2006 Forum on Energy:

Immediate Solutions, Emerging Technologies
May 15-17
Appleton, WI

Strategies to Optimizing Pump Efficiency and LCC Performance

Presented by: Joe Ruggiero

Title: Strategic Account Manager

Company: ITT IBG Goulds Pumps

ITT Industries
Fluid Technology

Pumping Systems Are Energy Intensive

Industry Type	Pump Energy (% of Total Motor Energy Use)
Petroleum	59%
Forest Products	31%
Chemicals	26%
Food Processing	19%
Primary Metals	9%

A 150 hp pump uses about $40,000 in electricity annually

MECS 1994, Bureau of Economic Analysis 1997
Census of Manufacturers, 1993

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:**
  - **throttled valves**
  - **pump over-sizing**
- **Seal leakage causes highest downtime and cost**

Excessive Valve Throttling is Expensive

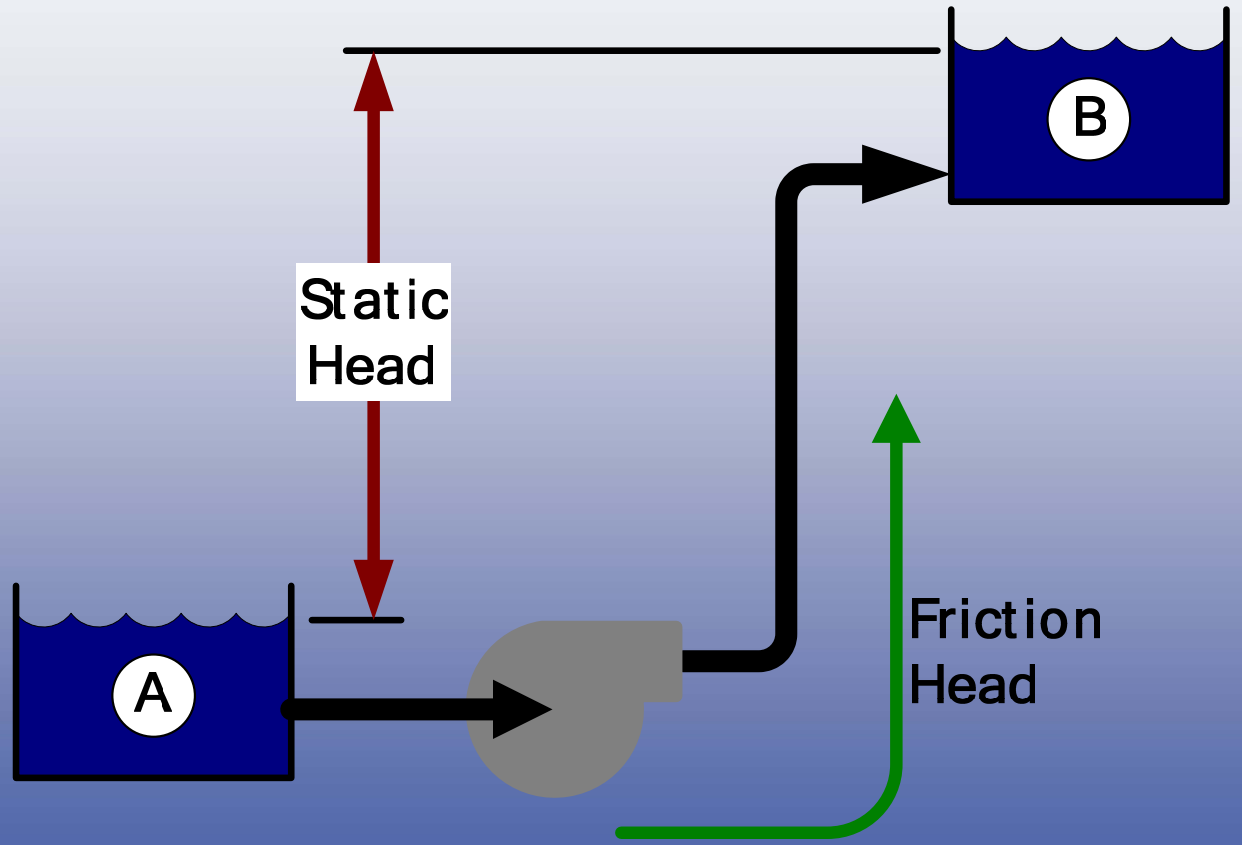
- Higher energy consumption
- Lower process reliability
- Poor process control
  - increased variability
  - manual operation

Control engineers need to incorporate the pumping system as part of the automation architecture

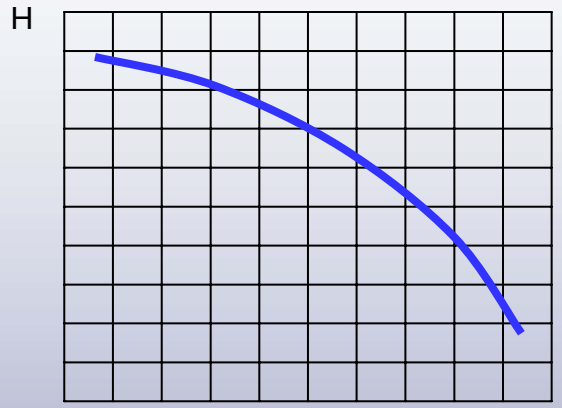
Some Fundamentals

Fixed vs. Variable Speed Pumping

Hydraulic System

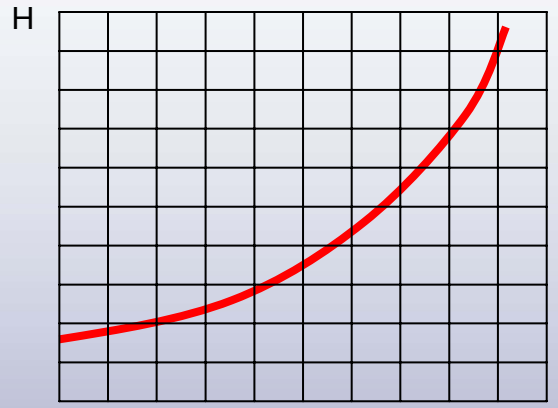


Basic Pump Curves



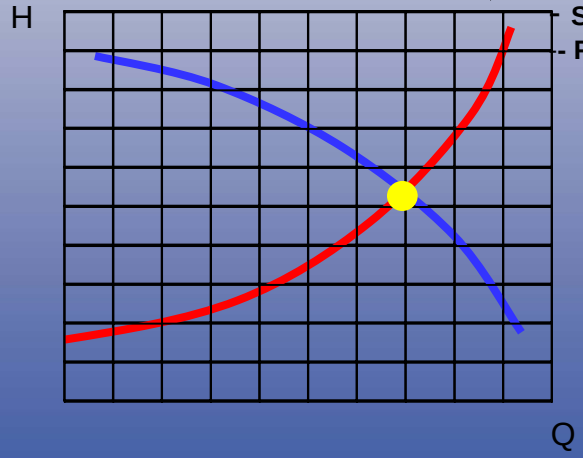
Pump Curve:

- **Motor Speed**
-- **Impeller Diam.**



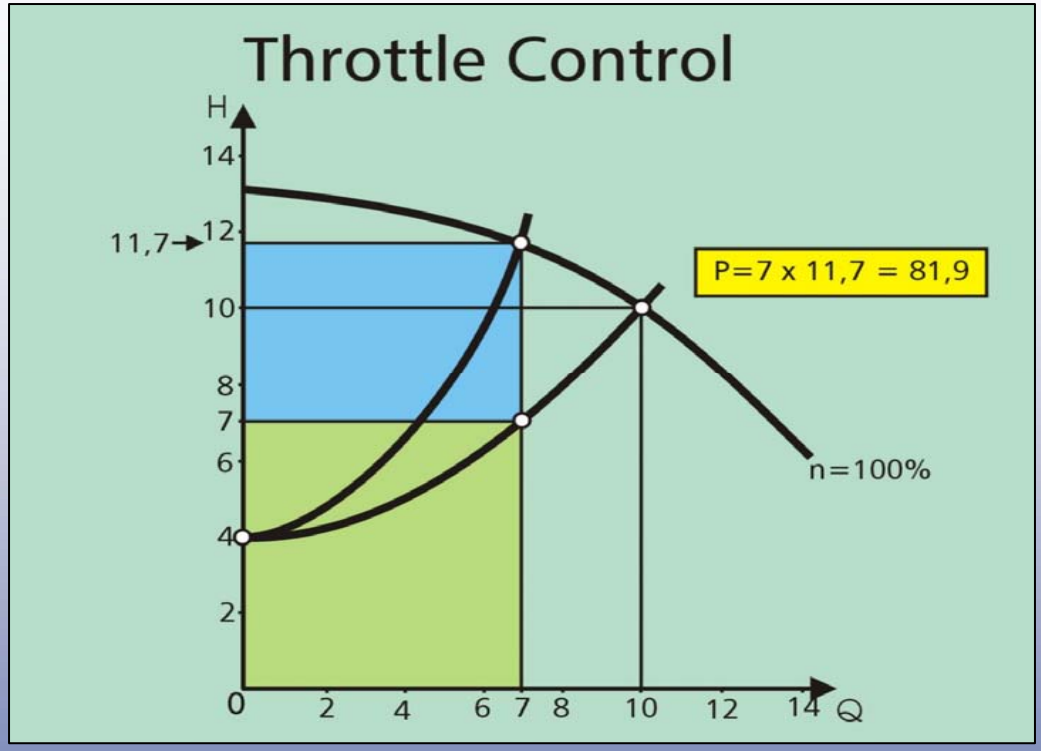
System Curve"

- **Static Head**
- **Friction Head**

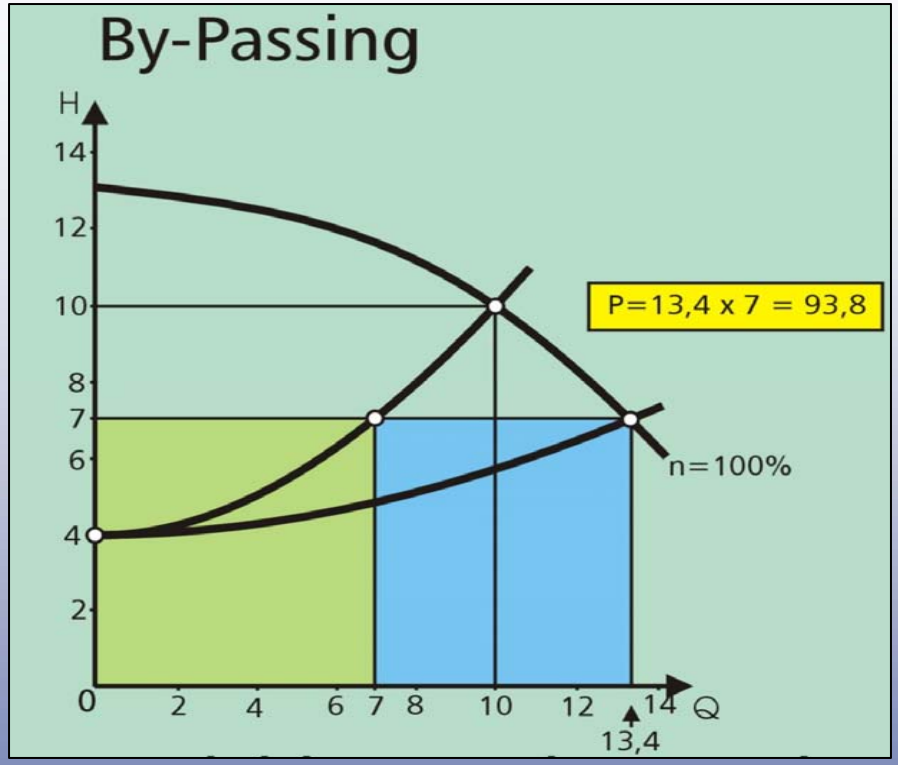


The operating point is at the intersection of the pump and system curves.

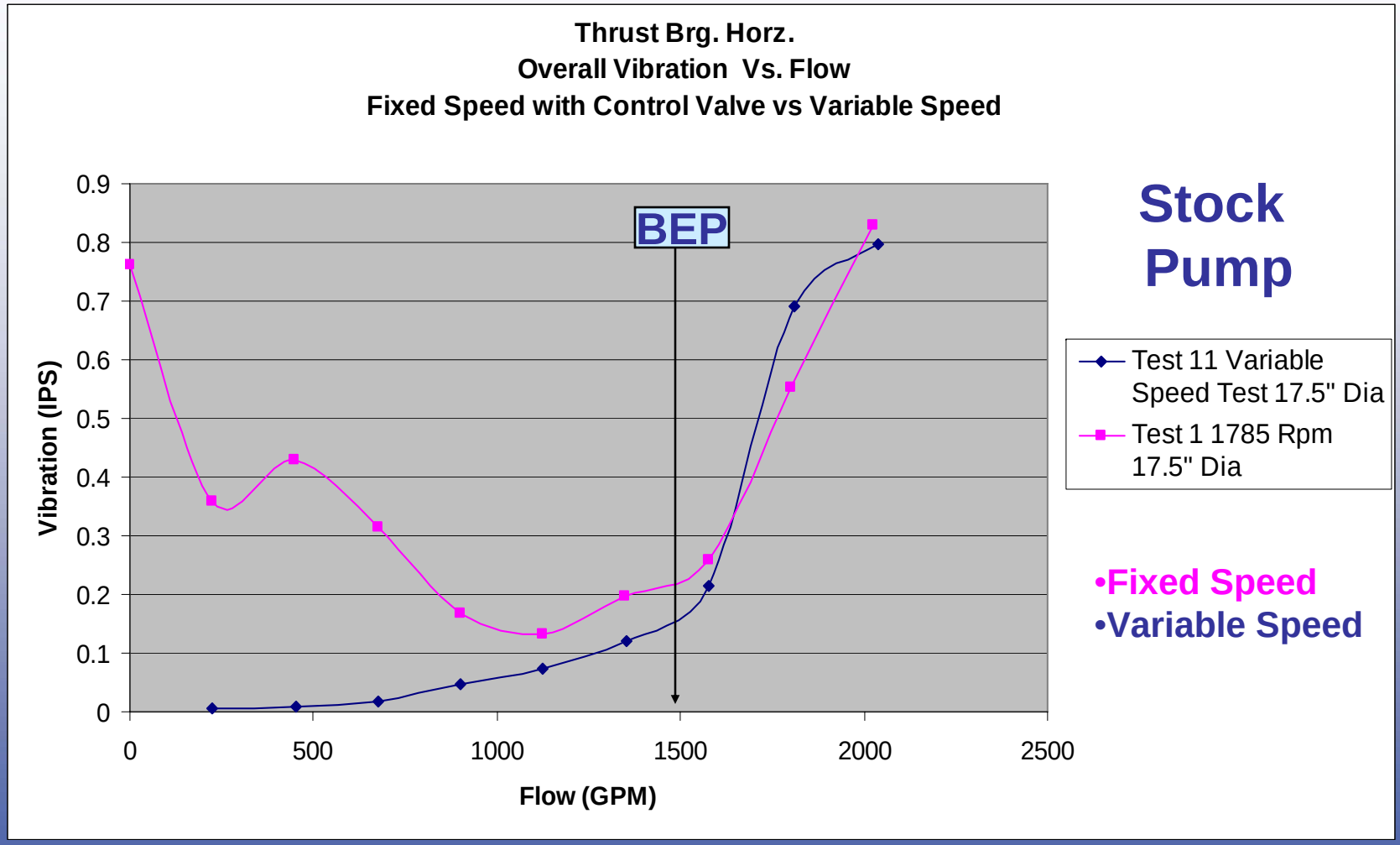
H = Head
Q = Flow
● = operating point



- Valve throttling results in excess power consumption
- Excess energy noted in blue area.



- Bypass lines consume excess power consumption.
- Excess energy noted in blue area.

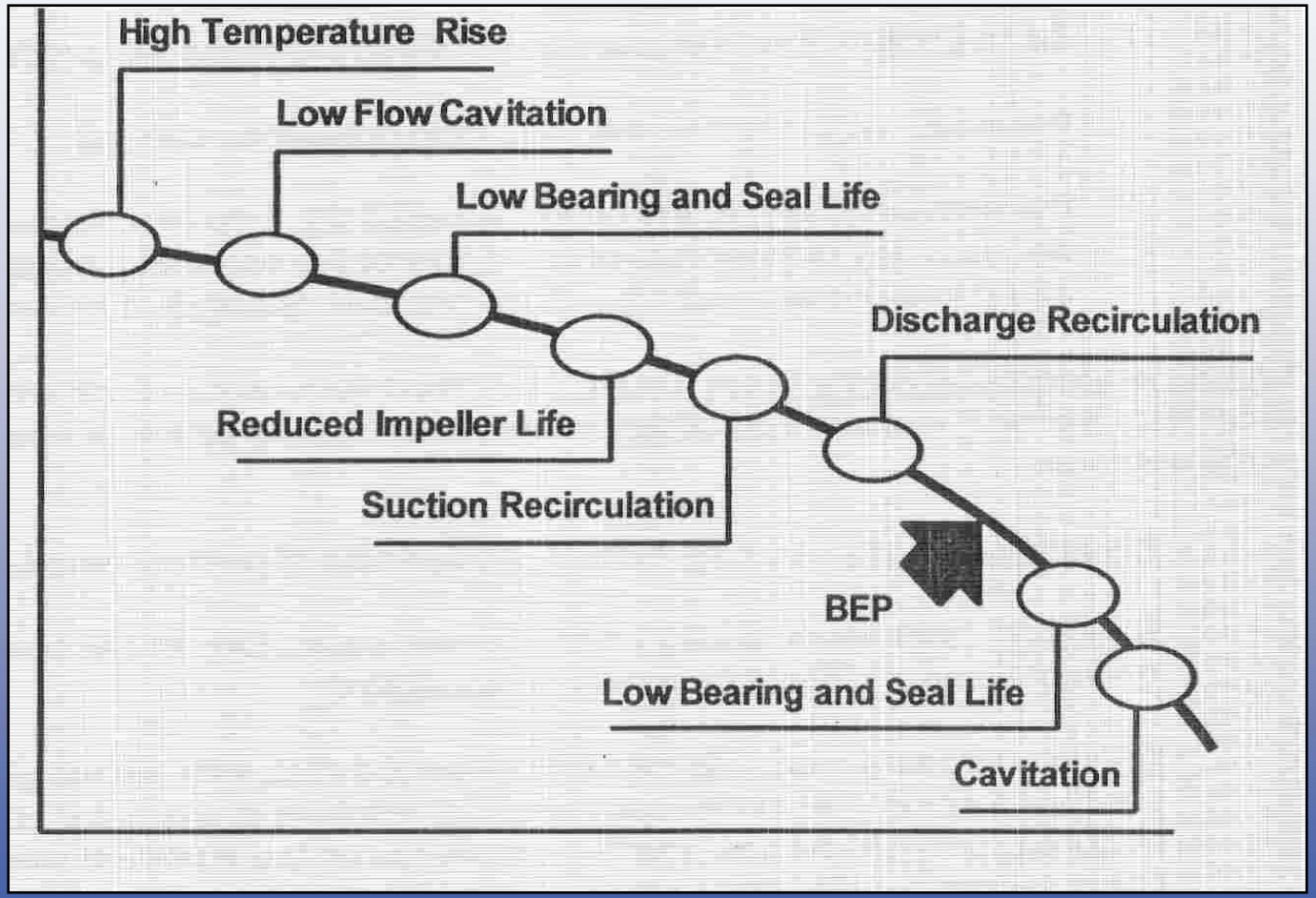


Stock Pump

- **Fixed Speed**
- **Variable Speed**

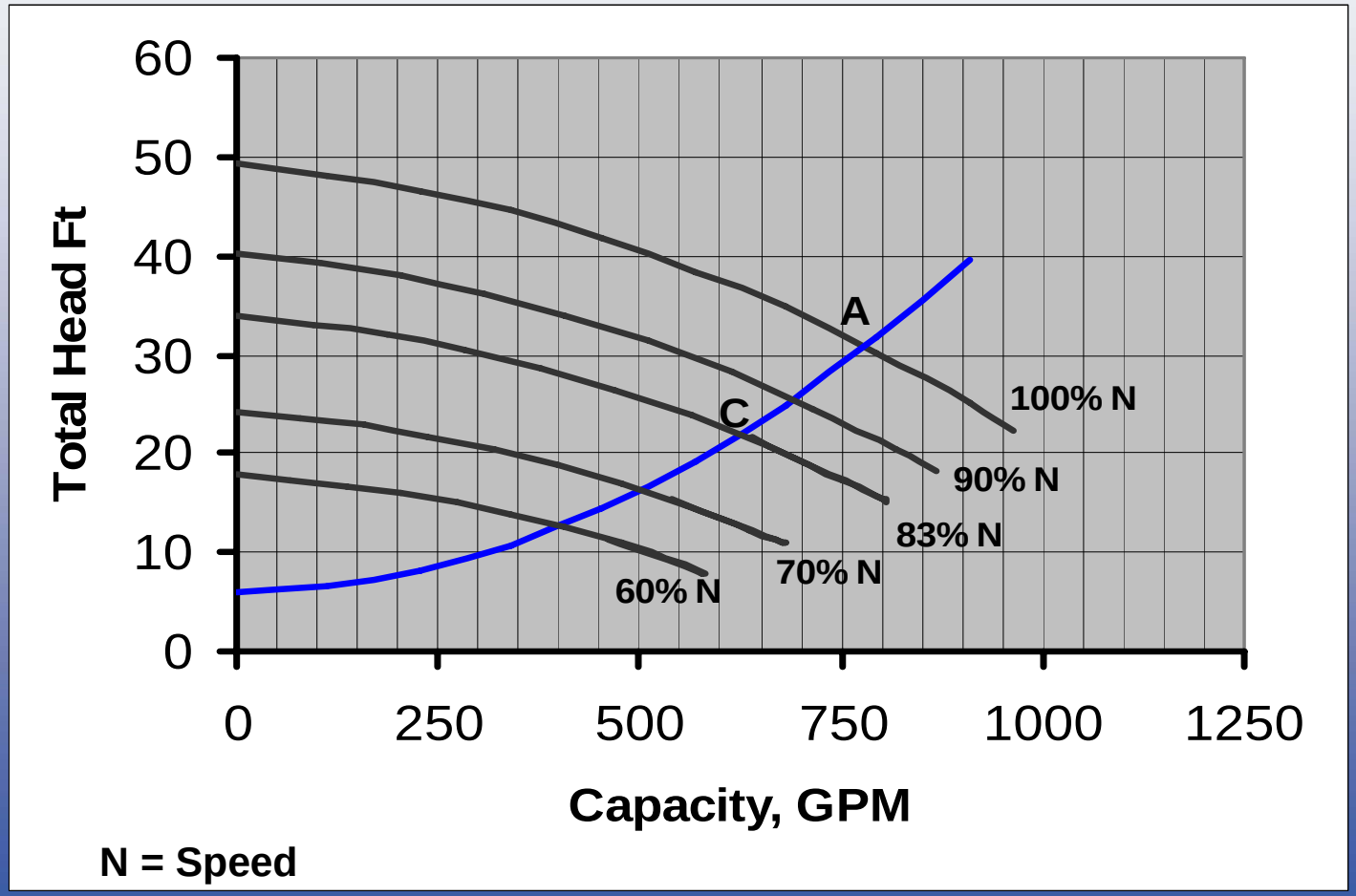
BEP = 1500 GPM

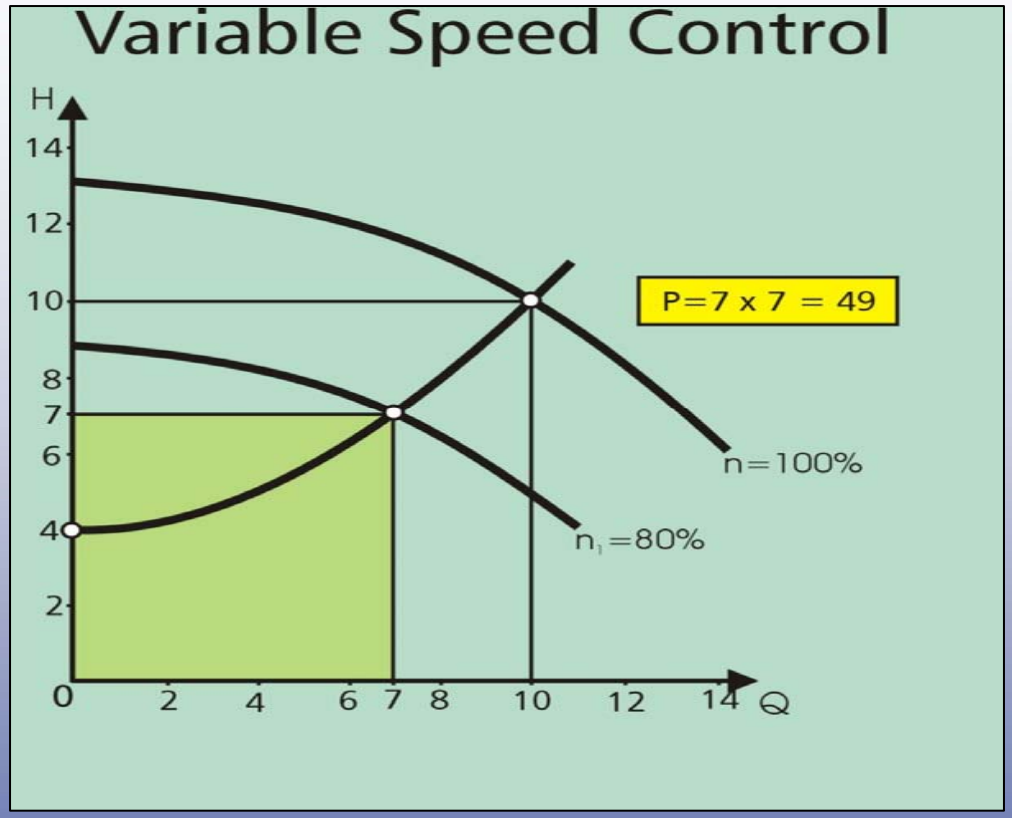
Reliability Issues Relative to BEP



Pump Performance Curve

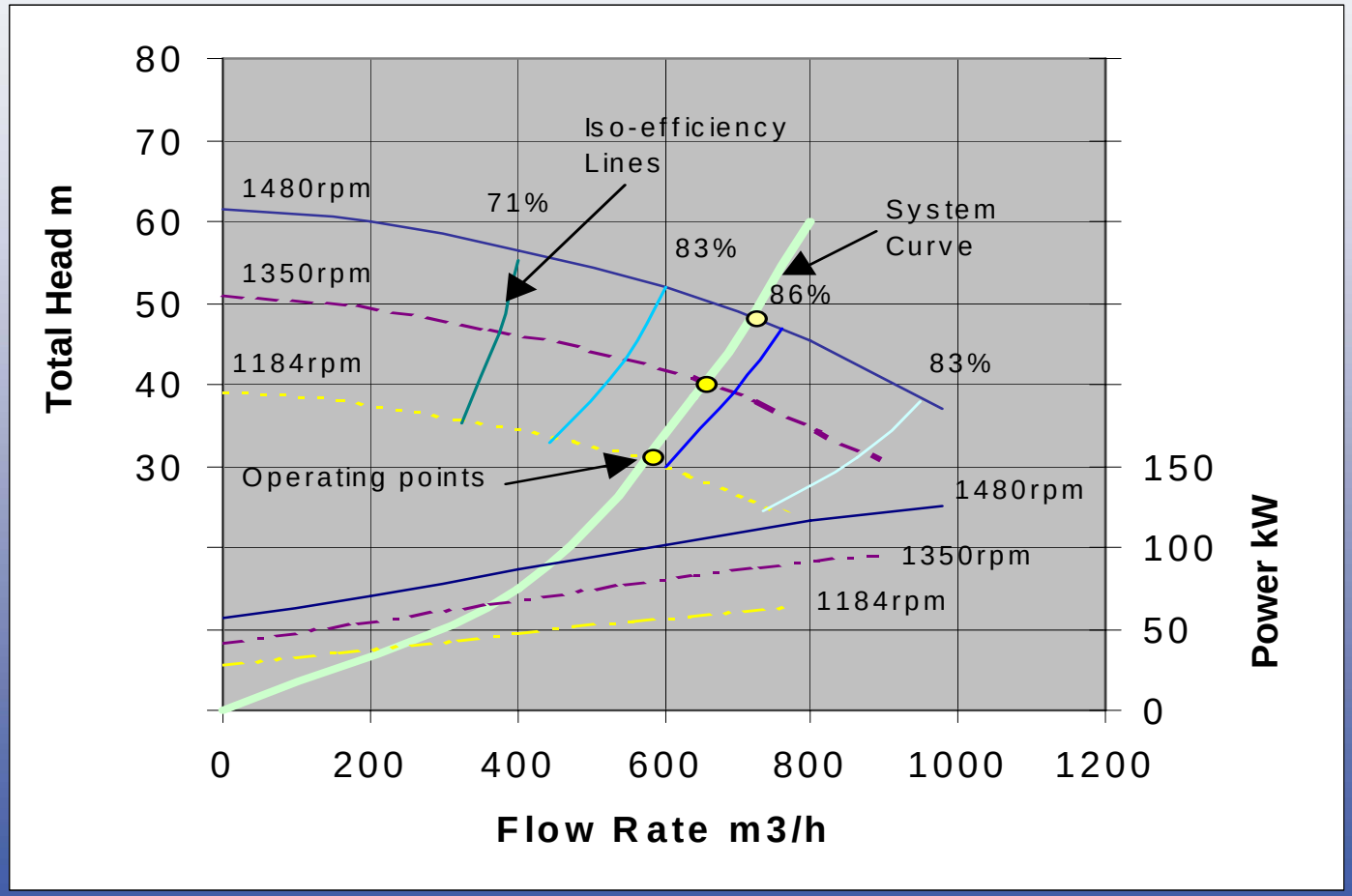
Variable Speed: *Maximizes HQ Flexibility*



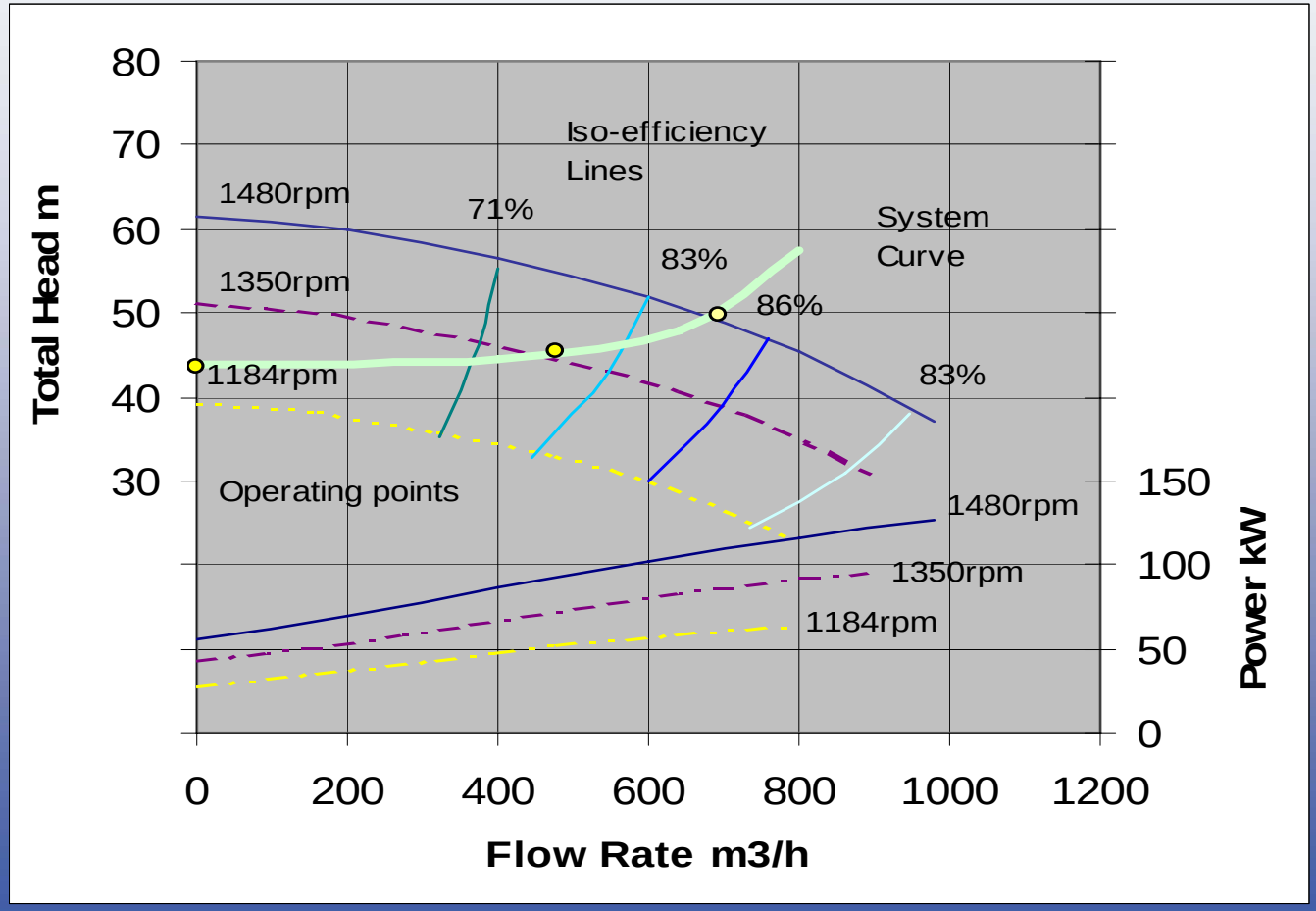


- Variable speed control meets the exact flow and head requirements
- No excess energy is consumed!

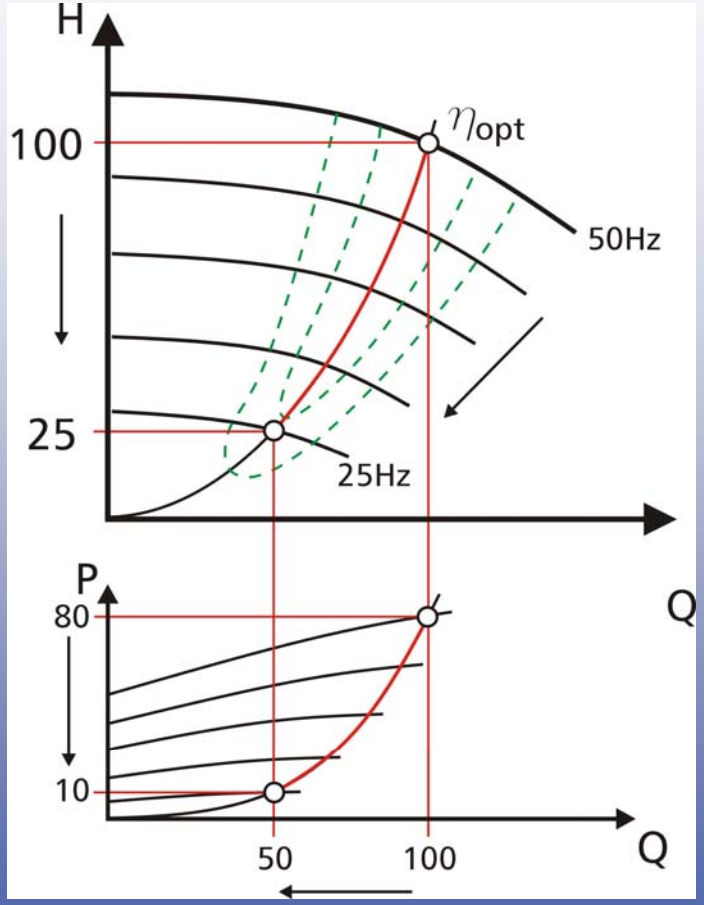
Effect of pump speed changes on a system with low static head.



Effect of pump speed changes on a system with high static head.



Affinity Laws in Action



P = Power

Energy savings are possible because of affinity laws.

Speed reduction provides significant energy savings at partial load.

The reduction of the speed provides:

- **Flow reduction according to the linear function**
- **Head reduction according to a square function**
- **Power reduction according to a cubic function!**

Variable Speed Control

Opportunities and Benefits

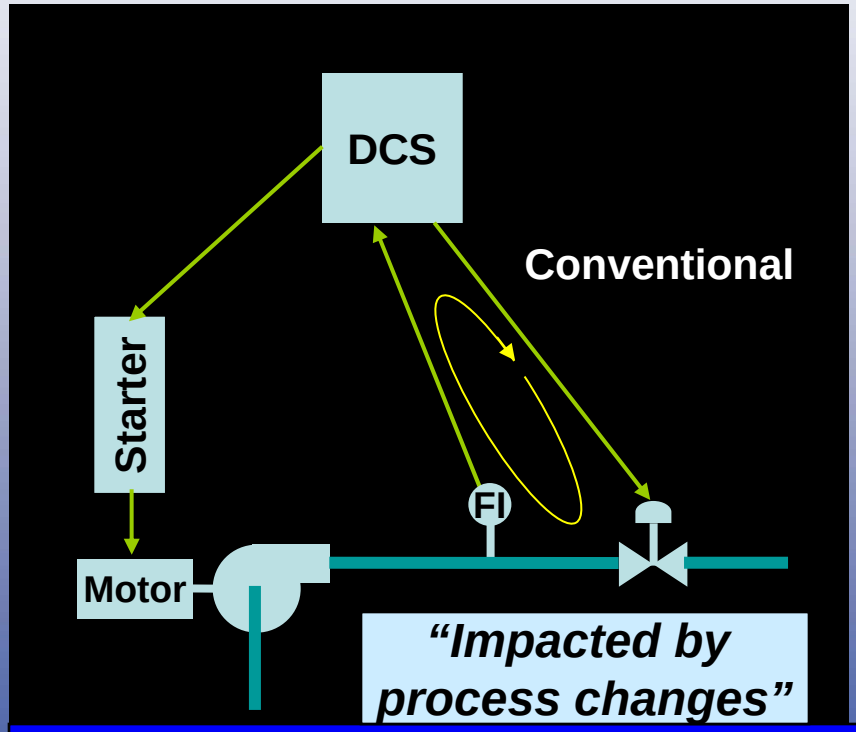
U.S. Motor Systems
Market Opportunity Assessment

"Motor systems equipped with VSD's account for only 4% of motor energy usage, compared to the potential for application on 18 - 25% of the total energy used…"

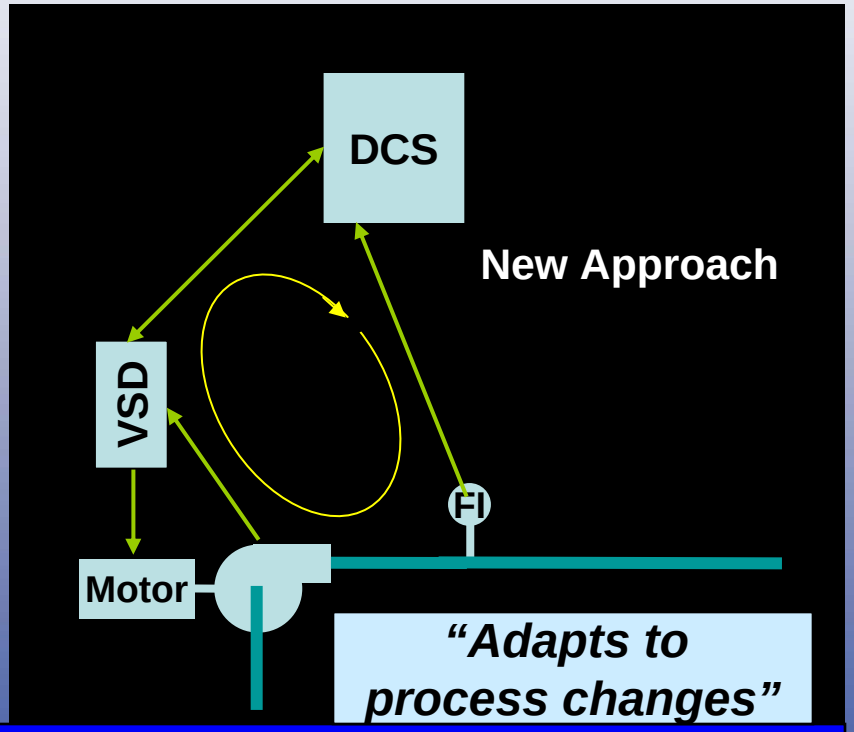
Source: DOE-Office of Industrial Technology

Pumping System Elements

Traditional Pumping System
(Fixed speed pump, control valve, transmitter)

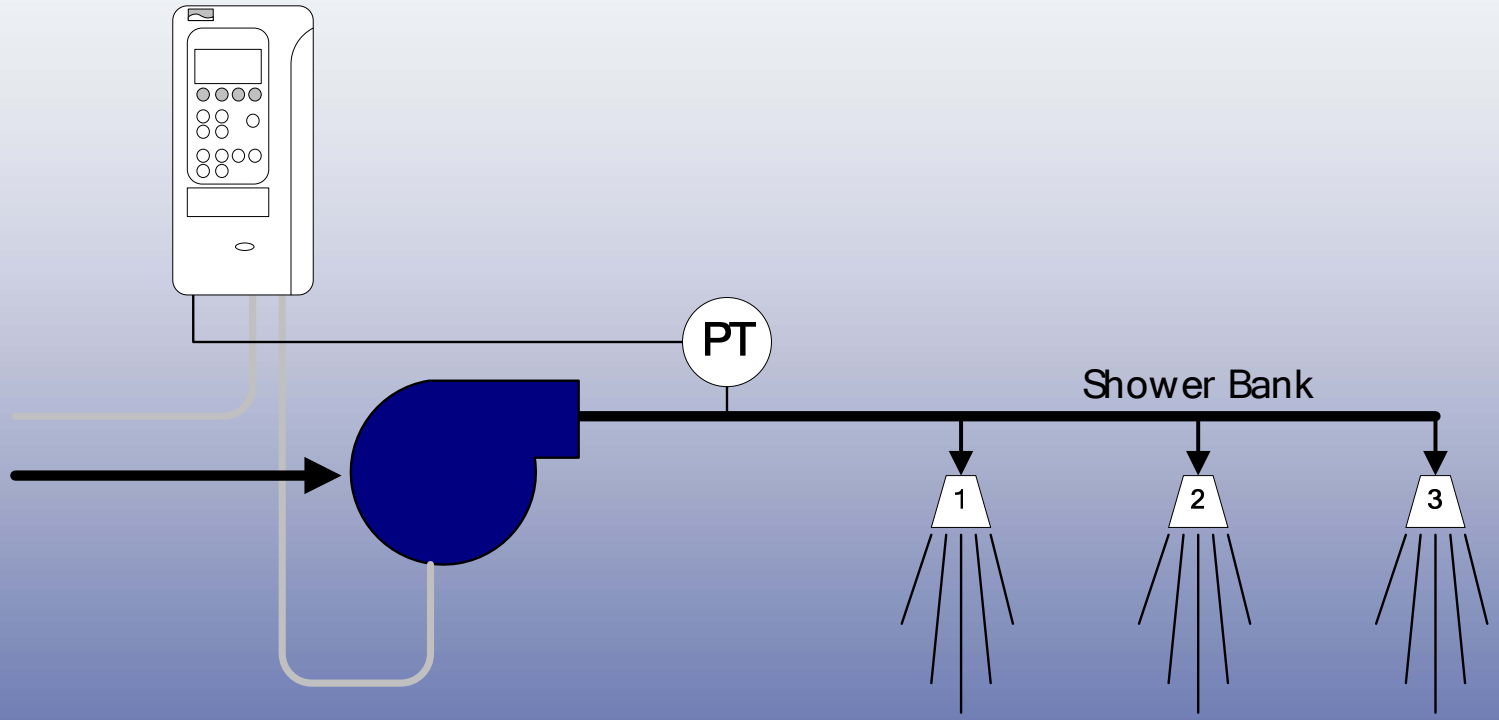


Variable Speed Drive Pumping System

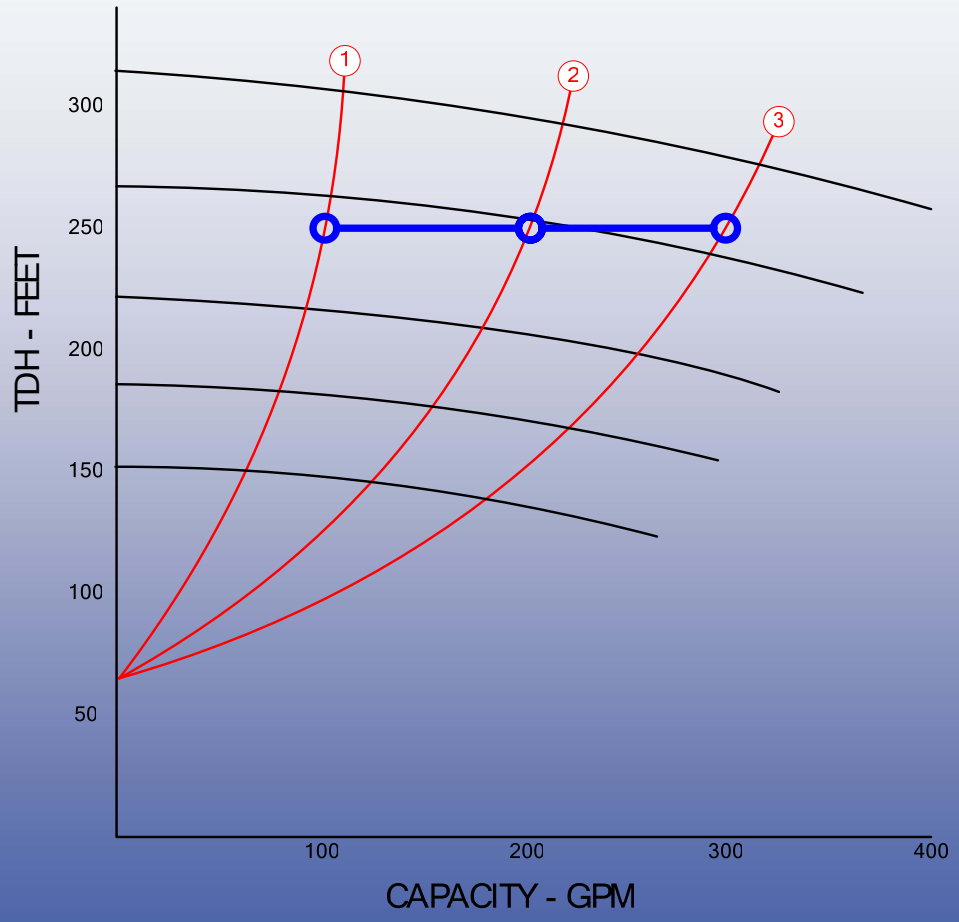


Control loops are tightly associated with pumping systems

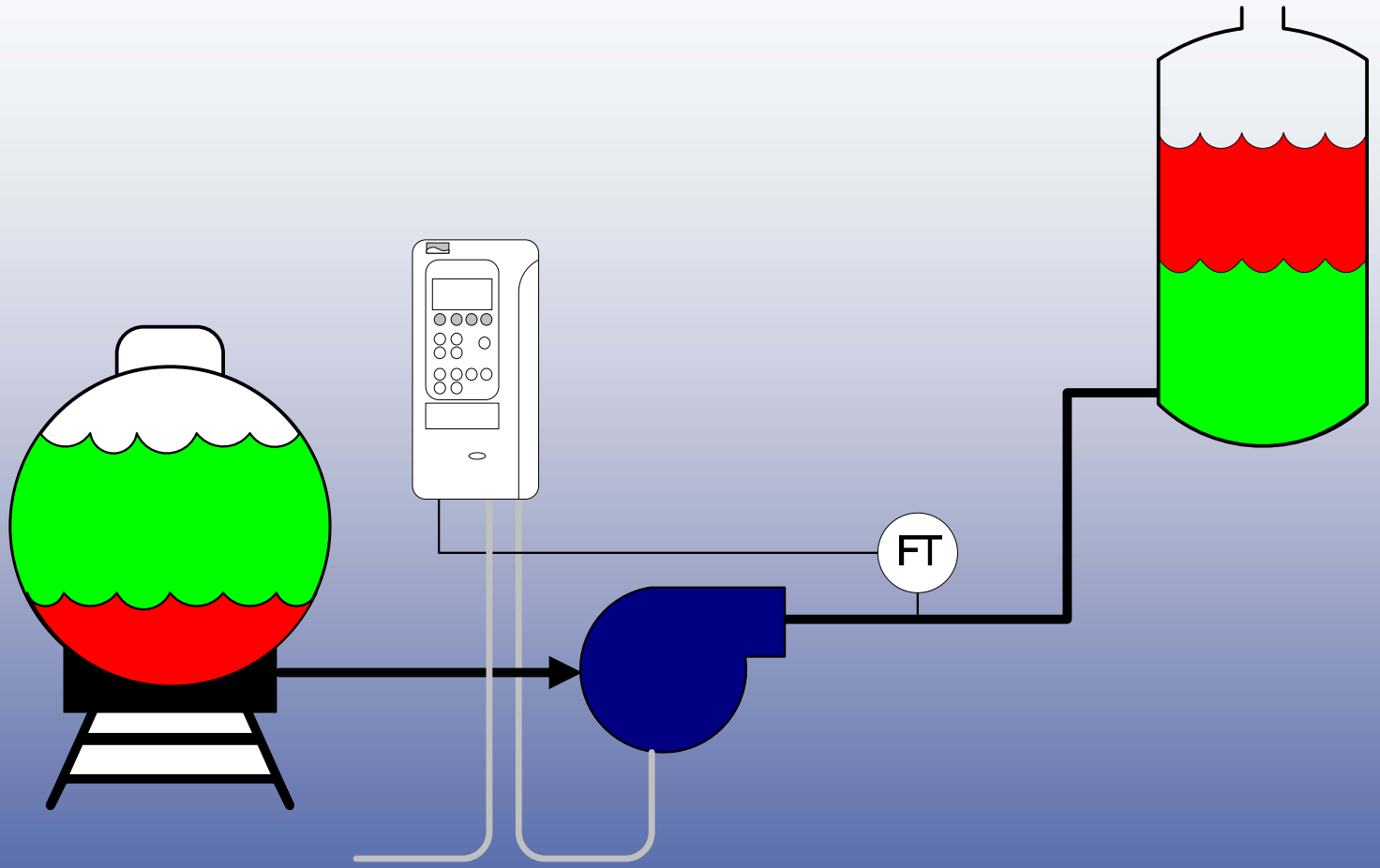
Pressure Control



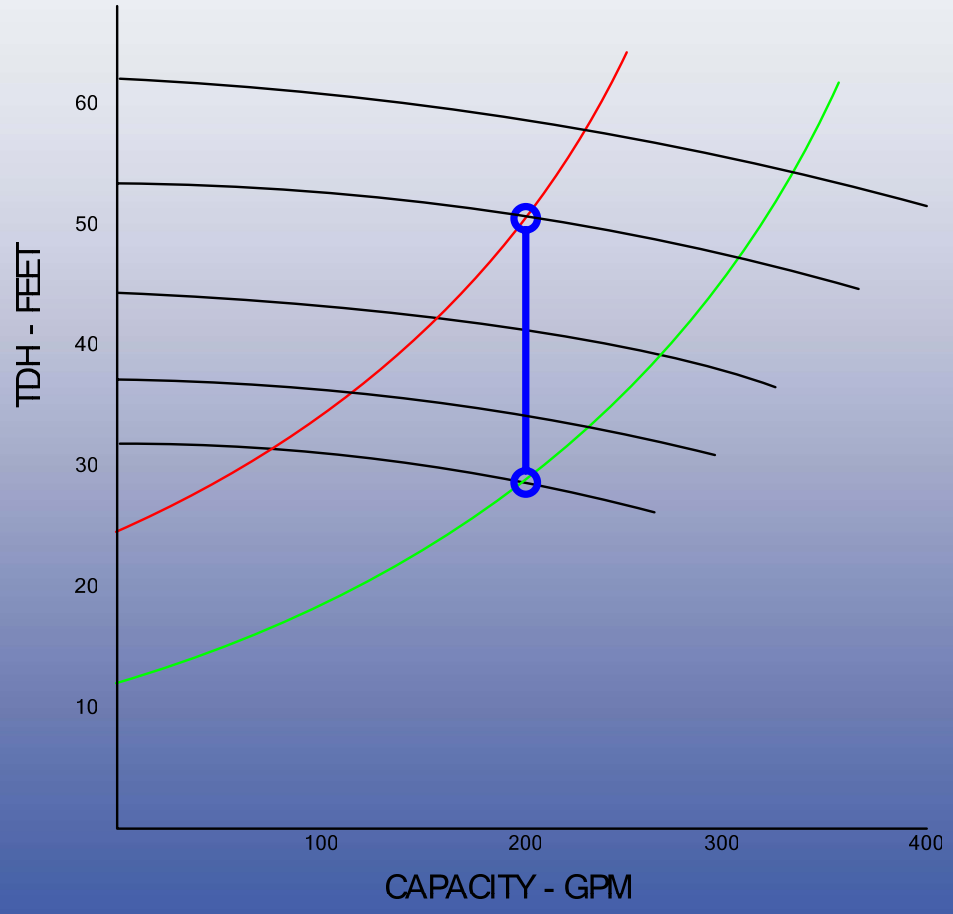
Pressure Control



Flow Control



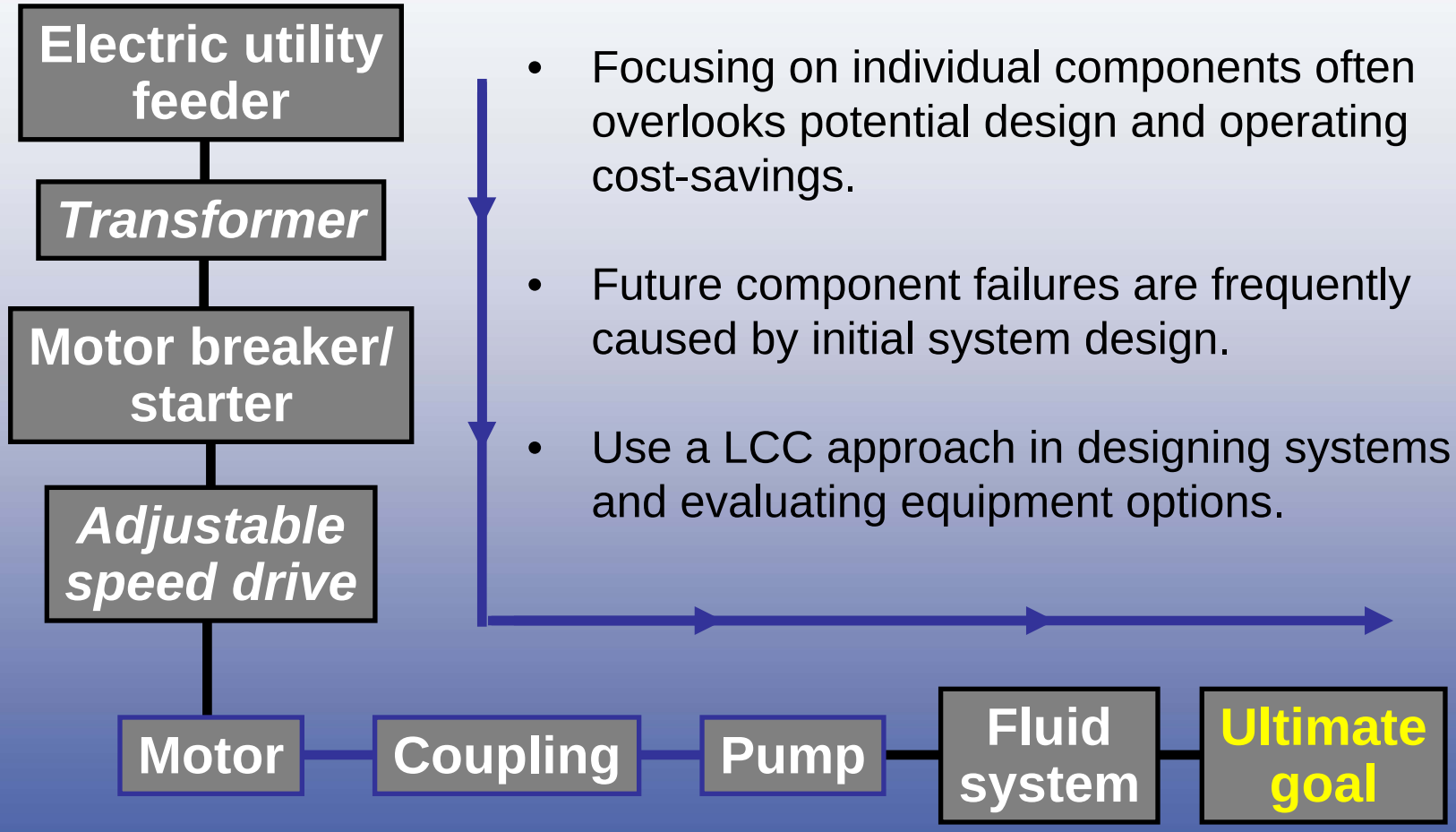
Flow Control



Optimizing Pump Performance

A Systems Approach

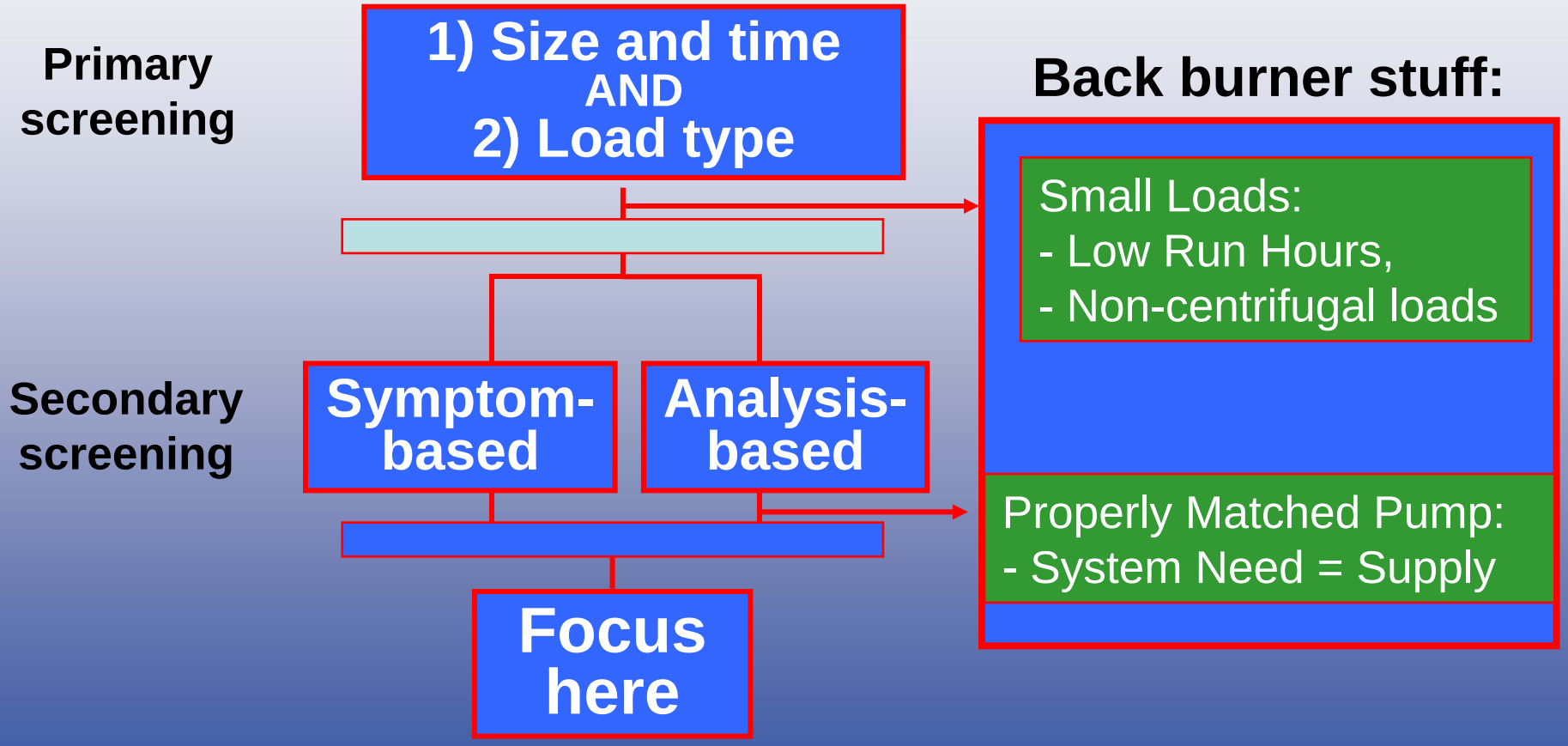
The Systems Approach



- Focusing on individual components often overlooks potential design and operating cost-savings.
- Future component failures are frequently caused by initial system design.
- Use a LCC approach in designing systems and evaluating equipment options.

Prescreening Methodology

First: Can it be turned off?



Source: DOE - OIT

Pump Symptoms that Indicate Potential Opportunity

- **Throttled valve-controlled systems**
- **Bypass (recirculation) line normally open**
- **Multiple parallel pump system with same number of pumps always operating**
- **Constant pump operation in a batch process or frequent cycle operation in a continuous process**
- **Presence of cavitation noise (at pump or elsewhere in the system)**

Energy Savings Methods

Action	Saving
Replace throttling valves with speed controls	10 - 60%
Reduce speed for fixed load	5 - 40%
Install parallel system for highly variable loads	10 - 30%
Equalize flow over product cycle using surge vessels	10 - 20%
Replace motor with more efficient model	1- 3%
Replace pump with more efficient model	1- 2%

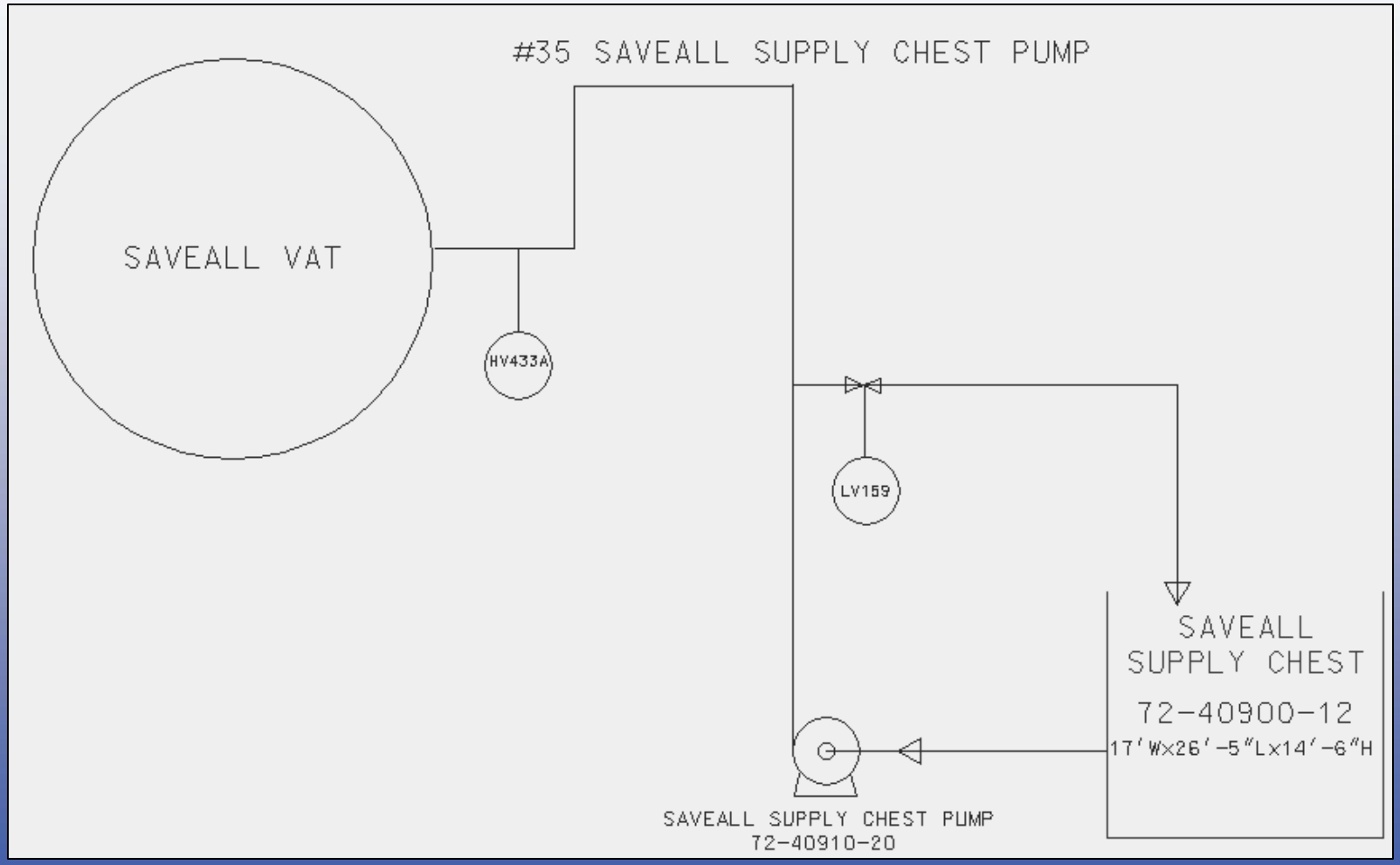
Source: DOE - Office of Industrial Technology

Throttled Valve

with

Bypass (recirculation line) normally open

PM Saveall Supply Pump



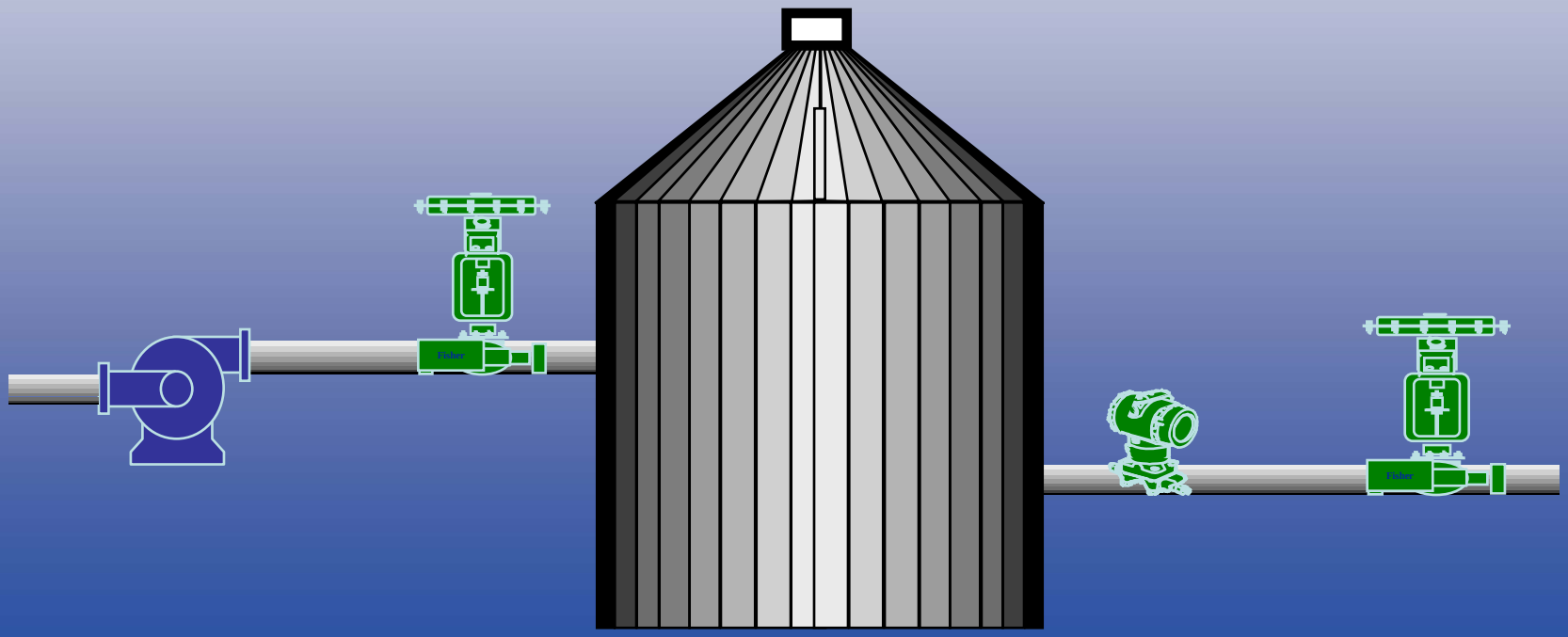
Paper Machine Saveall Supply

35PM Save-all Supply Pump								
#72-40910-20	21-Sep	22-Sep	23-Sep	24-Sep	27-Sep	28-Sep	29-Sep	30-Sep
Design 10,331 GPM@ 99.1' TDH	10,331	10,331	10331	10,331	10,331	10.331	10,331	10,331
Installed Motor 350HP								
Grade Basic Weight lb	51	OUTAGE	50	51	51	60	46	50
Speed ft/min	3130	OUTAGE	2975	3035	3153	3200	3410	3200
Pump Discharge Pressure in Ft	81	OUTAGE	79	79	79	76	76	76
Suction Pressure in Ft	8	OUTAGE	8	8	8	8	8	8
Motor Load in amps	60	0UTAGE	58	58	60	60	60	60
Tank level control valve position (LV 159)	31%	OUTAGE	37%	41%	35%	35%	41%	40%
Other Control Valve (HV433A)	87%	OUTAGE	87%	87%	87%	87%	87%	87%
Static Head in Ft	20	OUTAGE	20	20	20	20	20	20
GPM	10400	OUTAGE	10600	10600	10600	10800	10800	10800

Eliminate By-pass line & Valves, Cavitation and High Maintenance

Greenfield Project Benefits

- **Potential to downsize pumps, motors and pipes (smaller footprint)**
- **Eliminate valves, starters, pneumatic lines, and related wiring**
- **Reduce medium voltage power requirements in MCC**



Pump Optimization Benefits Summary

- **Reduce Energy and Maintenance Cost**
- **Improve Pump and Process Reliability**
- **Increase Process Uptime and Throughput**
- **Improve Process Control & Quality**
  - **less variability**
  - **higher % of loops in automatic**
- **Reduce Fugitive Emissions**

High Reliability Impact VFD Applications

- Mill Water Supply
  - Pressure control
- Seal Water Supply
  - Pressure control
  - Reduce process downtime
- Stock Blending
  - Consistency control
  - Improve product quality
- WW Dilution
  - Consistency control
- Machine Chest
  - Basis Weight MD control
  - Improve PM performance
- Broke Chest
  - Reduce Energy & Maintenance
- Repulper Chest
  - Reduce Energy & Maintenance

"There are many high impact applications that improve bottom line performance"

Strategies to Optimizing Pump Efficiency and LCC Performance

Thank You!