Understanding How to Read a Pump Curve

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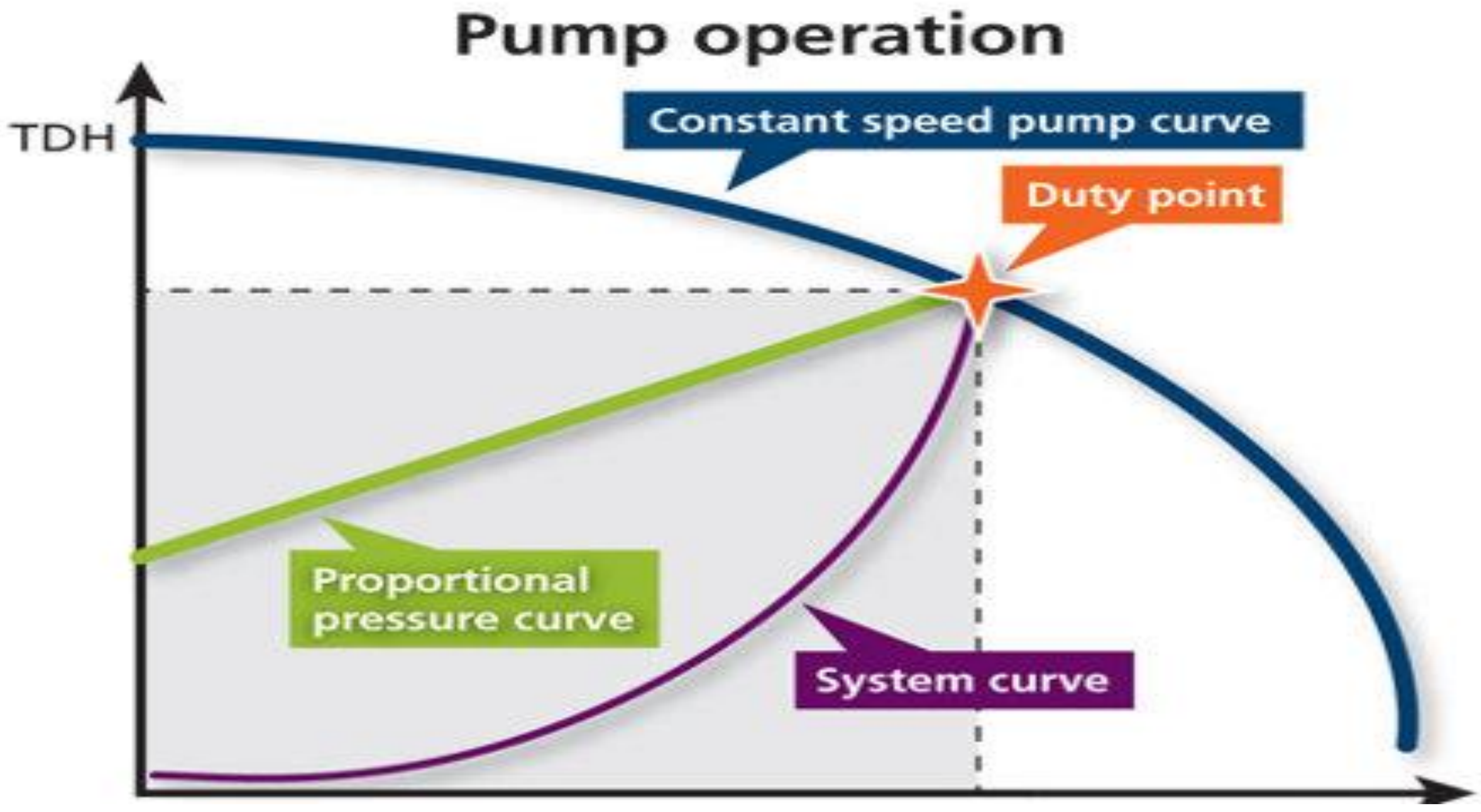
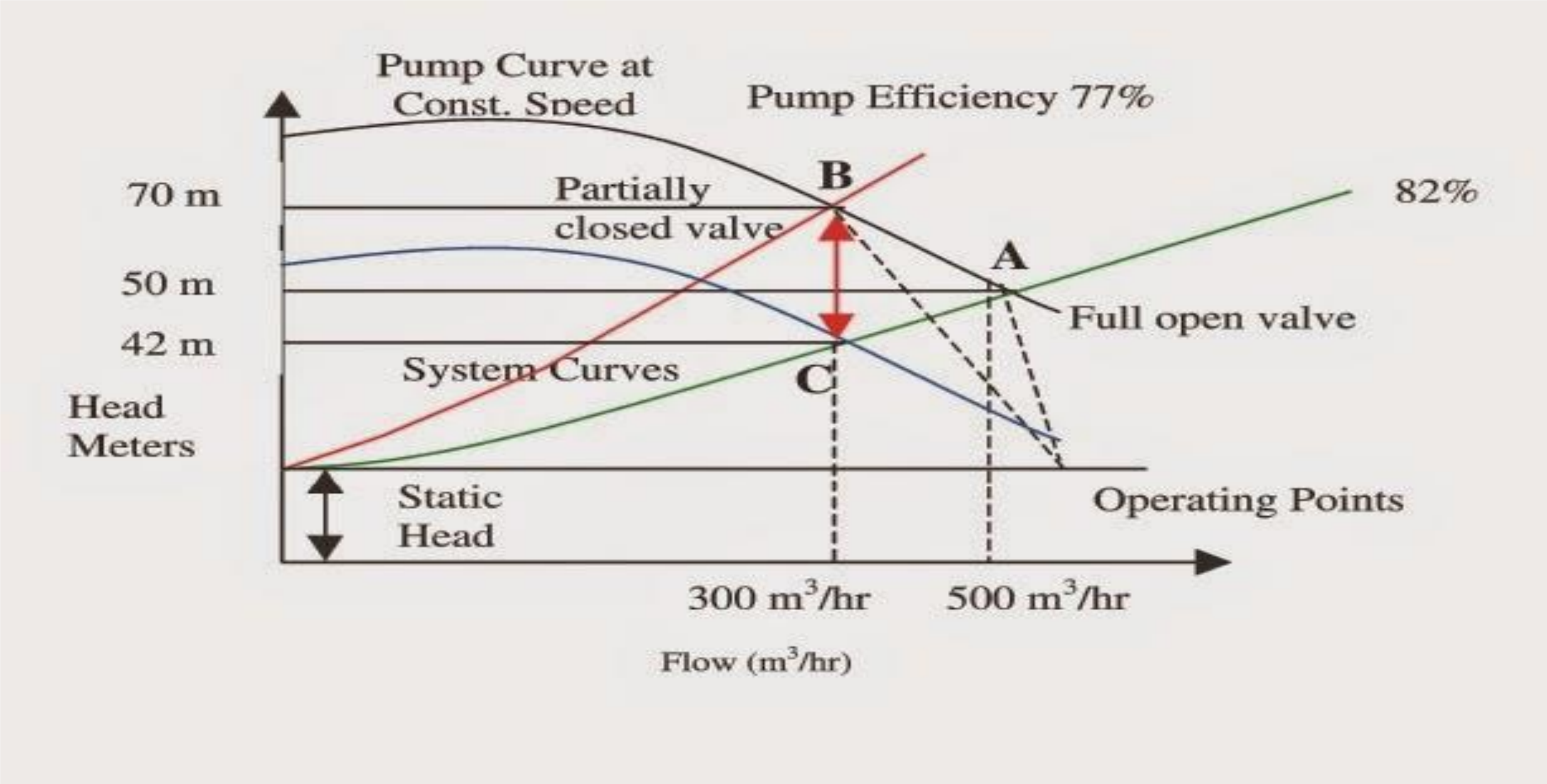
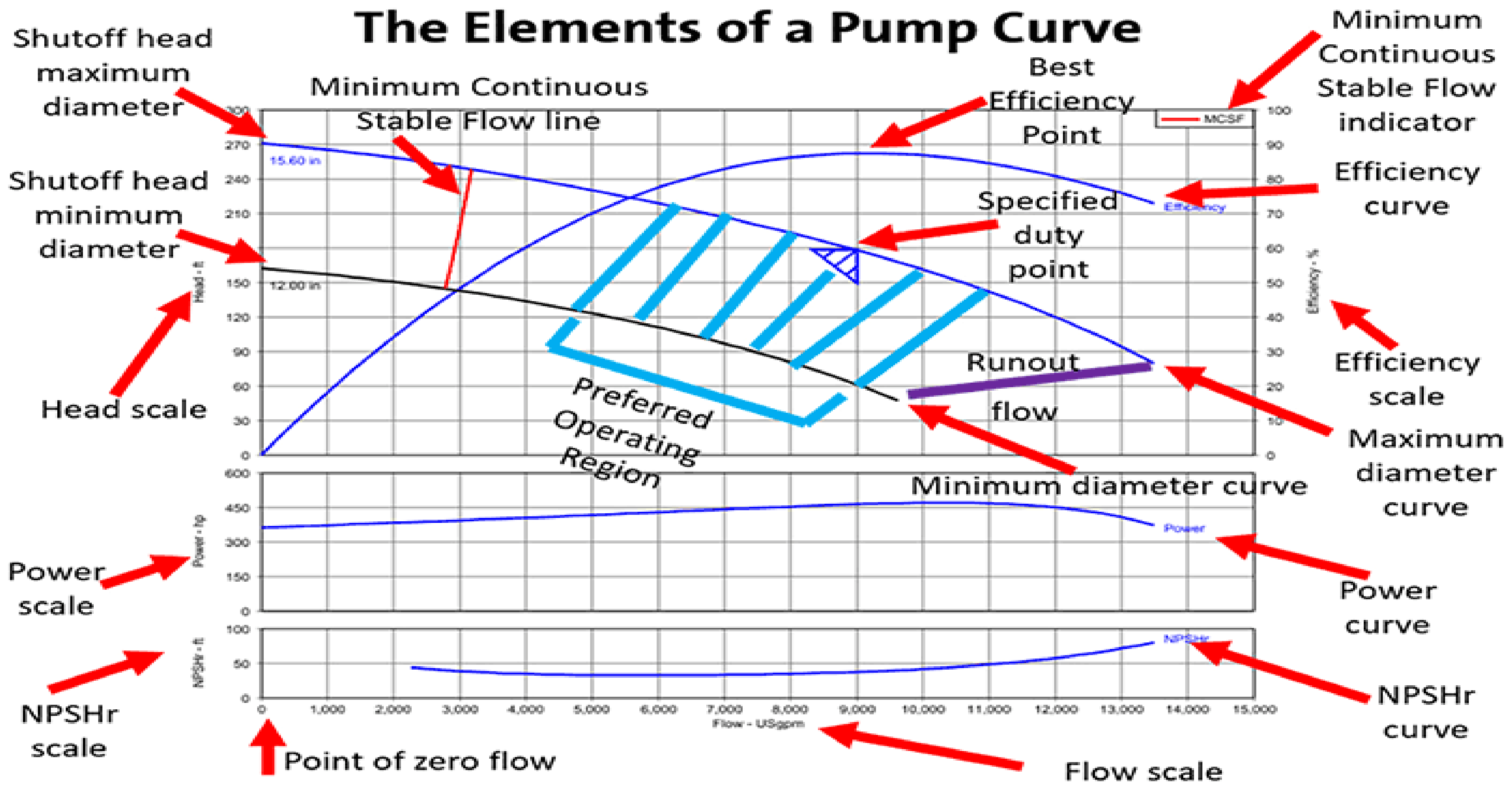
Pump Curve 101



Pump Curve 101



Pump Curve 101



Basic terms to understand

- **Pump Curve** - denotes flow on the x-axis (horizontal) and head pressure on the y-axis (vertical). The curve begins at the point of zero flow, or shutoff head, and gradually descends until it reaches the pump runout point or maximum flow rate.
- **BEP** - The pump's operating "sweet spot," or best efficiency point (BEP), is generally located near the middle of the curve. Pumps are the most efficient and have their highest life expectancy when they can run near their BEP, as determined by the manufacturer. Typically, the area on the curve between 70 and 120 percent of the BEP is known as the preferred operating region (POR) for the pump.

Basic terms to understand

- **Efficiency curve:** The pump efficiency curve represents a pump's efficiency across its entire operating range. Efficiency is expressed in percentages on the right of the curve graph. The BEP is represented by the efficiency curve's peak, with efficiency declining as the curve arcs away, either right or left, from the BEP. Knowing the efficiency percentage will also help calculate horsepower required for an application.

Basic terms to understand

- **ISO efficiency lines:** International Organization for Standardization (ISO) lines are concentrically elliptical curves indicating equal efficiency on a pump curve graph. They are used as another means of representing how efficiency levels change along a pump curve as it moves away from the BEP or if the impeller diameter is reduced.

Basic terms to understand

- **Power curve:** The power curve represents the load the pump imposes on the driver at a given point on the pump curve and helps with proper motor sizing. It is represented as a separate curve graph and gradually rises toward its peak load, which is typically close to the BEP with most rotodynamic pump types. Afterward, it declines as it approaches the runout point.

Basic terms to understand

- **Net Positive Suction Head Required:** The net positive suction head required (NPSHr) indicates how much force is needed to push liquid into the eye of the pump impeller. Knowing the correct amount of NPSHr will prevent the pump from cavitating, vibrating and failing prematurely. It is the minimum amount of pressure required on the suction side of the pump
- **Net Positive Suction Head Available**: is determined by the process piping, size, flooded suction of pump, etc. NPSHa should always be greater then NPSHr to avoid performance problems on a pump.

Basic terms to understand

- **TDH or Total Dynamic Head** – is the amount of head or pressure on the suction side of the pump (also called static lift), height that fluid is to be pumped plus the friction loss by internal pipe roughness or corrosion.
- **TDH = Static height + Static Lift + Friction Loss**
- Static lift is the height the water will rise before arriving at the suction side of the pump.
- Static Height is the maximum height reached by the pipe on the discharge side of the pump.
- Friction Loss are the losses due to type of pipe/valves etc.

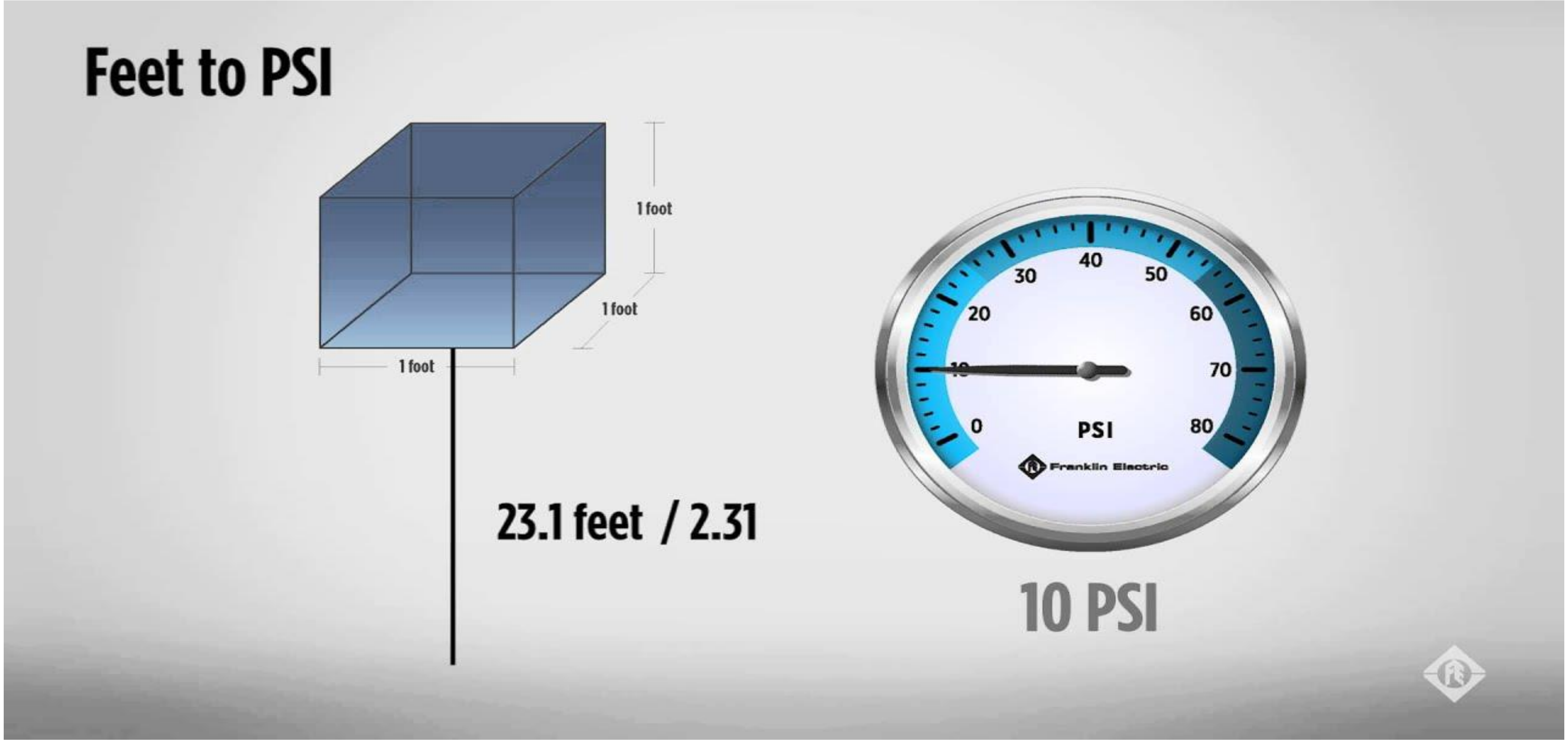
Basic terms to understand

- **Cavitation** - The formation of vapor bubbles in liquid, developed in areas where the pressure falls below the vapor pressure of the liquid. The imploding or collapsing of these bubbles as they move to higher pressure areas in the pump triggers intense shockwaves inside the pump, causing significant damage to the impeller and/or the pump housing.
- **Density** – The density of a fluid is its mass per unit of volume and is usually expressed as Pounds per gallon. Float or sink?
- **Specific Gravity** – The ratio of the density of a fluid to that of water at standard conditions. Water is rated 1 @ 68F. Water happens when it’s, 40F or 300F?

Basic terms to understand

- **Head -** is the height to which a pump can raise water straight up. Water creates pressure or resistance, at predictable rates, so we can calculate head as the differential pressure that a pump has to overcome in order to raise the water.
- Common units are feet of head and pounds per square inch. (A pump curve calculator might offer different units such as Bar or meters of head). 2.31 feet of head equals 1 PSI.
- **Flow -** is the volume of water a pump can move at a given pressure. Flow is indicated on the horizontal axis in units like gallons per minute, or gallons per hour.

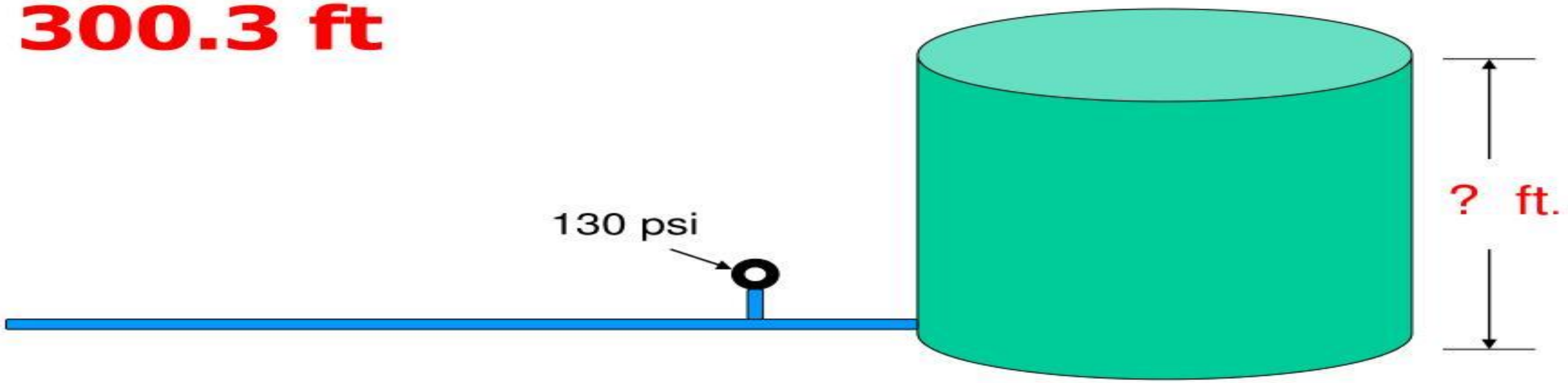
Basic terms to understand



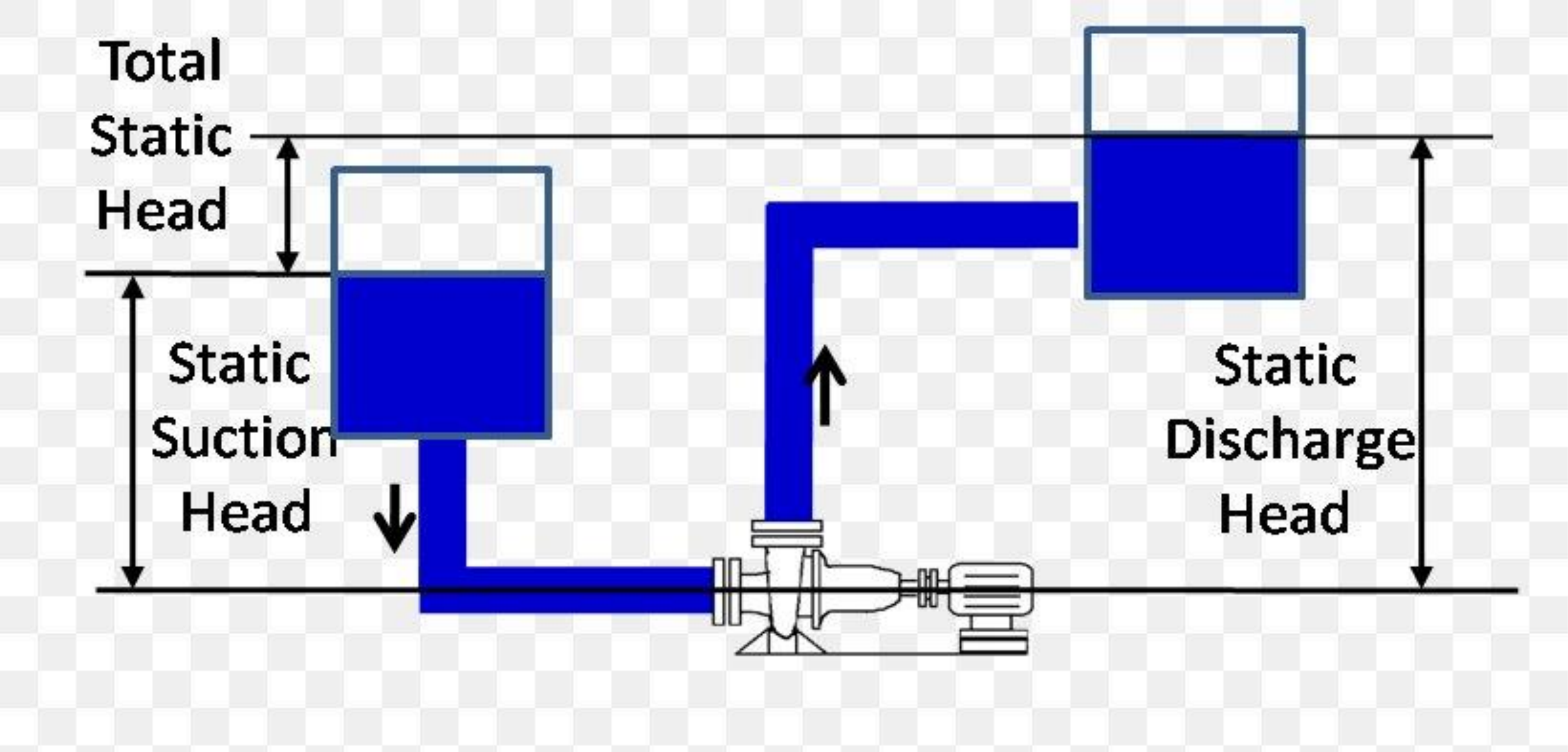
Basic terms to understand

How many feet of head would create a pressure of 130 psi?

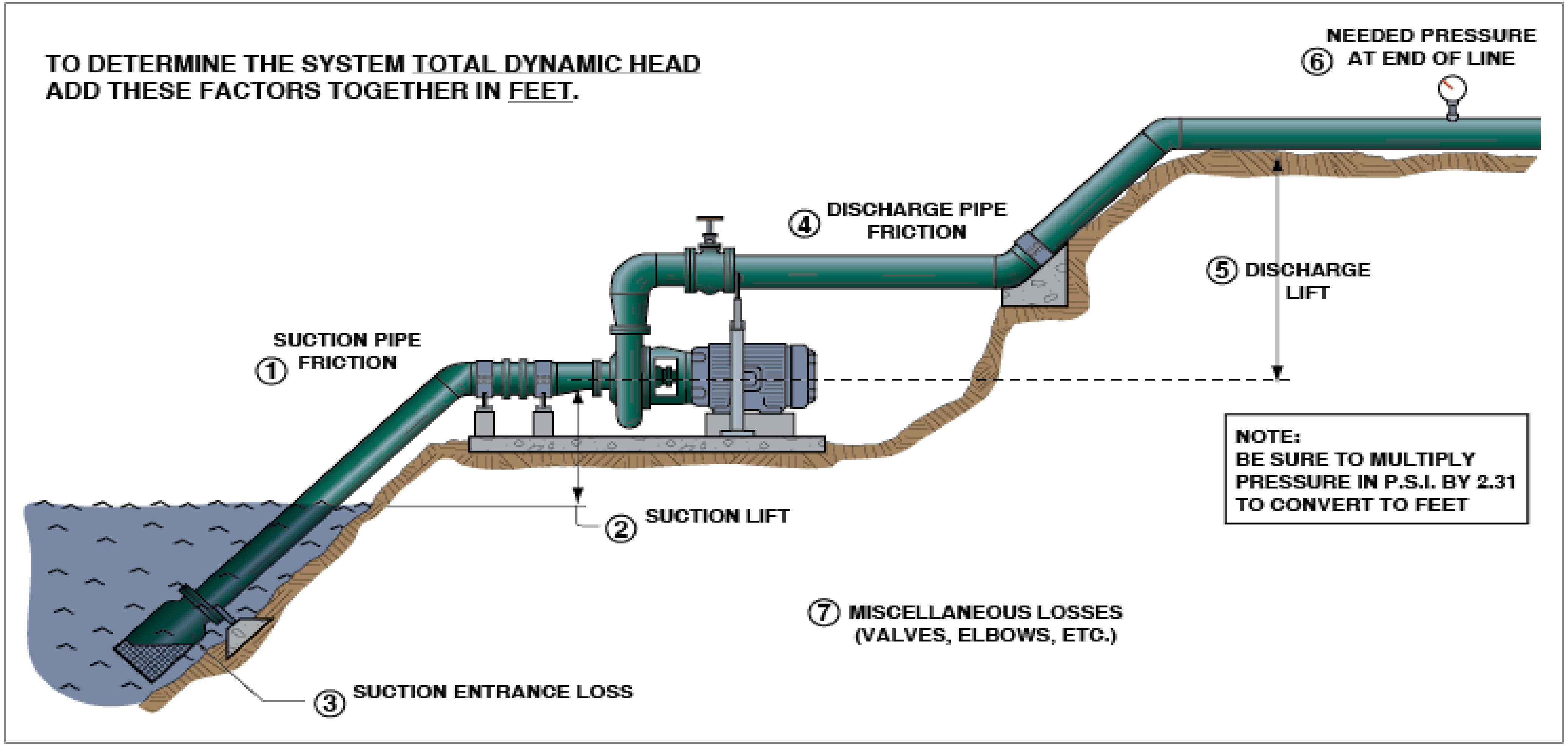
- **Formula: psi x 2.31 = feet of head**
- **130 psi x 2.31 ft/psi =**
- **300.3 ft**



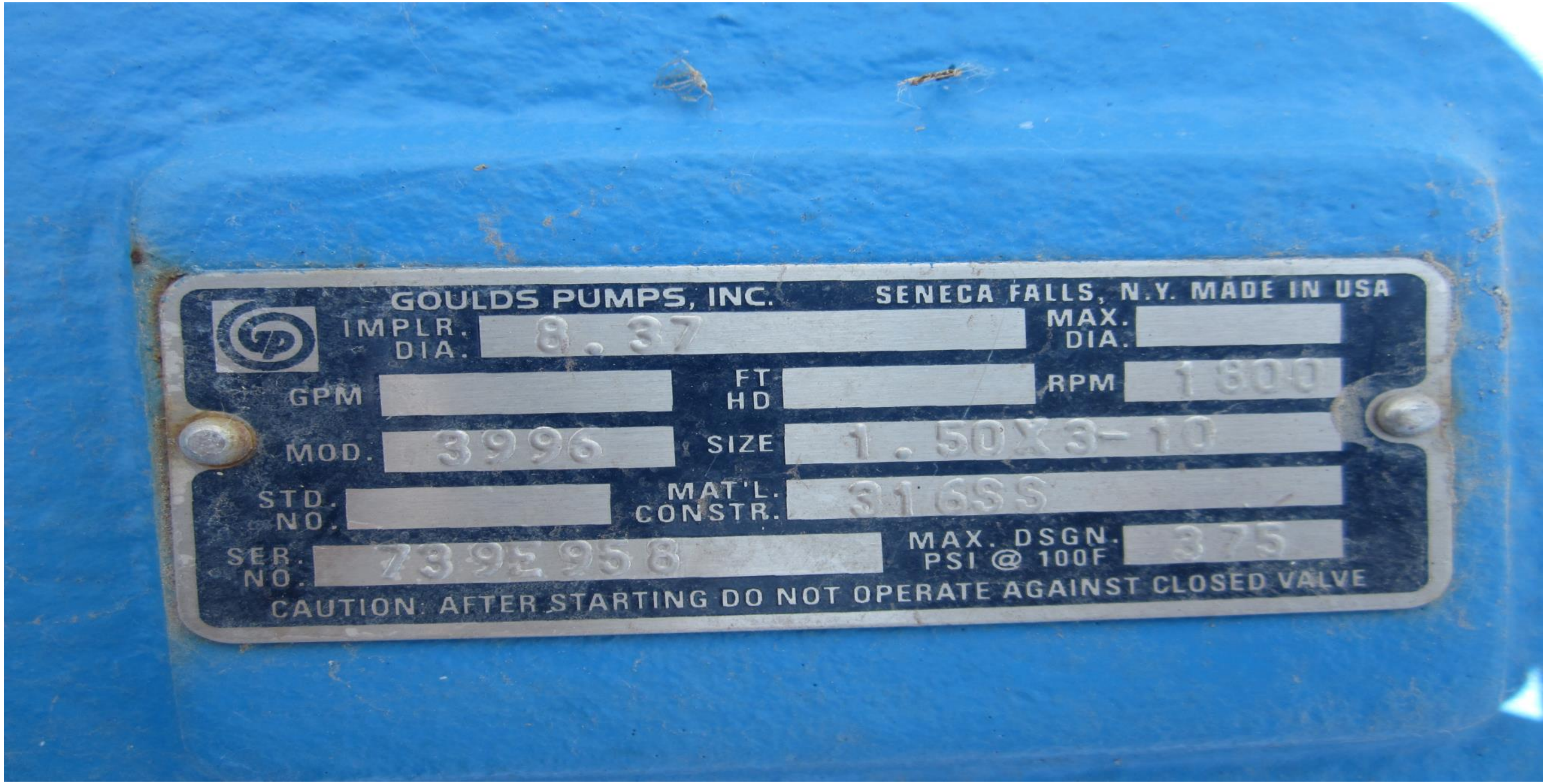
What is TDH? Flooded Suction



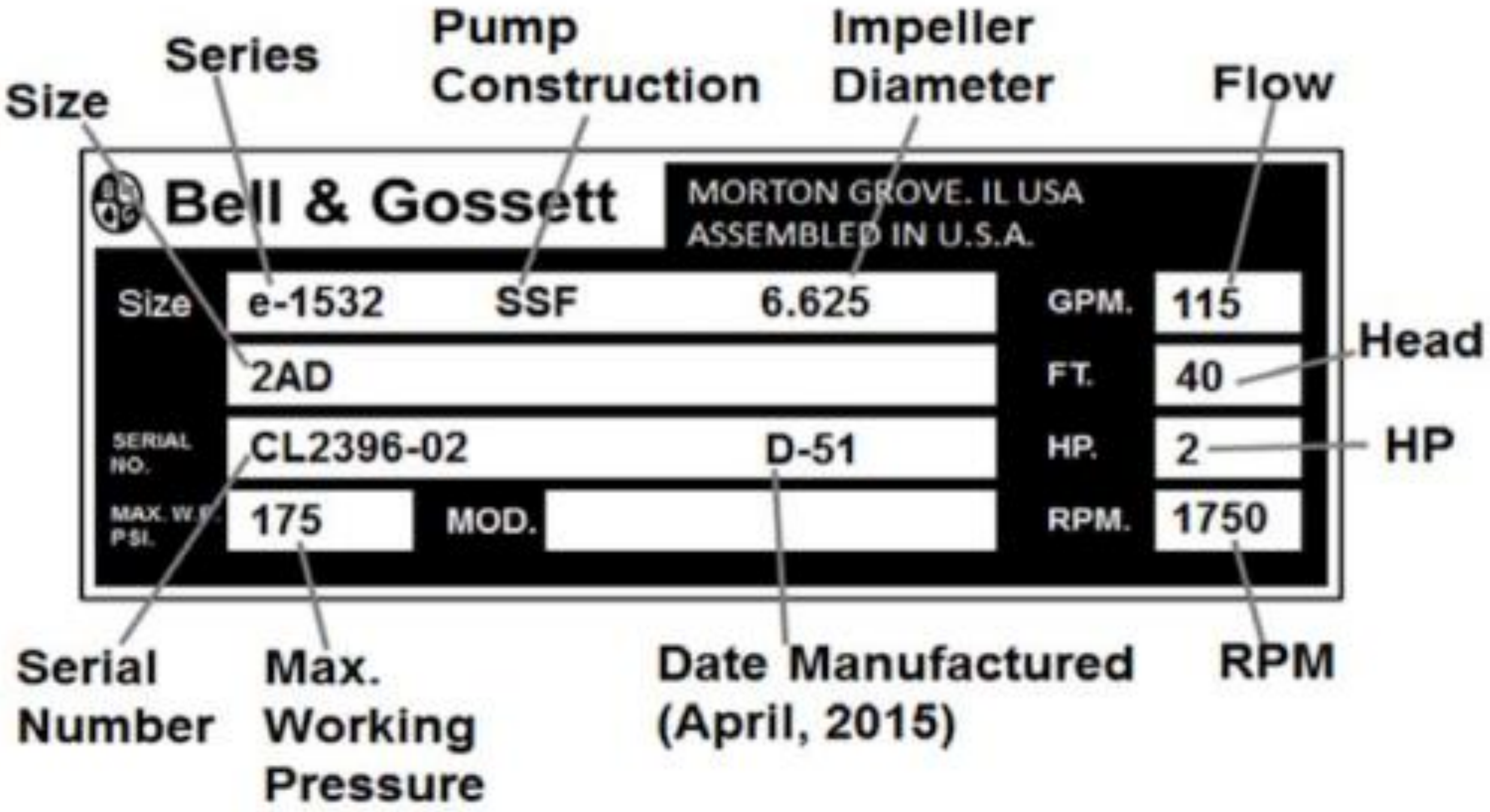
What is TDH? Vacuum Suction



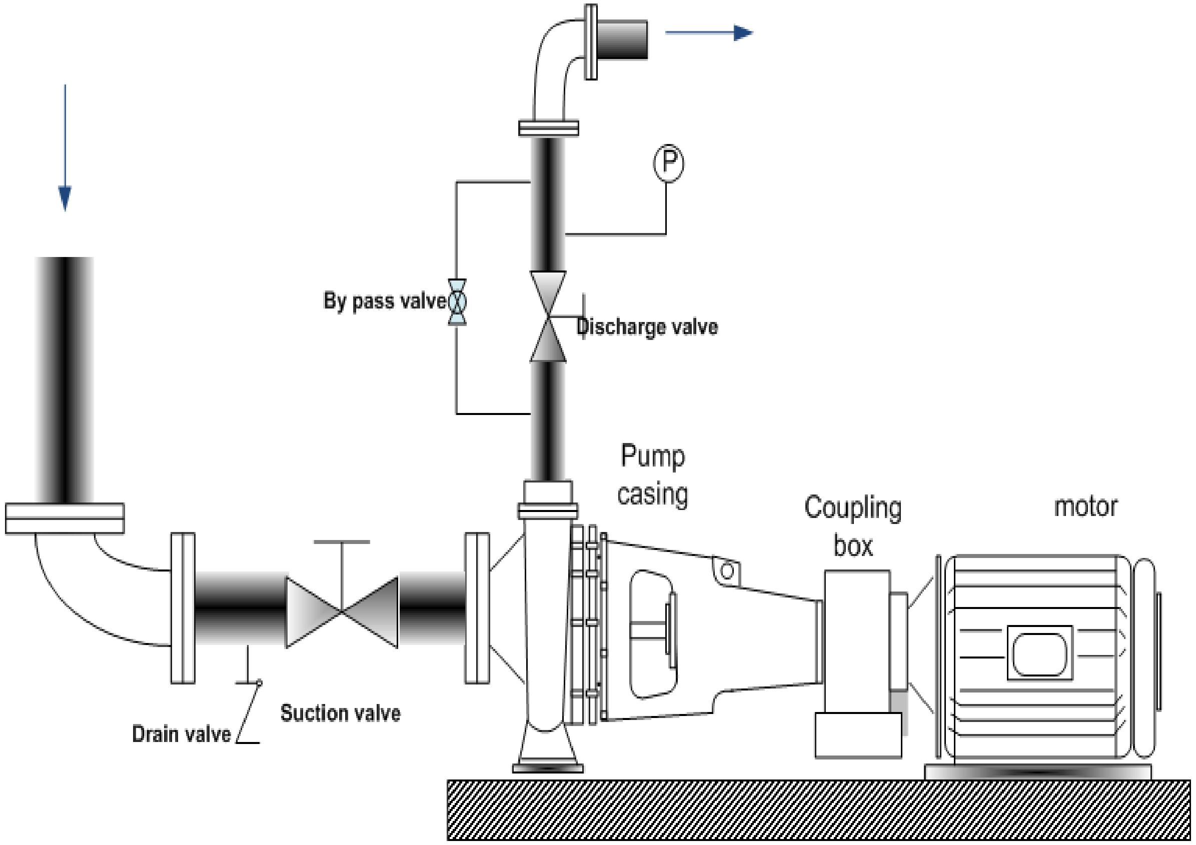
Pump information lacking



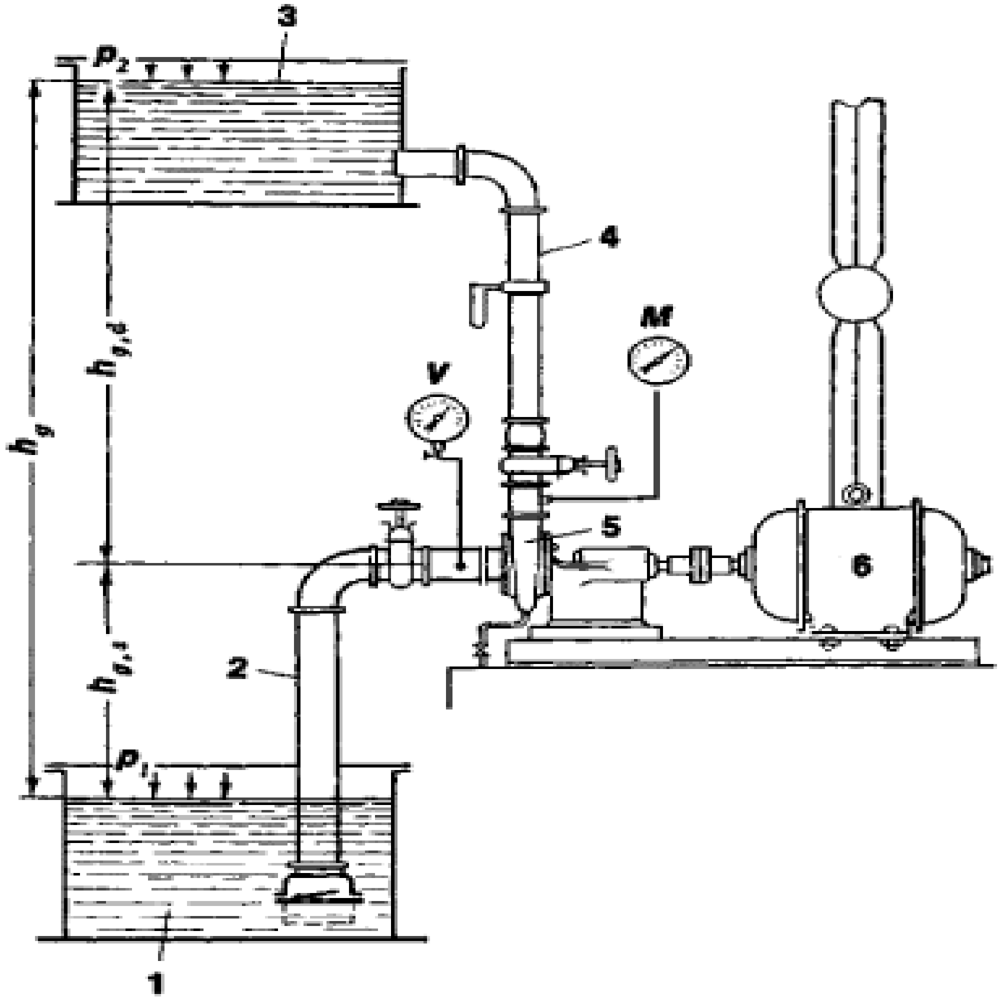
Better Pump information



Pressure Gauges are important



Centrifugal pump system

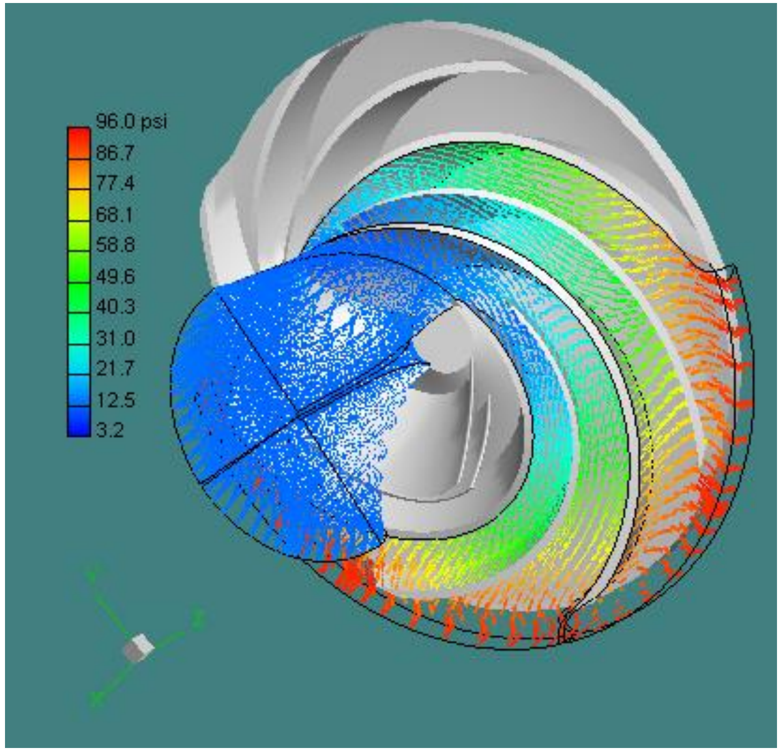


Things to be wary of

- **Impeller Sizes –** Trimming is done to match operating points. Trimming the impeller results in a change in the length and outlet angle of the flow at discharge.
- **Valves** – All valves should be operated in the fully open position. Semi open or closed valves change your output.
- **Know your Piping System –** 5 Diameters of straight piping into the suction side. Suction piping should be oversized to reduce friction losses. Eccentric reducers should be used correctly. Watch where you place your 90-degree elbows.

Centrifugal Pumps

How Impellers Induce Flow



Due to the spinning action of the impeller vanes the fluid near the impeller exit is thrown out of the impeller. This causes all of the fluid to slide outward radially. A void is formed at the center of the impeller thus reducing the pressure. Fluid in the inlet pipe is at a pressure higher than the pressure in the eye of the impeller and is pushed into the eye. As this process proceeds constant flow is established through the pump.

Centrifugal Pumps

❑Open impeller

Pros:

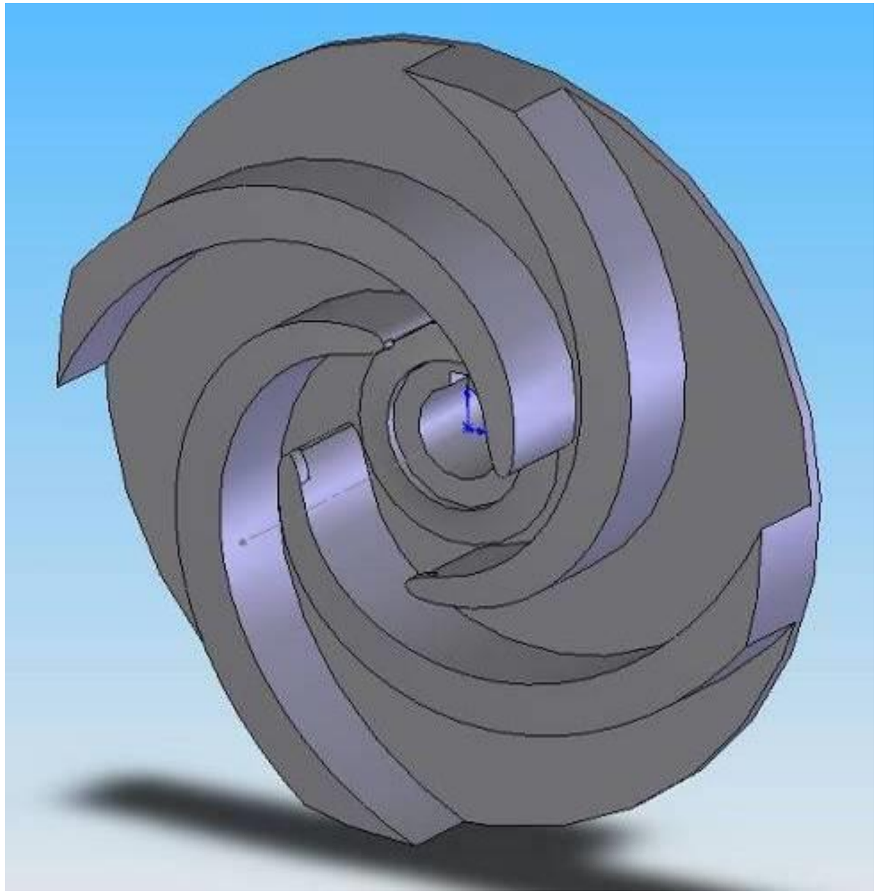
- Neither a front or rear shroud. The lack of shrouds allows debris to wear against the front and rear wear plates until it is small enough to pass through the impeller.
- Very low axial loads

Cons:

- Less efficient due to leakage over vanes.

Centrifugal Pumps

❑Semi-Open impeller



Pros:

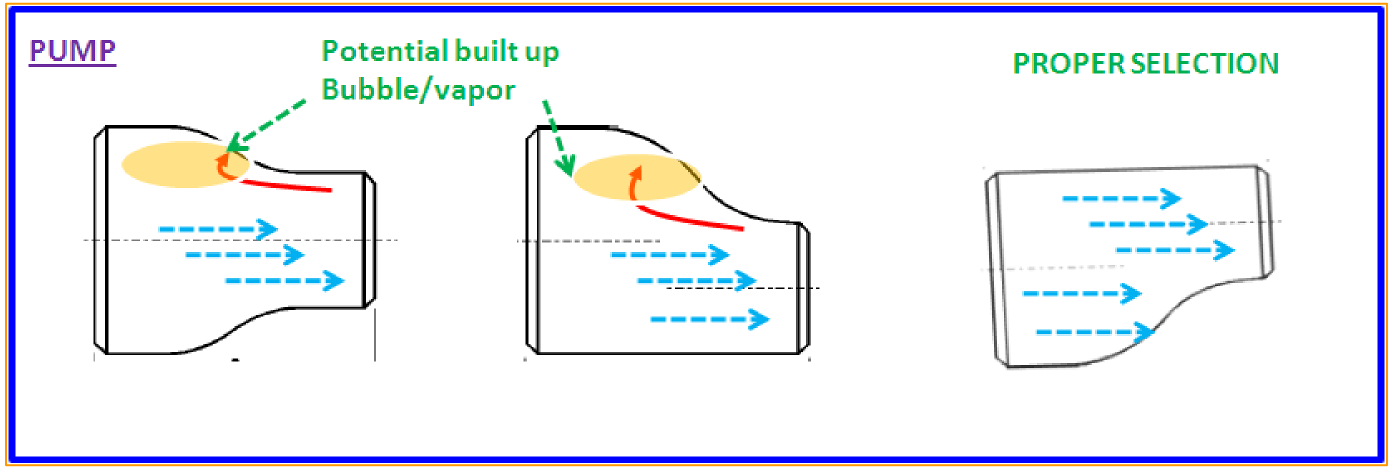
- **One shroud is removed to allow debris to wear against the front wear plate until it can pass through the impeller**
- **Easier to cast and manufacture**

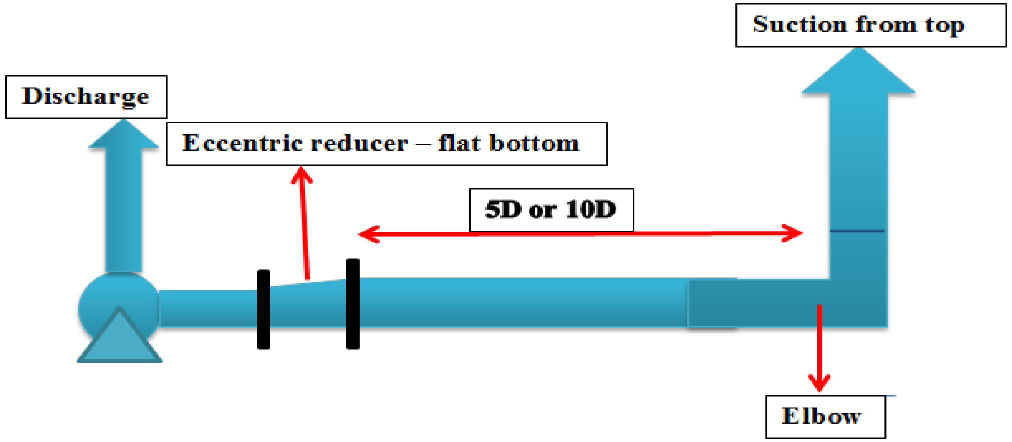
Cons:

- **Leakage over the vanes reduces the efficiency.**
- **Higher axial loads**

Piping Do's and Don'ts

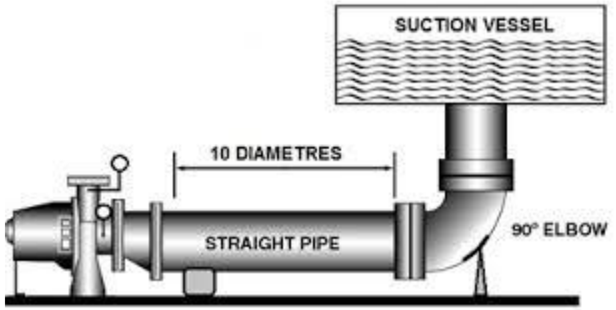
Suction and Discharge Piping

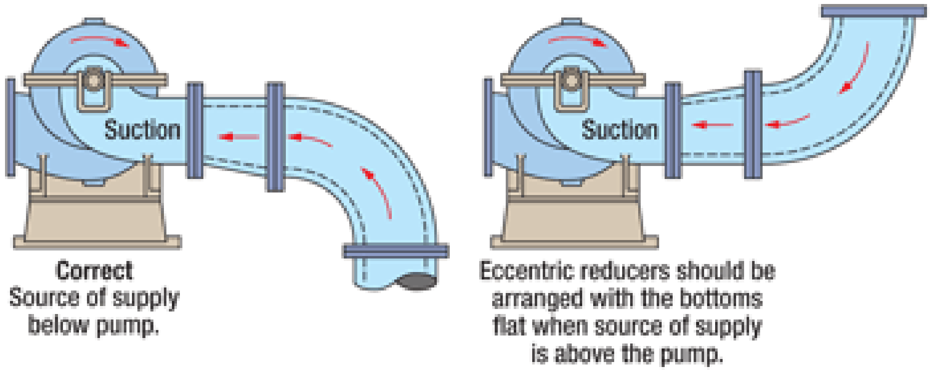


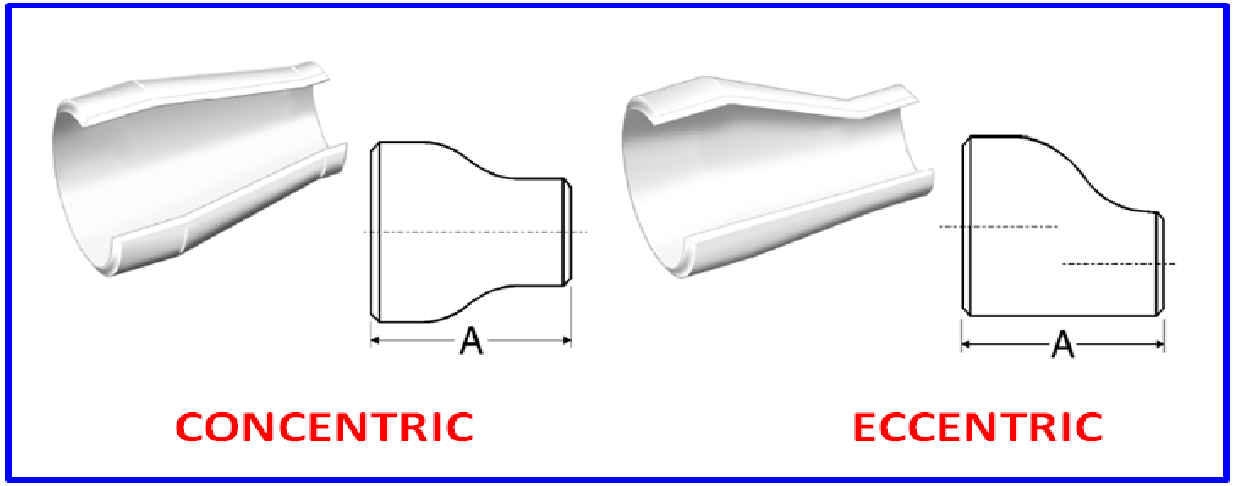


Piping Do's and Don'ts

Suction Side Piping







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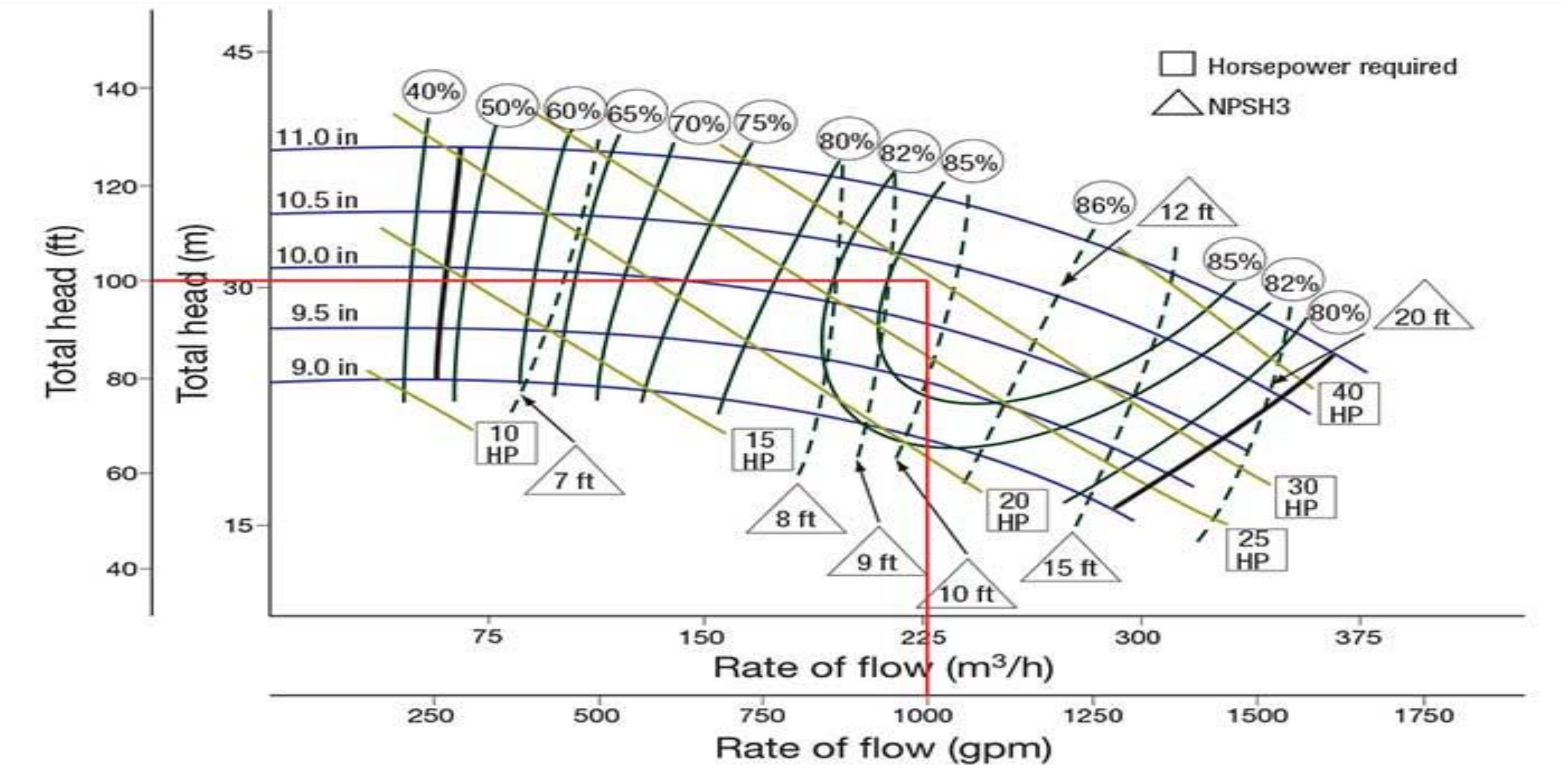
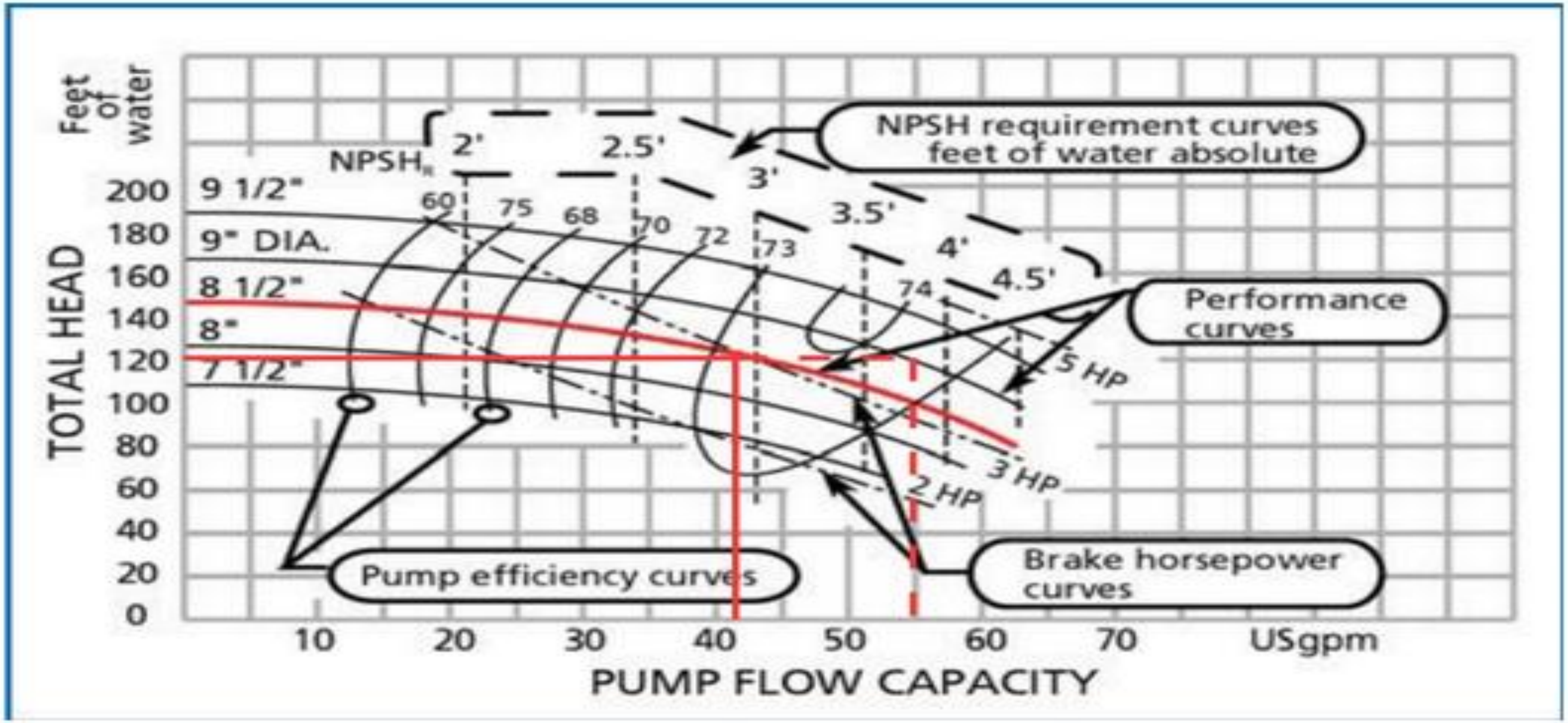
Things to be wary of

Pump Curve 1

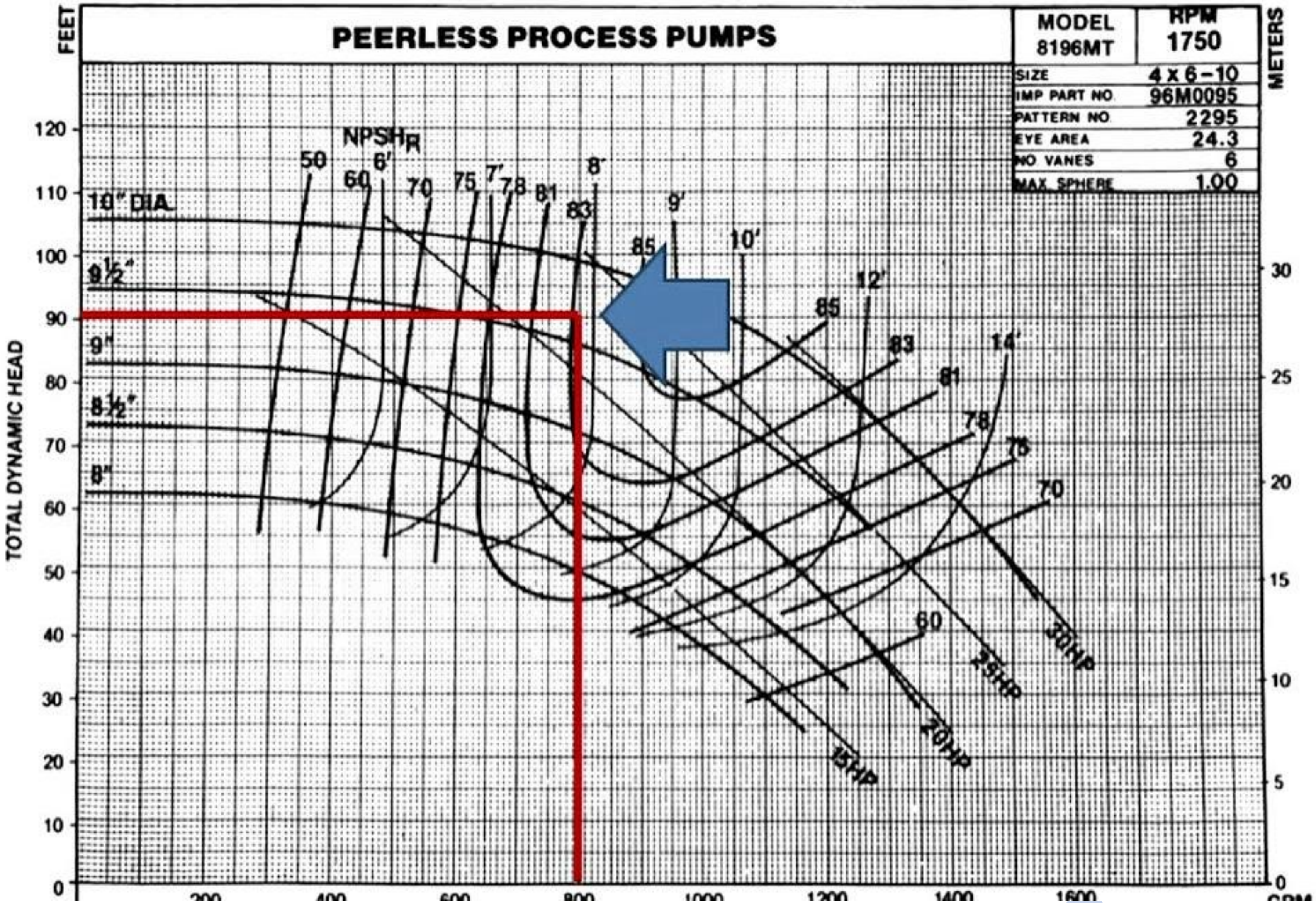


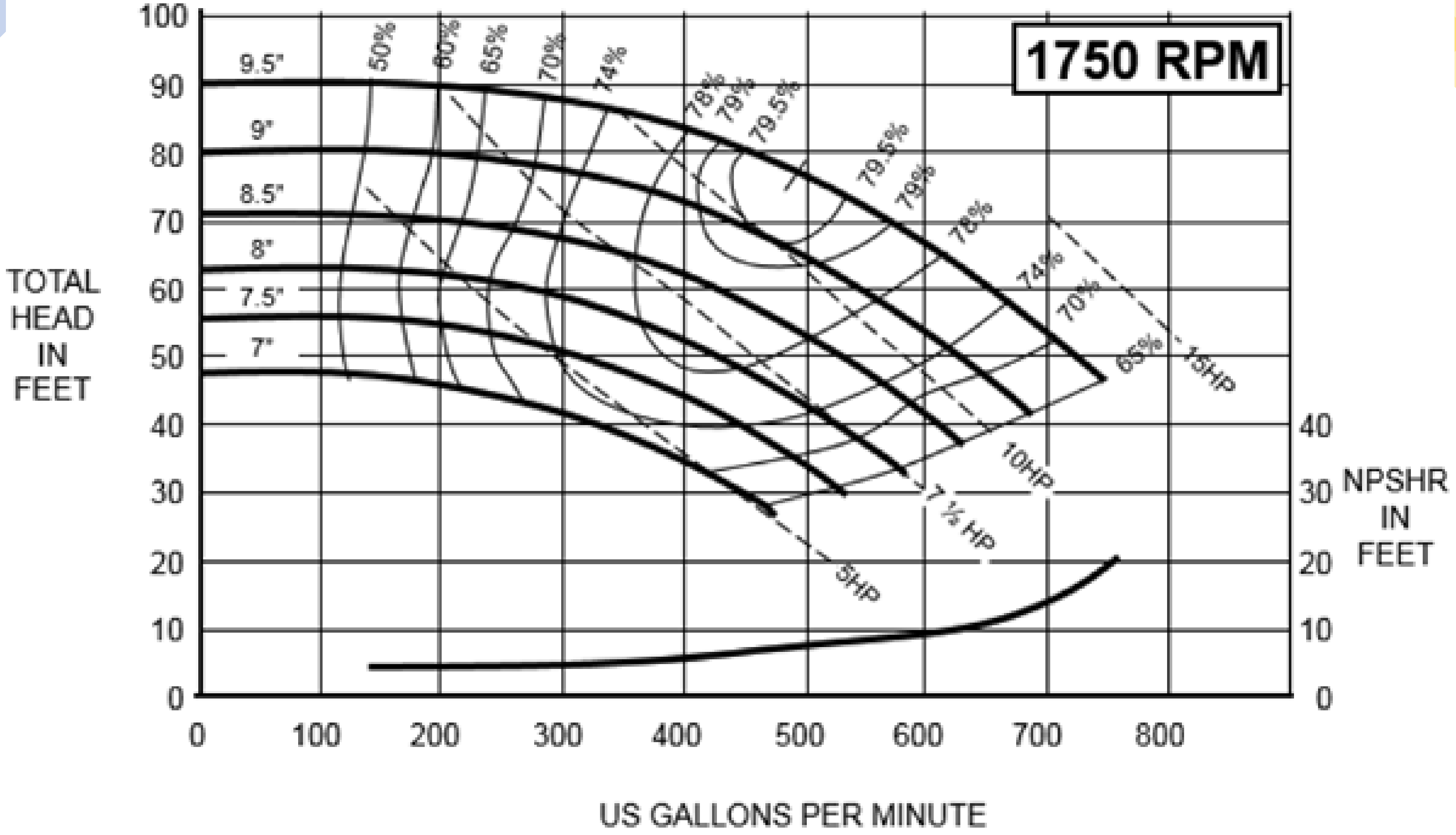
Horsepower required
NPSH3
Total head (ft)
Total head (m)
140
120
100
80
60
40
45
30
15
11.0 in
10.5 in
10.0 in
9.5 in
9.0 in
40%
50%
60%
65%
70%
75%
80%
82%
85%
86%
85%
82%
80%
12 ft
20 ft
7 ft
8 ft
9 ft
10 ft
15 ft
10 HP
15 HP
20 HP
25 HP
30 HP
40 HP
75
150
225
300
375
Rate of flow (m³/h)
250
500
750
1000
1250
1500
1750
Rate of flow (gpm)

Pump Curve 2



Source: City College of New York, Department of Civil Engineering


PEERLESS PROCESS PUMPS
MODEL 8196MT
RPM 1750
SIZE 4 x 6-10
IMP PART NO. 96M0095
PATTERN NO. 2295
EYE AREA 24.3
NO VANES 6
MAX. SPHERE 1.00
FEET
METERS
TOTAL DYNAMIC HEAD
10" DIA.
9½"
9"
8½"
8"
NPSHR
6'
7'
8'
9'
10'
12'
14'
50
60
70
75
78
81
83
85
15HP
20HP
25HP
30HP
GPM



1750 RPM
TOTAL HEAD IN FEET
NPSHR IN FEET
US GALLONS PER MINUTE
9.5"
9"
8.5"
8"
7.5"
7"
50%
60%
65%
70%
74%
78%
79%
79.5%
5HP
7 ½ HP
10HP
15HP
0
100
200
300
400
500
600
700
800
10
20
30
40
50
60
70
80
90

Are Your Questions Answered?

If you want to learn more about pumps and pump curves,

TPC can help!

Phone: (847) 808-4000

Email: sales@tpctraining.com

Thank You & Work Safely!