



Pumps And Motors Efficiency

WELCOME!

Session starts at 10:00 a.m.



WELCOME!

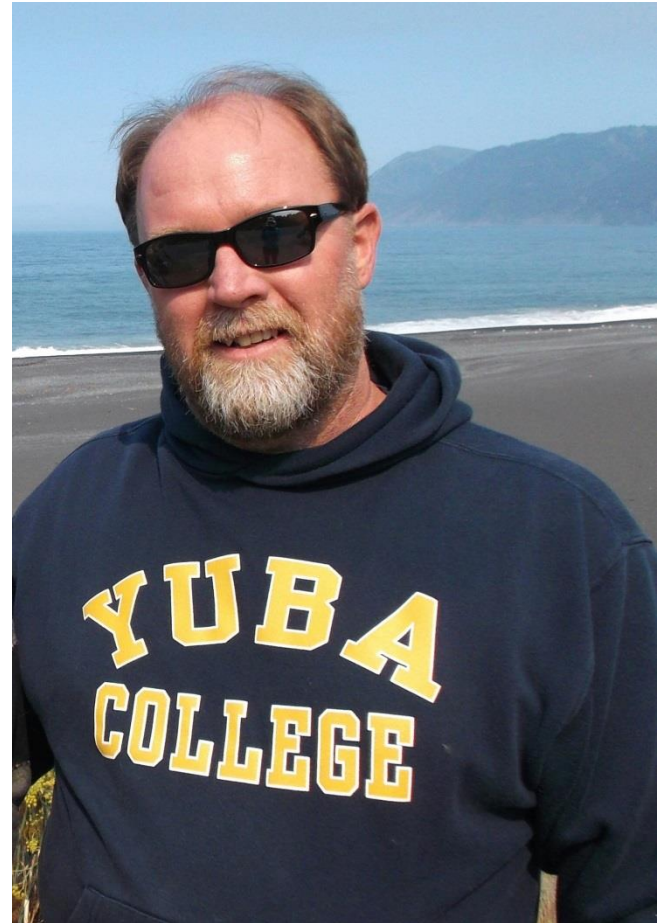
This training is presented by RCAC with
funding provided by the California State
Water Resources Control Board
Division of Drinking Water (DDW)



Your Moderators Today...



Mike Boyd
Gering NE



John Hamner
Kelseyville CA

The Rural Community Assistance Partnership



Southeast Rural
Community Assistance
Project, Inc.



COMMUNITY
RESOURCE GROUP

RCAC Programs

- ◆ Affordable housing
- ◆ Community facilities
- ◆ Water and wastewater infrastructure financing (Loan Fund)
- ◆ Classroom and online training
- ◆ On-site technical assistance
- ◆ Median Household Income (MHI) surveys

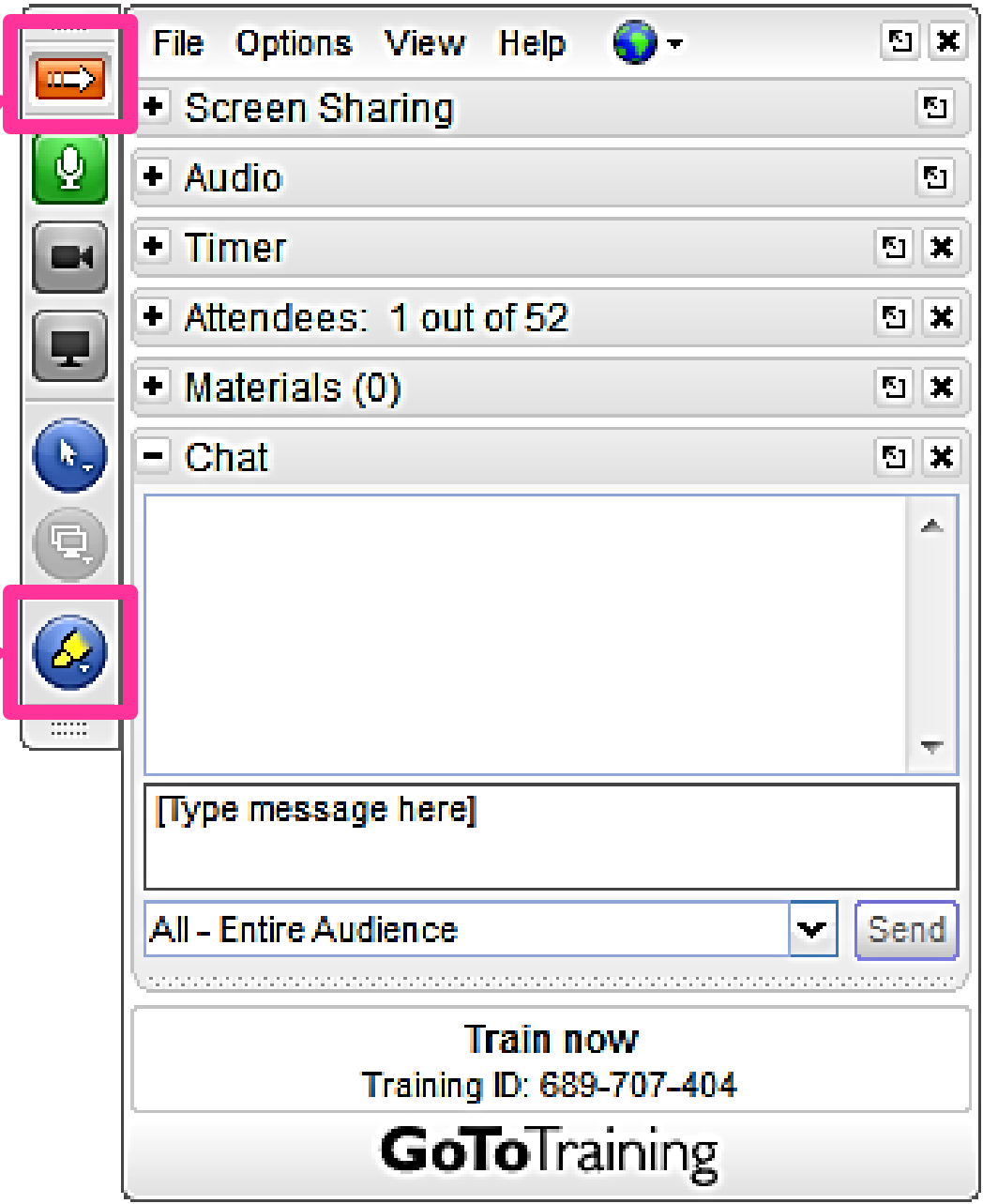
Performance Assessment Rating Tool (PART)



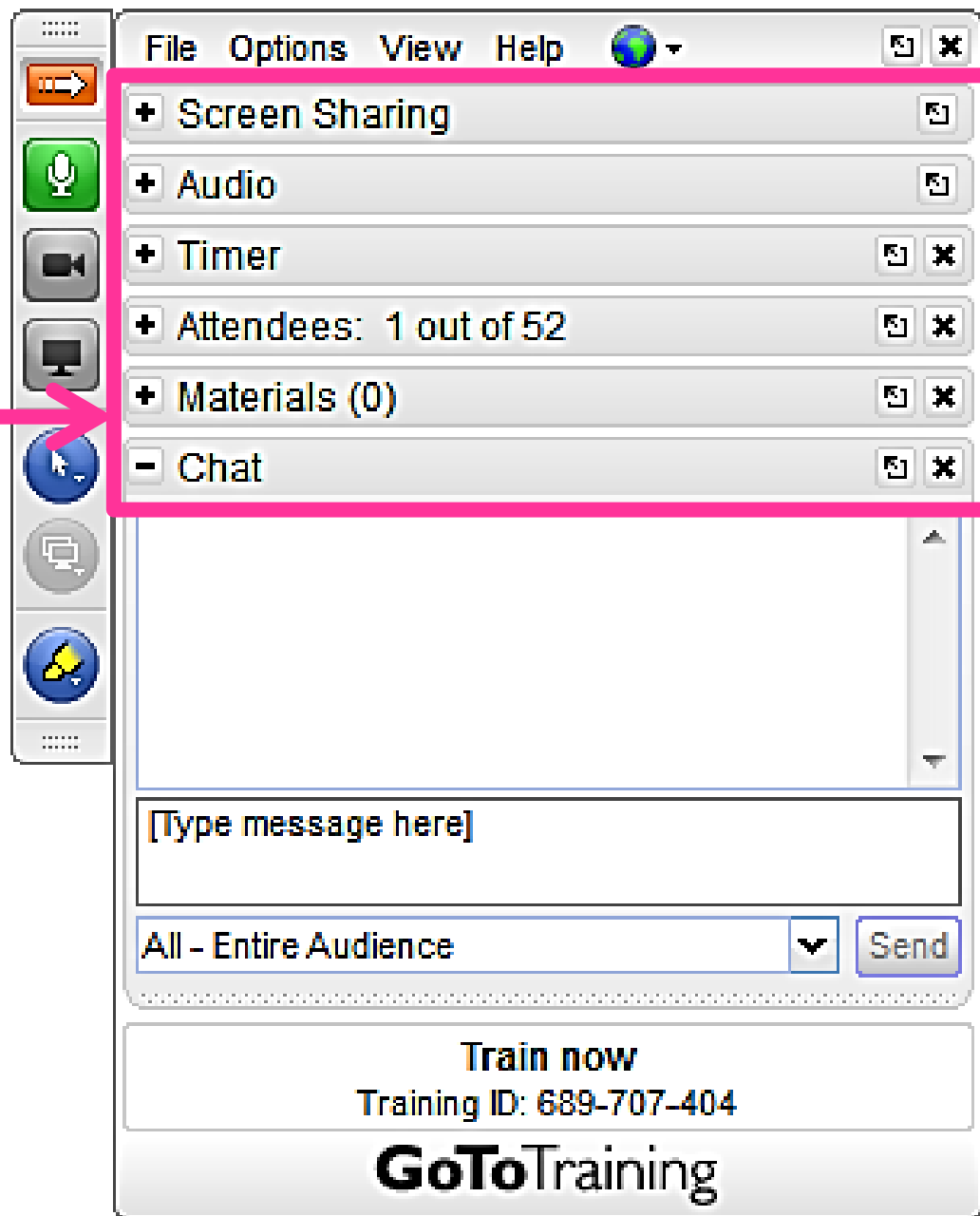
- ◆ 4 to 6 weeks from today
- ◆ Email w/ today's workshop in subject line
- ◆ 2 questions – 3 minutes maximum
- ◆ How did you use the information that was presented today?
- ◆ Funders are looking for positive changes
- ◆ Help us continue these free workshops!

**Hide/Restore
Control
Panel**

**Marking
Tool**



Control Tabs



Audio Controls



**Attendee
List**

**Today's
Materials**

The screenshot shows the GoToTraining interface with a sidebar on the left containing icons for various functions. The main window has a menu bar (File, Options, View, Help) and several expandable sections. The 'Attendees: 1 out of 52' section is highlighted with a pink box, showing a list of participants with icons for mute, video, and chat. The 'Materials (0)' section is also highlighted with a pink box. Below these are buttons for 'Mute All', 'Unmute All', 'All', and 'Invite Others'. At the bottom, there is a 'Train now' button, the training ID '689-707-404', and the 'GoToTraining' logo.

File Options View Help

+ Screen Sharing

+ Audio

+ Timer

- Attendees: 1 out of 52

NAMES - ALPHABETICALLY

Neil Worthen (Organizer, P...

Mute All Unmute All All Invite Others

+ Materials (0)

+ Chat

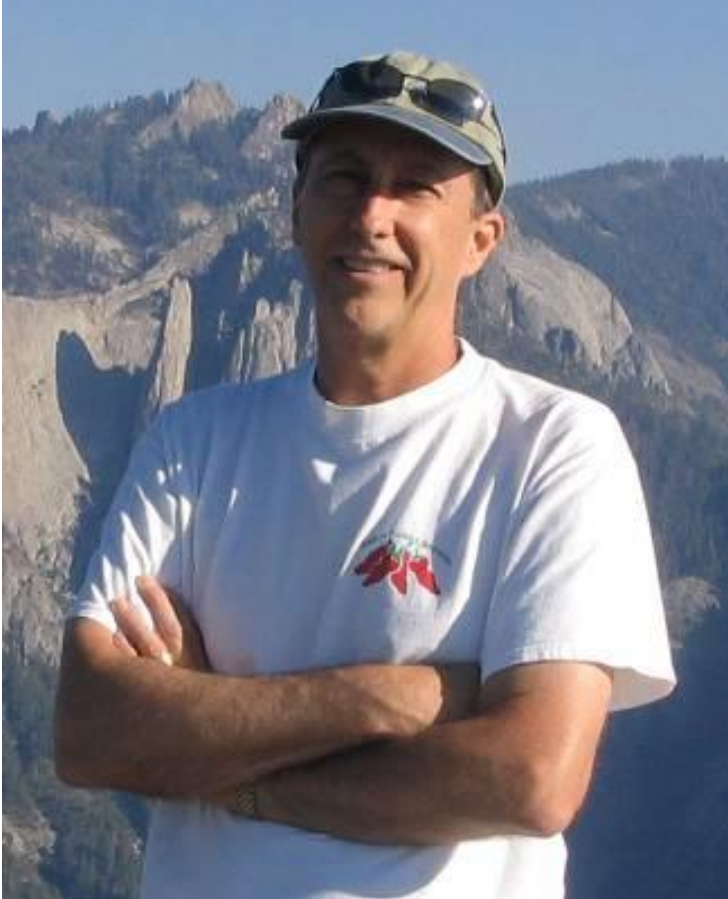
Train now
Training ID: 689-707-404
GoToTraining

Questions?



**Text your questions and comments
anytime during the session**

Your Presenter Today...



Neil Worthen
Las Cruces, NM

nworthen@rcac.org



Pumps And Motors Efficiency

RCAC 2015
Online Workshops





Poll Time!

Question 1: Who's here today?



Poll Time!

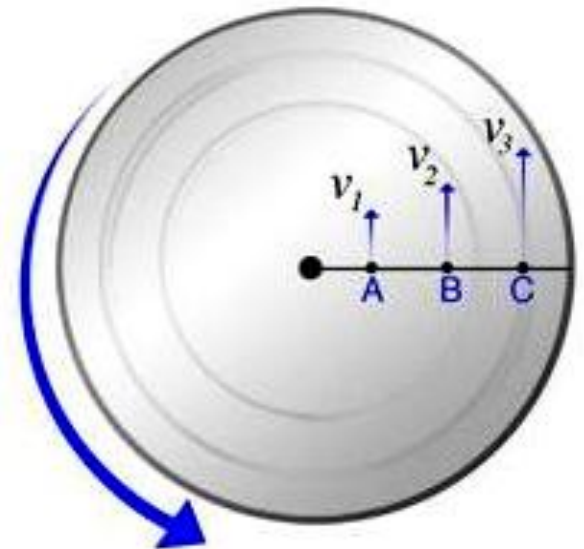
Question 2: If you answered "other"....

What Is...

- ◆ A Motor?
- ◆ A Pump?

Let's Start With Motors...

- ◆ A device that converts electrical energy into mechanical energy, typically by **inducing** rotation within a magnetic field



How About a Pump?

- ◆ A device that converts mechanical energy into fluid energy, generally by suction or compression, to move water, air or other fluids



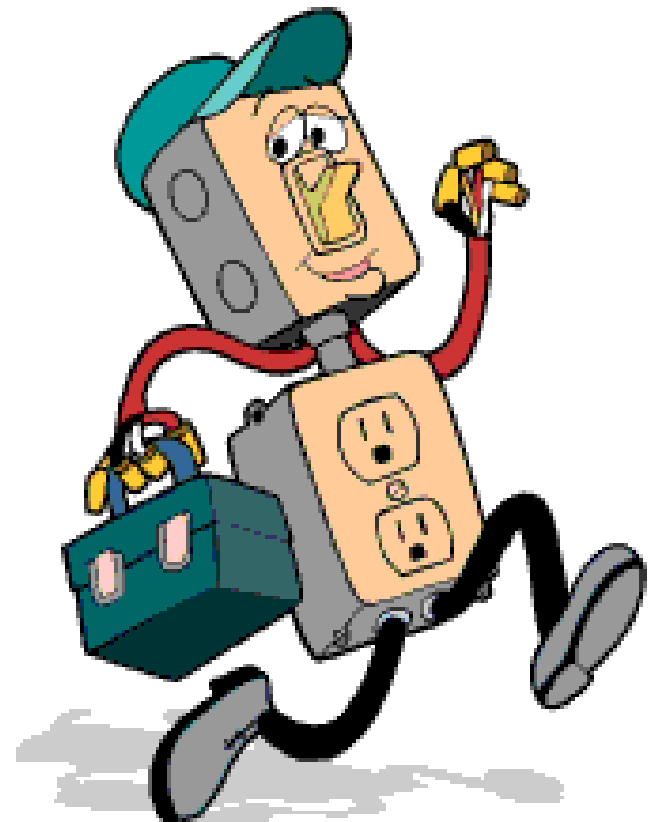
GROUP QUESTION...

(Raise your hand or text message)

Based on the previous two slides, what is happening when a motor is driving the movement of water?

ANSWER:

Electrical energy
is converted to
fluid energy!



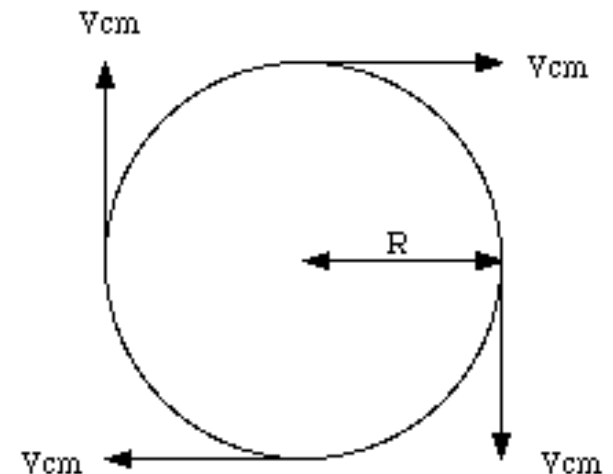
Why Aren't Motors Very Good At What They Do?

- ◆ Energy is converted to motion by the proximity of a magnetic field (induction)
- ◆ ***Not all the energy is converted –***
 - ▶ Heat
 - ▶ Friction
 - ▶ Resistance



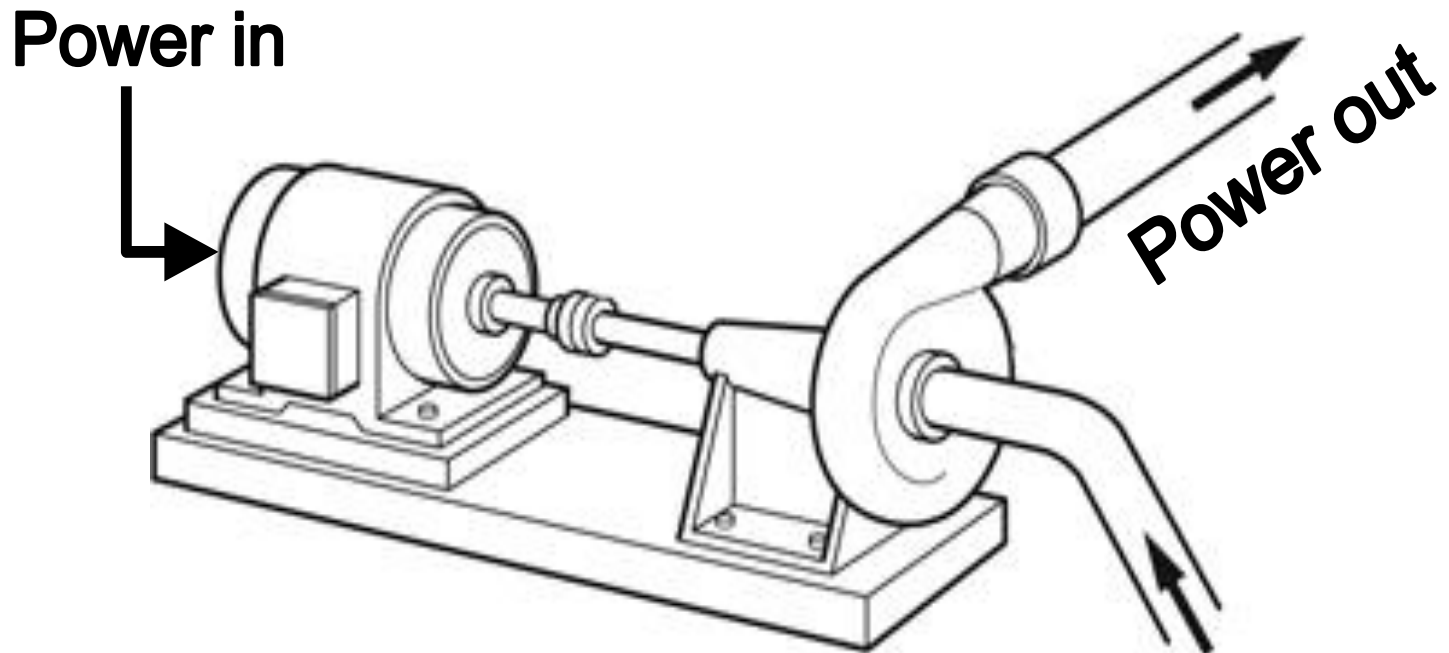
Why Aren't Pumps Very Good At What They Do?

- ◆ Not all rotational energy is converted to fluid power
- ◆ Some energy is lost to friction, wear, inefficiency



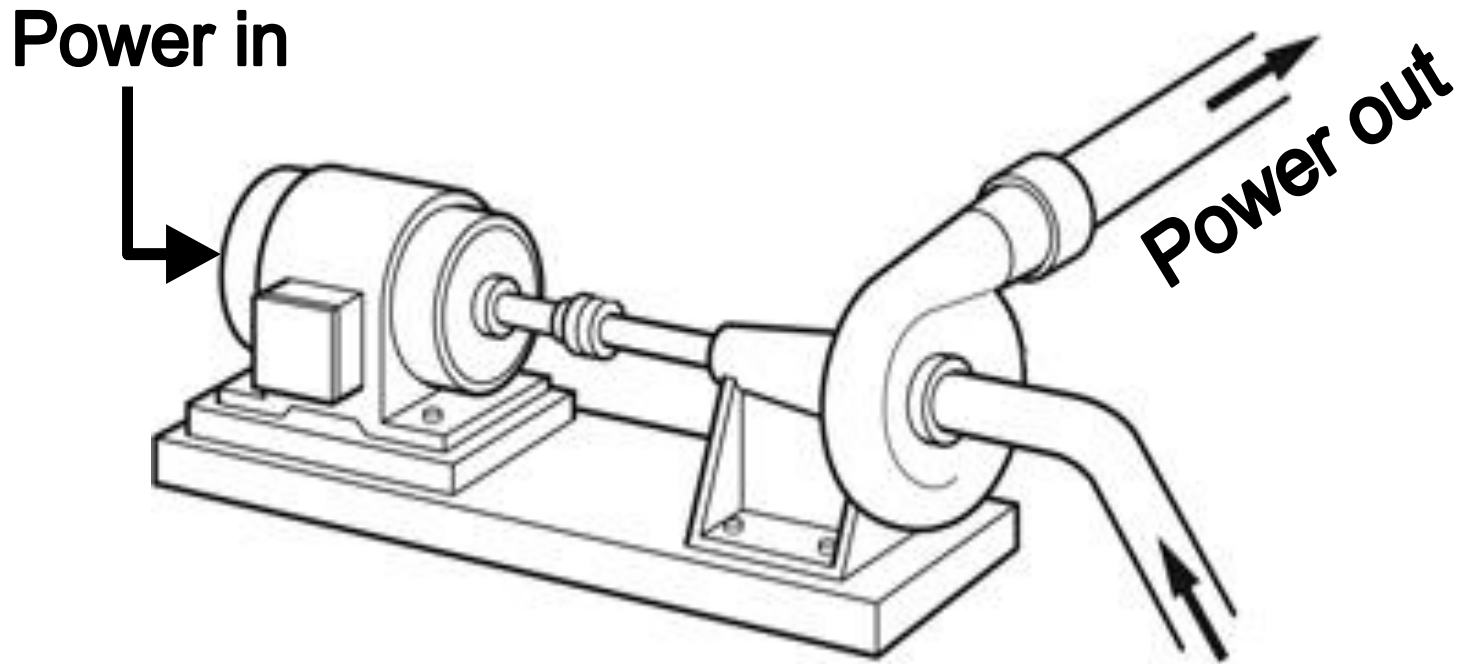
Basic Realities #1

- ◆ Motor output power will always be less than input power



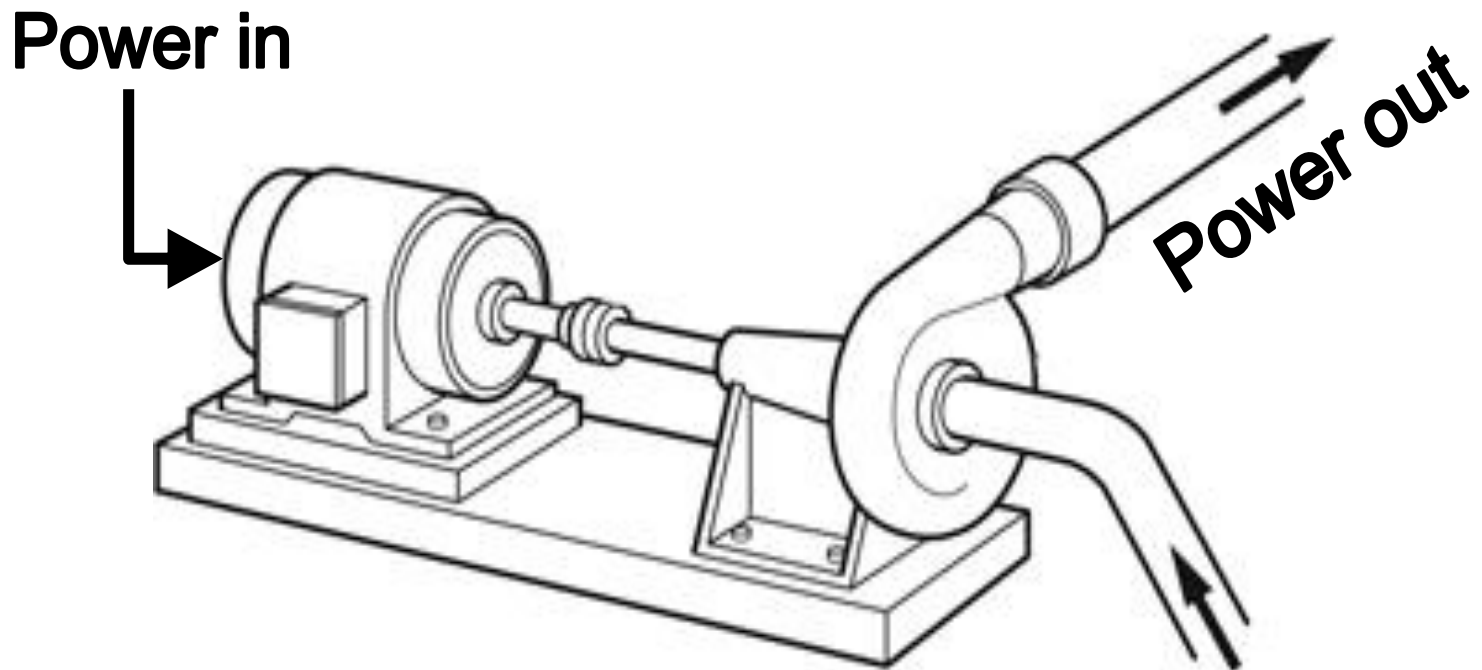
Basic Realities #2

- ◆ Fluid power will always be less than motor output power



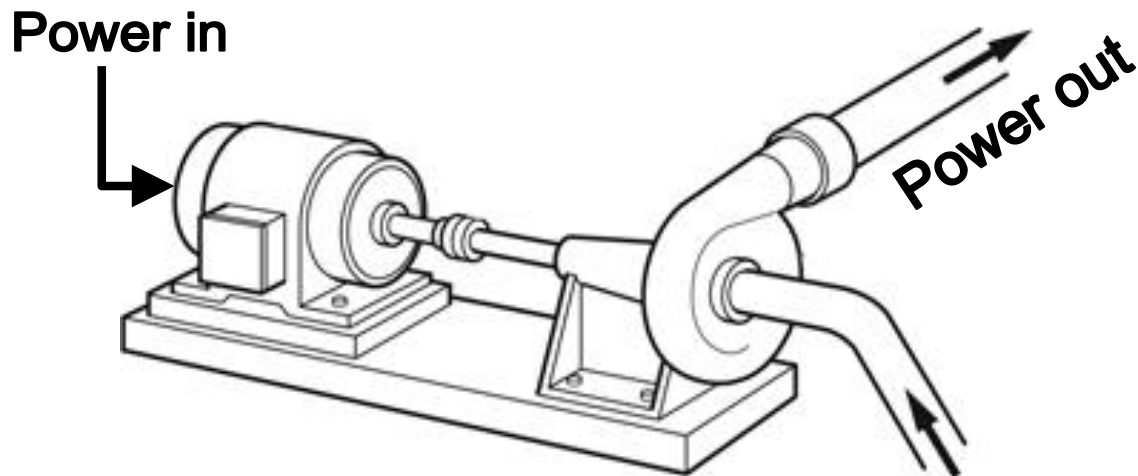
What Does This Mean?

- ◆ Ratio between input power and liquid power is called “Wire-To-Water” (WTW) efficiency



More Unpleasant Realities...

- ◆ Typical motor efficiency range –
77% @ 1 HP to **96%** @ 500 HP
- ◆ Typical centrifugal pump efficiency range –
50% to **85%**



**Power In:
20 HP
(14.9 kW)**

X

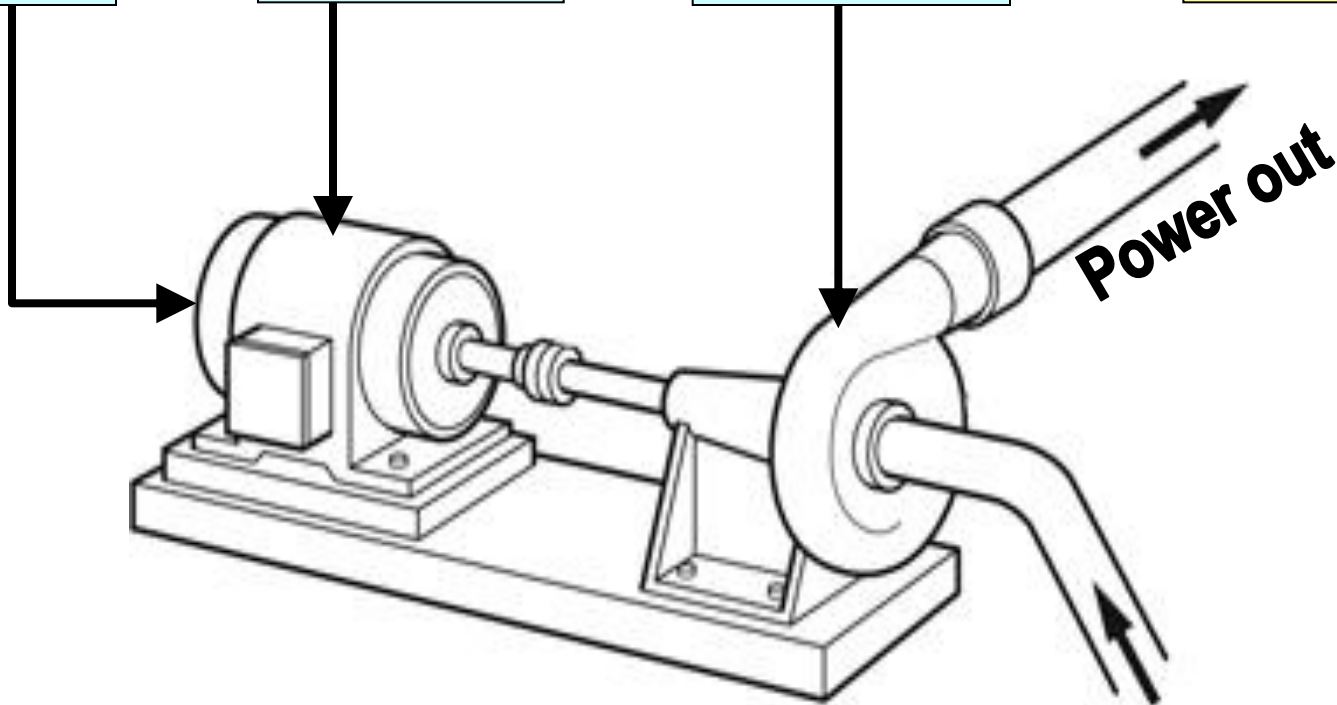
**Motor
Efficiency
(.92)**

X

**Pump
Efficiency
(.75)**


=

**Power Out:
13.8 HP
(10.3 kW)**



**Overall Wire-To-Water Efficiency in
This Example =
.69 OR 69%**

Why Should We Be Concerned?

- ◆ Power is consumed overcoming the inefficiency of pumps and motors
- ◆ You will pay lots of  for that power
- ◆ Choose your pumps and motors carefully!

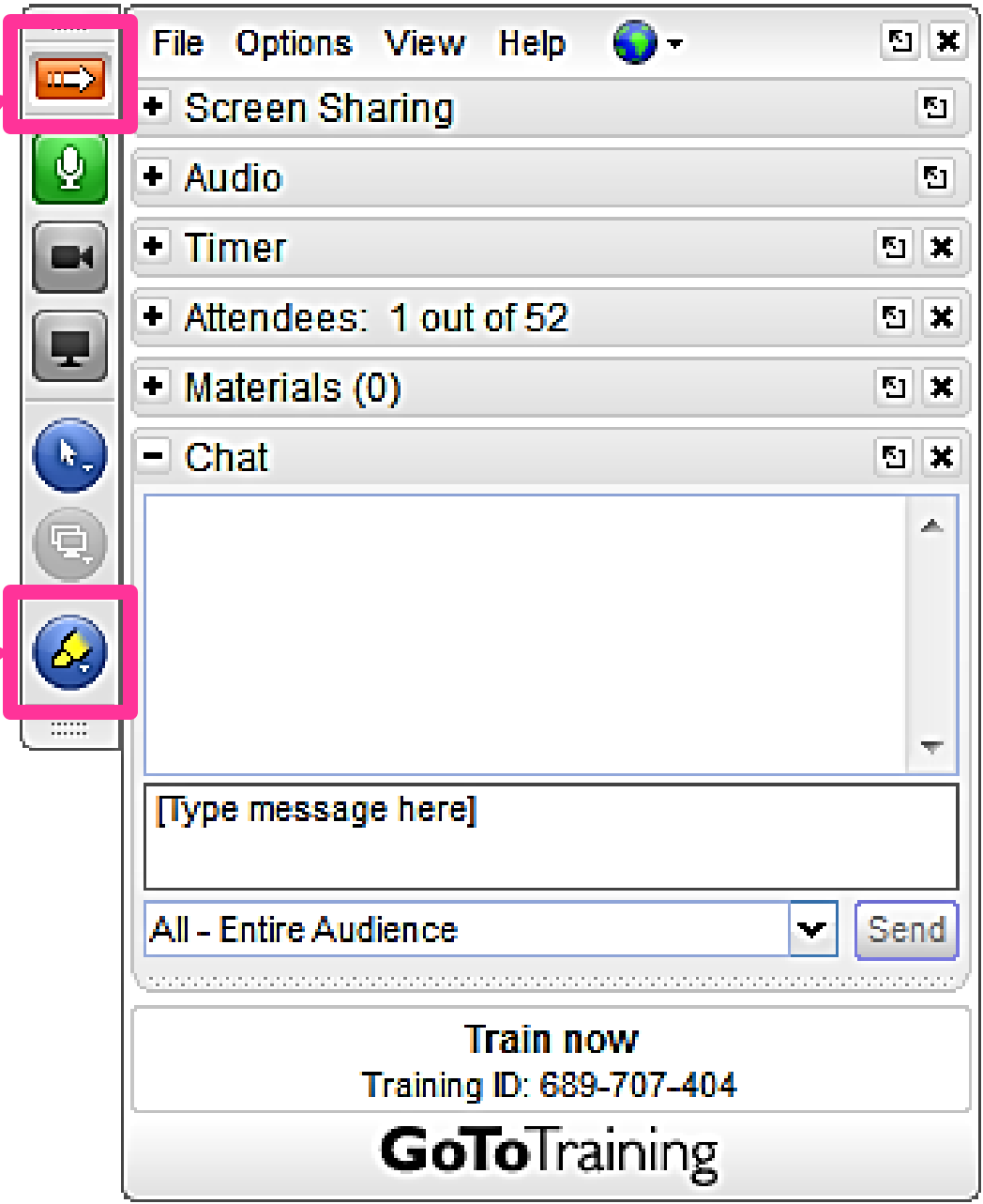


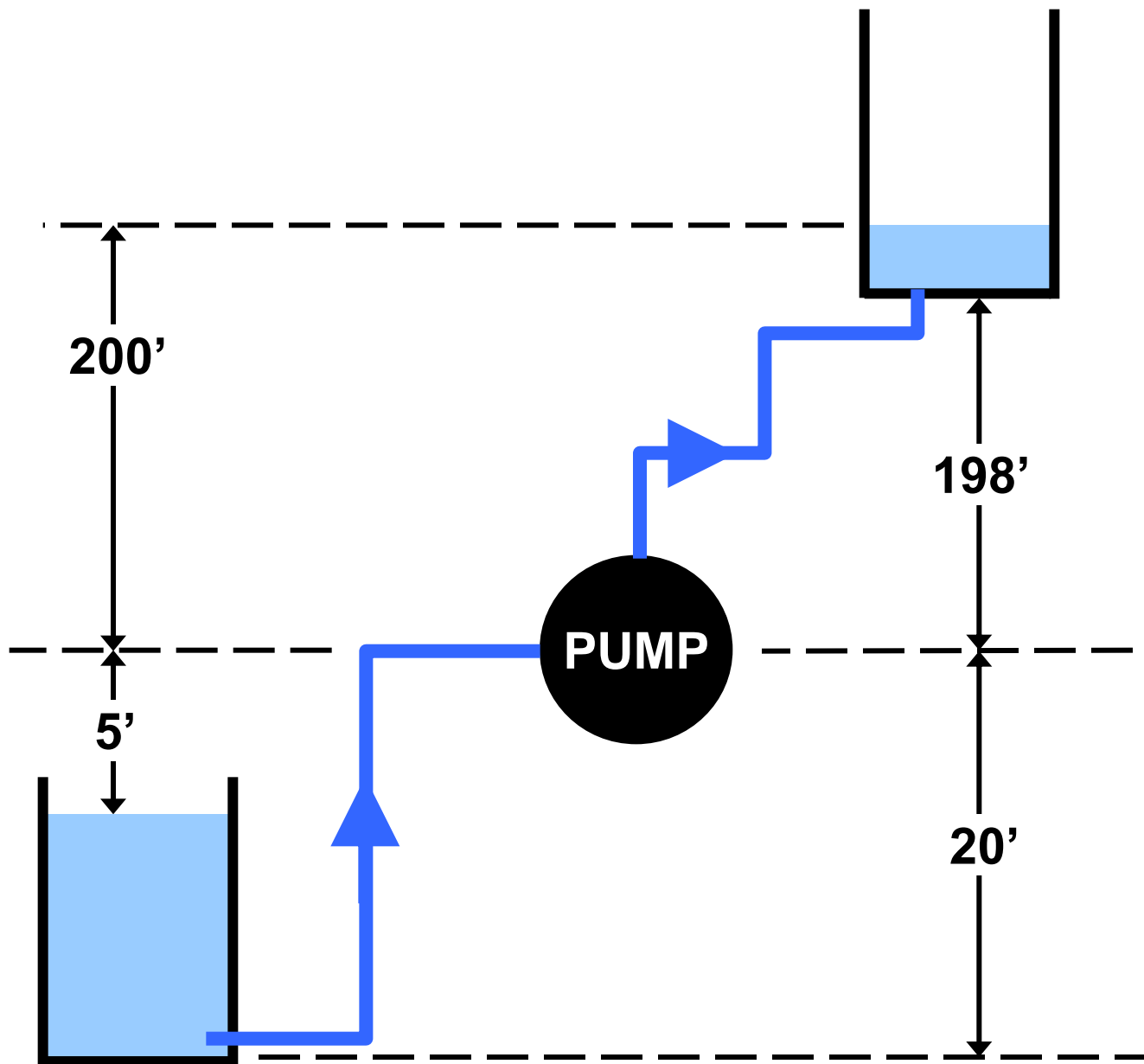
What Is Total Dynamic Head (TDH)?

- ◆ **ANSWER:** The sum of all the resistance in a fluid pumping system during operation
 - ▶ Suction lift
 - ▶ Discharge lift
 - ▶ Friction losses

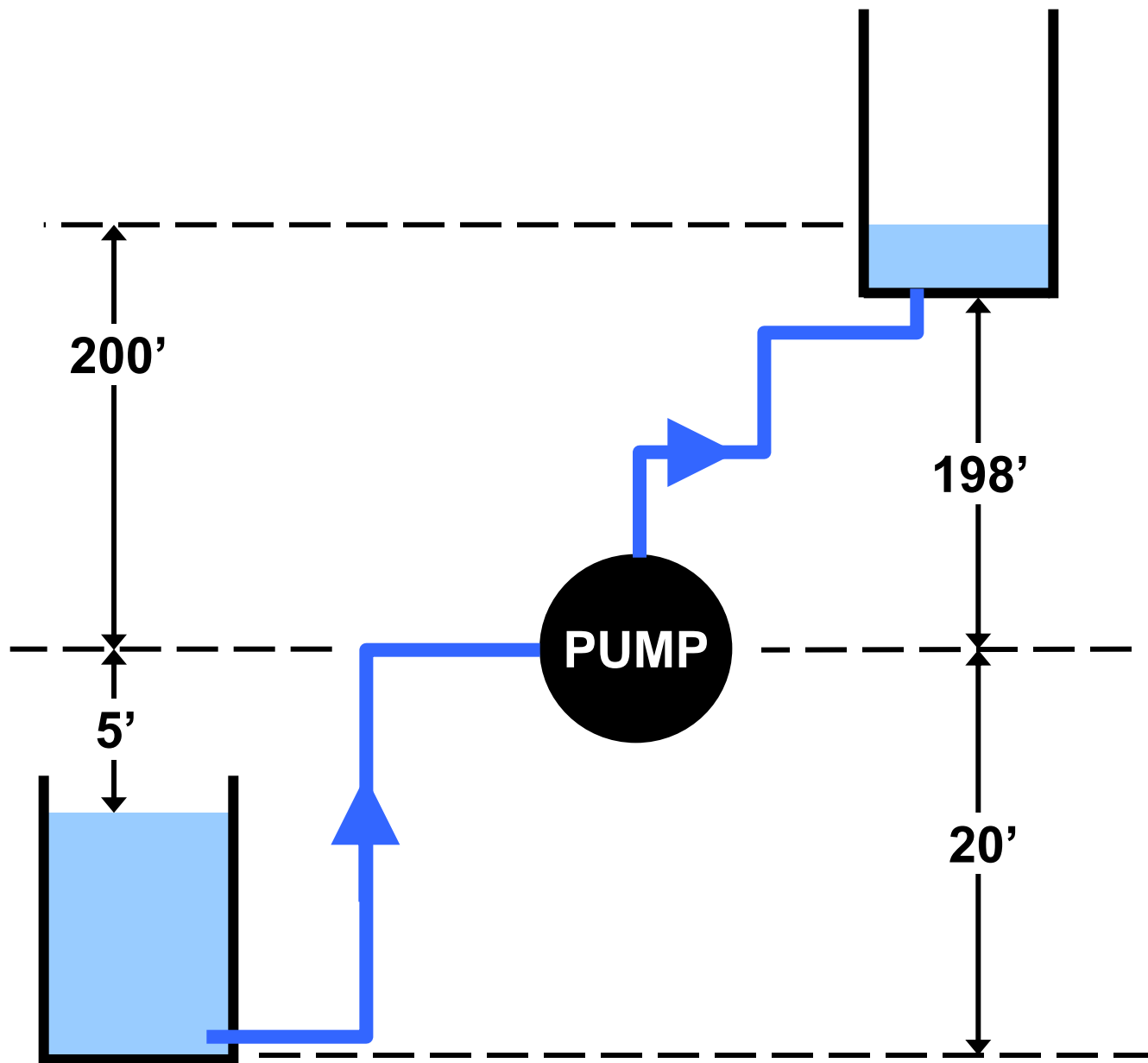
**Hide/Restore
Control
Panel**

**Marking
Tool**

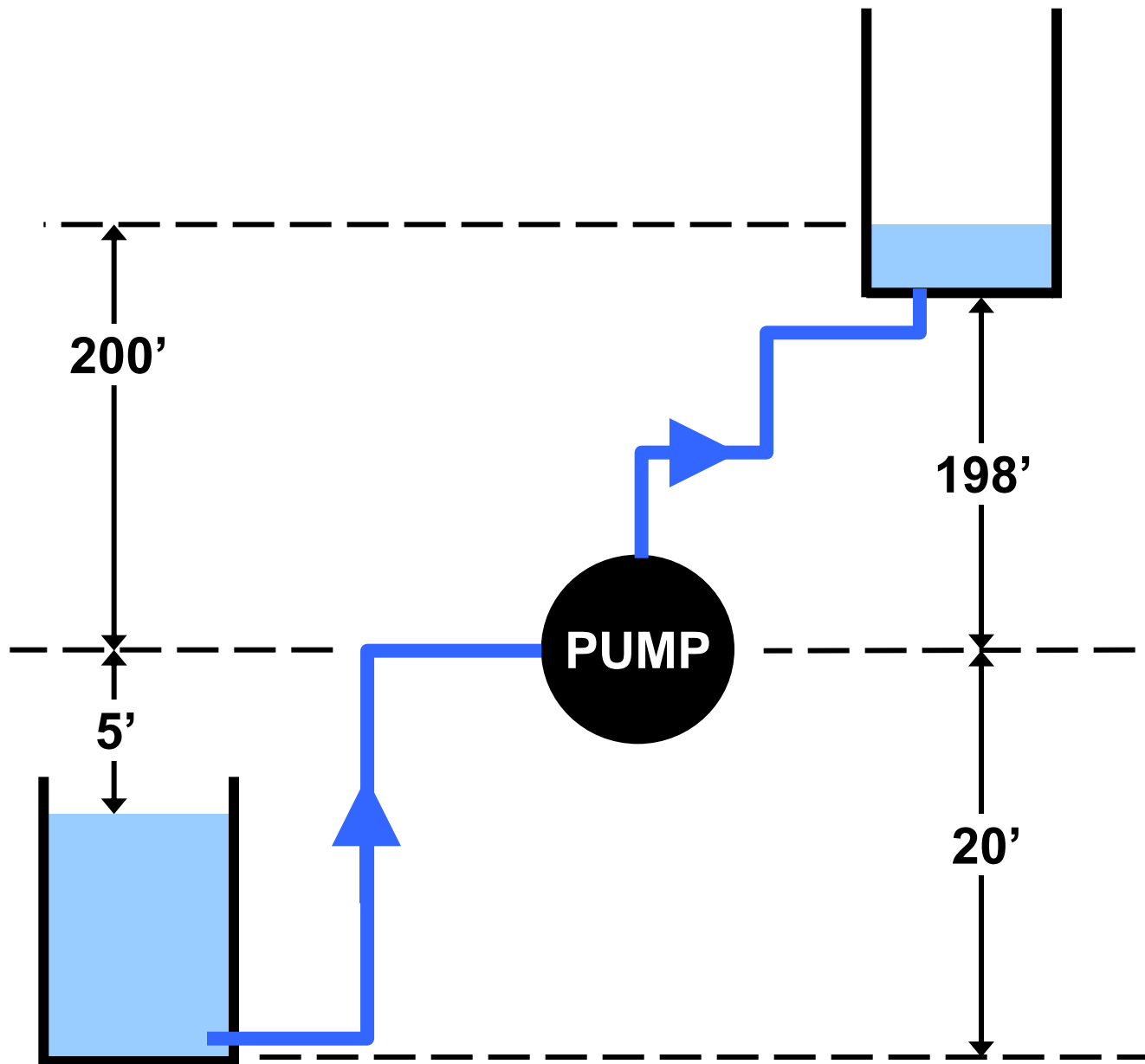




**Identify
Suction
Lift**

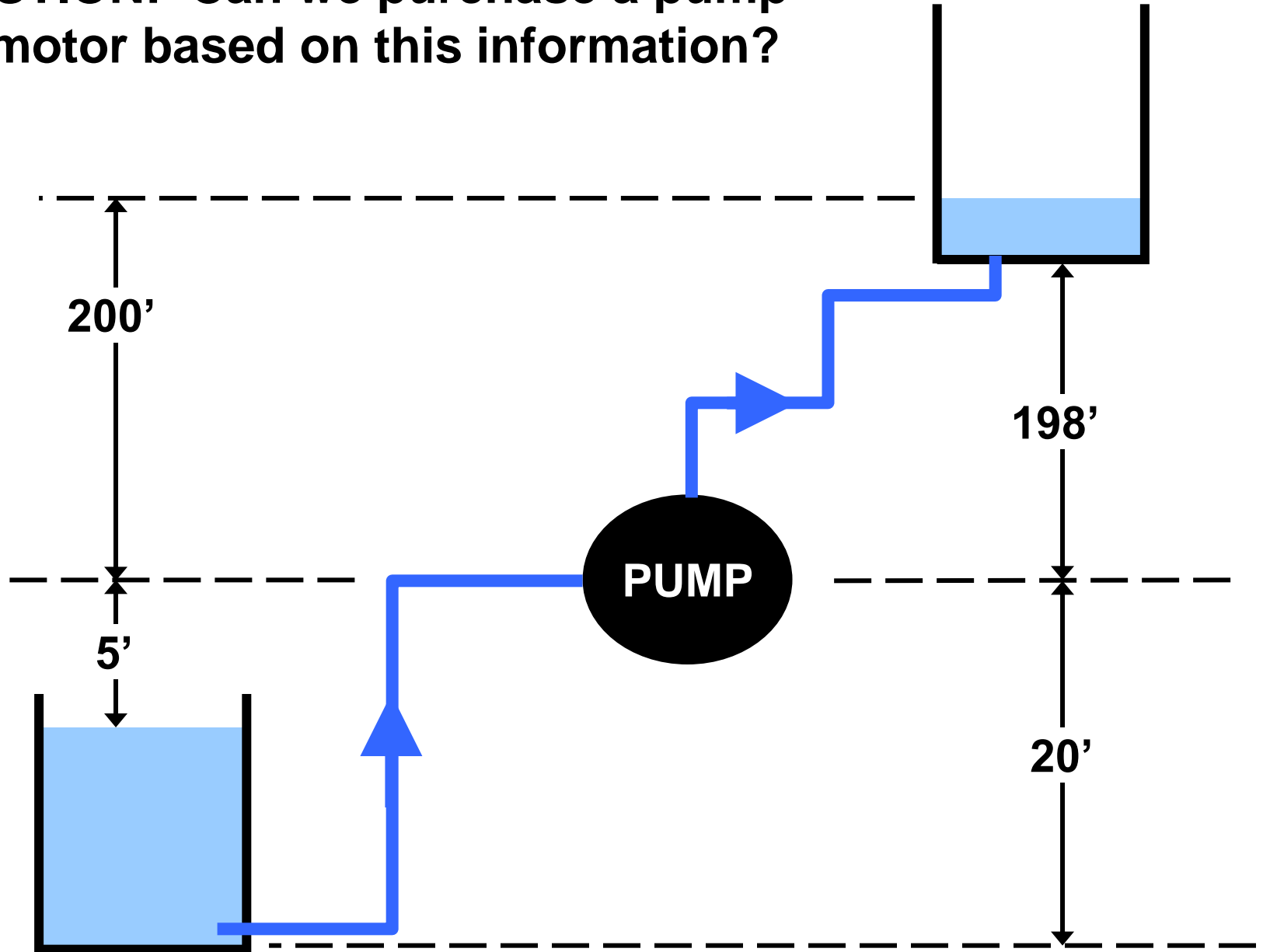


**Identify
Discharge
Lift**



**Identify
Friction
Losses**

QUESTION: Can we purchase a pump and motor based on this information?



Pop Quiz!



Let's Talk About Friction...

- ◆ Pipe condition



Friction...

- ◆ Pipe material



Friction...

- ◆ Pipe Diameter



Friction...

- ◆ Pipe length



Friction...

- ◆ Flow
(velocity)



Friction...

- ◆ Number & type of fittings

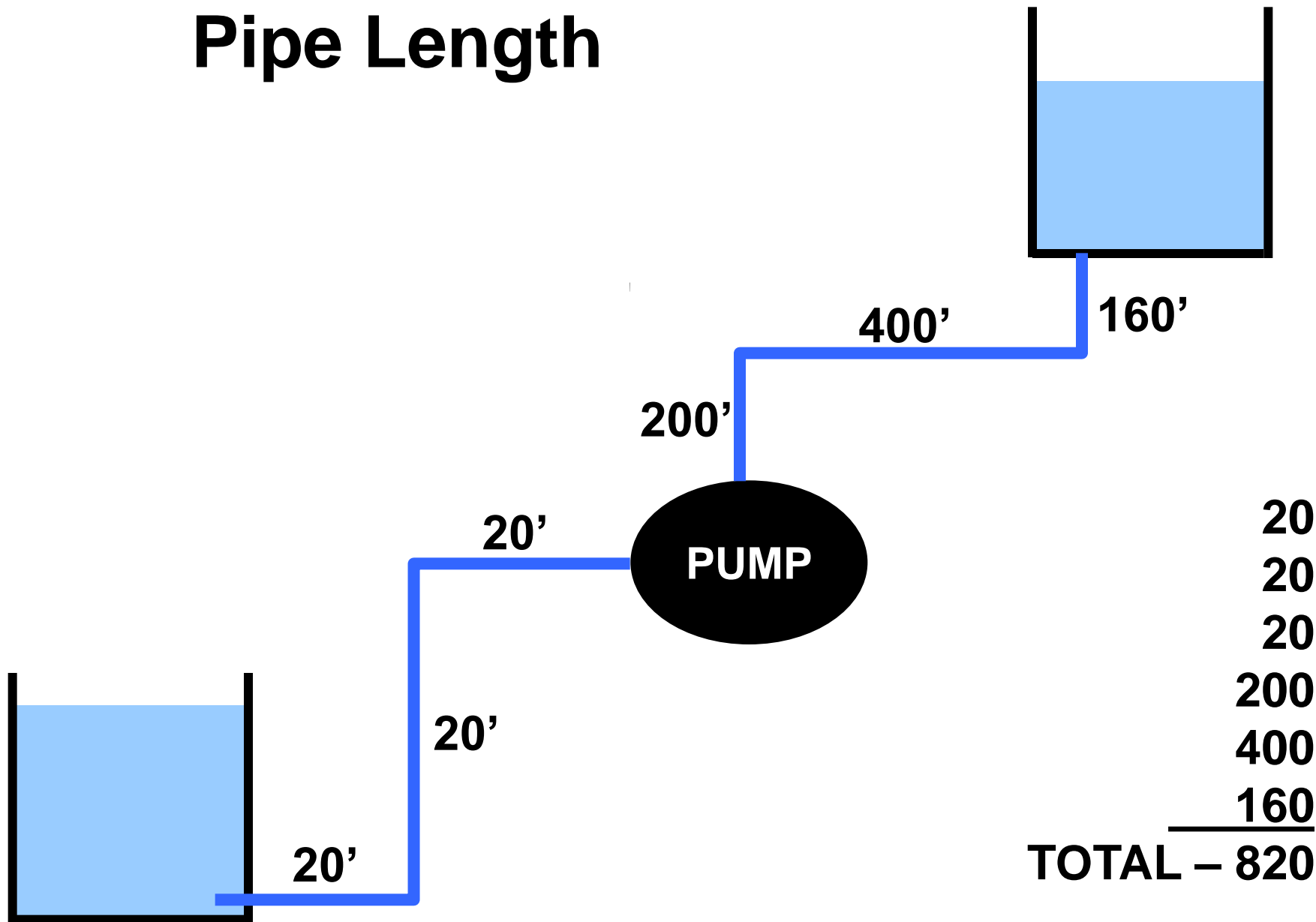


Questions?

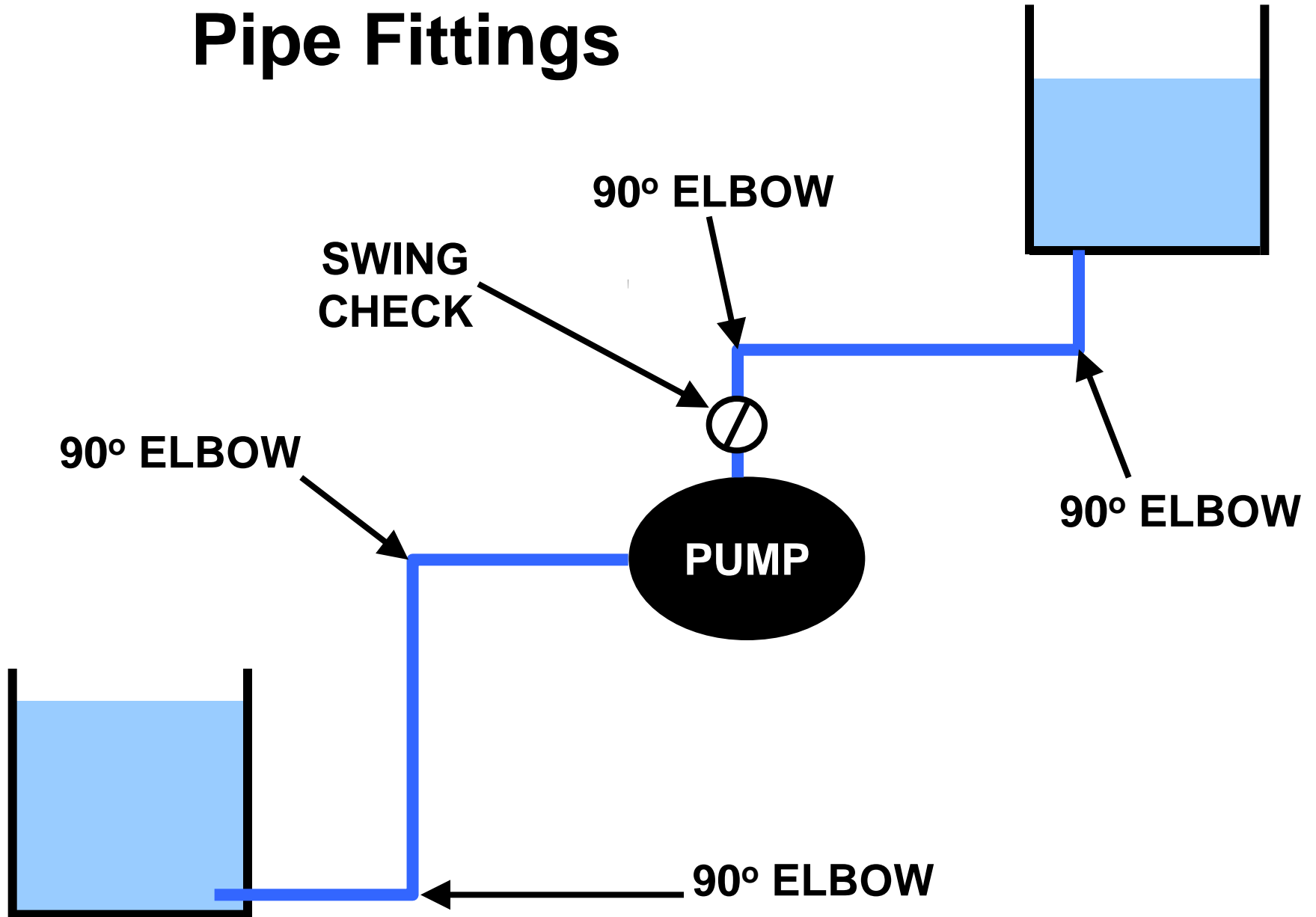


**Text your questions and comments
anytime during the session**

Pipe Length



Pipe Fittings



Sample TDH Problem

Total lift..... **380 feet**

Type of pipe..... **PVC**

Condition of pipe..... **New**

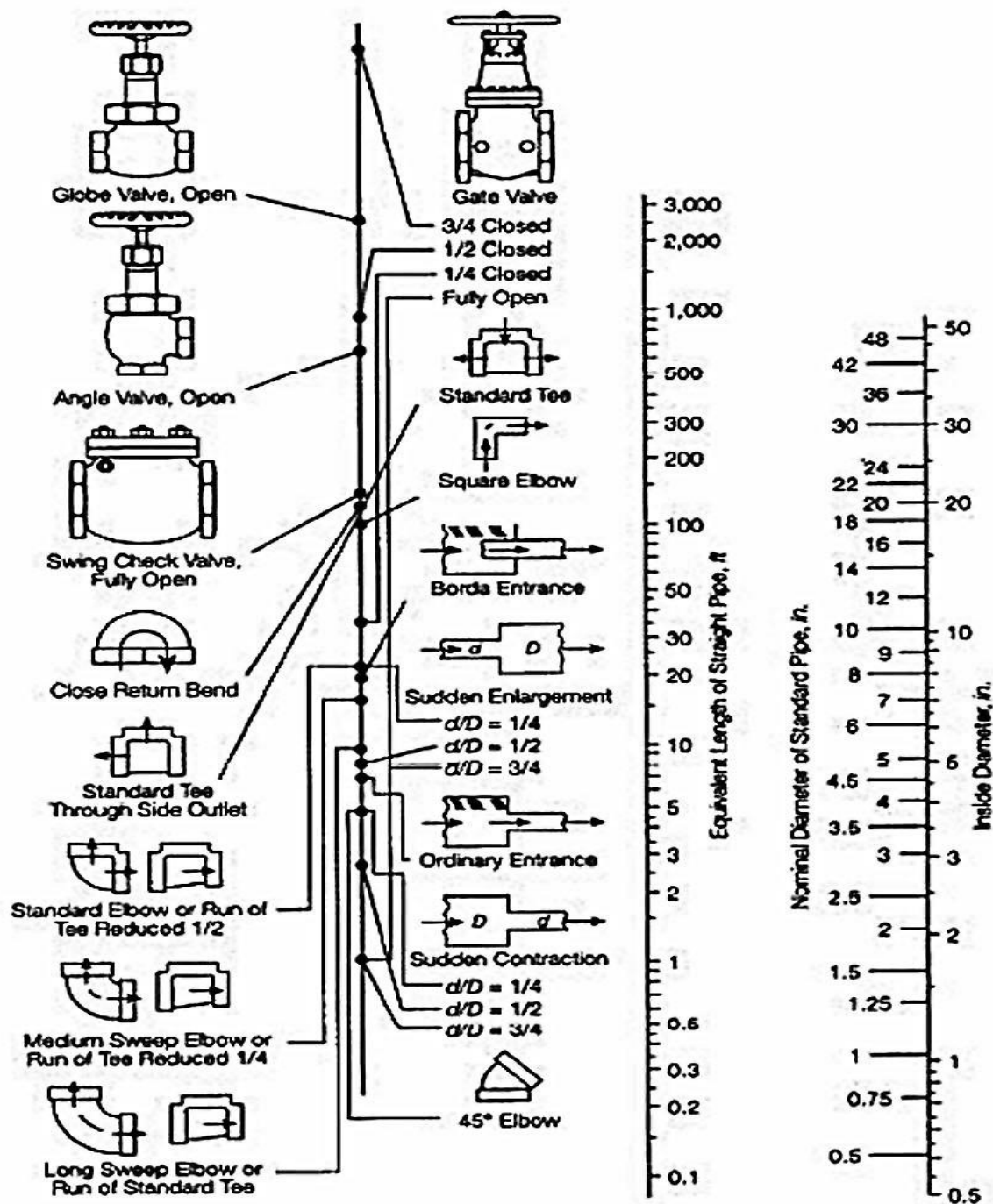
Diameter of pipe..... **6"**

Length of pipe..... **820 feet**

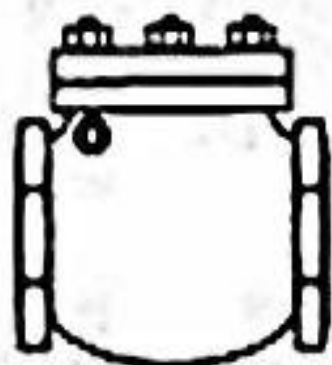
Number & type of fittings:

(1) swing check valve

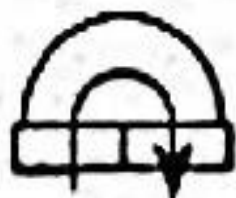
(4) 90° elbows



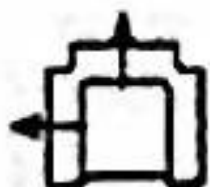
Hazen-Williams Pipe Fitting Friction Loss Nomograph



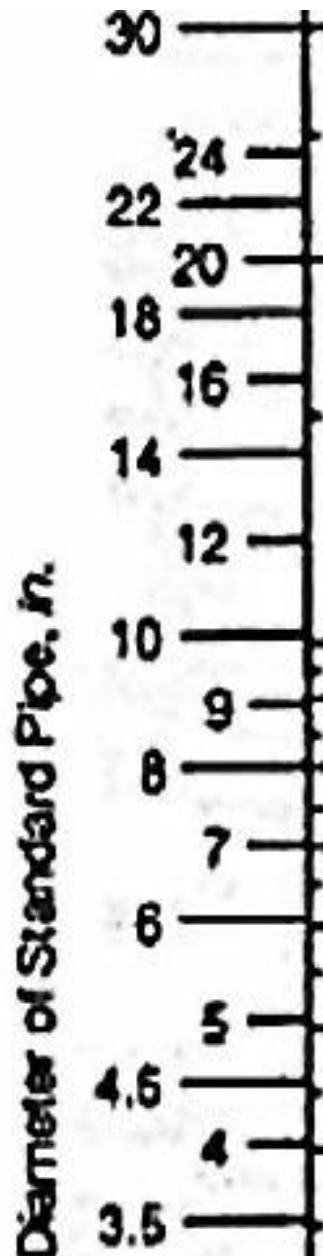
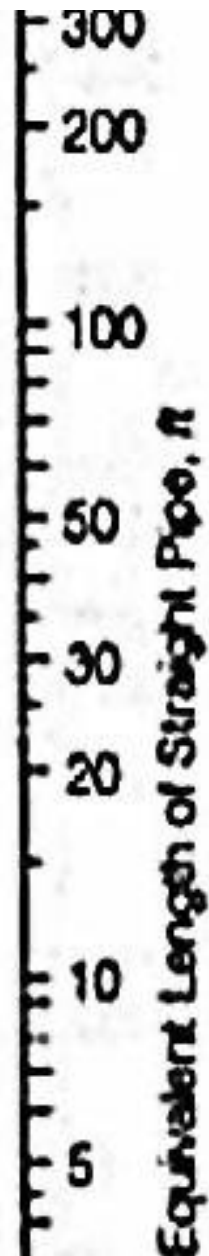
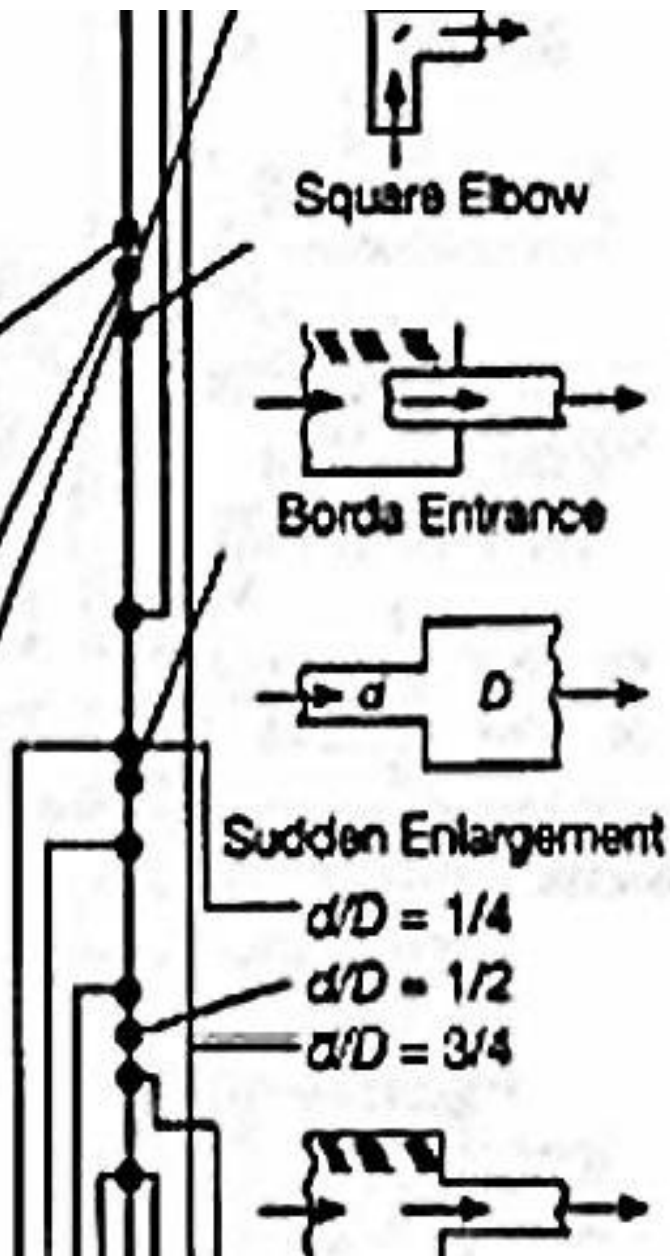
Swing Check Valve,
Fully Open

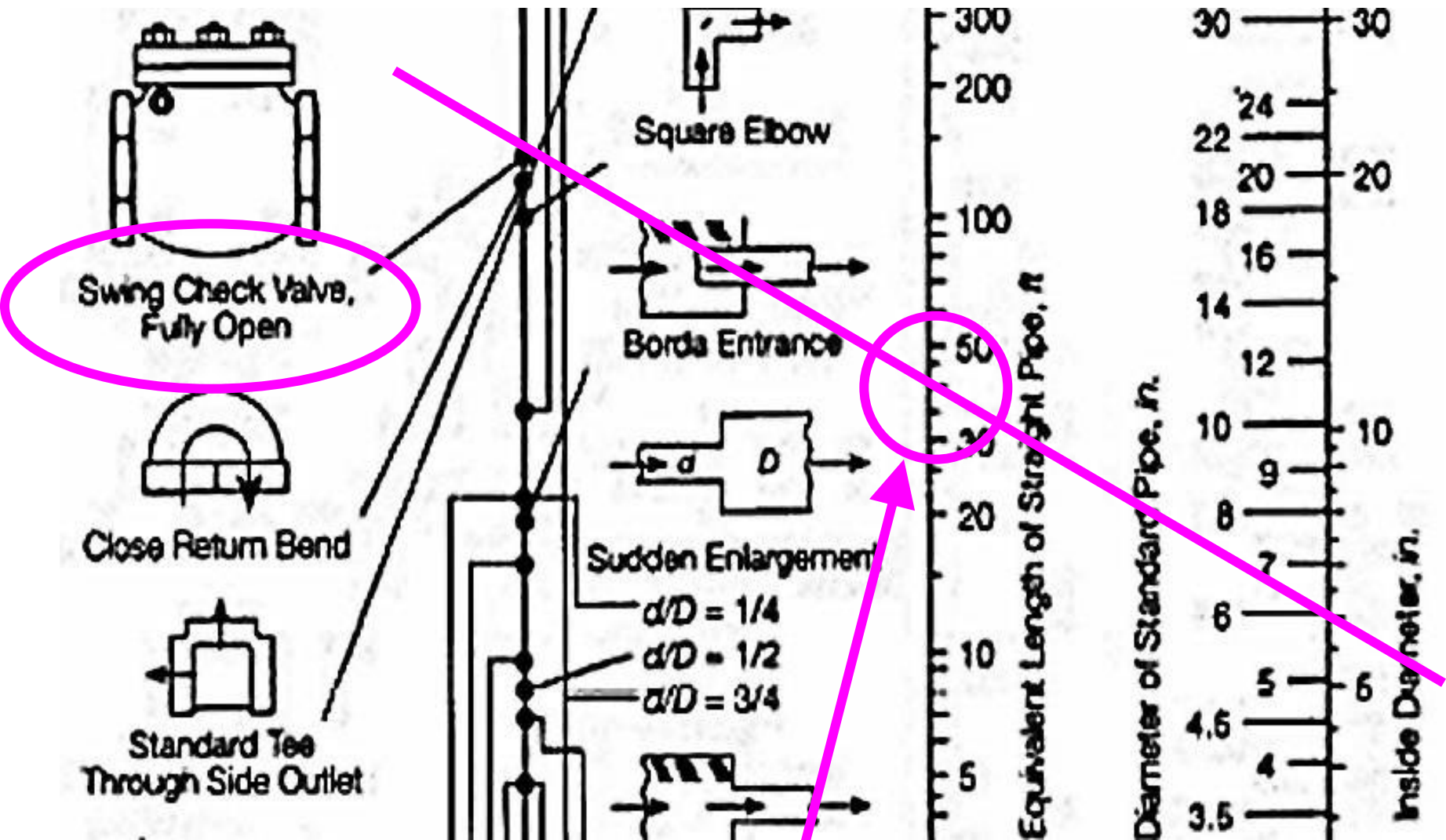


Close Return Bend

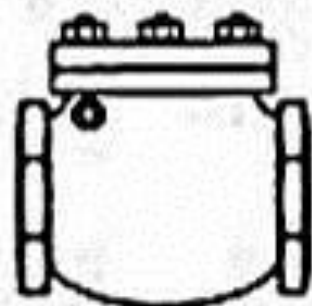


Standard Tee
Through Side Outlet





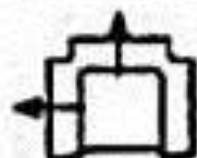
40 feet of straight pipe



Swing Check Valve,
Fully Open



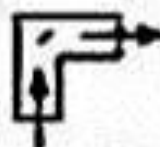
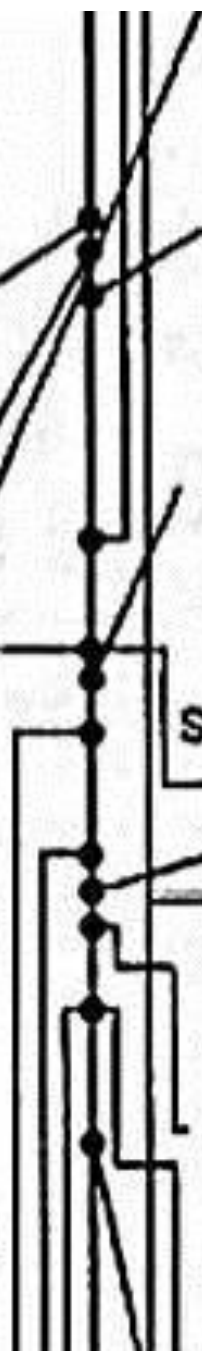
Close Return Bend



Standard Tee
Through Side Outlet



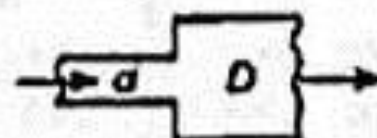
Standard Elbow or Run of
Tee Reduced 1/2



Square Elbow



Borda Entrance

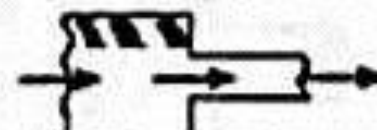


Sudden Enlargement

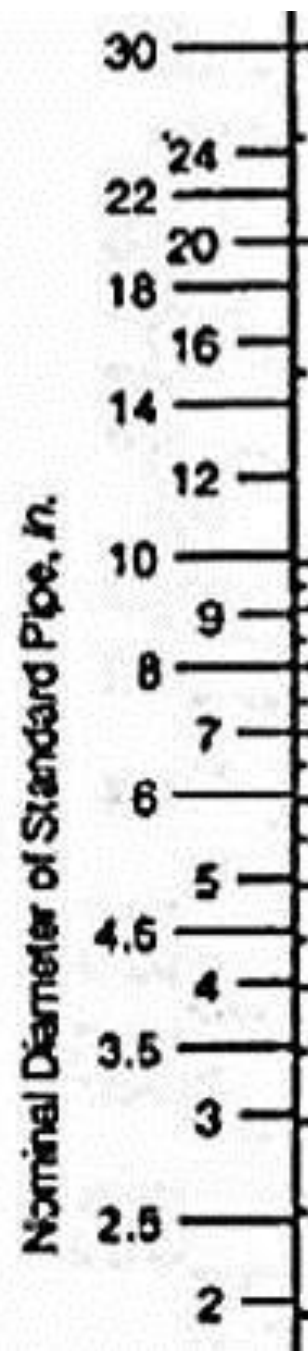
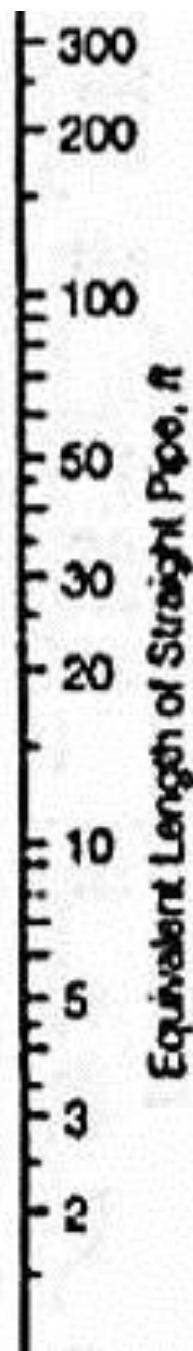
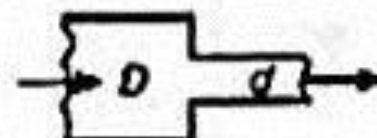
$$d/D = 1/4$$

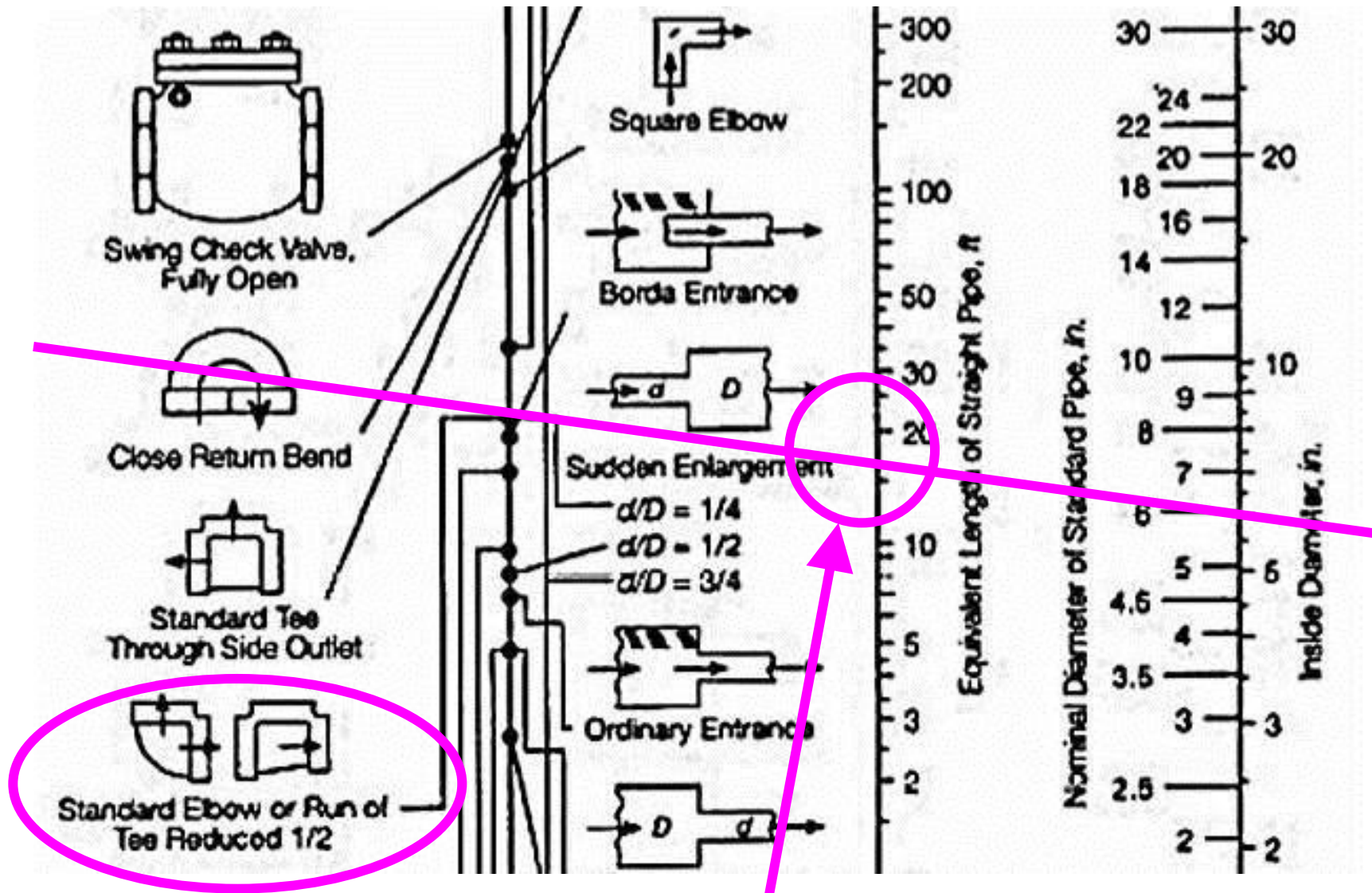
$$d/D = 1/2$$

$$d/D = 3/4$$



Ordinary Entrance





17 feet of straight pipe

What's The Real Length?

Original length - 820 ft

4 elbows @ 17 ft ea. -

1 swing check @ 40' -

Total -

| |
|--|
| |
| |

| |
|--|
| |
|--|

What's The Real Length?

| | |
|----------------------|--------------|
| Original length - | 820 ft |
| 4 elbows @ 17 ft ea. | 68 ft |
| 1 swing check @ 40' | <u>40 ft</u> |

“Real” pipe length - 928 ft

Why Is This Important?

- ◆ During design, we can avoid using fittings and materials with high friction losses
- ◆ Bottom line – ***SAVING* \$\$\$\$\$\$\$\$!**

Pop Quiz!

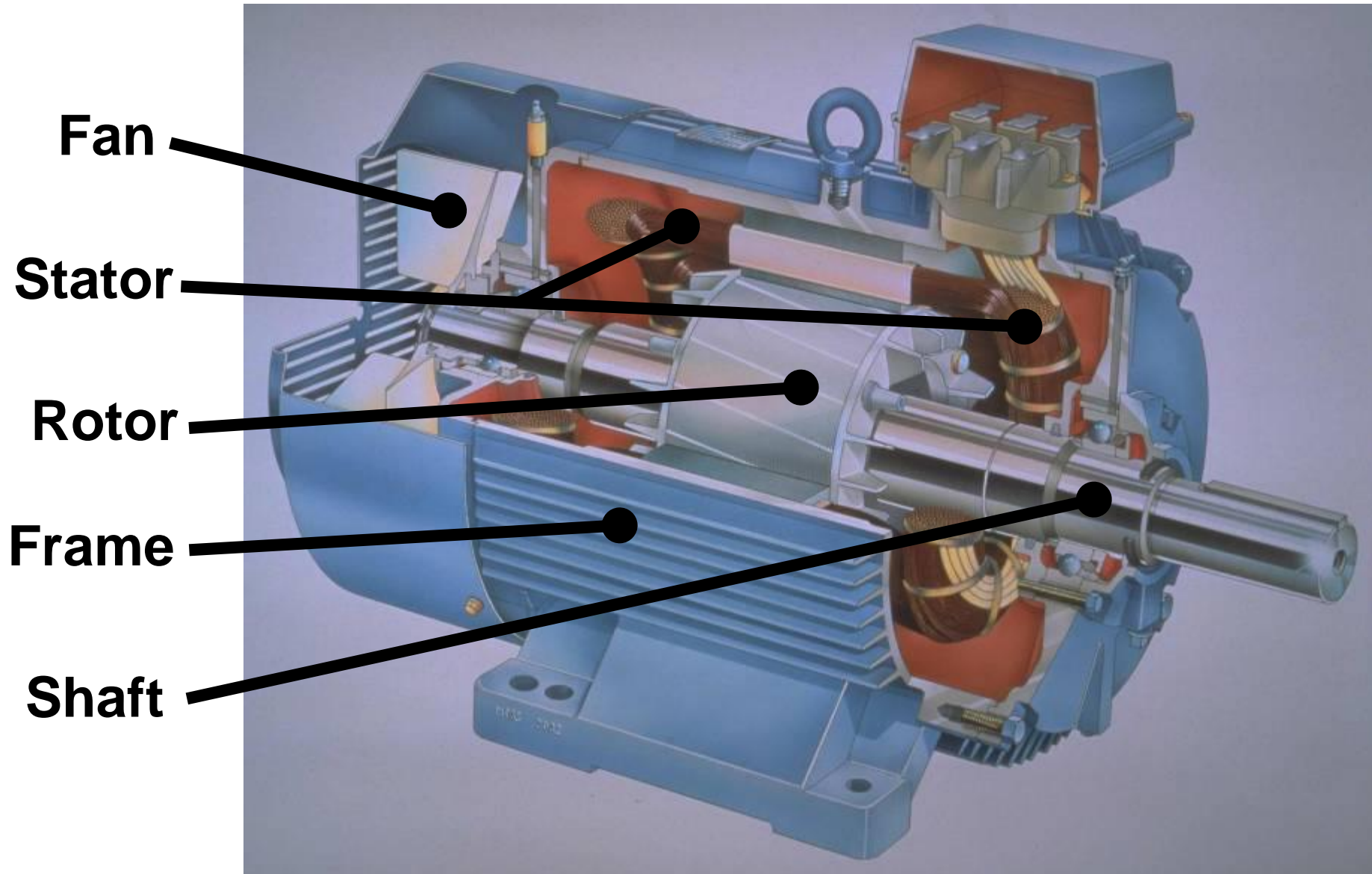


Web Tour – TDH Calculator

| | | | |
|---|----------------------|--------|---|
| Flow Rate | <input type="text"/> | GPM ▼ | |
| Pipe Diameter | <input type="text"/> | inch ▼ | Inside diameter |
| Pipe Length | <input type="text"/> | ft ▼ | Total length |
| Differential Elevation | <input type="text"/> | ft ▼ | From water drawdown level to highest point in the pipe set up. Water drawdown level is defined as the water level when the pump is turned on. |
| Pipe Material | Cast-Iron | ▼ | |
| Pressure Tank (Check for Yes) <input type="checkbox"/> | 0 | PSI ▼ | |
| Total Dynamic Head TDH: | 0 | ft ▼ | |

What's The Lesson?

- ◆ TDH increases...
 - ▶ With flow
 - ▶ With pipe roughness
 - ▶ With pipe length
 - ▶ When pipe size decreases
 - ▶ When flow changes direction



Motor Terminology



Poll Time!

Question 3: What is the highest horsepower motor in your water system?

Common AC Motor Types

- ◆ Induction
- ◆ Synchronous



Induction Motors

- ◆ Power is applied only to the stator
- ◆ Rotational motion is *induced* to the rotor by means of a rotating magnetic field
- ◆ Less efficient than synchronous motors

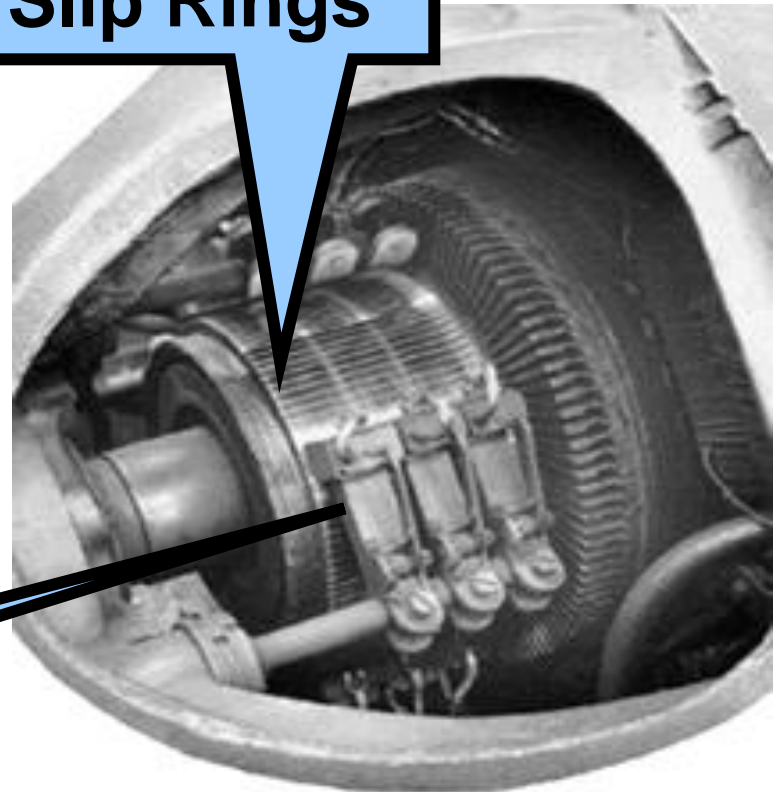


Synchronous Motors

- ◆ Power is applied to both rotor and stator
- ◆ **Slip rings** used to energize rotor windings
- ◆ More efficient than induction motors

Slip Rings

Brushes



Induction Motors

- ◆ Self-starting
- ◆ Widely used
- ◆ Widely available
- ◆ Durable
- ◆ Inexpensive
- ◆ High power-to-weight ratio



Motor Terminology...

NEMA Frame Types

- ◆ TEFC (Totally Enclosed Fan Cooled)
- ◆ TENV (Totally Enclosed Non-Ventilated)
- ◆ TEAO (Totally Enclosed Air Over)
- ◆ TEXP (Totally Enclosed Explosion-Proof)
- ◆ ODP (Open Drip-Proof)
- ◆ C-Face

Understanding Motor Nameplates

3 PHASE INDUCTION MOTOR ULTRA POWER SERIES



MODEL NO. TB0014DFA

VOLTS 208-230/460 AMP. 3.8-3.6/1.8

ENCL. □DP FRAME NO. 143T

MAX. AMB. 40 °C SERVICE FACTOR 1.15

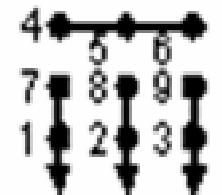
HP 1 TIME RATING CONT. BRG. D.E. 6205ZZ

RPM 1720 KVA CODE K NO. O.D.E. 6205ZZ

INS. B NEMA F.L. EFF. 77 NEMA DESIGN B

HZ 60 DATE CODE 0396 SER # 001687411

CONNECTIONS



LOW VOLTS



HIGH VOLTS



TATUNG CO.

MADE IN TAIWAN R.O.C.

4-20706

Motor Efficiency Matters!

- ◆ In U.S. Industry, electric motors consume:
 - ▶ ~680 billion kWh/year
 - ▶ ~63% of all industrial electricity consumption
 - ▶ ~23% of all U.S. consumption

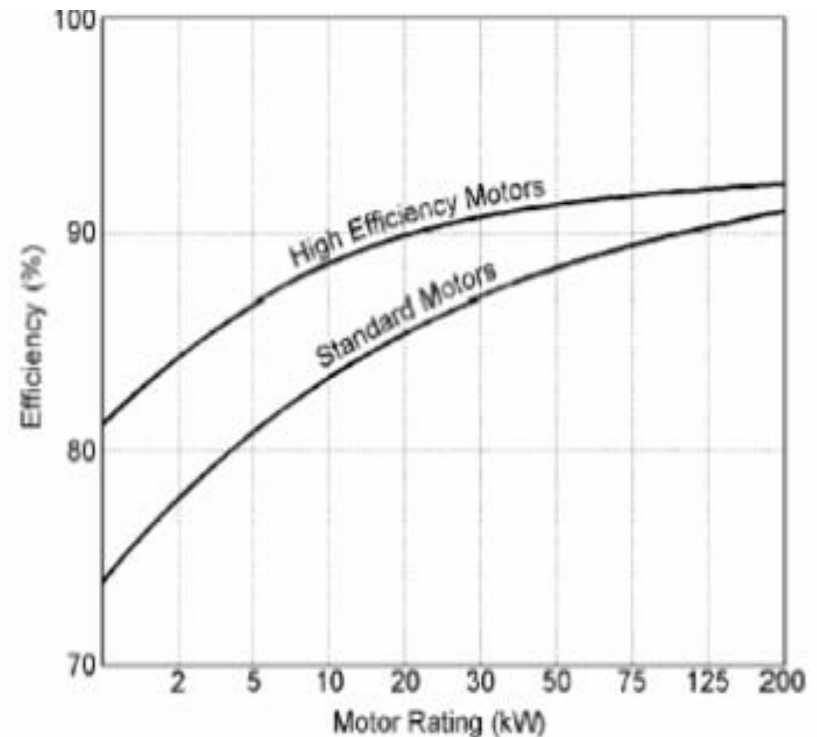


Factors Influencing Efficiency

- ◆ Age
- ◆ Capacity
- ◆ Speed
- ◆ Type
- ◆ Temperature
- ◆ Rewinding
- ◆ Load

Energy Efficient Motors

- ◆ 3-7% higher than standard motors
- ◆ Wide range of ratings
- ◆ More expensive but rapid payback
- ◆ Best to replace when existing motors fail



What's An Efficient Motor?



Same components; just more and better materials and closer tolerances.

- Larger wire gauge – Lower stator winding loss
- Longer rotor and stator – Lower core loss
- Lower rotor bar resistance – Lower rotor loss
- Smaller fan – Lower windage loss
- Optimized air gap size – Lower stray load loss
- Better steel with thinner laminations -- Lower core loss
- Optimum bearing seal/shield – Lower friction loss



Poll Time!

Question 4: What is the oldest motor in your water system?

Motor Performance Affected By...

- ◆ Poor power quality: fluctuations in voltage and frequency
- ◆ Voltage unbalance: unequal voltages to three phases of motor

| | Example 1 | Example 2 | Example 3 |
|---------------------------|-----------|-----------|-----------|
| Voltage unbalance (%) | 0.30 | 2.30 | 5.40 |
| Unbalance in current (%) | 0.4 | 17.7 | 40.0 |
| Temperature increase (oC) | 0 | 30 | 40 |

Rewinding

- ◆ Can reduce motor efficiency
- ◆ Maintain efficiency after rewinding by
 - ▶ Using qualified/certified firm
 - ▶ Maintain original motor design
 - ▶ Replace <40HP, 15+ year old motors instead of rewinding
 - ▶ If rewinding/rebuilding costs more than 30-40% of a new motor... ***buy a new motor!***

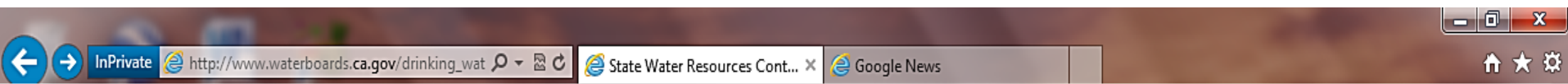
Maintain Motor Efficiency

- ▶ Inspect motors regularly for wear, dirt/dust
- ▶ Checking motor loads for over/under loading
- ▶ Lubricate appropriately
- ▶ Check alignment of motor and equipment
- ▶ Ensure supply wiring and terminal box and properly sized and installed
- ▶ Provide adequate ventilation

Questions?



**Text your questions and comments
anytime during the session**



- » Cal/EPA
- » State and Regional Water Boards' Map
- » Board Priorities
- » Laws/Regulations
- » Plans/Policies
- » Programs
- » Decisions Pending and Opportunities for Public Participation

Agendas
English/Español



Resources

Home » Drinking Water » Certlic » Drinkingwater

Capacity Development Program

Last Updated: August 6, 2014

The federal [Safe Drinking Water Act Amendments of 1996 \(SDWA\)](#) were signed into law in part because of the significant problems that small public water systems (SWS) had in providing safe, reliable drinking water to their customers. The SDWA emphasized technical, managerial, and financial (TMF) prevention and assistance to resolve the problems. It included mandates to the states to prevent new non-viable systems. It also mandated the development and implementation of a comprehensive capacity development strategy to assist public water systems in obtaining adequate capacity. The SDWA provided the resources and flexibility to accomplish the end objective.

In 1997 [Senate Bill \(SB\) 1307](#) became law, enabling California to implement the provisions of the federal SDWA. This statute established a financial assistance program entitled the [State Revolving Fund \(SRF\)](#), which included a comprehensive technical assistance program for small systems. In order to help ensure the provision of safe, reliable drinking water to customers on a long term basis, this legislation was designed to prevent the formation of a new public water system or the approval of a public water system change of ownership unless that system had been determined by the State to have adequate TMF capacity.

We developed TMF capacity criteria based on guidance provided by the federal Environmental Protection Agency, experience in the Department of Public Health's Drinking Water Program (now the [Division of Drinking Water](#)) and [Local Primacy Agencies](#), and experiences of other states. Input also was received from affected stakeholders and the public. The current TMF Assessment Information can be found at the links noted below.

The Division of Drinking Water (DDW) works with Rural Community Assistance Corporation (RCAC), California Rural Water Association (CRWA) and other organizations to provide technical, managerial, or financial issues or help with the SRF Funding Program contact your local DDW district office or your local water agency.

For more information, visit the [Water Systems](#) and [Small Water Systems - Technical Support Unit](#).

FREE: For a measure of a public water system's TMF capacity and a list of resources to help build TMF capacity, go to the [TMF Tune-Up](#).

For More Information

For more information, contact:

Phone: (916) 449-5600, fax: (916) 449-5601

or write us at:

Technical Support Unit

Scroll Down



- Grants & Loans
- Fees
- Customer Service Survey
- File an Environmental Complaint
- Employment
- Frequently Asked Questions
- Useful Links
- Website Index



TMF Form and Staff Evaluation

| TMF Assessment Information For All Water System Types | Budget Templates | Resources | Reports | Other Links |
|--|---|---|---|---|
| <ul style="list-style-type: none">→ TMF Assessment Form (Word)→ TMF Capacity Criteria (Word)→ TMF Staff Evaluation Form for Funding (Word)→ Documentation Requirements for TMF Assessments (PDF)→ TMF Staff Evaluation Form for New Water System or Change of Ownership (Word)→ Alternative TMF Assessment and Staff Evaluation (Word)→ Alternative TMF Assessment and Staff Evaluation (PDF)→ TMF Capacity Assessment "E-Z" Form For Transient-Noncommunity Public Water Systems -Change of Ownership (Word) | <ul style="list-style-type: none">→ 5-yr Budget Projection/Capital Improvement Plan (CIP) (Excel)→ Expense Only: 5-Yr Budget Projection/Capital Improvement Plan (CIP) (Excel)→ 5-Yr Budget for Large Community (Excel) | <ul style="list-style-type: none">→ Rural Community Assistance Corporation (RCAC)→ California Rural Water Association (CRWA)→ Self-Help Enterprises (SHE)→ California State University Sacramento, Office of Water Programs (CSUS)→ American Water Works Association (AWWA), California-Nevada Section→ Basic Small Water System Operations Book | <ul style="list-style-type: none">→ Capacity Development Strategy (2000) (Word)→ Capacity Development Report to Governor (2002) (PDF)→ Capacity Development Report to USEPA (2004-2005) (PDF)→ Capacity Development Report to USEPA (2005-2006) (PDF)→ Capacity Development Report to USEPA (2006-2007) (PDF)→ Annual Capacity Development Report to USEPA (2007-08)→ Triennial Capacity Development Report to the Governor (2005-2008)→ Annual Capacity Development Report to USEPA (2008-2009)→ Annual Capacity Development Program Implementation Report to USEPA (2009-2010)→ Annual Capacity Development Program Implementation Report to USEPA (2011-2012) | <ul style="list-style-type: none">→ TMF Tune-Up→ Safe Drinking Water State Revolving Fund→ Check Up Program for Small Systems (CUPSS) |

- Planning Assistance**
- [Operations Plan](#)
 - [Typical Equipment Life Expectancy \(PDF\)](#)
 - [Emergency Disaster Response Plan \(Word\)](#)
 - [Consumer Confidence Reports](#)
 - [Template for Public Notification](#)

(Updated 9/3/14)





Thank You For Attending!



Neil Worthen
nworthen@rcac.org
(575) 527-5372

Thank You For Attending!

We look forward to seeing you
in future online classes!

nworthen@rcac.org

mboyd@rcac.org

jhamner@rcac.org



**Rural Community
Assistance Corporation**



Water Boards

STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS