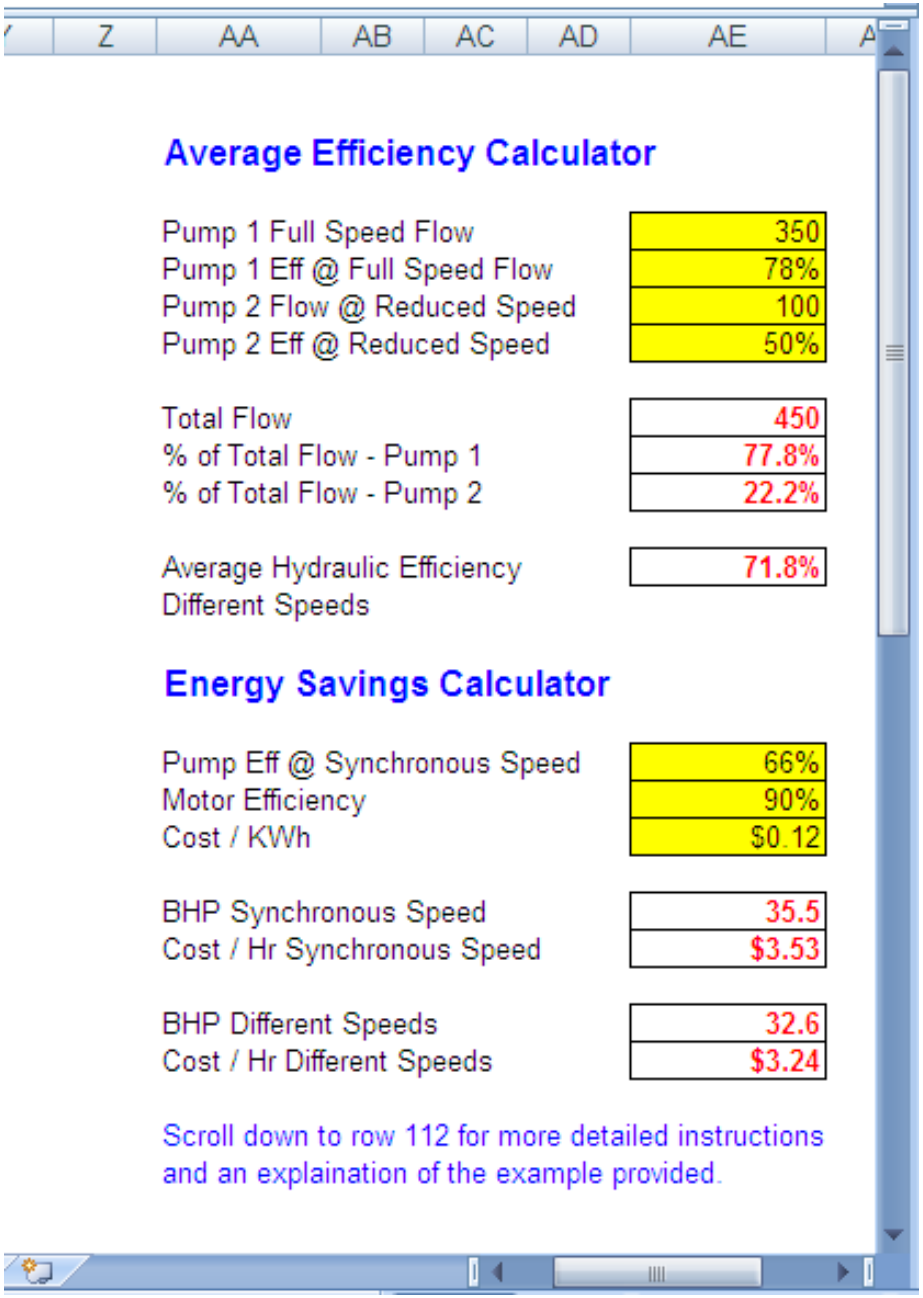


Average Efficiency Calculator

Pump 1 Full Speed Flow	350
Pump 1 Eff @ Full Speed Flow	78%
Pump 2 Flow @ Reduced Speed	100
Pump 2 Eff @ Reduced Speed	50%
Total Flow	450
% of Total Flow - Pump 1	77.8%
% of Total Flow - Pump 2	22.2%
Average Hydraulic Efficiency Different Speeds	71.8%

Energy Savings Calculator

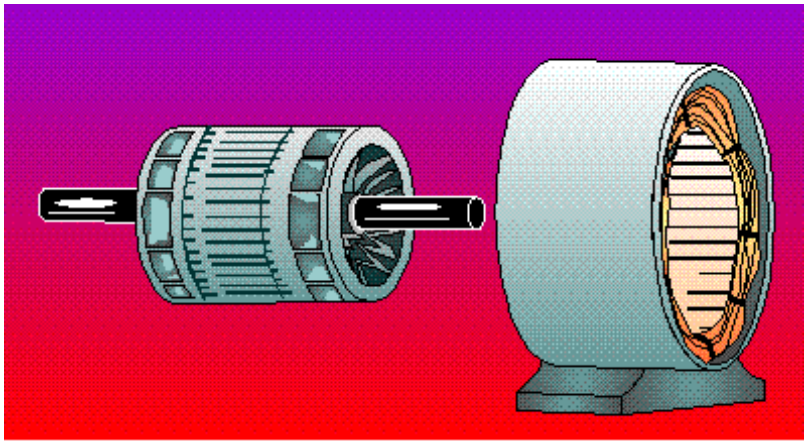
Pump Eff @ Synchronous Speed	66%
Motor Efficiency	90%
Cost / KWh	$0.12
BHP Synchronous Speed	35.5
Cost / Hr Synchronous Speed	$3.53
BHP Different Speeds	32.6
Cost / Hr Different Speeds	$3.24

Scroll down to row 112 for more detailed instructions and an explaination of the example provided.

Regardless of the Application

- Soft Start & Stop

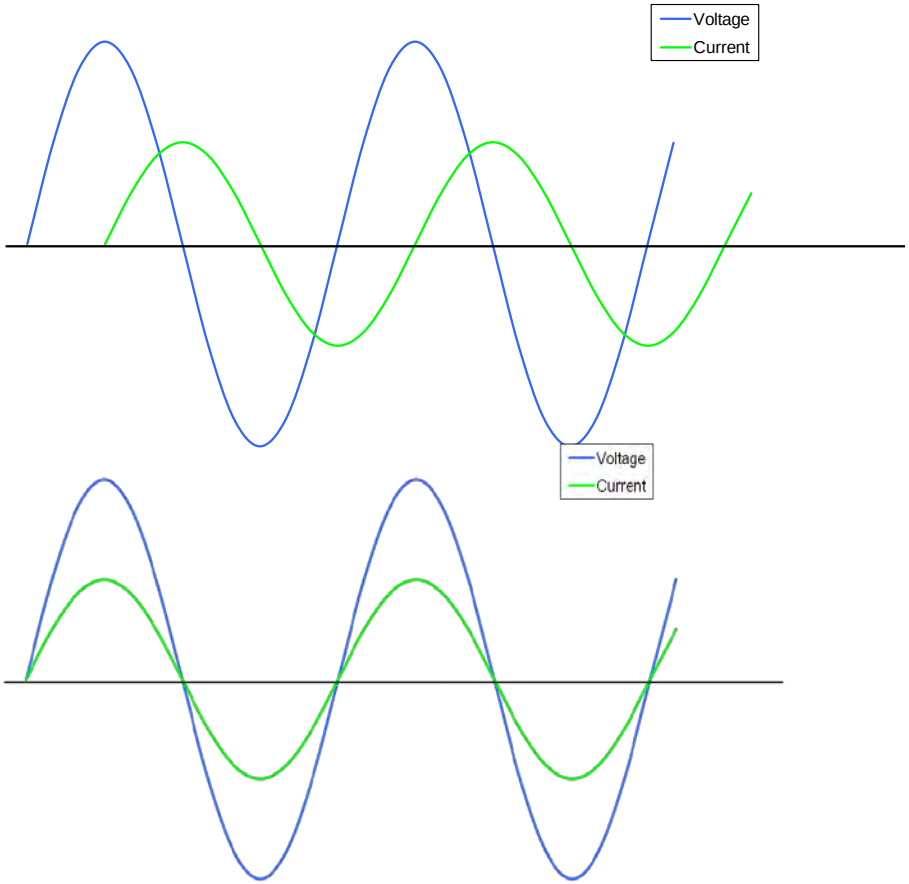
- Lower Locked Rotor Current
- Lower Mechanical Stress
- Lower Hydraulic Stress
- Longer Pump & Motor Life



A point on the periphery of a two pole, 11.5" diameter rotor accelerates to 180 fps (123 MPH) in less than 2 seconds.

Regardless of the Application

Power Factor Correction



Balanced Voltage

460 / 460 / 460

versus

462 / 465 / 447

2.4% Unbalance

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