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# Advanced Pumping Efficiency Program (APEP)

## Pumps Efficiency- 2016

# OPE- Overall Pump Efficiency

- Overall Pump Efficiency- OPE
  - The efficient use of energy to move water

# Pumps deliver water to various irrigation systems like, flood, center pivot, sprinklers, fanjets, drip

# The Goal is to Save Energy and Water...

Because Saving Energy and Water Saves Money and Conserves Our Natural Resources- Approximately 20% of the electricity in California is used to move water.

Do this by:

- Installing good pump hardware in the field.
- Achieving good management of that pump hardware.

# Good Hardware Means...

An Efficient Pumping Plant

-Does the pump move water with the least amount of energy possible? Does it need repaired or replaced?

-Get a Pump Efficiency Test Performed

# Efficient management

- Efficient irrigation equipment is managed properly to use the least amount of energy and water to accomplish the goal. (i.e.- an energy efficient pump run twice as long as necessary to irrigate a farm wastes energy and water and isn't efficient because of poor management)

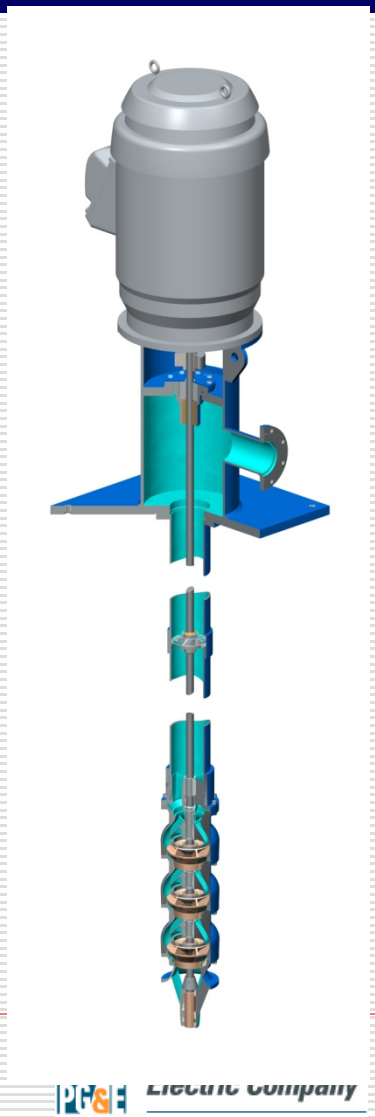
# Pumps as Energy Converters...

- Energy enters the pump and creates mechanical movement resulting in an output of water flow under pressure.
- The more efficiently this is accomplished, less energy will be used to create this water movement.
- Think of energy efficiency as it pertains to automobiles- better fuel mileage (MPG)

# Overall Pump Efficiency (OPE)

- This is a measurement of how efficiently energy into the pump is used (Horsepower in- HPin) and required to move a specified amount of water flow with pressure to properly operate an irrigation system (Horsepower out- HPout).
- Pumps can be tested and measured for their energy efficiency or OPE

# OPE (Overall Pumping Plant Efficiency) is a Combination of Efficiencies...



- 1. Bowl Efficiency (the pump itself) is only one aspect of <u>Overall Pumping Plant Efficiency- OPE</u>
- Must also consider:
  - 2. Transmission efficiency and losses (shafts, bearings, pulleys, etc.)
  - 3. Driver efficiency or the efficiency of the power source (motor, engine, etc.)

# OPE example

- Motor efficiency- 85%
- Bowl efficiency- 70 %
- Transmission Efficiency (Misc. losses)- 92.5%

.85 X .70 X .925 = .5503 or approximately 55% OPE

# The “Operating Condition” of a pump…

- HPin or “energy in” depends in part on the combination of flow and pressure or TDH (Total Dynamic Head) developed.
- The combination of flow and pressure is termed the “Operating Condition”.
- Every pump has a combination of flow and pressure as it operates

# How do we get flow rates? From flowmeters...

WHY?

You need to measure water in order to manage water!


- On every list of “best management practices”.
- Cannot plan, monitor, or improve without knowing how much water is flowing or was applied.
- Provides the benchmark for management and improvement of pumping systems.



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# Doesn't a Pump Test Give Me Flow?...

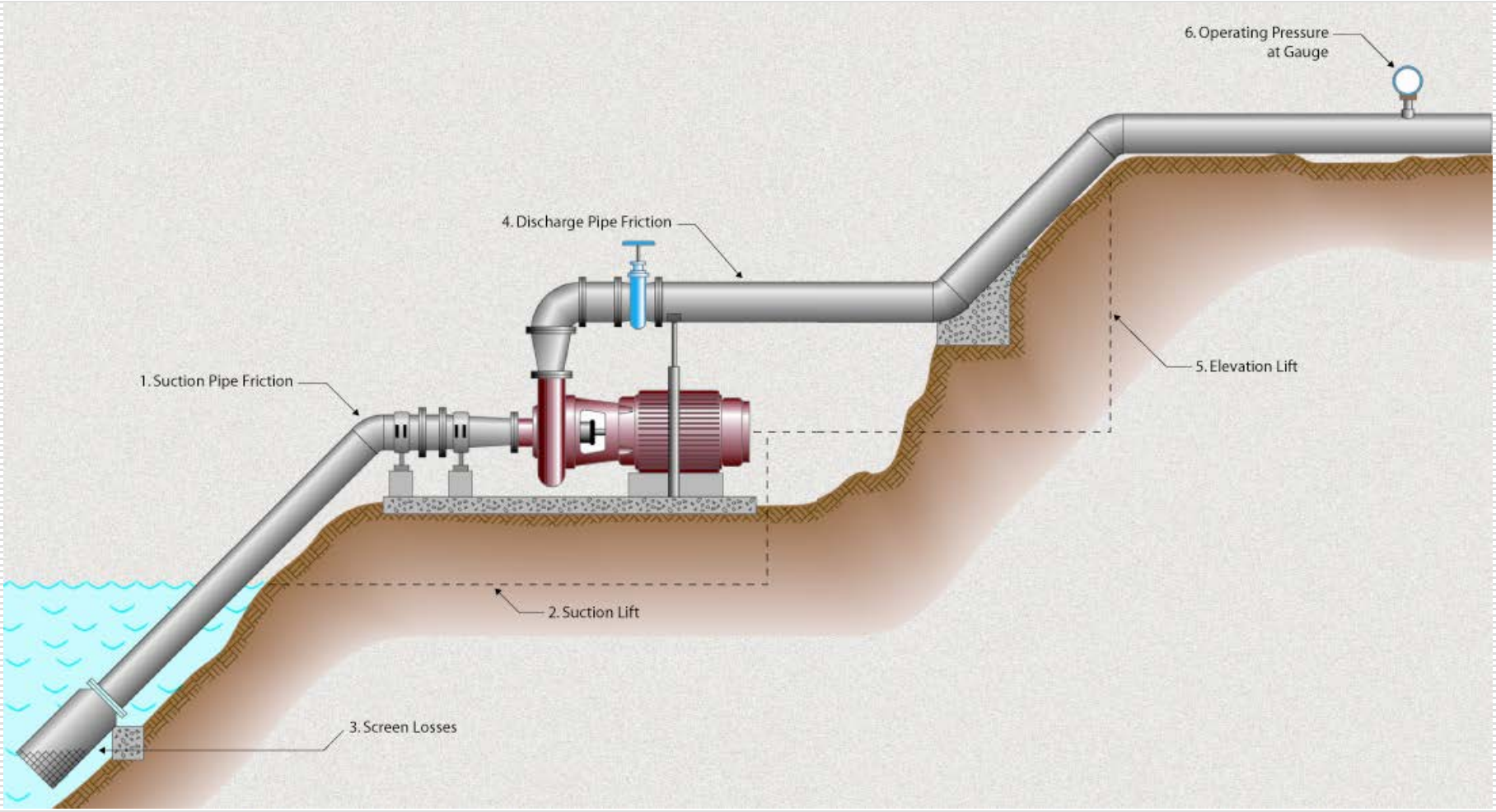
- The pump test is a snapshot, at the conditions tested.
- Especially with wells, flow rates may be significantly different throughout a season.
- Won't help if something starts to go wrong during a season.

# Water Flow Meters Do What?...

- May measure the “flow rate” - volume of water passing the measurement point per unit time
  - Gallons per minute (gpm)
  - Cubic feet per second (cfs) – “second feet”
- May measure total volume of water passing the measurement point
  - Acre-feet
  - Gallons (325,900 gallons per acre-foot)
- Many do both



# What is Total Dynamic Head- Diagram showing TDH components



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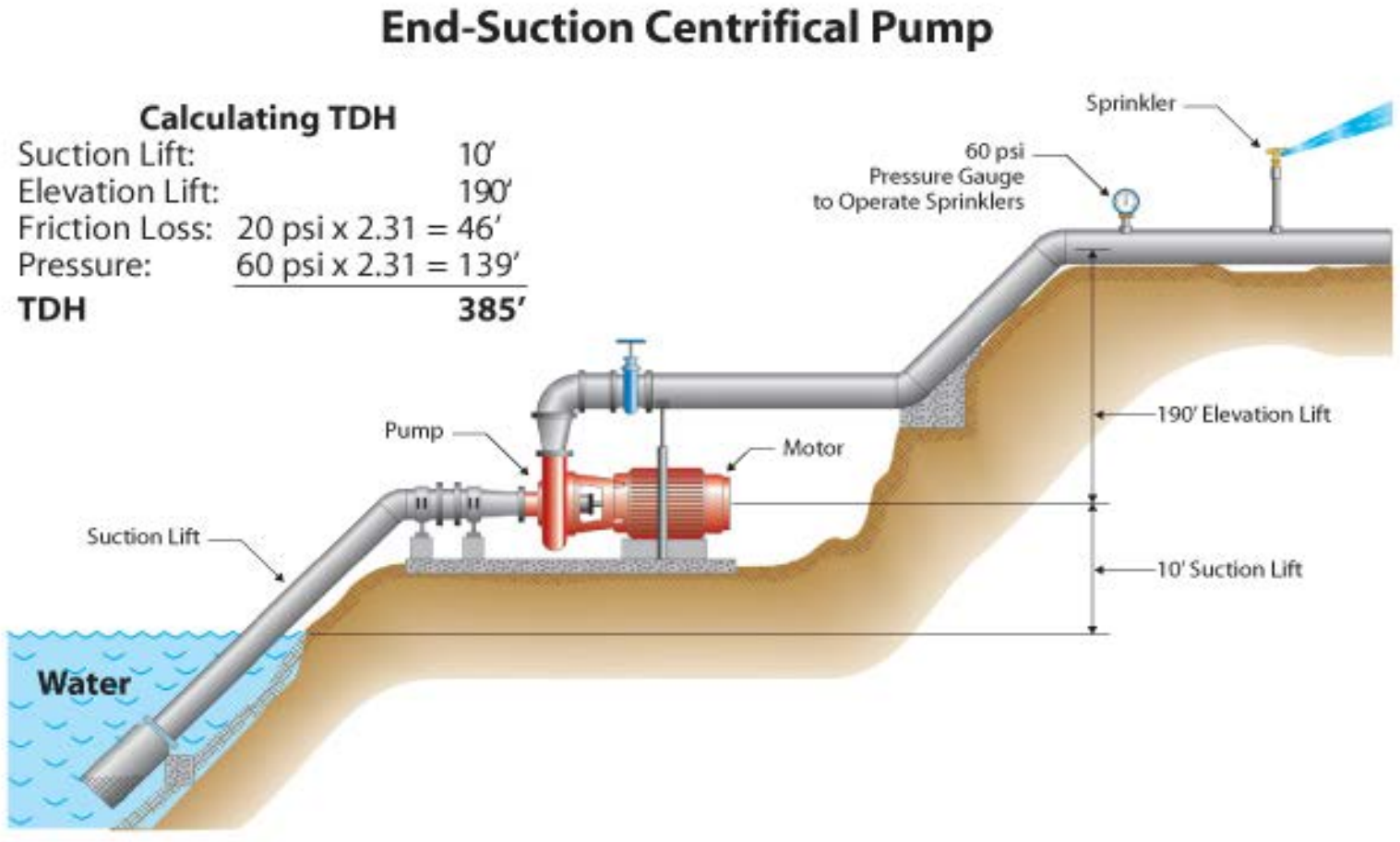
# TDH example- Total Lift from the water source level (PWL) to the field level + the pressure to operate the irrigation system



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# Input Horsepower and Pumping Costs...

$$HPin = \frac{Flow \times TDH}{(3960 \times OPE)}$$

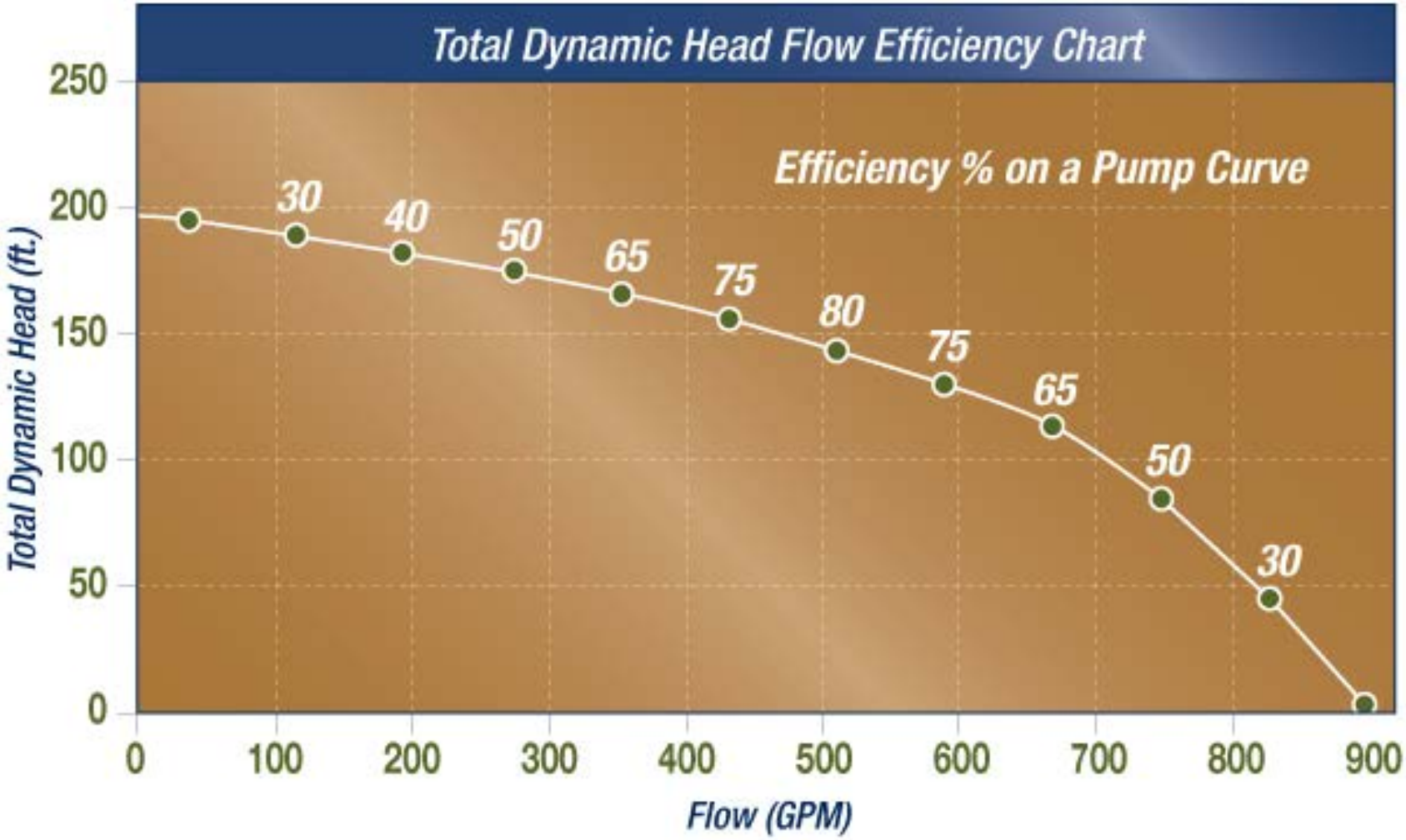
Where:

- HPin = required input horsepower
- Flow = pump flow rate (gpm)
- TDH = pressure in system (ft) OR (psi)
- 3960 = constant
- OPE = overall pump efficiency (%)

# The Pump Performance Curve…

- Every pump is engineered to create Operating Conditions specific to each individual pump design and should be matched to the irrigation system flow and pressure requirement.
- Manufacturers publish Pump Performance Curves to illustrate each individual pump capability

# Impeller Efficiency % on a pump curve…

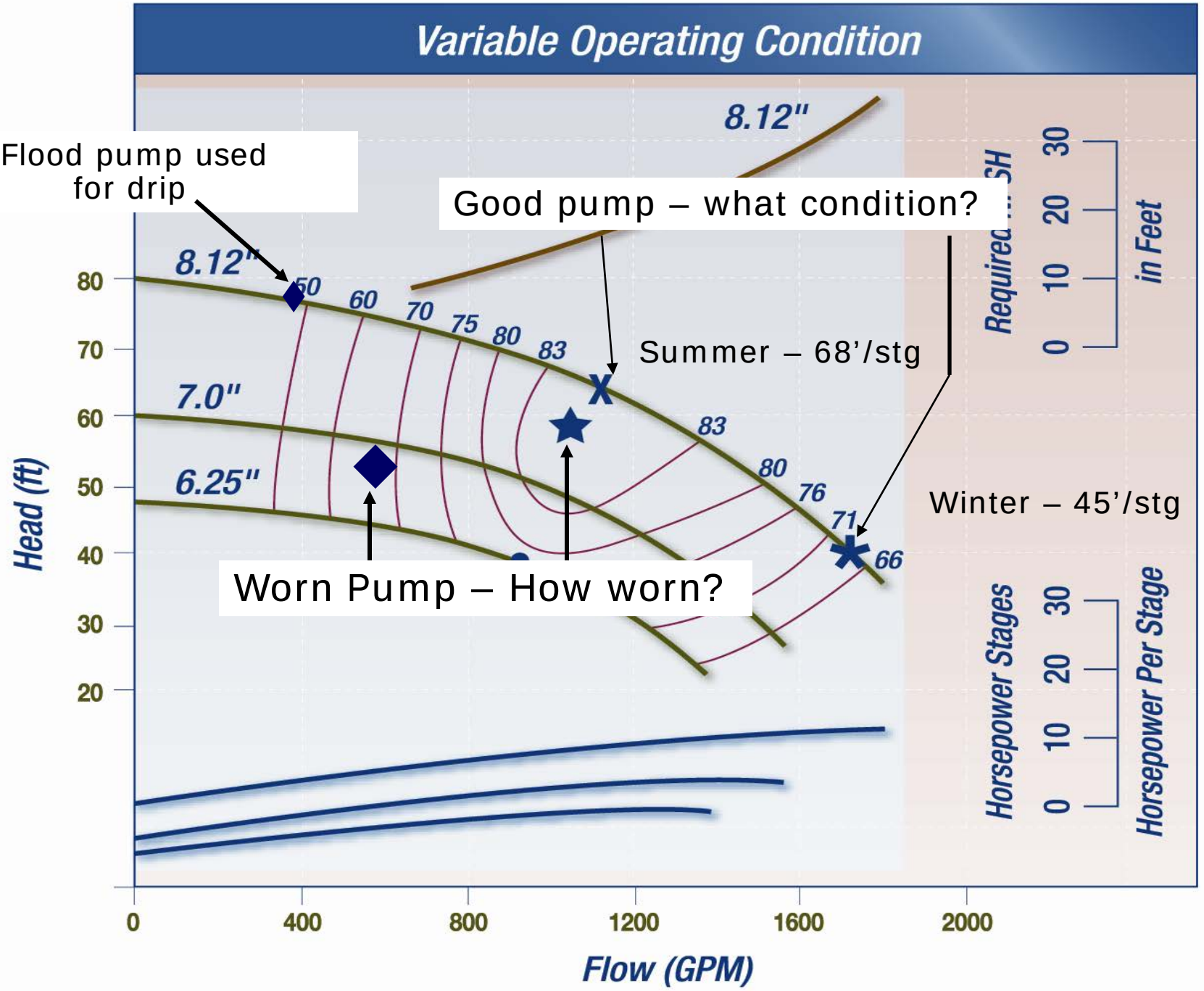


# Keys to specifying an efficient pump…

- Operating Condition- pressure and flow needed to properly operate the irrigation system
- Water Source- what is the water supply and how many feet will the pump have to lift the water? What about friction losses through the system?
- Highest Efficiency components- to create necessary flow and TDH
  - Bowls and Impellers
  - Motor
  - Shaft and Tubing
  - Electrical
- Type of Pump- to deliver water efficiently
- Variable or Stable Condition- from water source to irrigation target

# What affects the OPE

- Changes in TDH, PWL changes, irrigation system changes
- Worn pump
  - Sand or silt can wear impellers
  - Bearings wear
  - Shaft and tubing not aligned properly
  - Motor has been re-wound multiple times, decreasing motor efficiency


Variable Operating Condition
Flood pump used for drip
Good pump – what condition?
Summer – 68'/stg
Winter – 45'/stg
Worn Pump – How worn?
8.12"
7.0"
6.25"
50
60
70
75
80
83
83
80
76
71
66
Head (ft)
80
70
60
50
40
30
20
0
400
800
1200
1600
2000
Flow (GPM)
Required NPSH in Feet
0
10
20
30
Horsepower Stages
Horsepower Per Stage
0
10
20
30

# Pumps in a series (booster pump)

- Deep Well Pump brings water to the surface
- Booster pump creates additional pressure (TDH) required for drip or sprinkler irrigation system

# Pumps in parallel…

- Very common in municipal water systems but also used in agriculture
  - Maintain pressure in the delivery system under different flow rates.
  - Can use pumps of different sizes but recognize each operating pump will “see” the same discharge pressure.
  - Different combinations of flow and pressure from different combinations of pumps.
  - The alternative – VFDs on one or more pumps.

# Varying Speed of Pump…

- Varying the rotational speed of a pump changes the performance curve, just as trimming an impeller.
- This may help you meet variable operating conditions in real time (i.e. you can't install different diameter impellers "on the fly").
- You can do this with Internal Combustion engines or Variable Frequency Drives (VFD's)

# Variable Frequency Drives…


- Allow you to (automatically) <u>throttle</u> an electric motor – just as you would a diesel or natural gas engine
- Can save energy, which equals money
- Easier on machinery (soft-starts)
- HOWEVER, there are always tradeoffs
  - Cost
  - Power quality considerations
  - Physical restrictions



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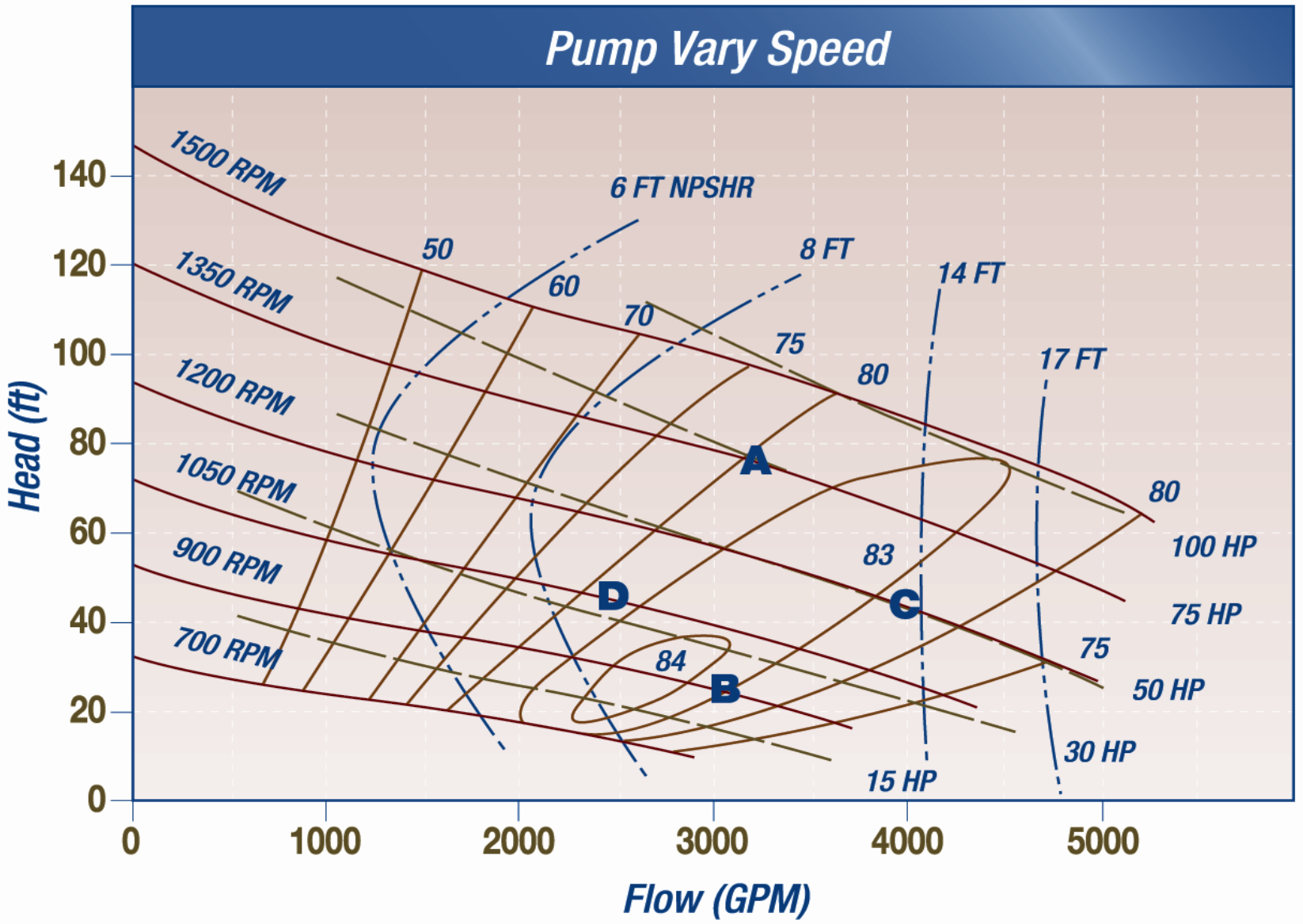
# Pump Curves at different speeds – same pump in field, different speed



# Maintain an efficient pump- Pump Efficiency Tests…

- Regular Maintenance- making sure oil dripper is working, having pump companies do regular (yearly) maintenance checks, pump efficiency tests every two years

- Checking the electrical system, panels, gauges, etc.

# Pump Efficiency Test...

- A pump test gives the pump manager the Overall Pumping Plant Efficiency (OPE) at the operating condition(s) tested.

- In the picture at right, a pump tester is measuring flow, TDH, and energy into the pumping plant to establish the OPE of this pump while in operation.

# Pump Efficiency Test…

May be done in many different types of environments with different equipment.

A pitot tube is being used to measure water flow rates here.

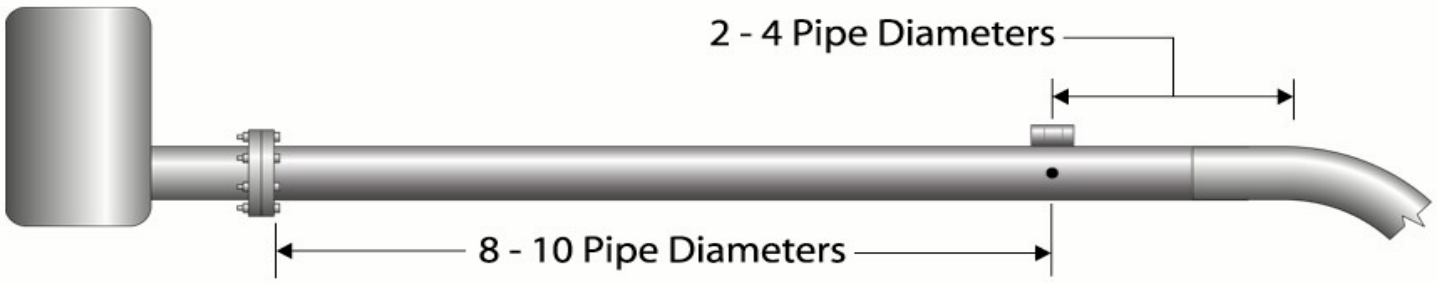
# Pump Efficiency Tests...

- Snapshot of the pumping plant at the operating condition(s) tested
- More helpful if:
  - You have original specifications and pump performance curve
  - Done on a regular basis
  - Do multiple operating conditions or points need tested?
  - Done at normal operating conditions (should you test a well in winter?)

# Pump Efficiency Test – how?...

- Measure three things in the field:
  1. Flow rate
  2. Total dynamic head – including:
     - Pumping lift
     - Discharge pressure
  3. kW or horsepower into the plant
- Perform a lot of calculations.
- Report results and conditions of test.

# Accurate flow measurement...




- Water flow measurement many times the “weak” link.
- Pump engineers agree that getting an accurate flow rate measurement is enhanced by constructing a pump station with a discharge pipe that has plenty of “clean” space to conduct the test.
- The diagram above shows the recommended “clean” distances up stream and downstream from the measurement point.

# APEP offers...

1. Subsidized pump efficiency tests- always start with getting a pump test- 25+ HP
   - 2- 4 years since last test- $100 subsidy
   - 4+ years since last test- $200 subsidy
2. Incentives for pump retrofit/ repair 30+ HP
3. Technical Assistance
4. Education



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# PG&E's new deemed rebates for 25 HP and under pumps...

- Pumps 25 HP and under are now eligible for retrofit/ repair rebates of $75/ HP from PG&E

- Example 20 HP pump X $75/HP = $1,500 deemed rebate

# PG&E's new deemed rebate for VFDs...

- New $40/ HP deemed rebate for Variable Frequency Drives (VFDs)- ag pumps retrofits and new installations




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# APEP eligibility…

1. Eligible pumps…
   - Agricultural pumps
   - Municipal pumps
   - Large Turf, Golf Courses, Parks, Recreational
   - Tertiary treated waste water
2. Ineligible pumps…
   - Primary and Secondary treated waste water
   - Industrial
   - Change in operating condition (I.e. flood to drip)

# APEP 2016-17

- The Advanced Pumping Efficiency Program has been extended through 2017 as a PG&E Customer Energy Efficiency offering, funded through the Public Purpose Programs Charge under the auspices of the California Public Utilities Commission. Information pertaining to APEP contained in the pamphlets and brochures may be outdated. Please call APEP at **1.800.845.6038** or log on to www.pumpefficiency.org for current information regarding eligibility, educational seminars, pump tests and incentives for pump retrofits. Eligibility now extends to agricultural, large turf, and municipal (including tertiary-treated water) water pumping customers with PG&E electric or natural gas accounts. Residential, commercial, industrial process, primary sewage and secondary sewage pumps are ineligible.

# Disclaimers as per CPUC...

- California consumers are not obligated to purchase any full fee service or other service not funded by this program. This program is funded by California utility ratepayers under the auspices of the California Public Utilities Commission.
- Los consumidores en California no estan obligados a comprar servicios completos o adicionales que no esten cubiertos bajo este programa. Este programa esta financiado por los usuarios de servicios públicos en California bajo la jurisdiccion de la Comisión de Servicios Públicos de California.