Pump Optimization

Repair and Refurbishment
Efficiency Improvement
Reliability Enhancement

CHESTERTON®
Global Solutions, Local Service.

The Business of Pumping

- The Department of Energy estimates that electric motors account for 2/3 of industrial use in the United States.
- 27% of these motors are coupled to a pump.
- In 2016, the US industrial sector consumed 936 million megawatt hours of electricity at a total cost of $63 billion.

$11.3 Billion Pumping Cost

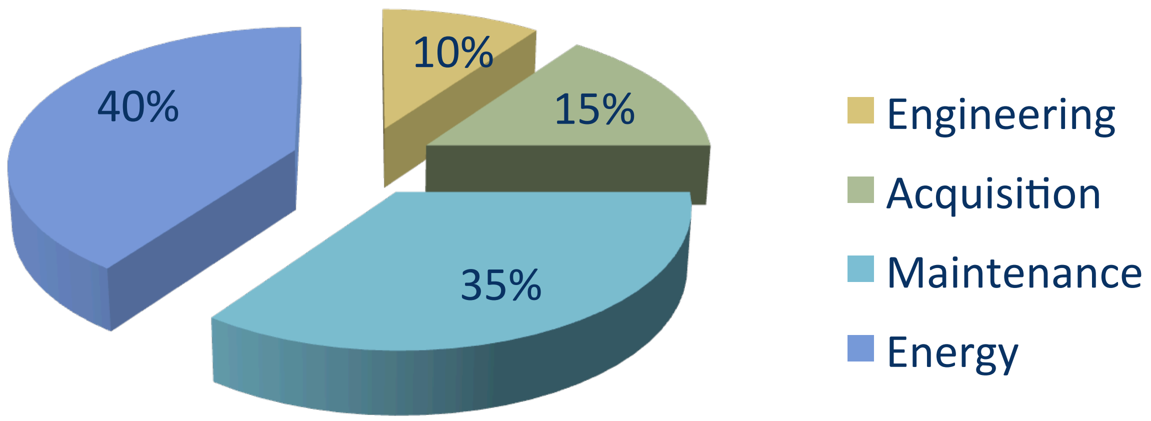
What are our pumps doing with all that Energy?

Evaluation of 1690 pumps at 20 process plants:

- Average pumping efficiency is below 40%
- Over 10% of pumps running below 10% efficiency
- Major factors affecting pump efficiency:
  - ✓ Throttled valves
  - ✓ Pump over-sizing
  - ✓ Worn internals

Finnish Technical Research Center Report

Pump Life Cycle Cost over 7 Years



Energy required to operate the pump is the largest cost contributor to a pumps total life cycle cost and yet is the most likely element to be overlooked by the maintenance staff.

The Optimization Process

Prioritize and Qualify Systems Through Pre-Screening

Conduct Pump and System Assessments

Identify Opportunity for Improvement

Implement Action Plan

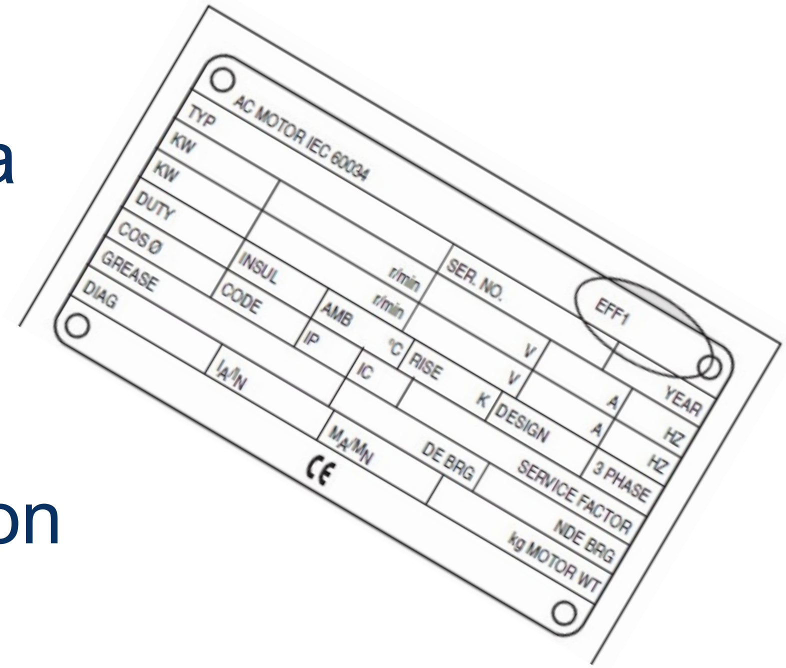
- Repair and Refurbishment
- Application of Coatings
- Proper Equipment Sizing
- System Control Scheme

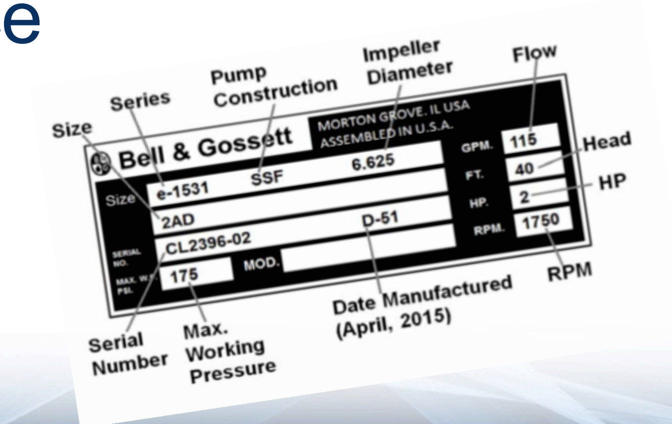
Repeat Process for Next Candidate

Pre-Screening – Start With The Basics

Information Gathering

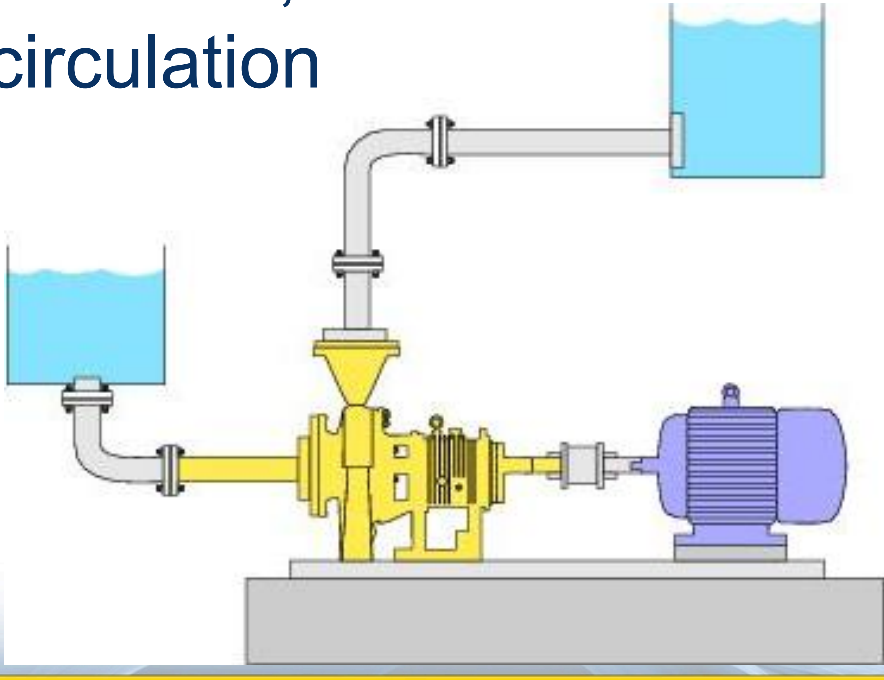
- Equipment Nameplate Data
  - Motor HP & RPM
  - Pump Flow and Head
  - Model and Size
- Manufacturer Documentation
  - Performance Curves
  - Operation and Maintenance Manuals





Pre-Screening – Gather System and Operational Details

- Pump Arrangements – Series? Parallel?
- Control Strategies
  - Variable Speed Drives
  - Control Valves / Throttling
  - Level Control, Pressure Control, Flow Control
  - Low-flow By-Pass / Recirculation
- Operational Sequencing and Runtime
- Piping system and components
- Modifications or retrofits?

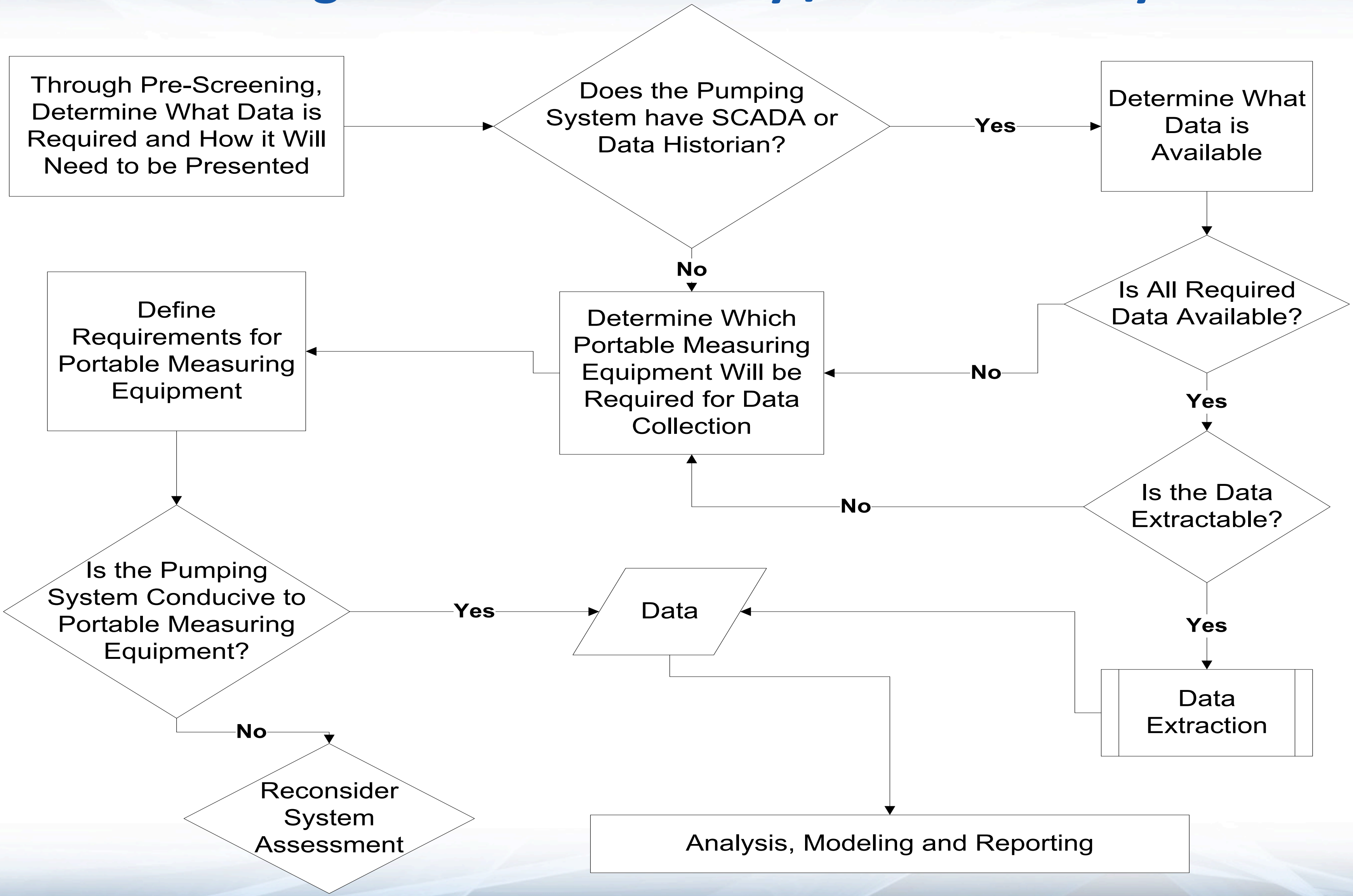


Pre-Screening – Pertinent Background Info & Planning

Project Drivers
- Energy Savings
- Non-Energy Benefits
  - Maintenance and Reliability
  - Safety and Environmental Compliance

- Assemble the Appropriate Team
  - Project Champion / Sponsor
  - Assessment Team
  - Pump System Expert

Pre-Screening – Data Availability / Collectability

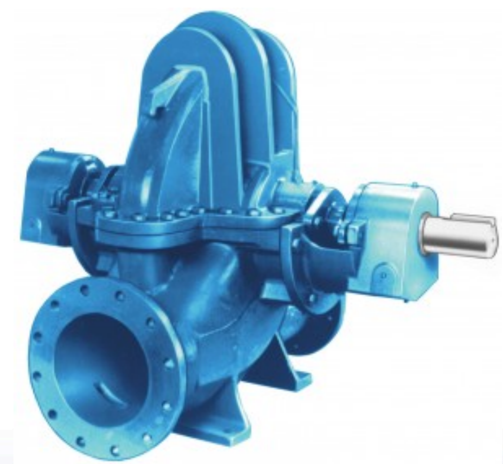


Why Pre-Screening is Important

- By properly pre-screening, efforts spent on low prospect systems are avoided.
- Opportunities can be prioritized based on the project drivers.
- Define the objectives and avoid scope-creep.
- Identify the appropriate team to maximize the success rate.
- Anticipate potential obstacles and plan accordingly.
- Prevent dead-end projects and wasted resources.

Time is Money

What Equipment Should be Targeted?



Understanding a Pump Performance Curve

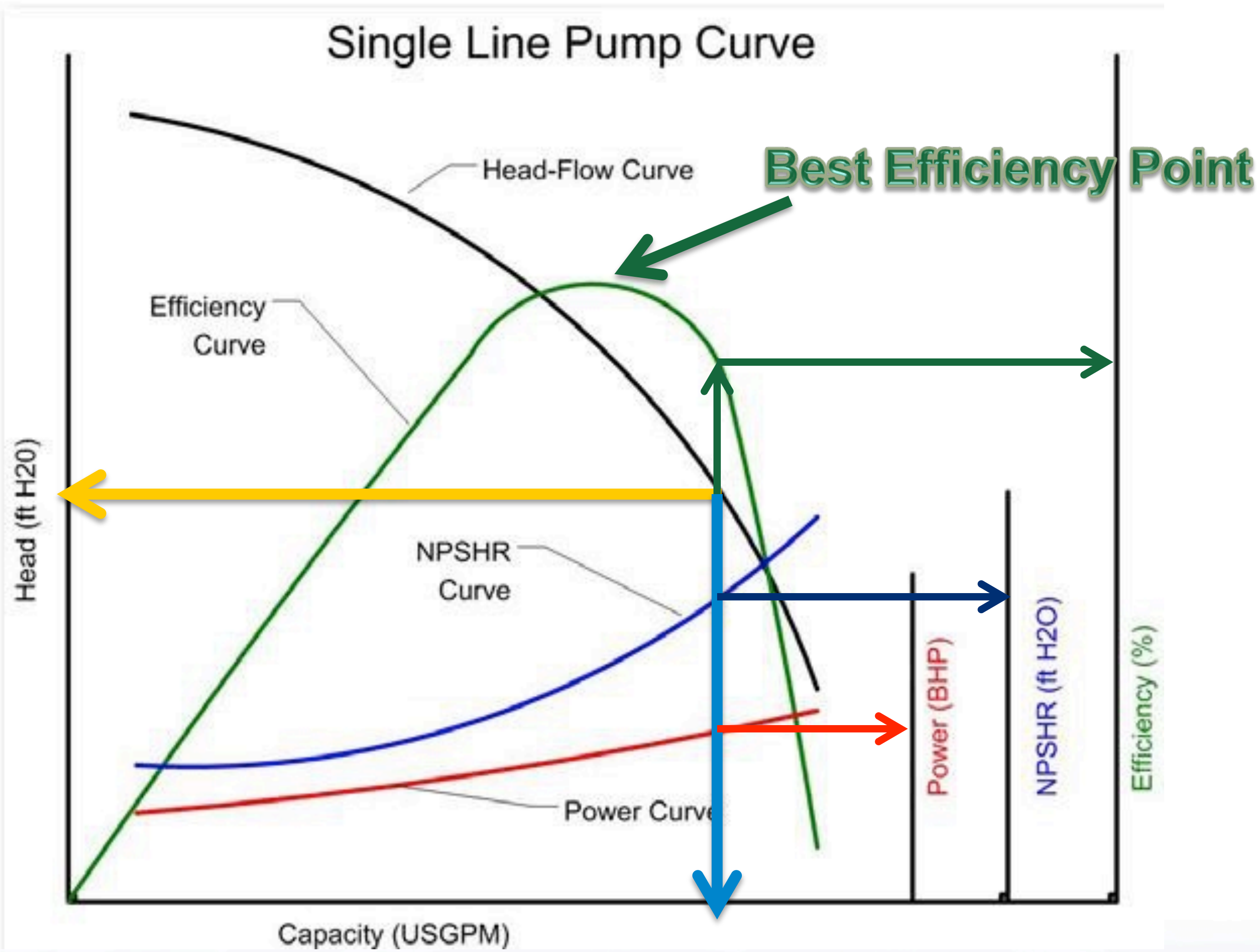
FLOW

HEAD

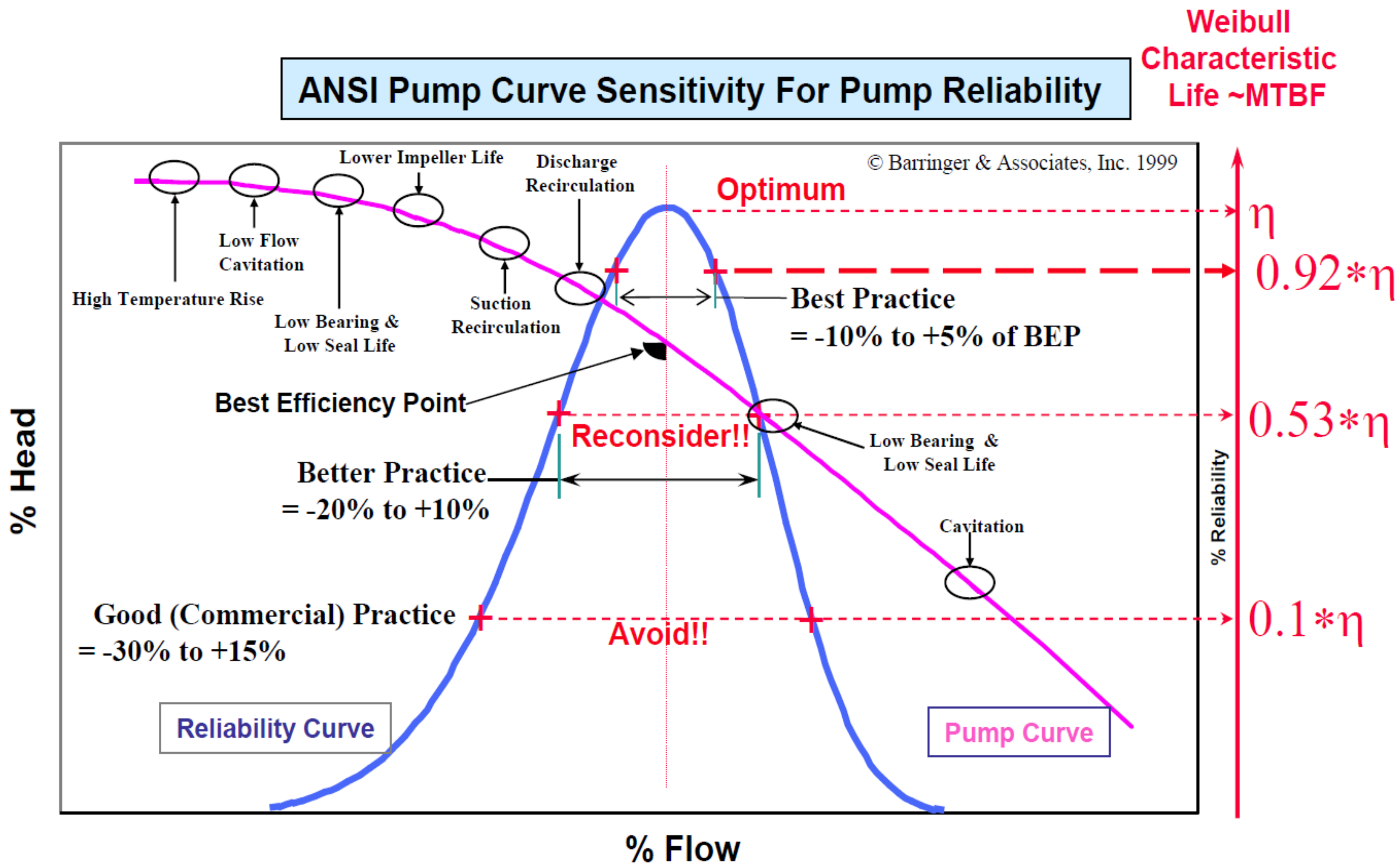
POWER

EFFICIENCY

NPSHr



Pump Reliability



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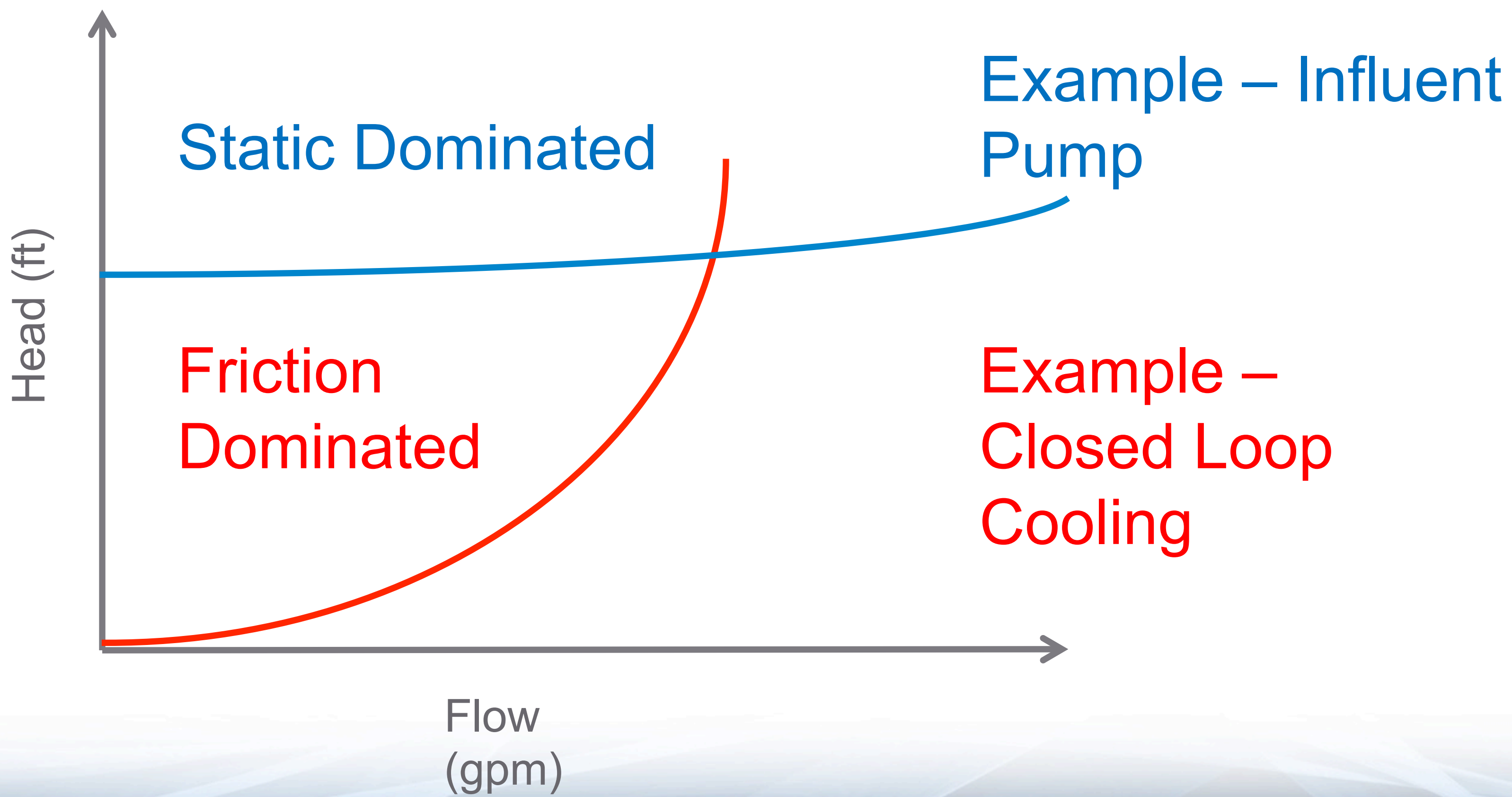
Understanding The System

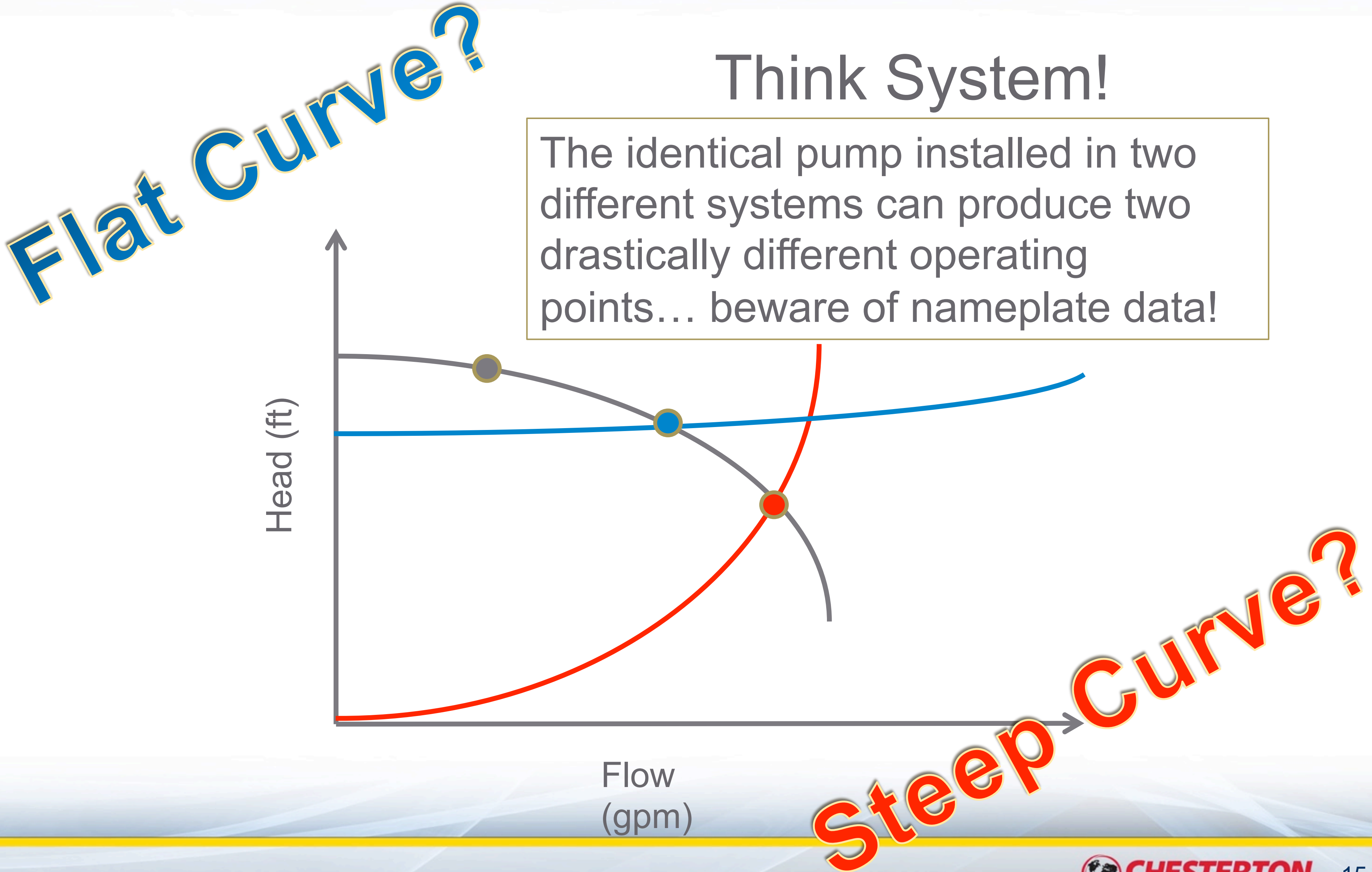
System Curves



Where Does the Pump Live?

Think System!

The identical pump installed in two different systems can produce two drastically different operating points… beware of nameplate data!

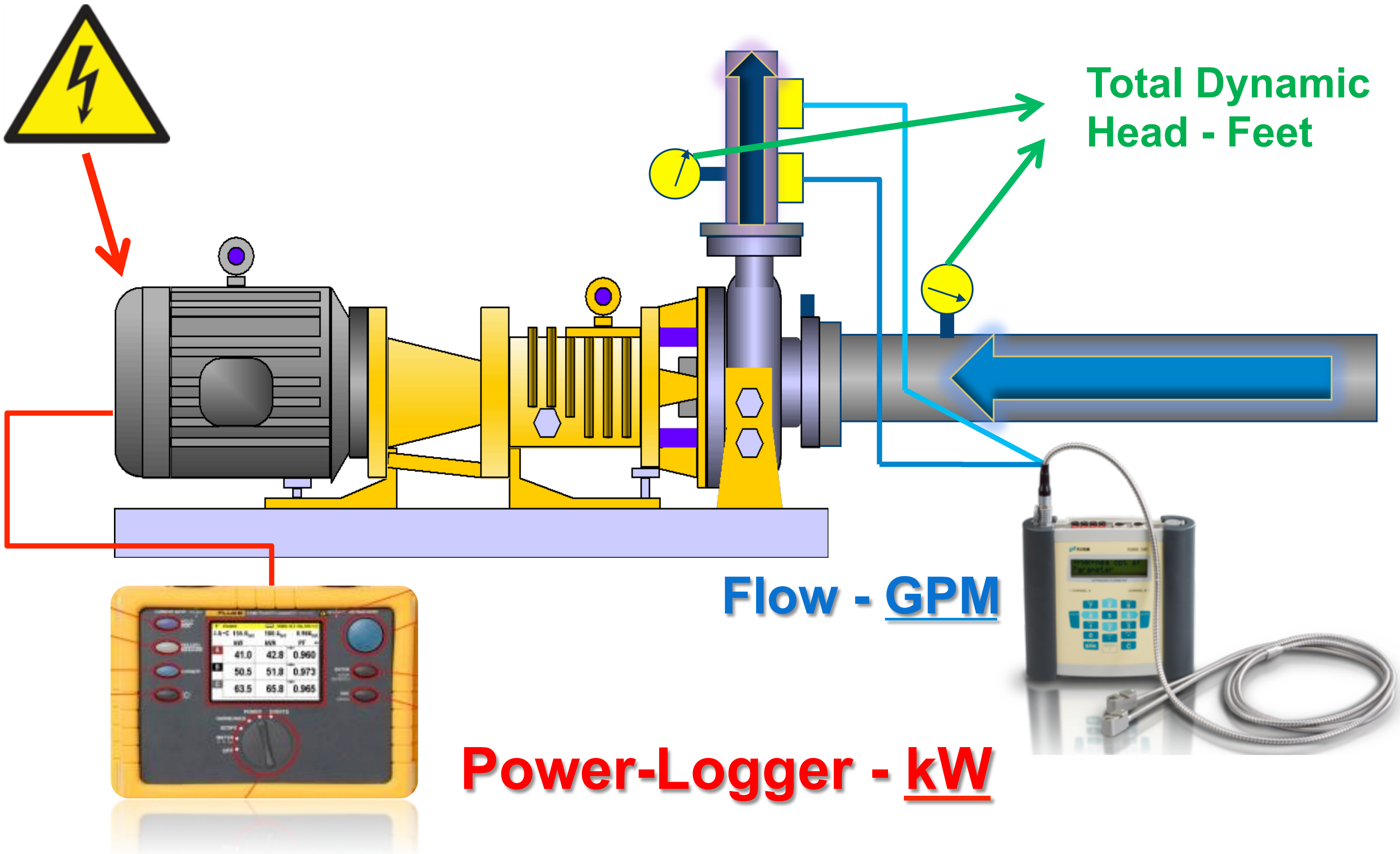


System Assessments and Field Testing

Typical test requires;

1. Pump and System will need to be available for operation.
2. Simulation of normal operation.
3. Manipulation of pump speeds and valve positions to establish baseline performance data, where possible.
4. Depending on system type and arrangement, pumps can be tested in 1-2 hours.
5. Field testing for projects involving up to 6 pumps can typically be done in one day.
6. End-user will need to make available an operator, who is familiar with the system, for the duration of the field test.
7. End-user will need to make available historical data, drawings, pump curves and be able to answer some questions about how the system is operated and maintained.

Wire to Water Efficiency



Case Study - Oversized Pump

- The process requires 4000 GPM flow.
- Operations requested 4600 GPM for margin of safety.
- Jr. Project Engineer calculated the head loss to be 39 feet @ 4600 GPM. The head required at 4000 gpm would only have been 30 feet.
- Sr. Engineer added 7 feet to the calculated head loss because the Jr. Engineer can't be trusted….
- The pump is sized for 4600 GPM and 46 feet of head @ 82% efficiency.
- The process still only required 4000 GPM so the pump required throttling to where it was producing 50 feet of head @ 77% efficiency.

Cost of throttling an oversized pump?

$$BHP1 = 4000 GPM \ x \ (50 ft) / 3960 \ x \ (77\%) = 65.6$$

$$BHP2 = 4000 GPM \ x \ (30 ft) / 3960 \ x \ (82\%) = 37$$

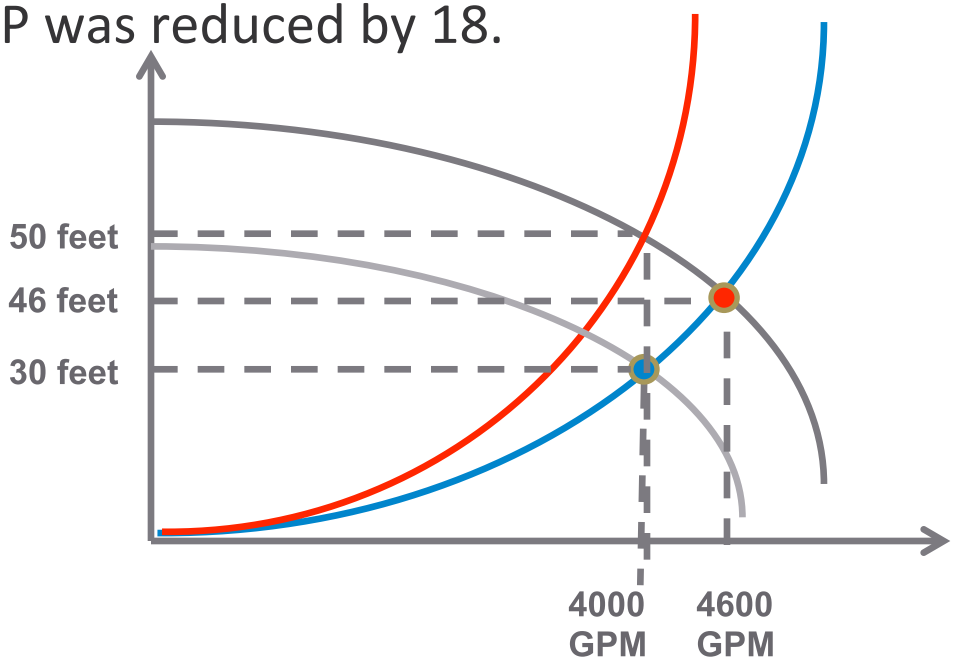
4000 hours of operation per year, premium efficiency motor (95%)

$$kWh = .746 \ x \ (BHP1 - BHP2) / 95\% \ \ x \ 4000 hrs = 89{,}834$$

$$\mathbf{89{,}834 \ kWh \ x \ \$0.12 / kWh = \$10{,}780!}$$

The Solution

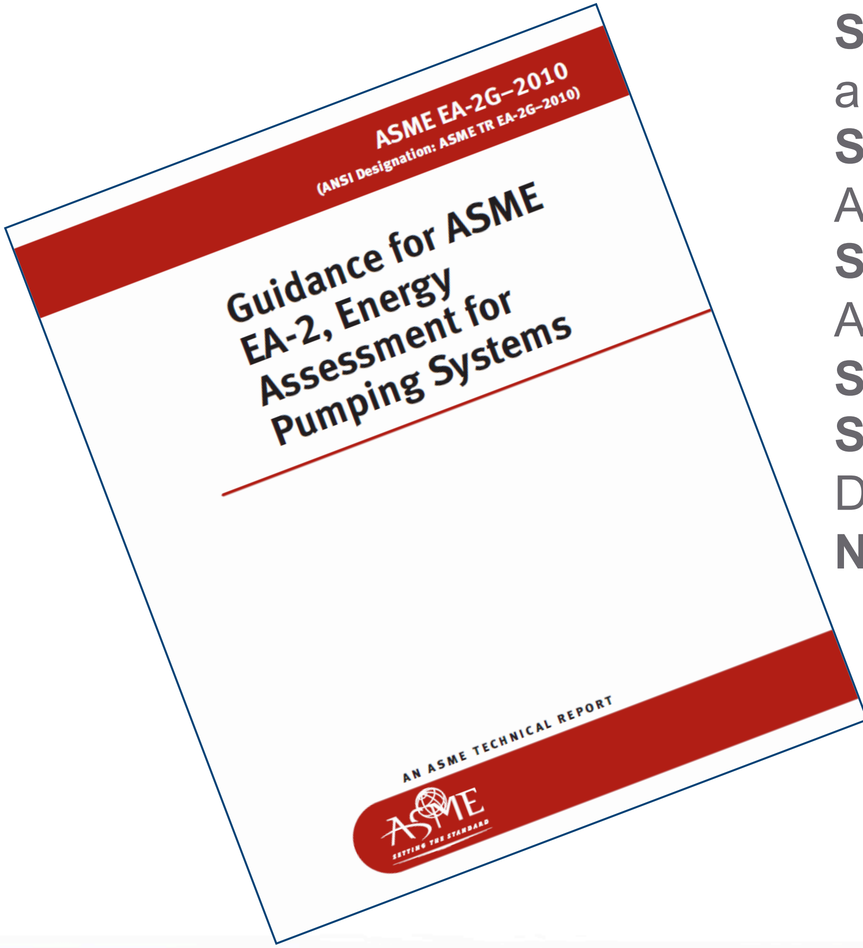
- A VFD was installed on the existing pump and pump speed reduced to 80%.
- The throttle valve was fully opened. Head was reduced by 11 feet. BHP was reduced by 18.



<u>Total Project Cost was $10,000.</u>

<u>Pay-back period was 13 months.</u>

Assessment Standards and Guidance



ASME EA-2
Section 1-3: Scope, Definitions and References
Section 4: Organizing the Assessment
Section 5: Conducting the Assessment
Section 6: Analysis of Data
Section 7: Reporting and Documentation
Next Steps

Questions

and

Discussion