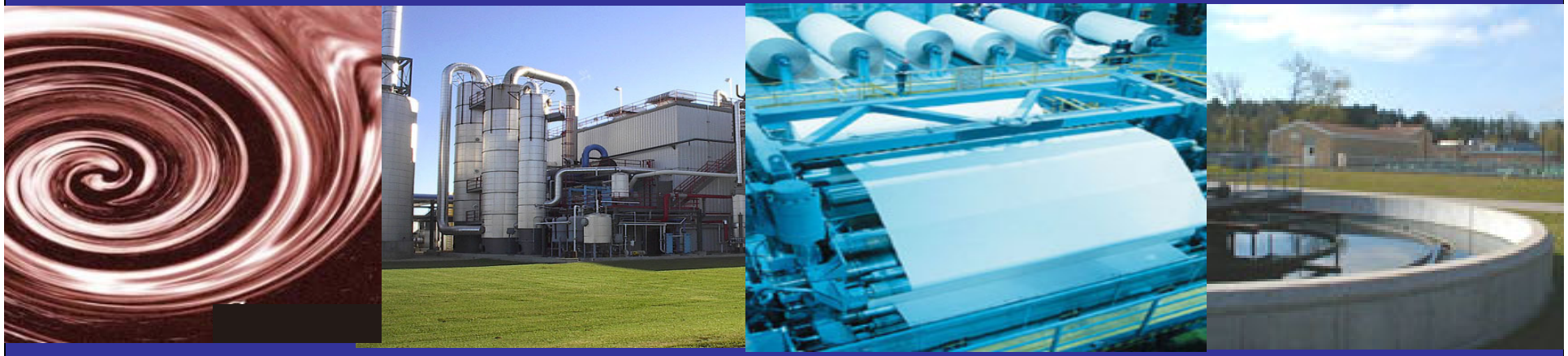


Lake States Tappi Energy Reduction Forum

Pumping System Audits/Case Studies

2-25-09

Bridgewood Inn, Neenah, WI

CRANE ENGINEERING

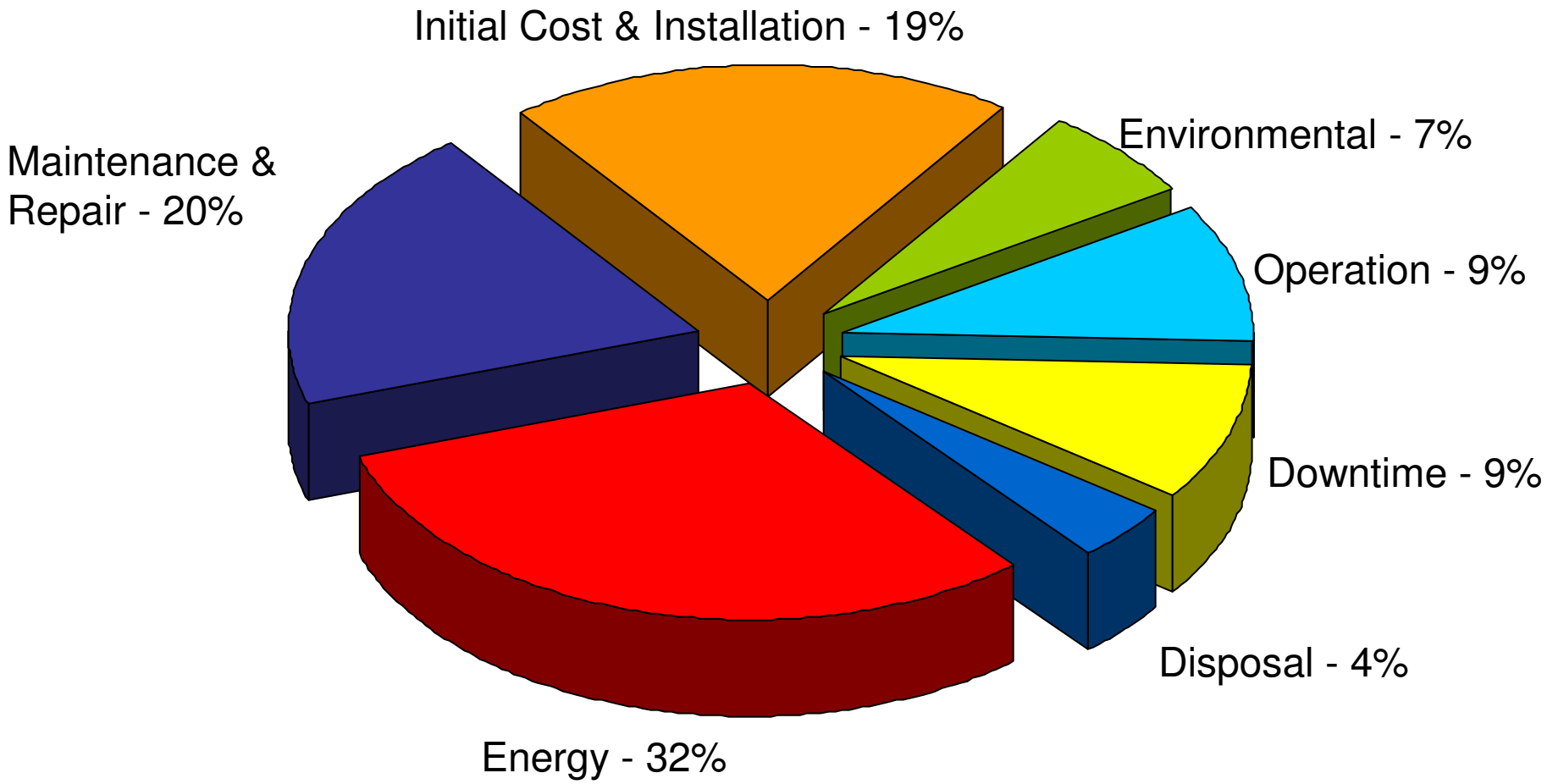
Energy Study

- Finnish Technical Research Center Report

  "Expert Systems for Diagnosis of the Condition and Performance of Centrifugal Pumps"

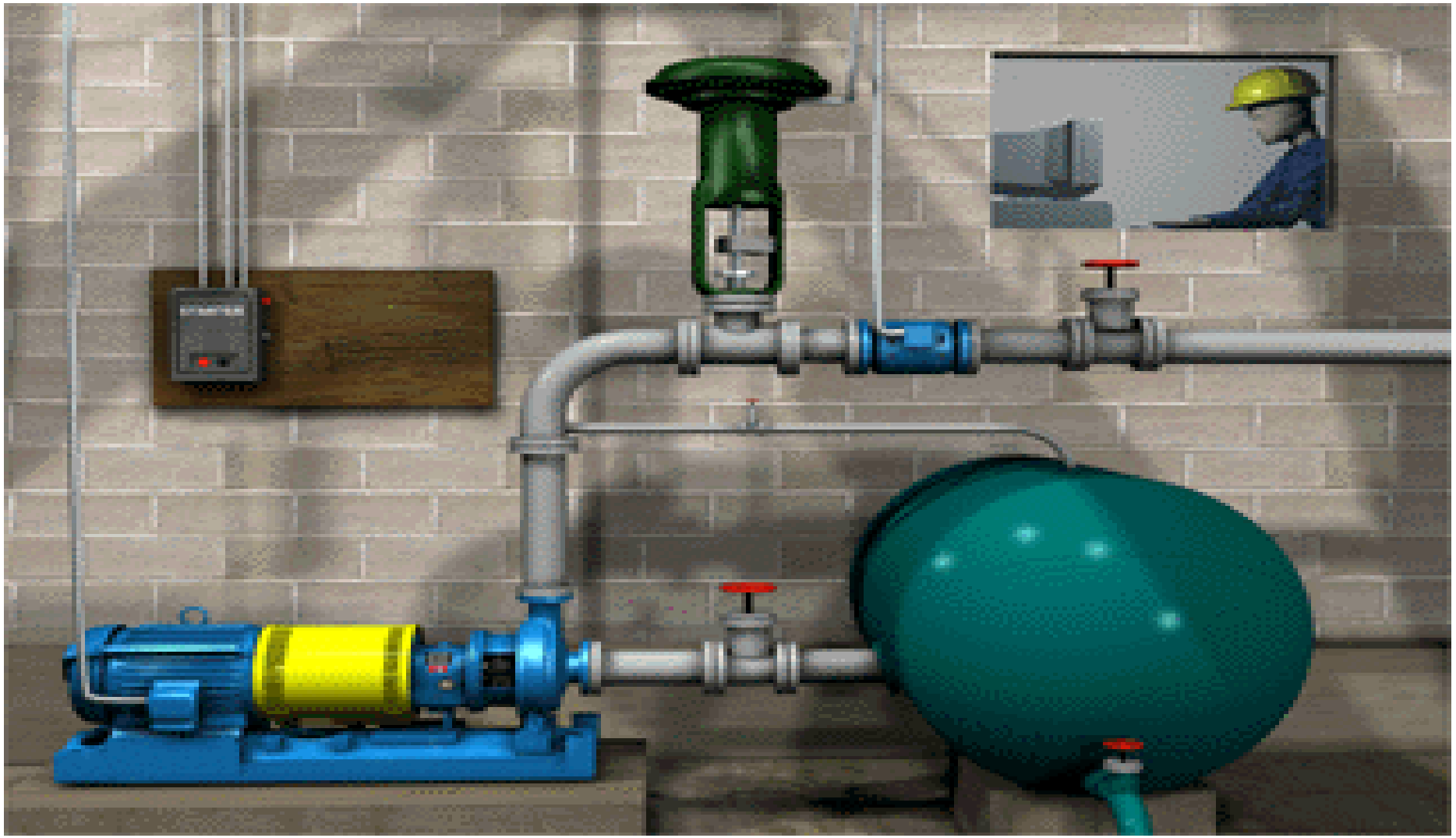
  - Evaluation of 1690 pumps at 20 process plants
  - Average pumping efficiency is below 40%
  - Over 10% of pumps run below 10% efficiency
  - Major factors affecting pump efficiency:
    - throttling valves
    - pump over-sizing
  - Seal leakage causes highest downtime and cost

Total Cost of Pump Ownership



* Source: Hydraulic Institute

Typical Pumping System



Fluid Energy – Pumping Systems

- Important Fundamental Relationships

$$\text{Horsepower (Hp)} = \frac{\text{Flow rate } (\boldsymbol{Q}) * \text{Head } (\boldsymbol{H}) * \text{specific gravity}}{3960 * \boldsymbol{\text{Pump Efficiency}}}$$

Fluid Energy = Fluid Power (Hp) * operating time (***T***)

To **Conserve Energy** Use:

- **Reduce the Run Time (*T*)**
  Shed load
- **Reduce the Flow Rate (*Q*)**
  close bypass; resize
- **Reduce the Head (*H*)**
  Trim Impeller, VFD
- **Improve *Pump Efficiency***
  Right Sizing of Pumps, VFD

Improving Pump Efficiency
Right Sizing Pumps

- **The Classic Oversized Pump**
  - System Demand – 2000 gpm @ 100’ TDH
  - Project Engineer – Adds 15% to Flow and TDH to ensure future capacity
  - Sr. Project Engineer – Ensures calculations, adds 10% to Flow & TDH
  - Purchasing – Sends request out to supplier for 2500 gpm @ 136’ TDH
  - Supplier – Chooses most efficient pump, left of BEP to ensure future capacity

Improving Pump Efficiency
Right Sizing Pumps

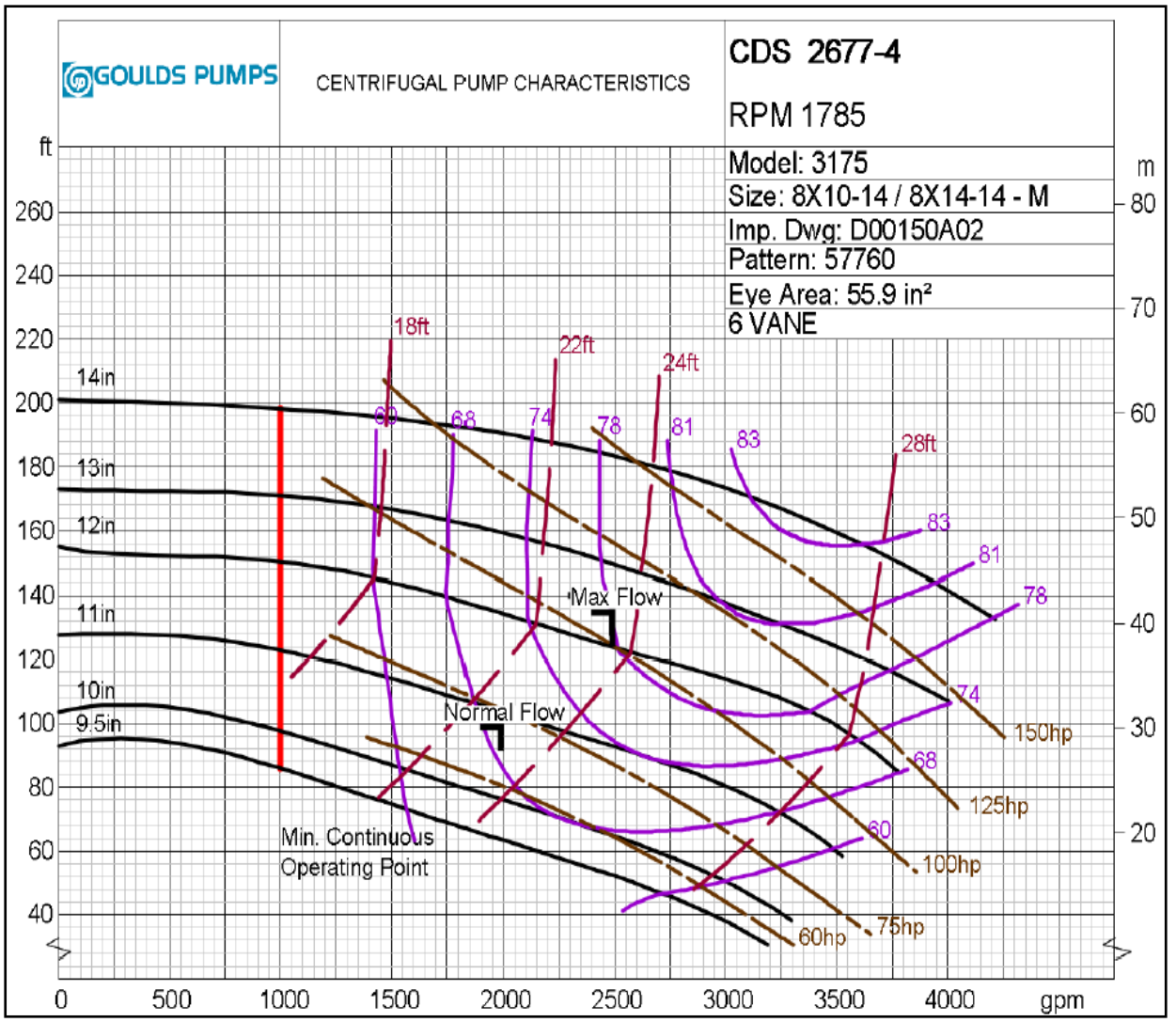
- ***The Classic Oversized Pump***

Pump sized for

2500 gpm @ 136' TDH

Conditions at design point

Efficiency = 69%
BHP = 73.2
% BEP = 76%



Improving Pump Efficiency
Right Sizing Pumps

- ***The RIGHT SIZED Pump***

Pump sized for

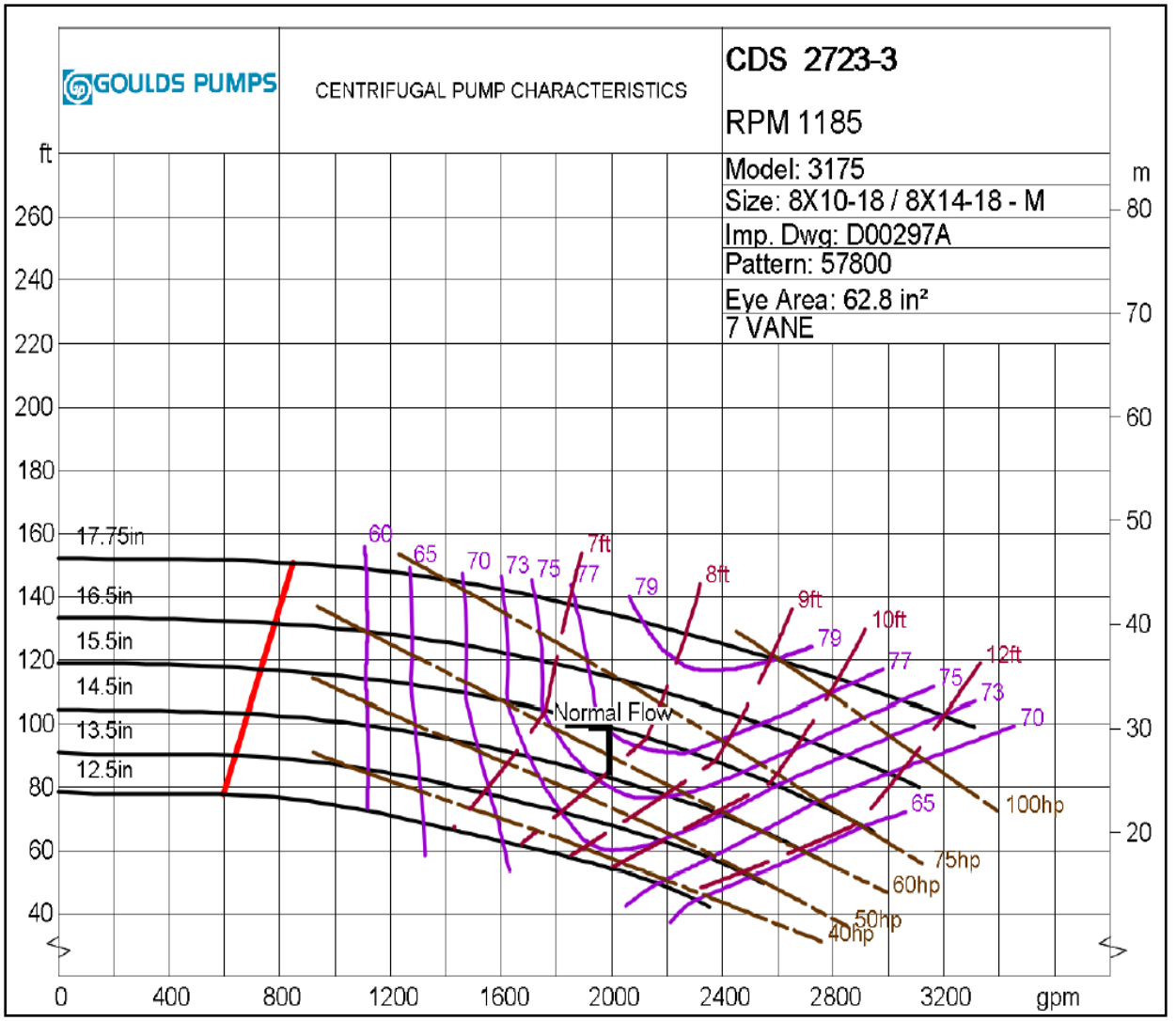
2000 gpm @ 100' TDH

Conditions at design point

Efficiency = 77%
BHP = 65.8
% BEP = 93%

Right Sized Savings

Efficiency = 8 points (12%)
BHP = 7.4
Savings = $2600/year

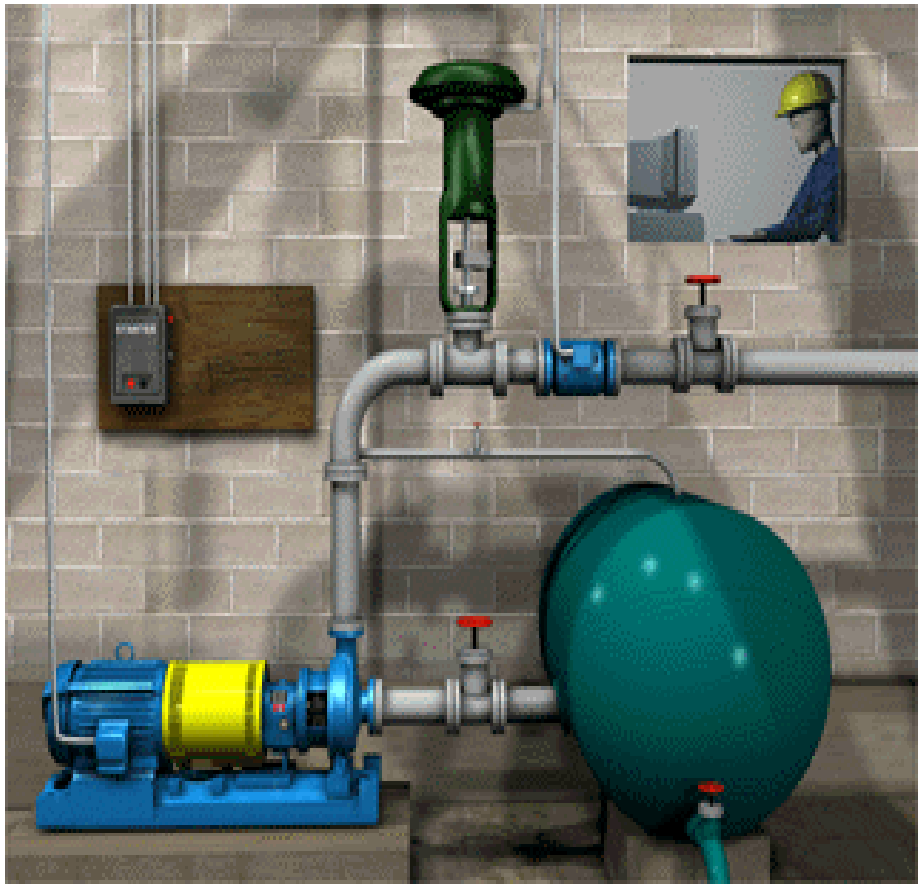


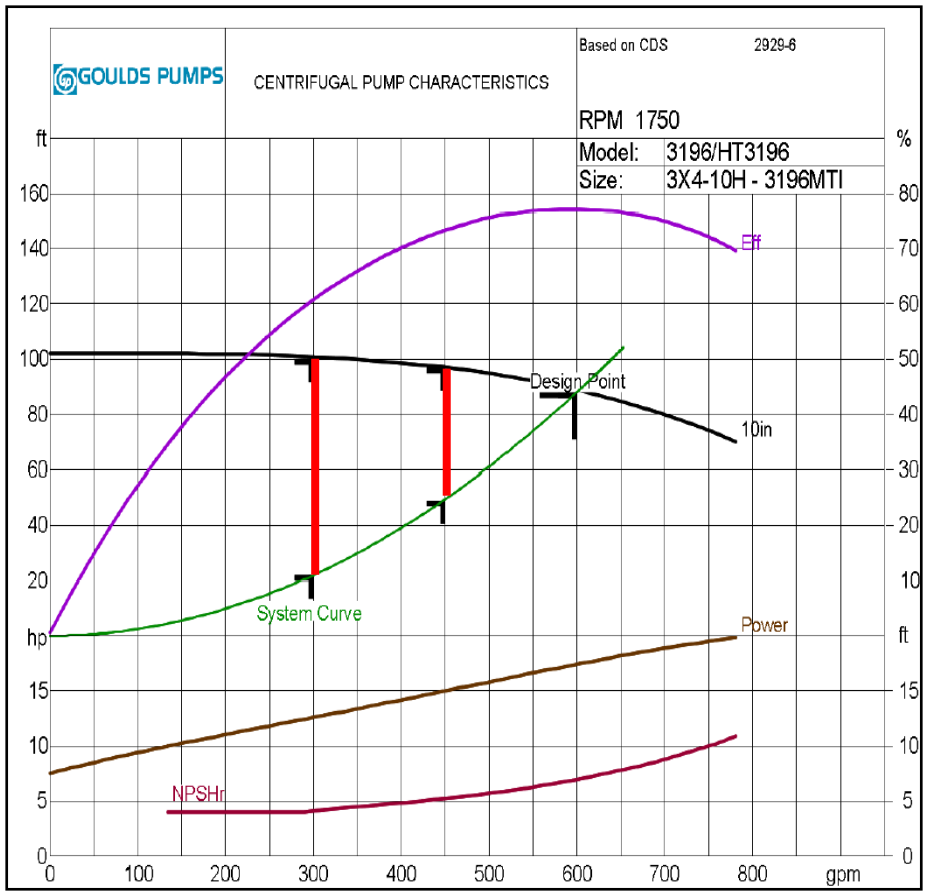
Reducing the Head (H)
Variable Frequency Drives (VFD's)

Typical Pumping System

Fixed Speed Pump @ 1800 RPM

Control Valve to control flow to 600, 450 and 300 gpm

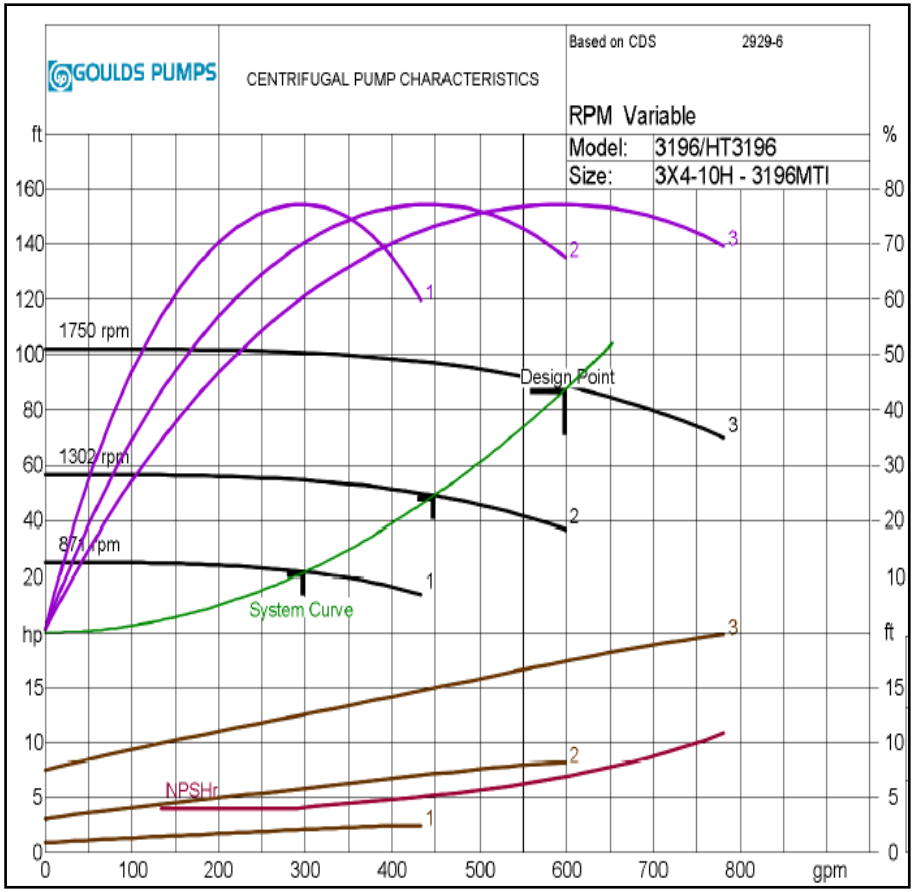




Reducing the Head (H)
Variable Frequency Drives (VFD's)

Variable Speed Pumping System

Pump Speed to control flow to 600, 450 and 300 gpm



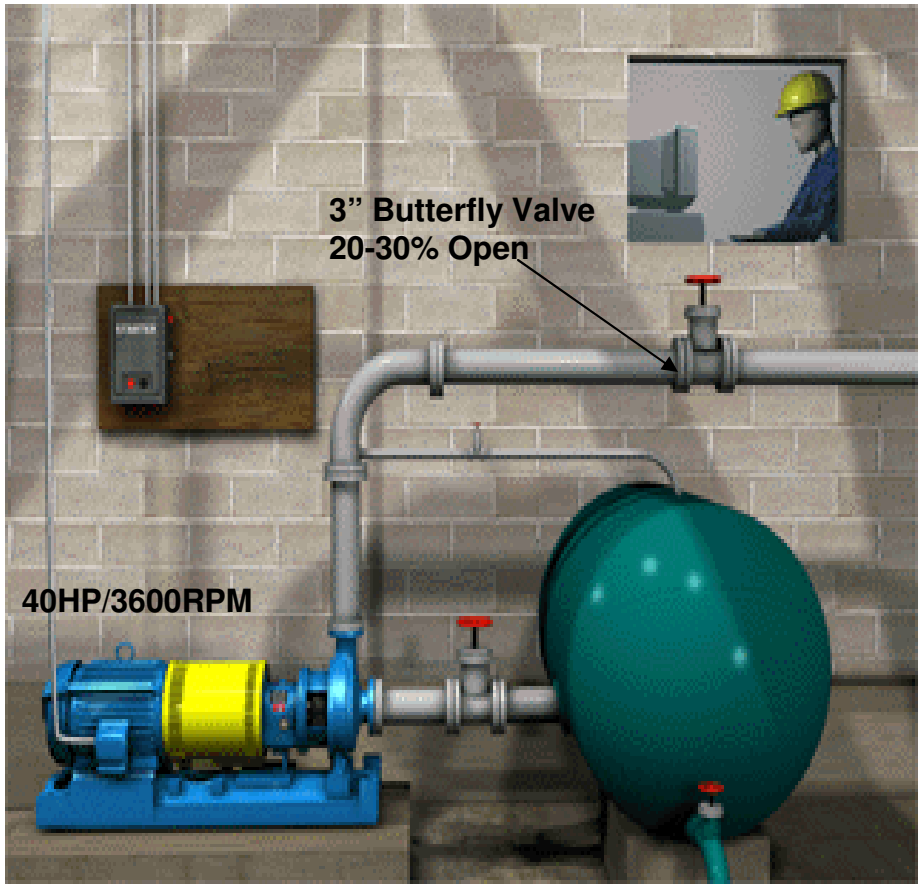
Case Study #1
Reducing the Head (H)

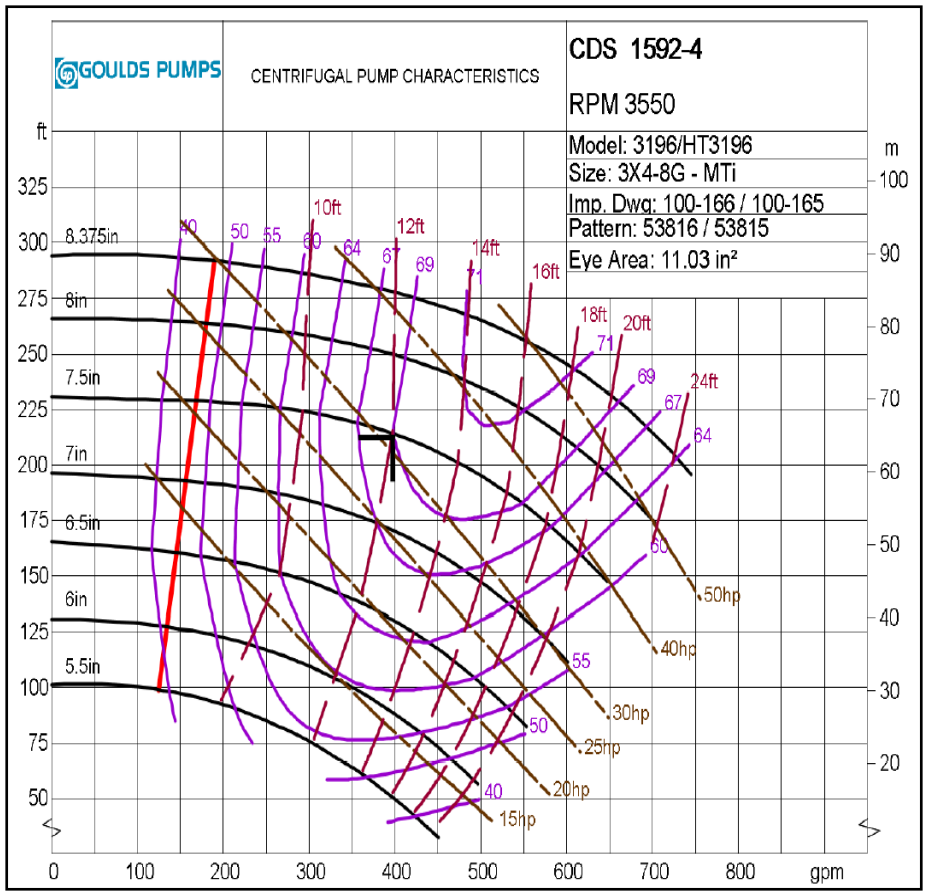
Design Conditions

400 gpm @ 208' TDH
69% Efficiency
31.2 BHP

Application Problems

High Vibration / Sealing Issues
High Noise





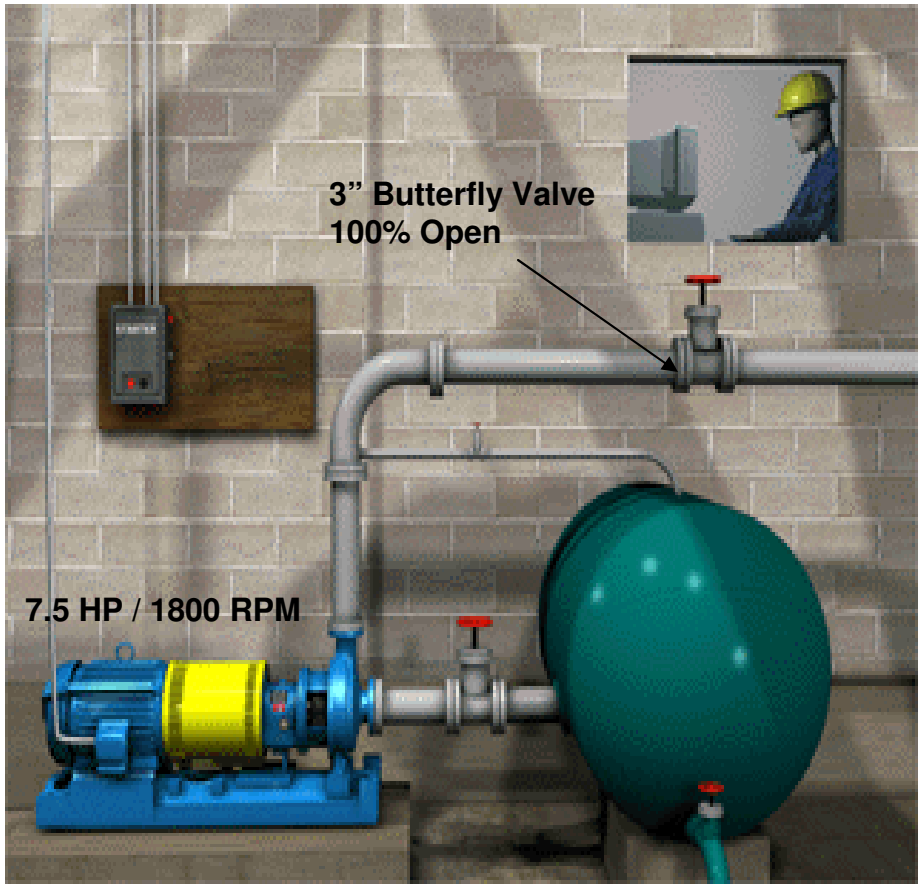
Case Study #1
Reducing the Head (H)

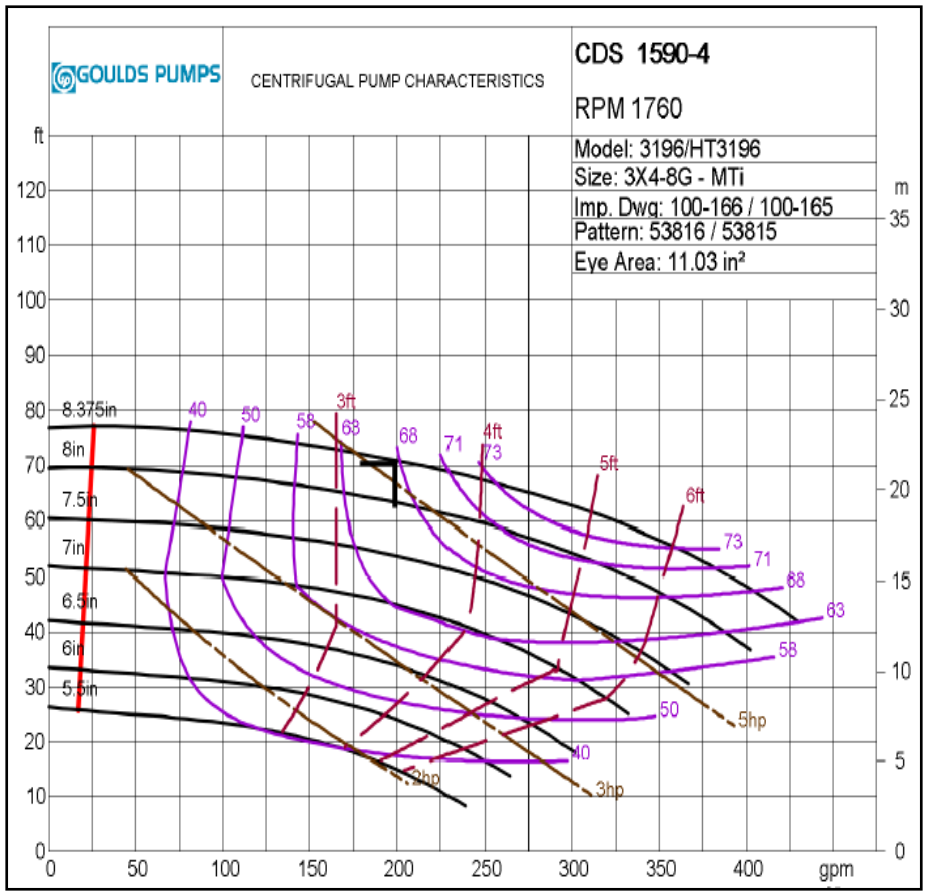
New Design Conditions

200 gpm @ 70’ TDH
68% Efficiency
5.3 BHP

Improvements:

~ $7400 Annual Energy Savings
No Vibration issues / Improved Seal Life
1800 RPM vs. 3600 RPM





Case Study #2
Improving Pump Efficiency

- Pulp Mill Scrubber Application
  - Issue
    - Two installed pumps, unable to keep up with flow requirements
    - High energy requirements
    - No installed spare pump
  - Investigation
    - Pumps running in parallel, not operating near predicted based on external measurements (Flow, Pressure, Amp readings)
    - Pump inspection showed significant wear, casing cutwater was worn completely away
  - Solution
    - Replaced Casings
    - Running on single pump, now have installed spare
    - Saved 127 bhp (~ $39K savings per year)

Case Study #3
Energy Assessment

- Energy Assessment of Centrifugal Pumping Systems 06/05

  - Systems evaluated : 23
  - Installed HP : 2550
  - 3 day on-site study

  - Results
    - New Installed HP : 2040
    - Annual Energy Savings : $315,667
    - Capital Investment (Equipment) : $310,000

  - Implementation
    - Installed VFD's on 5 applications
      - Realized $102,000 in annual energy savings (95% of predicted savings)
      - Additional cost savings in MTBF on the subject pumps and seals

Case Study #4
Energy Assessment

- Energy Assessment of Centrifugal Pumping Systems 10/07

  - Systems evaluated : 39
  - Installed HP : 2575
  - 3 day on-site study

  - Results
    - Annual Energy Savings : $456,333
    - Capital Investment (Equipment) : $406,000

  - Implementation
    - Waiting on capital $'s

Case Study #5
Energy Assessment

- Energy Assessment of Centrifugal Pumping Systems 07/08

  - Systems evaluated : 15
  - Installed HP : 750
  - 1.5 day on-site study

  - Results
    - New Installed HP : 700
    - Annual Energy Savings : $289,930
    - Capital Investment (Equipment) : $243,850

  - Implementation
    - Waiting on capital $'s

Case Study #6
Energy Assessment

- Energy Assessment of Centrifugal Pumping Systems 10/07

  - Systems evaluated : 43
  - Installed HP : 4005
  - 3 day on-site study

  - Results
    - Annual Energy Savings : $675,333
    - Capital Investment (Equipment) : $544,000

  - Implementation
    - Waiting on capital $'s

Summary

Potential Energy Saving Opportunities

- Important Fundamental Relationships
  - Horsepower (Hp) = $\frac{\text{Flow rate } (\textit{Q}) * \text{Head } (\textit{H}) * \text{specific gravity}}{3960 * \textit{Pump Efficiency}}$
  - Fluid Energy = Fluid Power (***Hp***) * operating time (***T***)
  - To **<u>Conserve Energy</u>** Use:
    - **Reduce the Run Time (*T*)**
      Shed load
    - **Reduce the Flow Rate (*Q*)**
      close bypass; resize
    - **Reduce the Head (*H*)**
      Trim Impeller, VFD
    - **Improve *Pump Efficiency***
      Right Sizing of Pumps, VFD

Thank You …….

CRANE ENGINEERING

Greg A. Johnson
P&P Account Manager