Rural Community Assistance Corporation
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Pumps And Motors Efficiency

WELCOME!

Session starts at 10:00 a.m.

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

WELCOME!

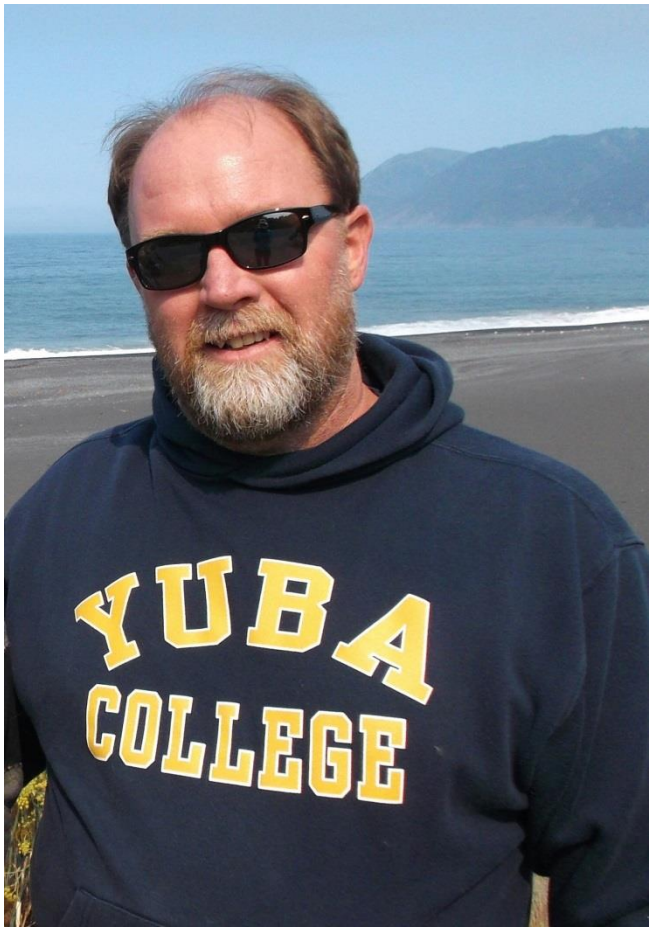
This training is presented by RCAC with funding provided by the California State Water Resources Control Board Division of Drinking Water (DDW)

Rural Community Assistance Corporation

CALIFORNIA Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

Your Moderators Today…

Mike Boyd
Gering NE



John Hamner
Kelseyville CA

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The Rural Community Assistance Partnership

RCAC Programs

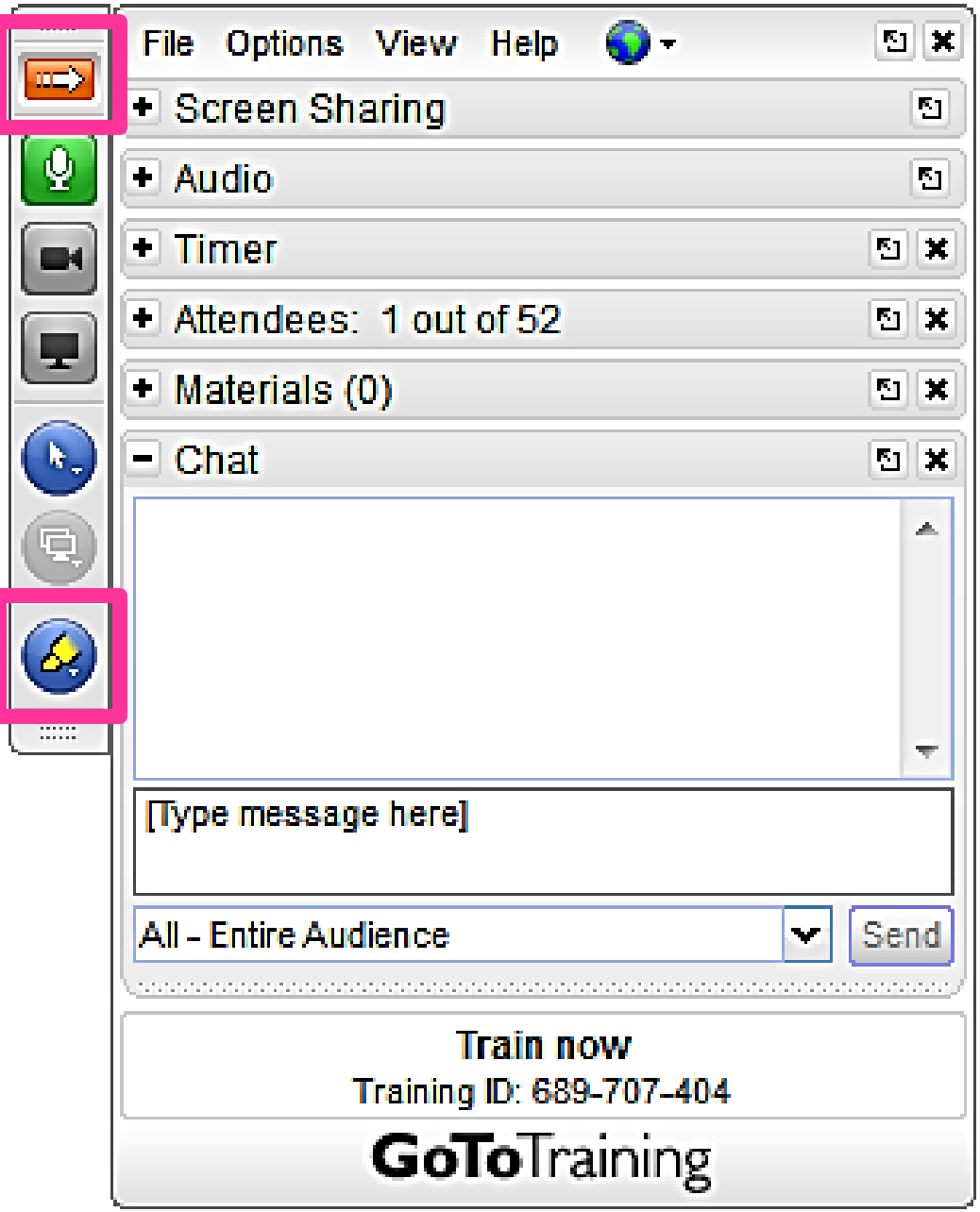
- Affordable housing
- Community facilities
- Water and wastewater infrastructure financing (Loan Fund)
- Classroom and online training
- On-site technical assistance
- Median Household Income (MHI) surveys

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



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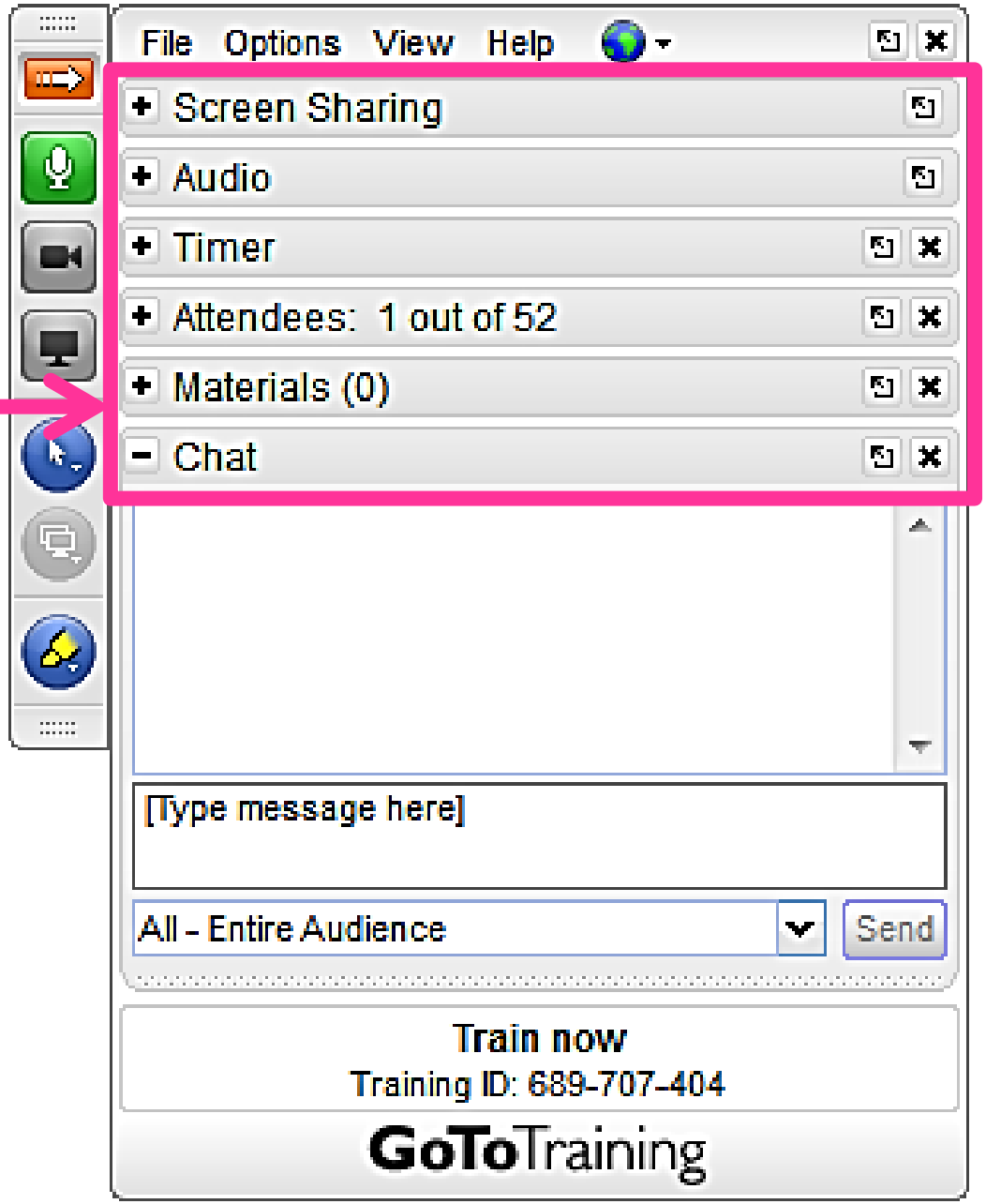
Control Tabs



Audio Controls

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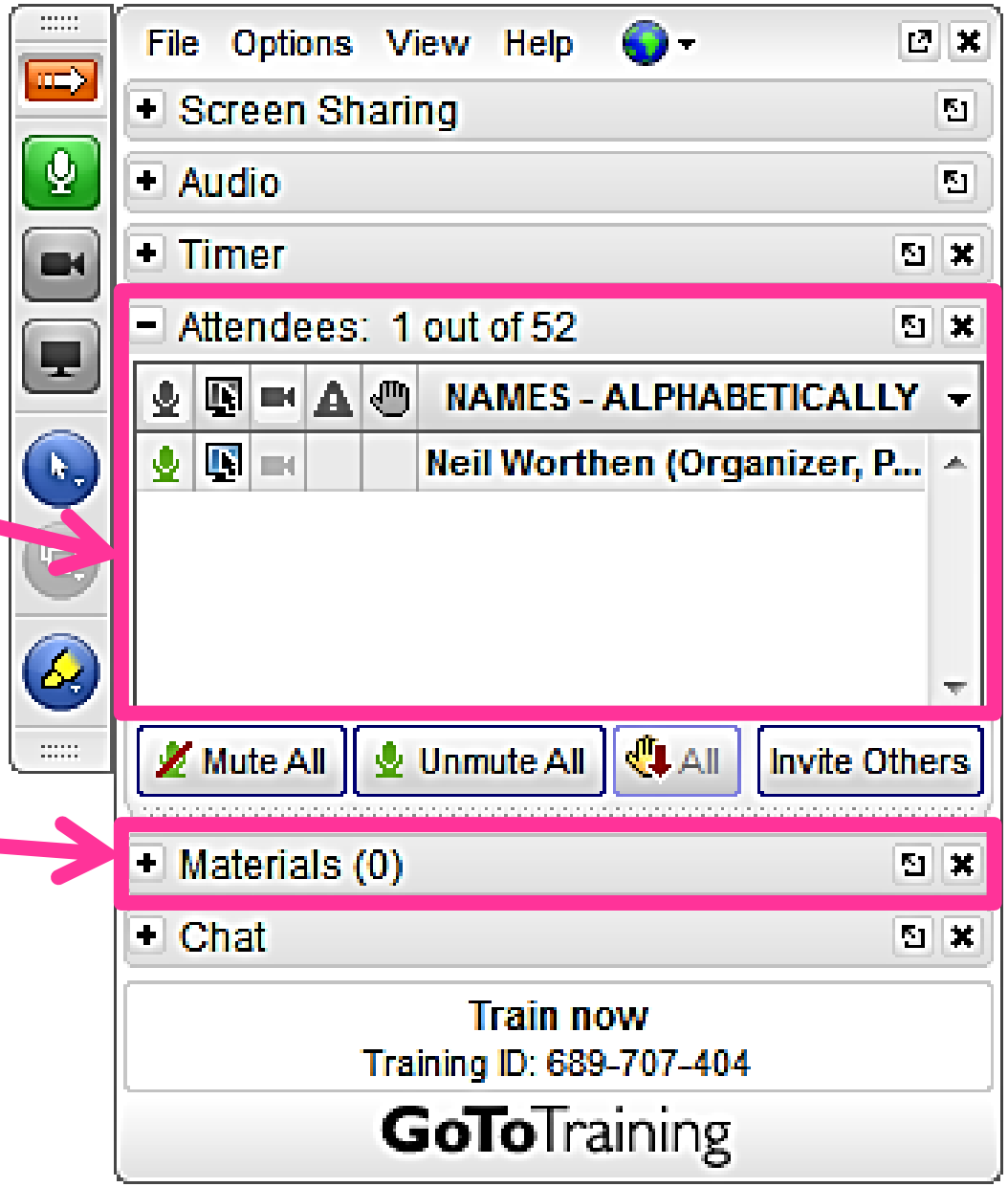
Attendee List

Today's Materials



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Questions?

Text your questions and comments anytime during the session

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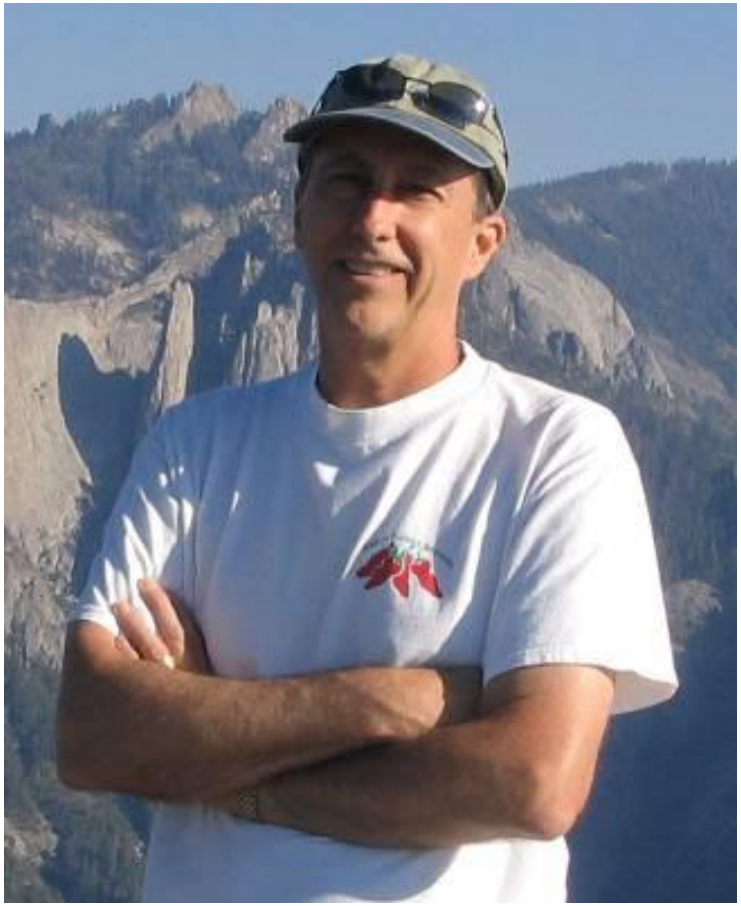
Your Presenter Today…



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Pumps And Motors Efficiency

RCAC 2015
Online Workshops

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

Poll Time!

Question 1: Who’s here today?

Poll Time!

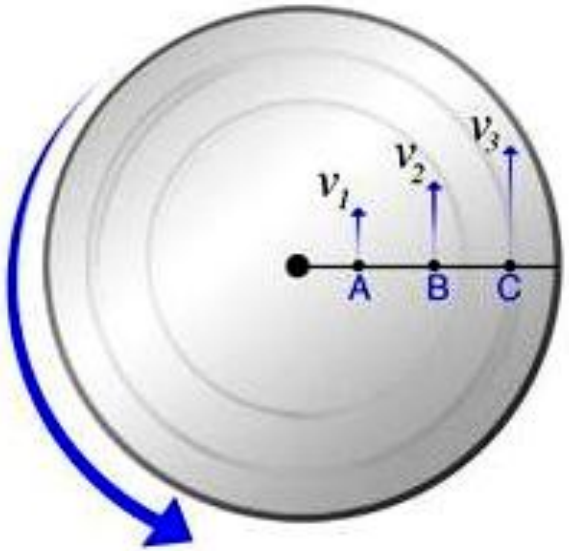
Question 2: If you answered “other”....

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?

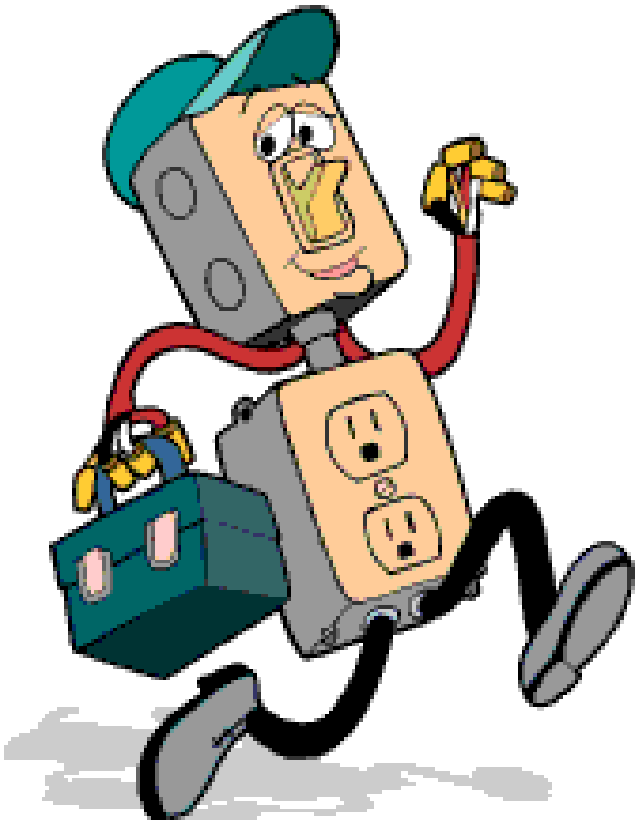
- A device that converts mechanical energy into fluid energy, generally by suction or compression, to move water, air or other fluids

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!

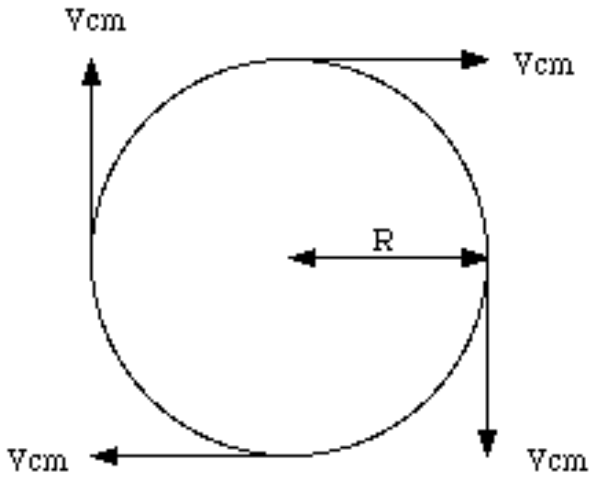


Why Aren't Motors Very Good At What They Do?

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

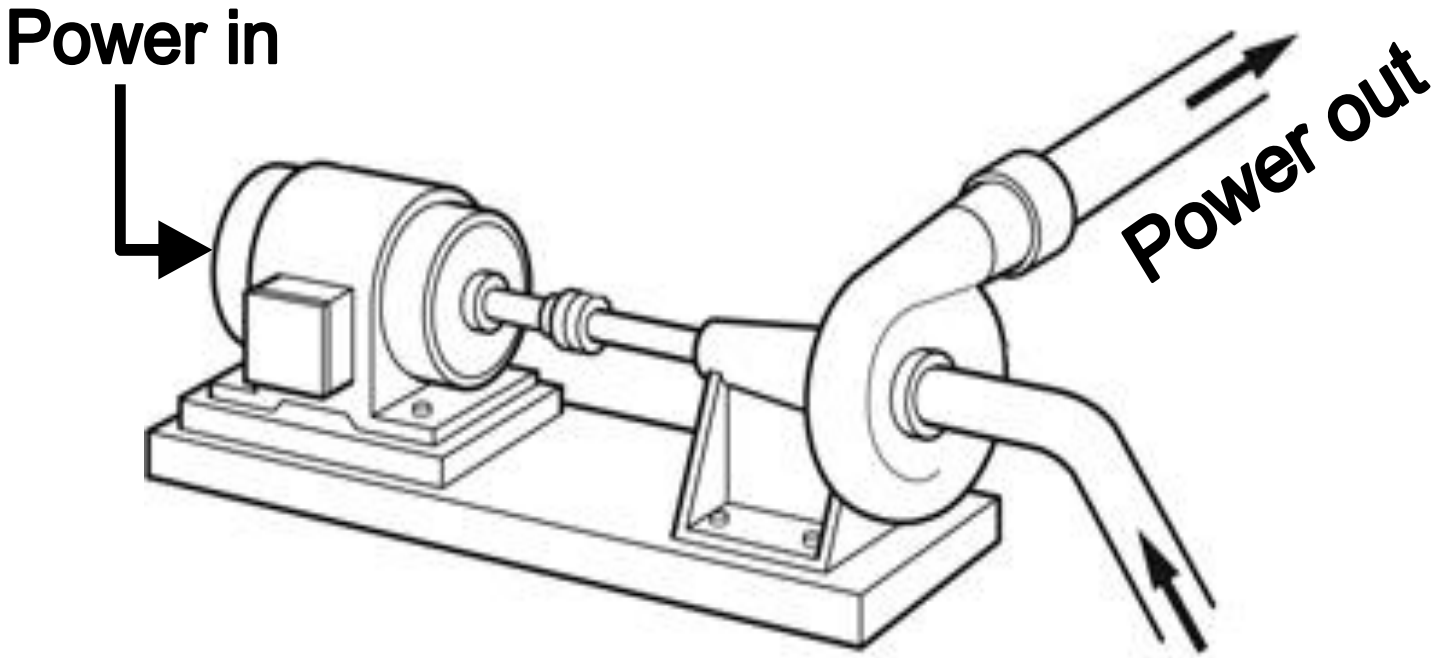
Why Aren't Pumps Very Good At What They Do?

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



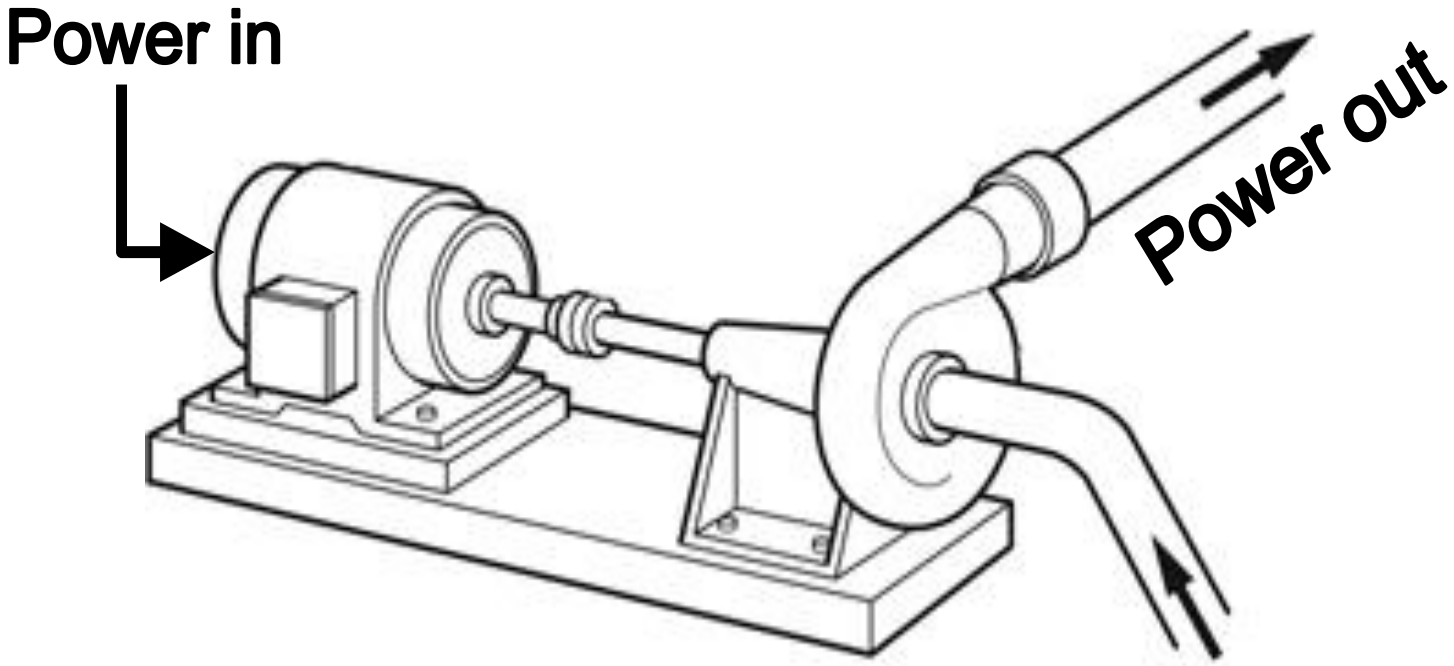
Basic Realities #1

- Motor output power will always be less than input power



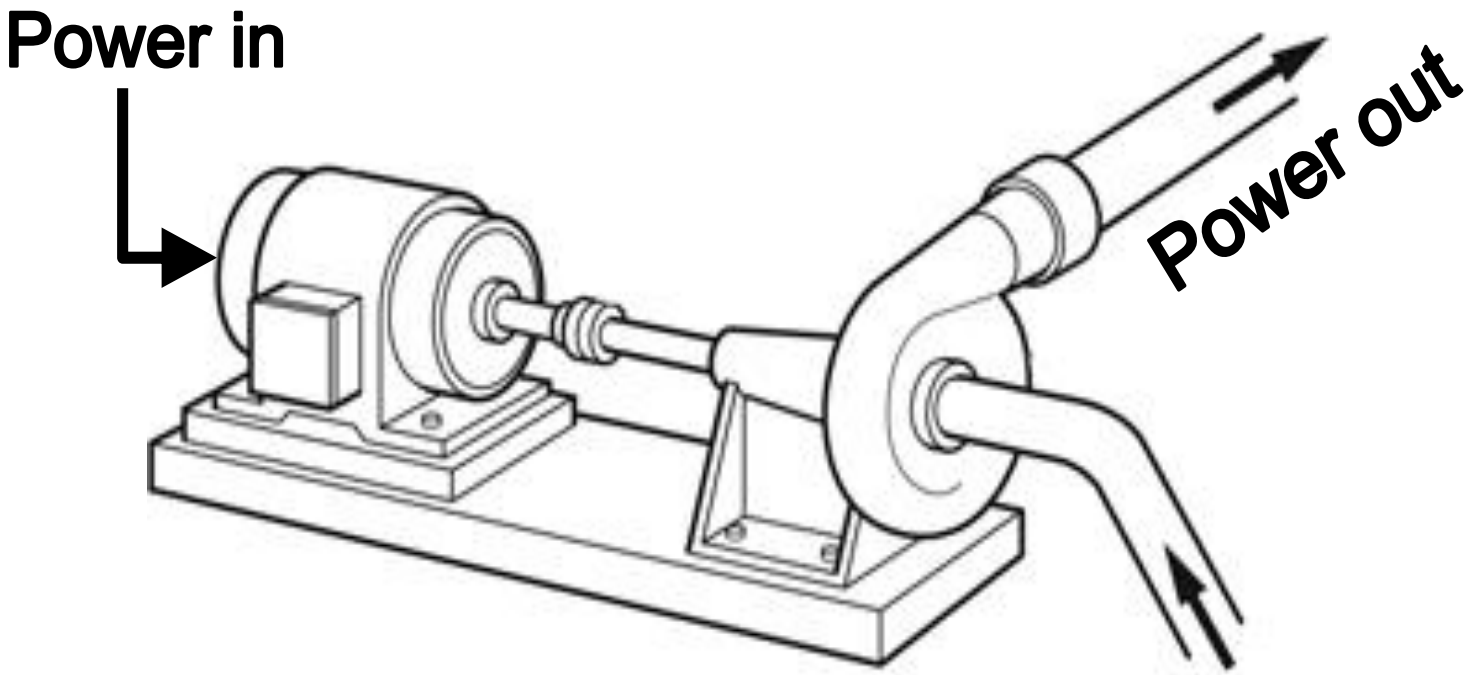
Basic Realities #2

- Fluid power will always be less than motor output power



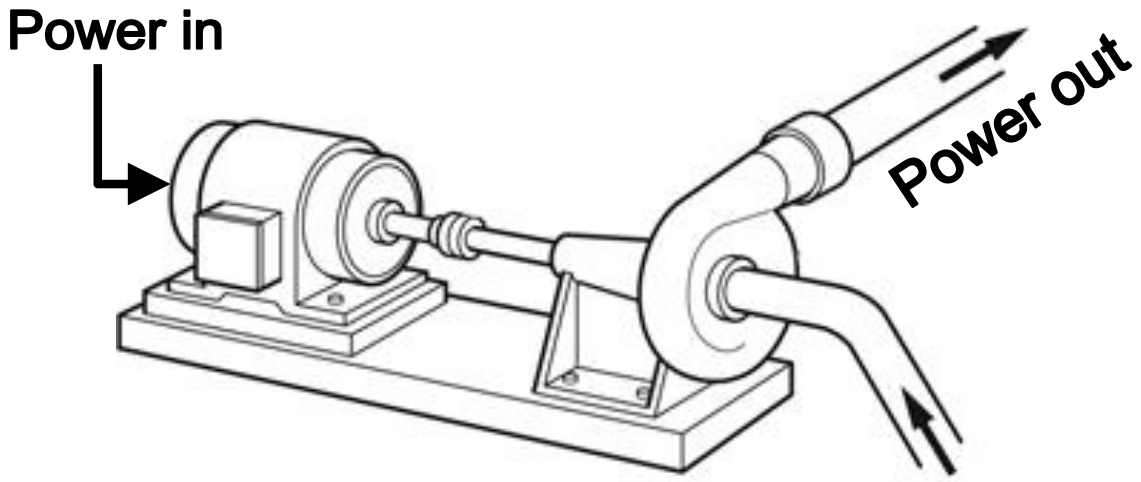
What Does This Mean?

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

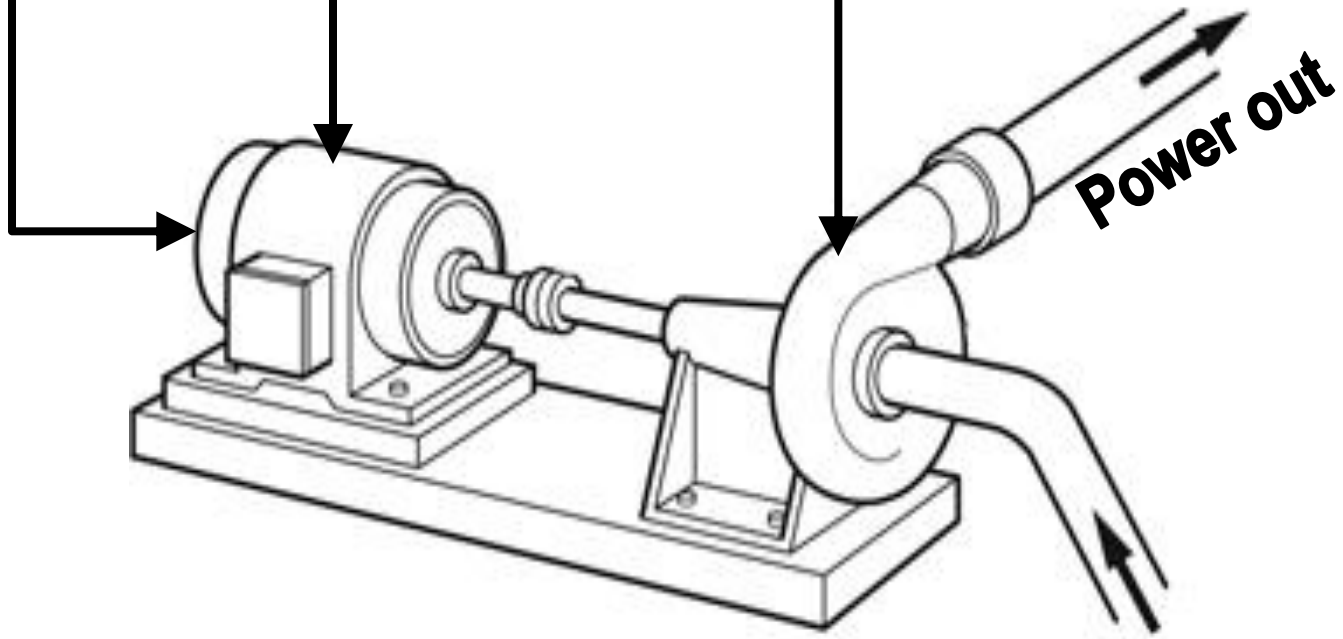


More Unpleasant Realities...

- 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?

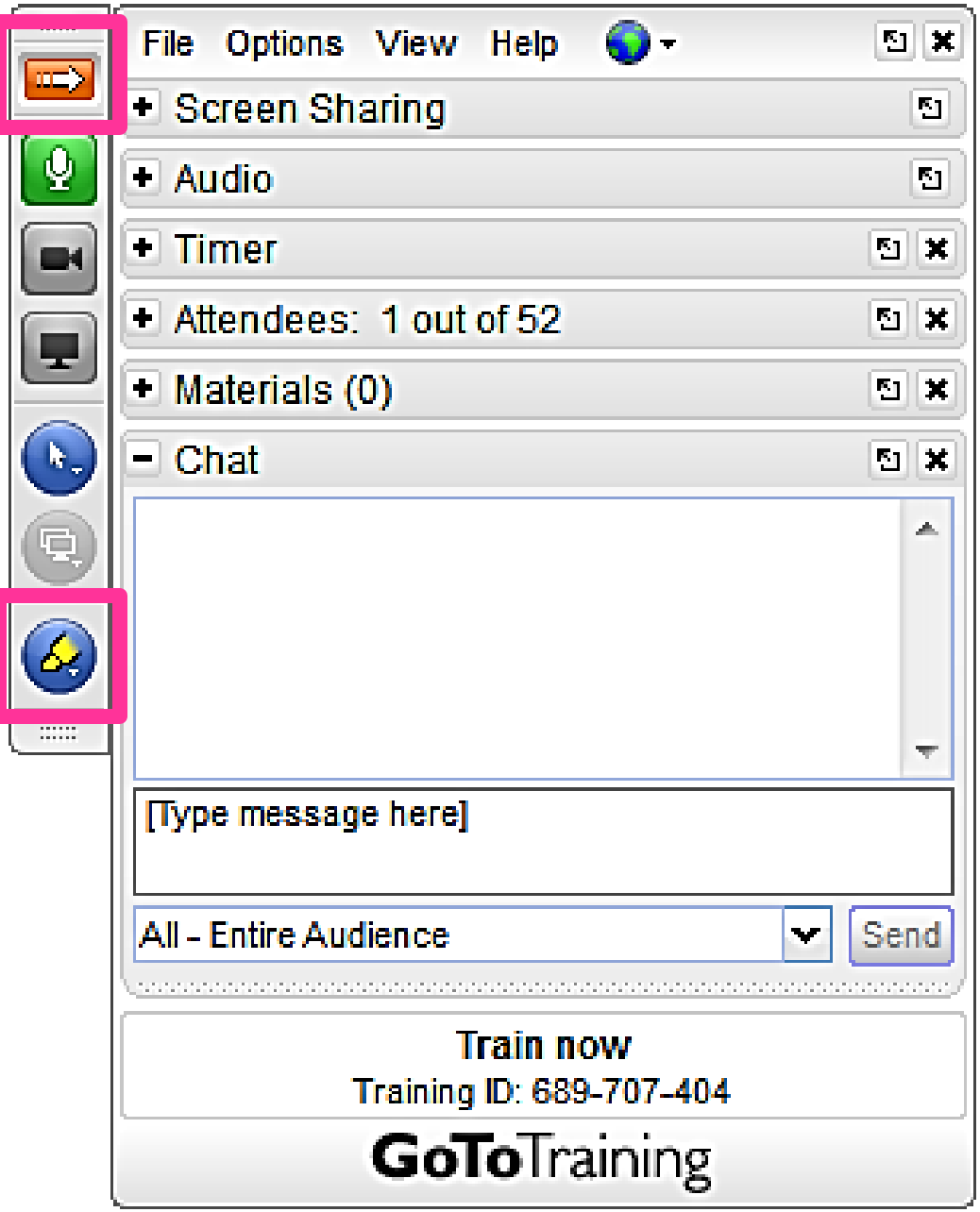
- Power is consumed overcoming the inefficiency of pumps and motors
- You will pay lots of  for that power
- Choose your pumps and motors carefully!

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



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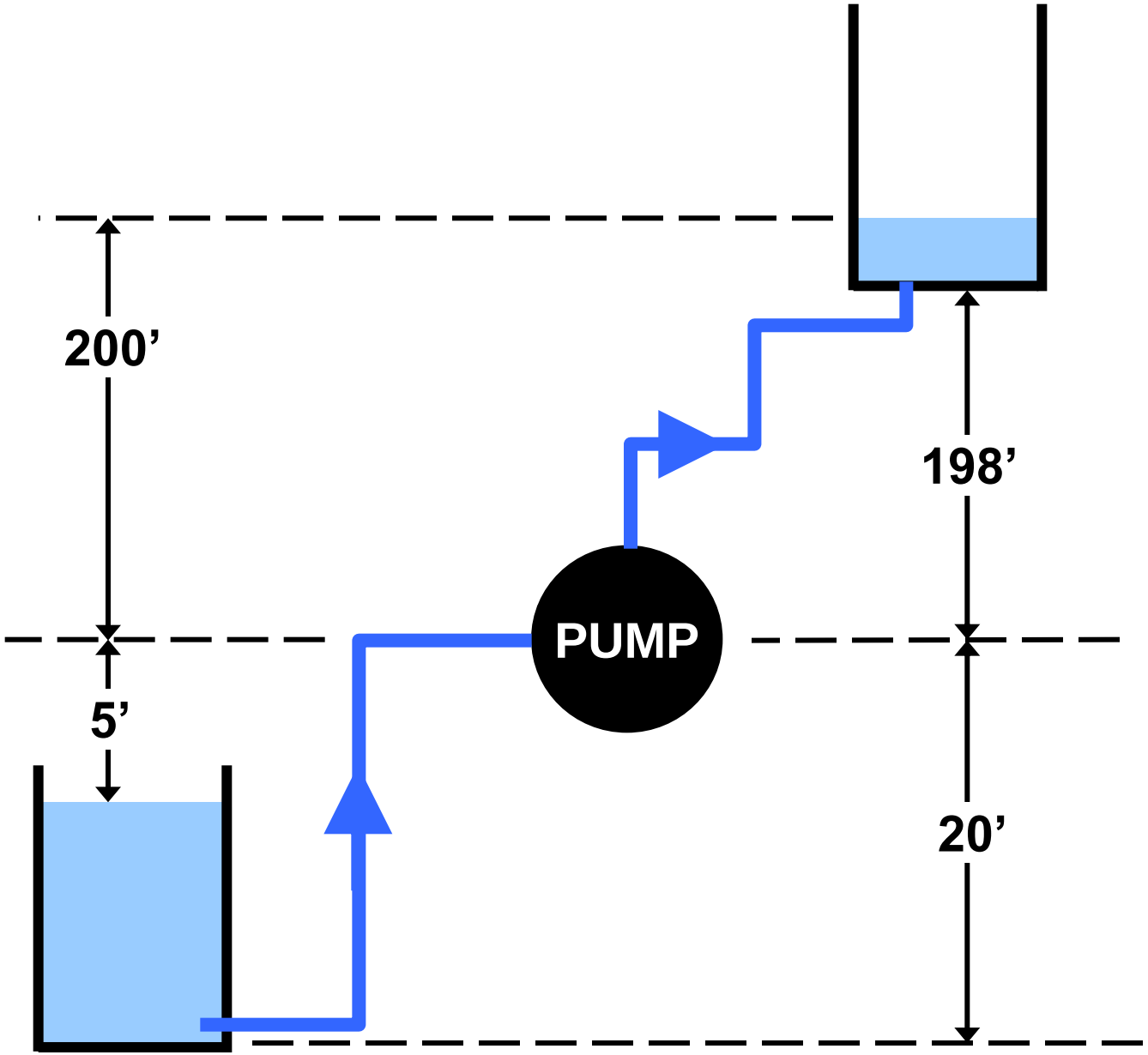
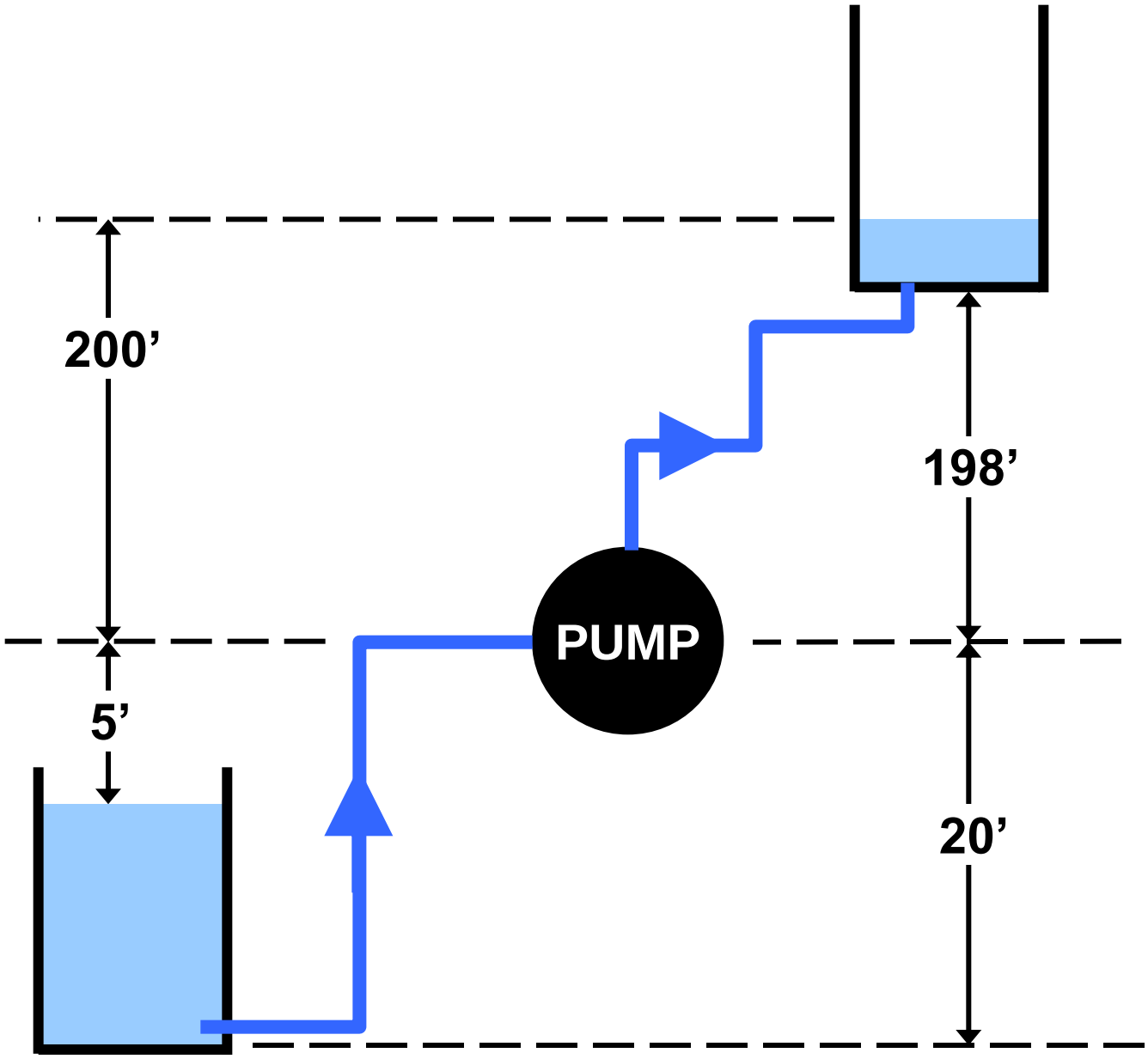
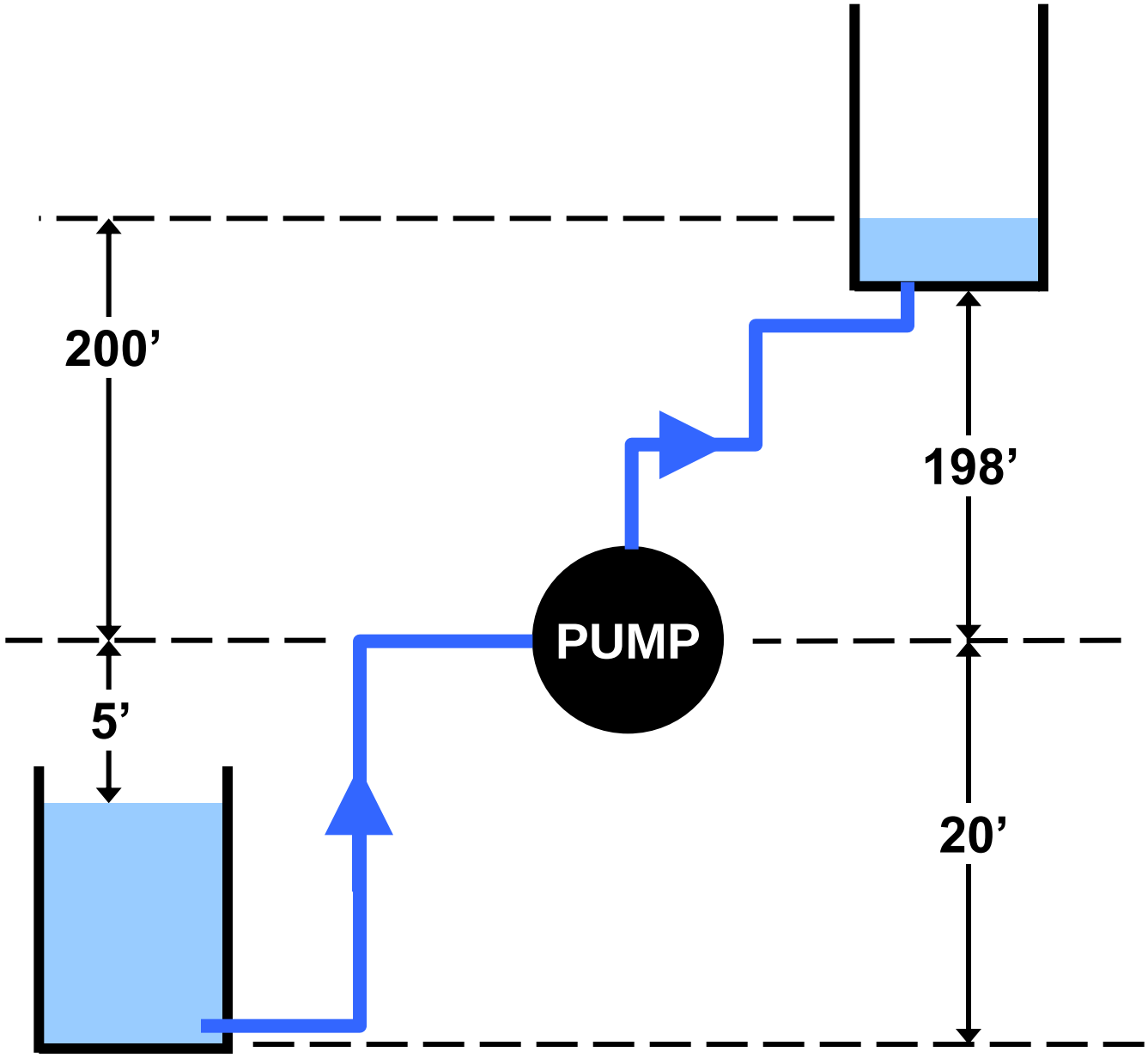


Identify Suction Lift

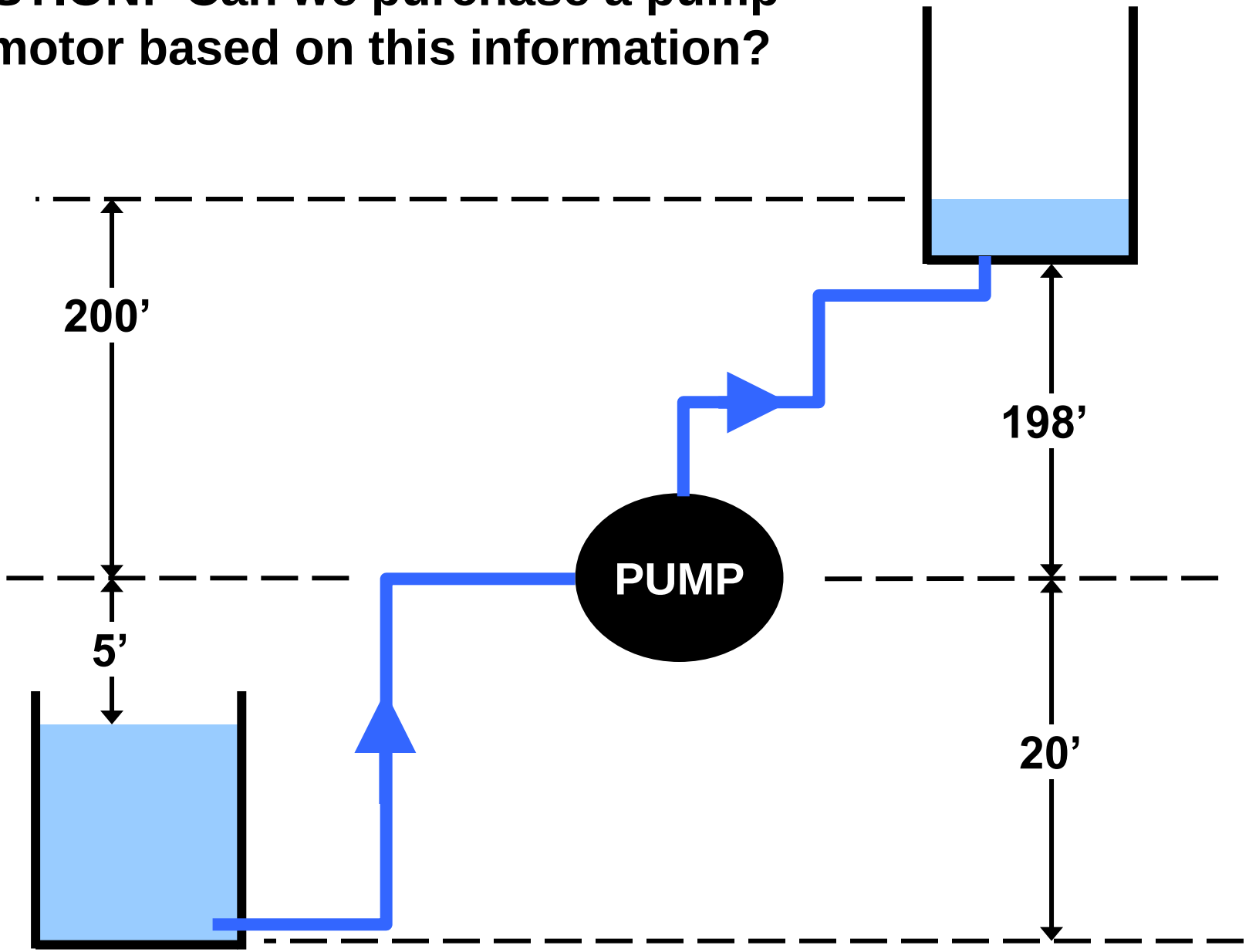


Identify Discharge Lift



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)

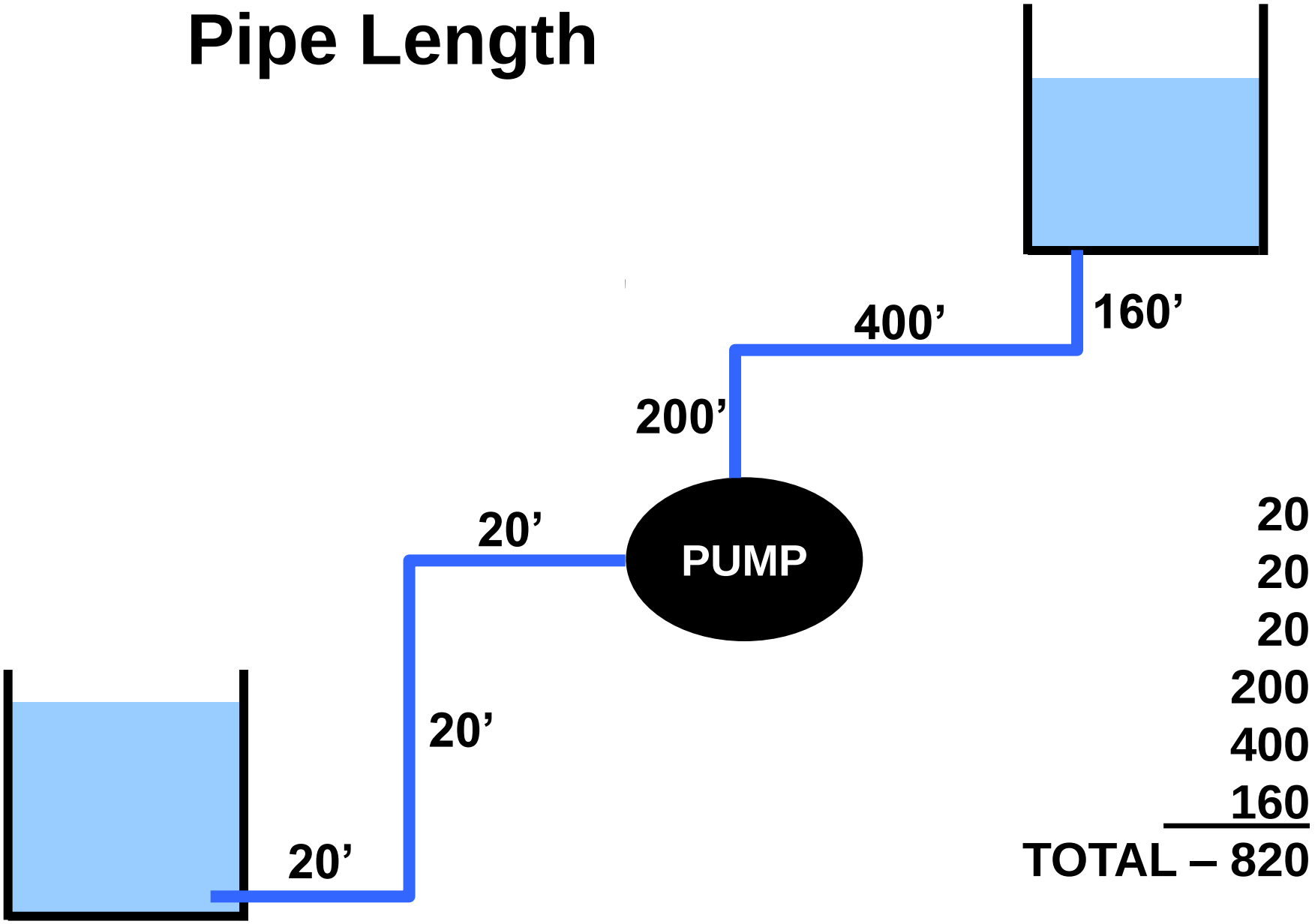
Friction...

- Number & type of fittings

Questions?

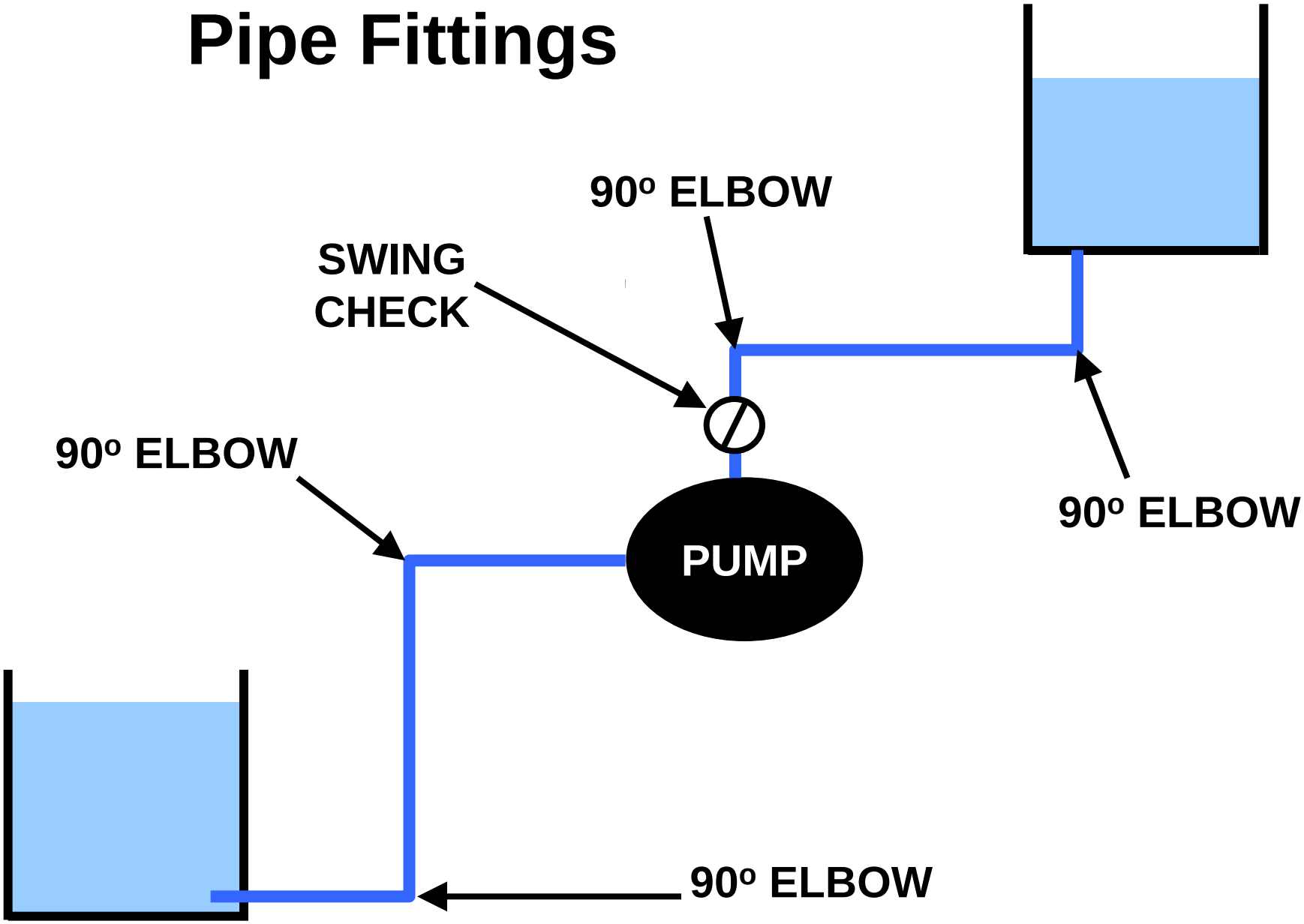
Text your questions and comments anytime during the session

Pipe Length



20
20
20
200
400
160
TOTAL – 820

Pipe Fittings



Sample TDH Problem

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

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

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

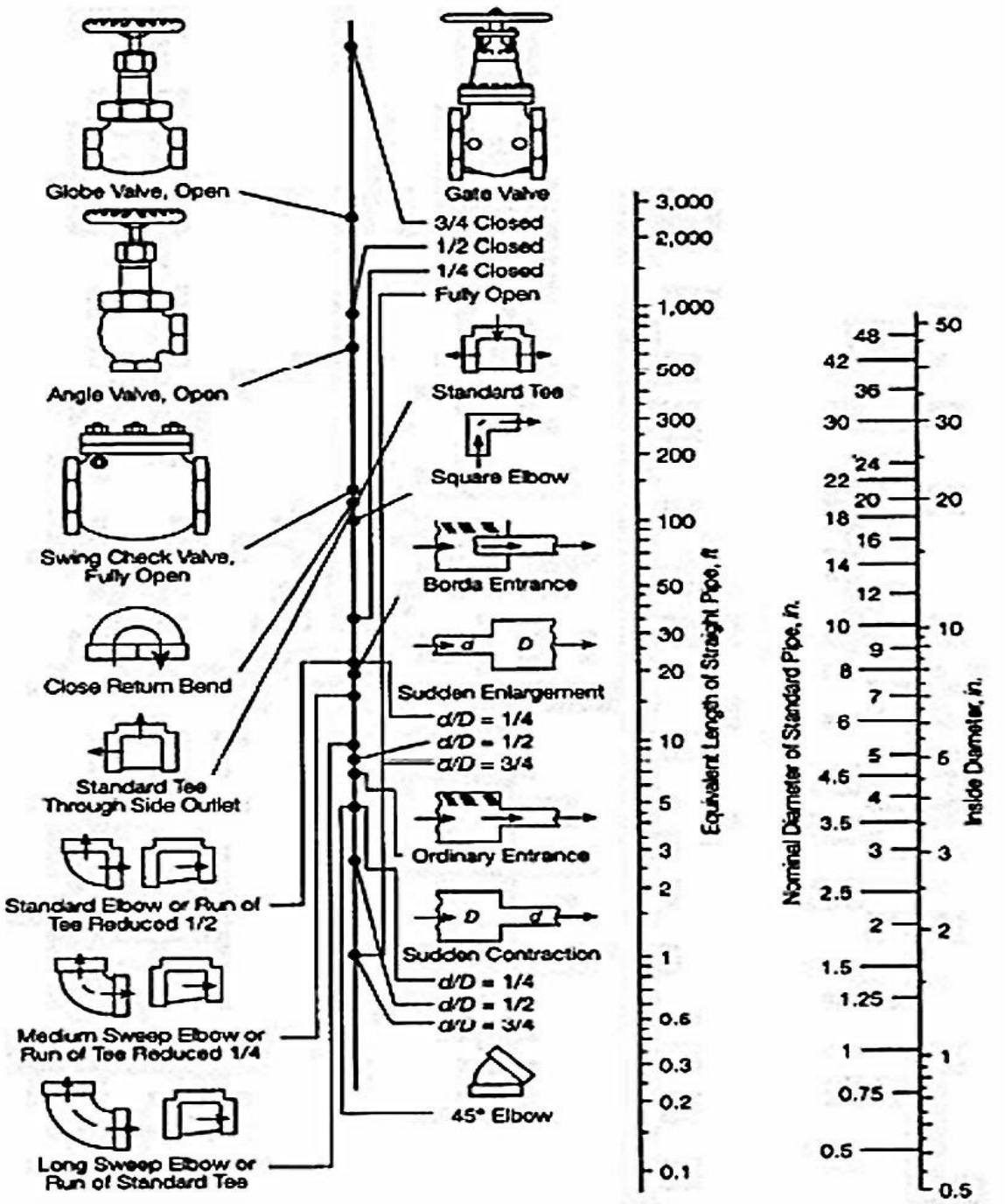
Diameter of pipe..... **6”**

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

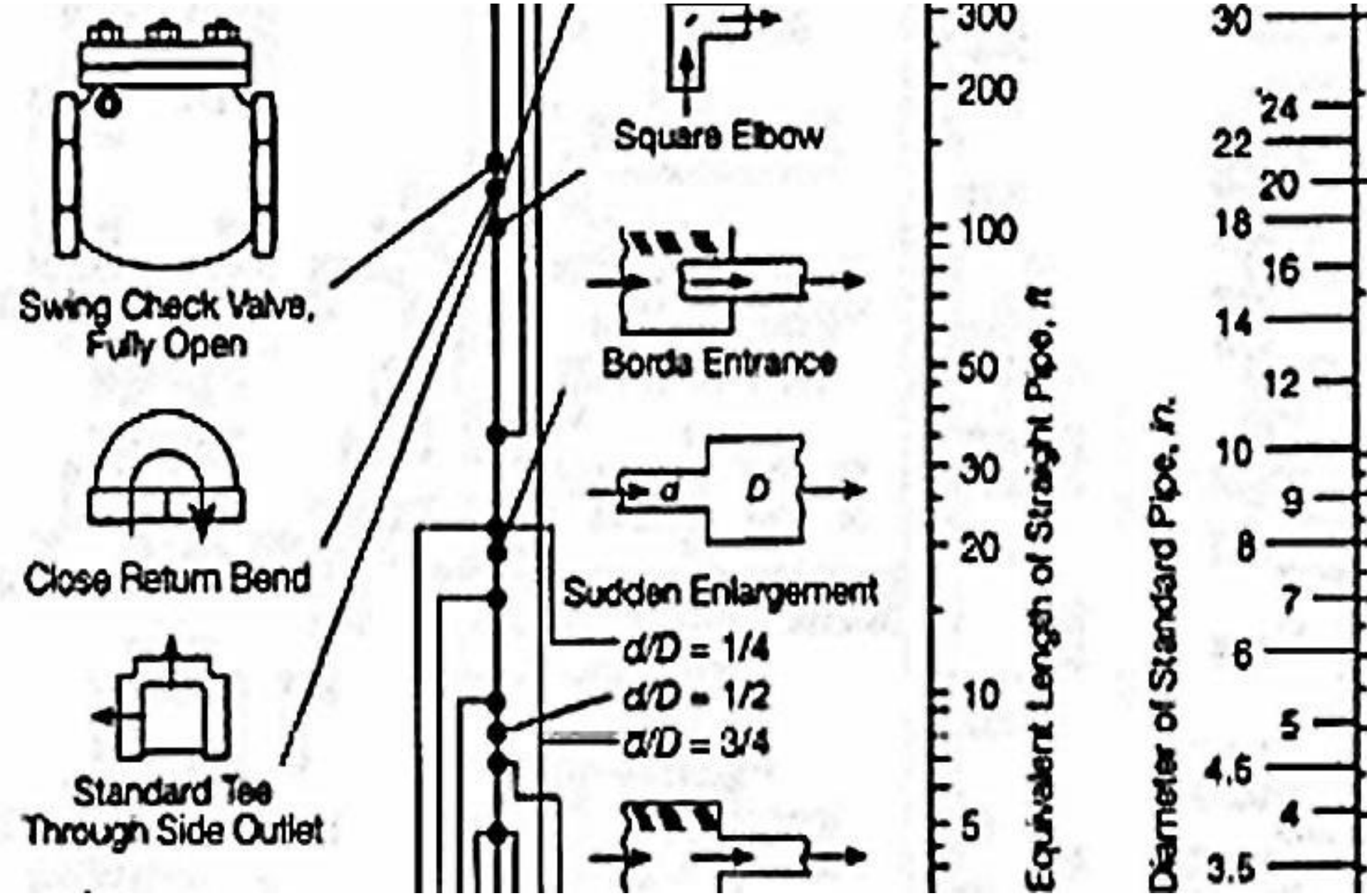
Number & type of fittings:

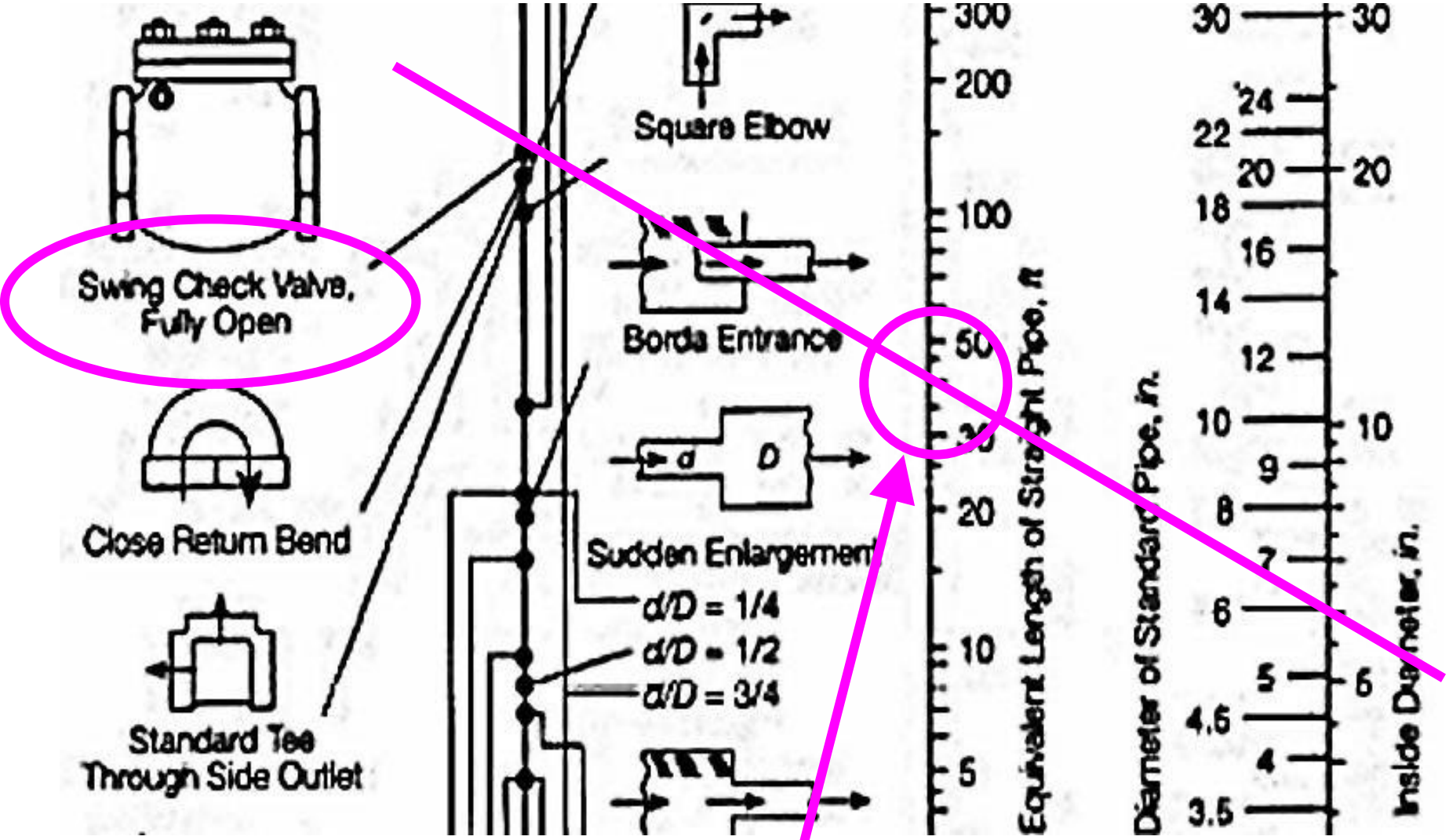
(1) swing check valve

(4) 90^{o} elbows

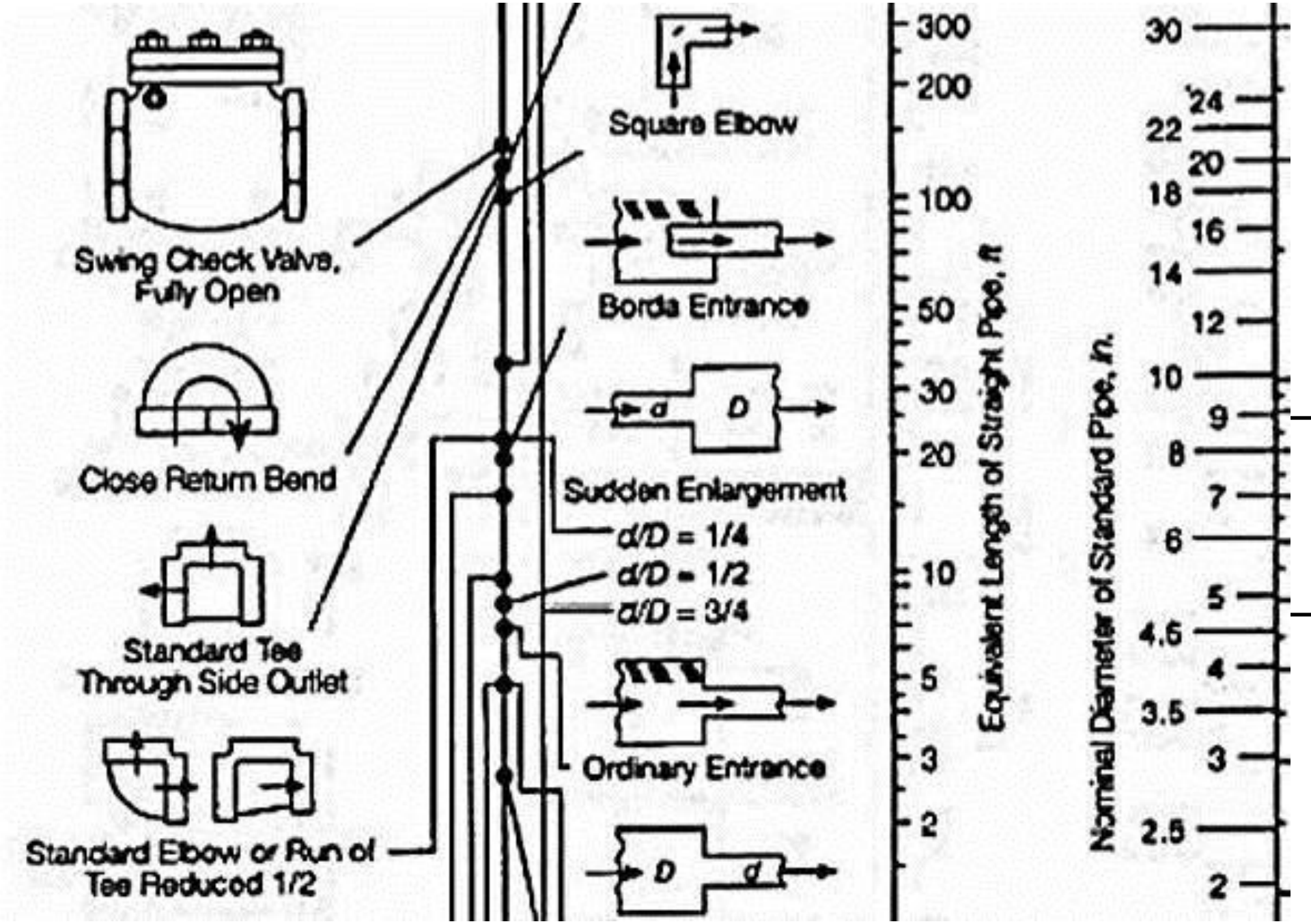


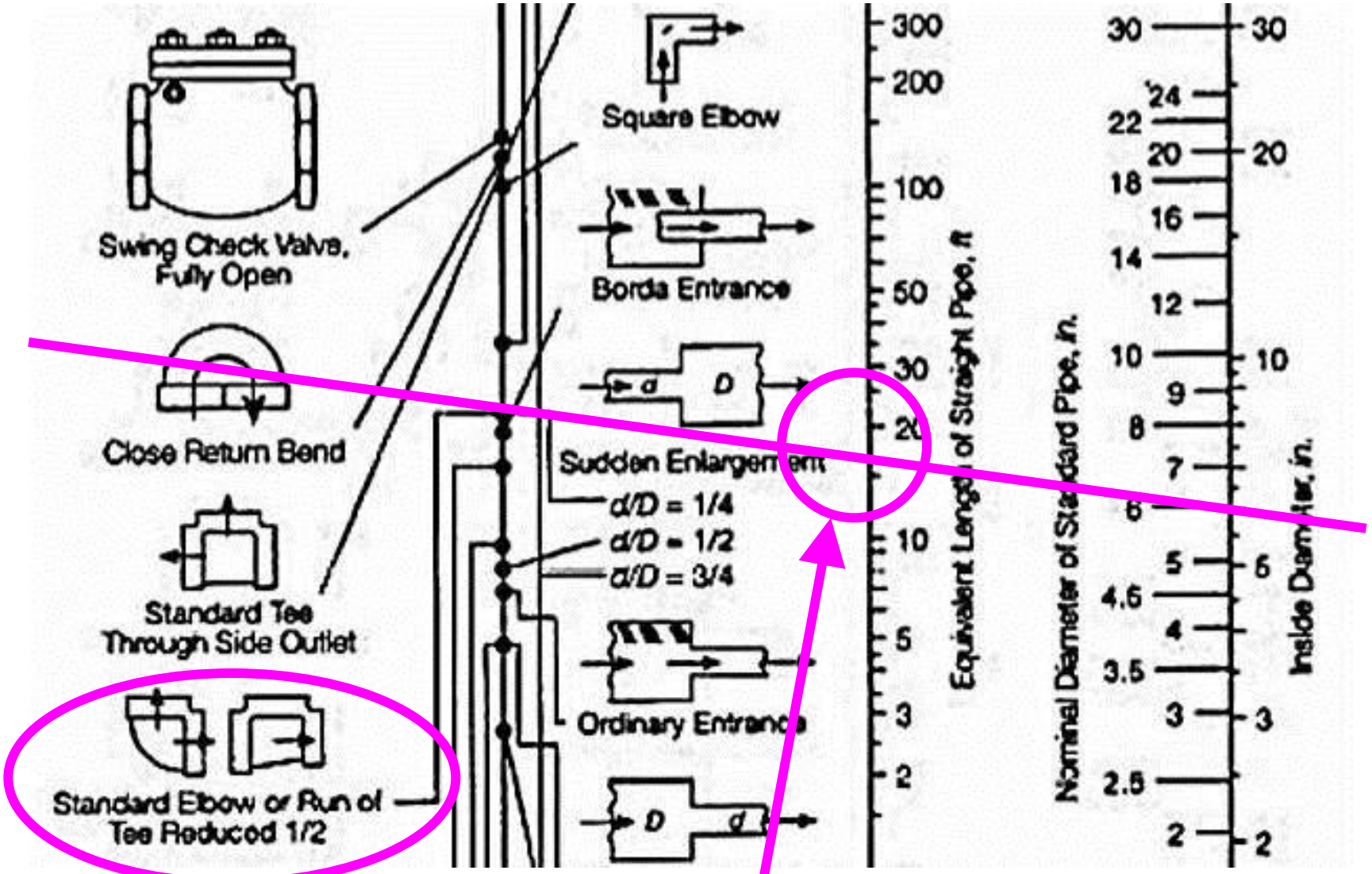
Hazen-Williams Pipe Fitting Friction Loss Nomograph


Swing Check Valve, Fully Open
Close Return Bend
Standard Tee Through Side Outlet
Square Elbow
Borda Entrance
d
D
Sudden Enlargement
d/D = 1/4
d/D = 1/2
d/D = 3/4
300
200
100
50
30
20
10
5
Equivalent Length of Straight Pipe, ft
30
24
22
20
18
16
14
12
10
9
8
7
6
5
4.6
4
3.5
Diameter of Standard Pipe, in.



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
d
D
Sudden Enlargement
d/D = 1/4
d/D = 1/2
d/D = 3/4
Ordinary Entrance
D
d
300
200
100
50
30
20
10
5
3
2
Equivalent Length of Straight Pipe, ft
30
24
22
20
18
16
14
12
10
9
8
7
6
5
4.5
4
3.5
3
2.5
2
Nominal Diameter of Standard Pipe, in.



17 feet of straight pipe

What's The Real Length?

Original length - 820 ft

4 elbows @ 17 ft ea. -

1 swing check @ 40' -

Total -

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What's The Real Length?

Original length -	820 ft
4 elbows @ 17 ft ea.	68 ft
1 swing check @ 40'	40 ft
"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 $$$$$$$*** !

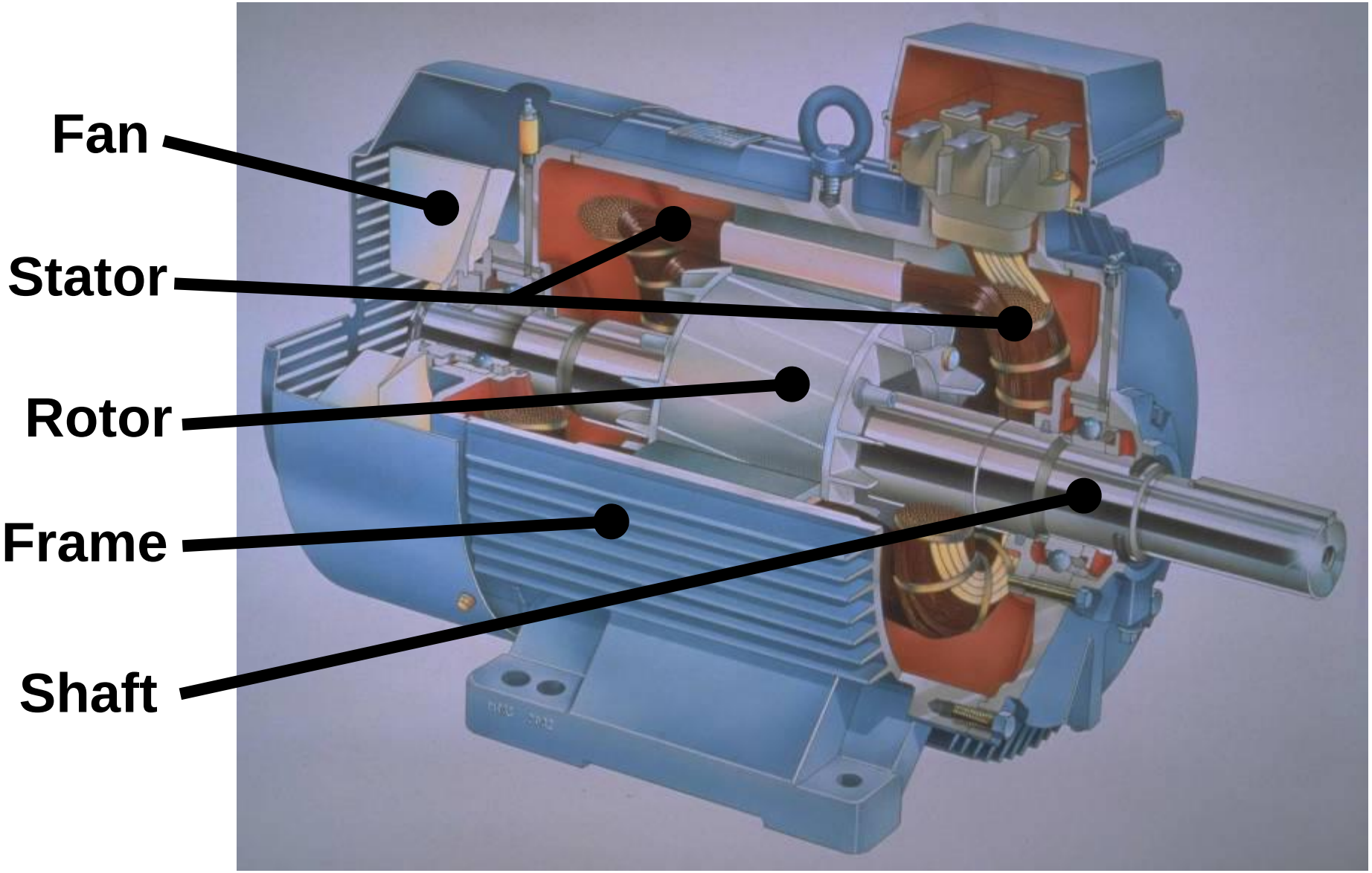
Pop Quiz!

Web Tour – TDH Calculator

Flow Rate	GPM	
Pipe Diameter	inch	Inside diameter
Pipe Length	ft	Total length
Differential Elevation	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) ☐	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

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Poll Time!

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

Common AC Motor Types

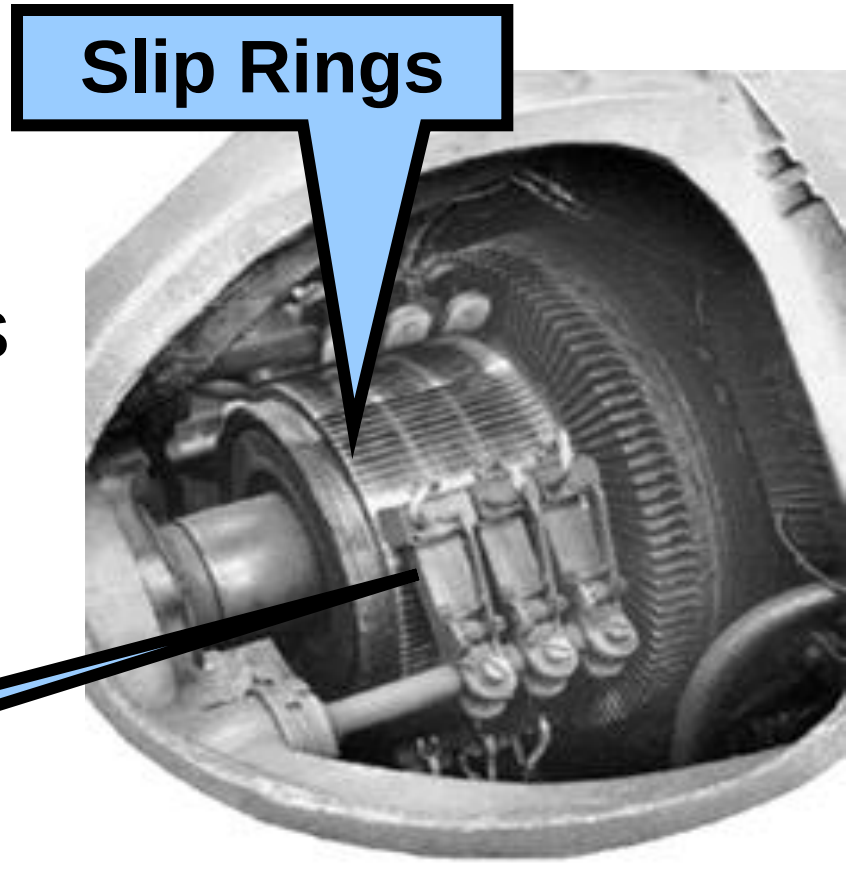
- Induction
- Synchronous

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



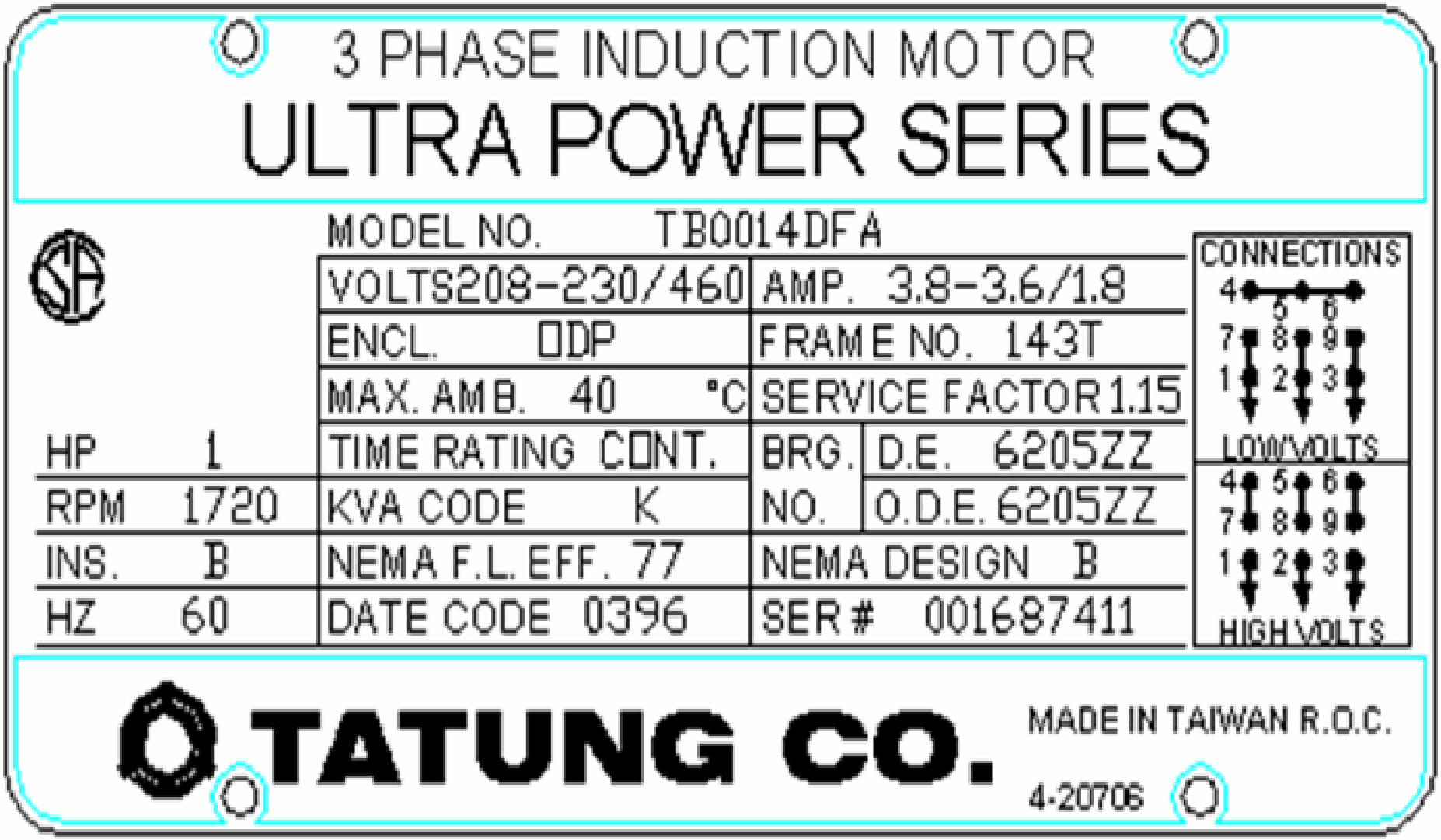
Induction Motors

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

Motor Terminology...
NEMA Frame Types

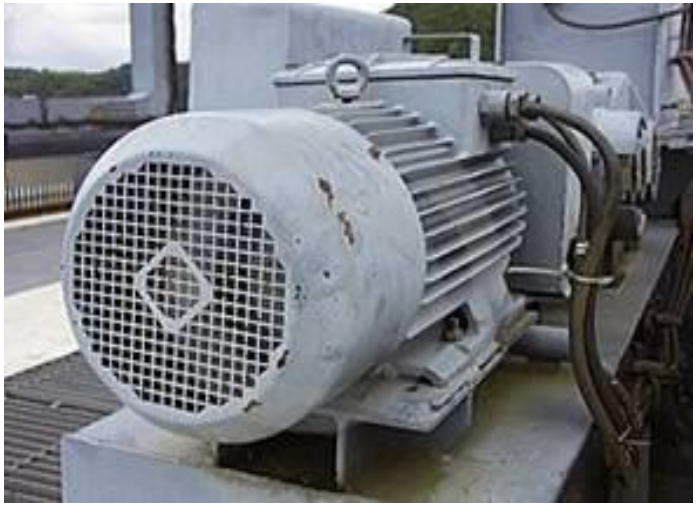
- TEFC (Totally Enclosed Fan Cooled)
- TENV (Totally Enclosed Non-Ventilated)
- TEAO (Totally Enclosed Air Over)
- TEXP (Totally Enclosed Explosion-Proof)
- ODP (Open Drip-Proof)
- C-Face

Understanding Motor Nameplates



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

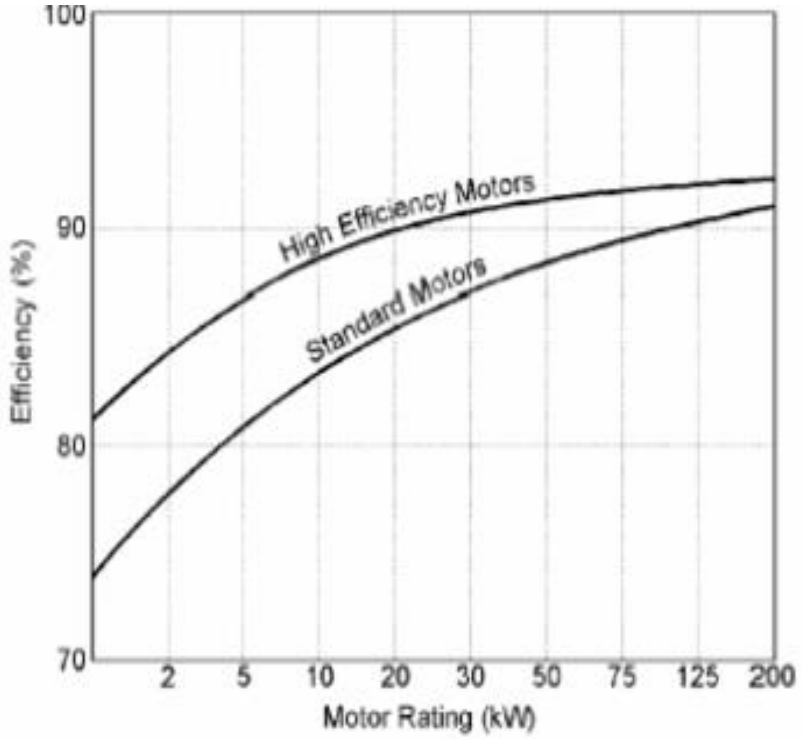


Factors Influencing Efficiency

- 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?

NEMA Premium®

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**

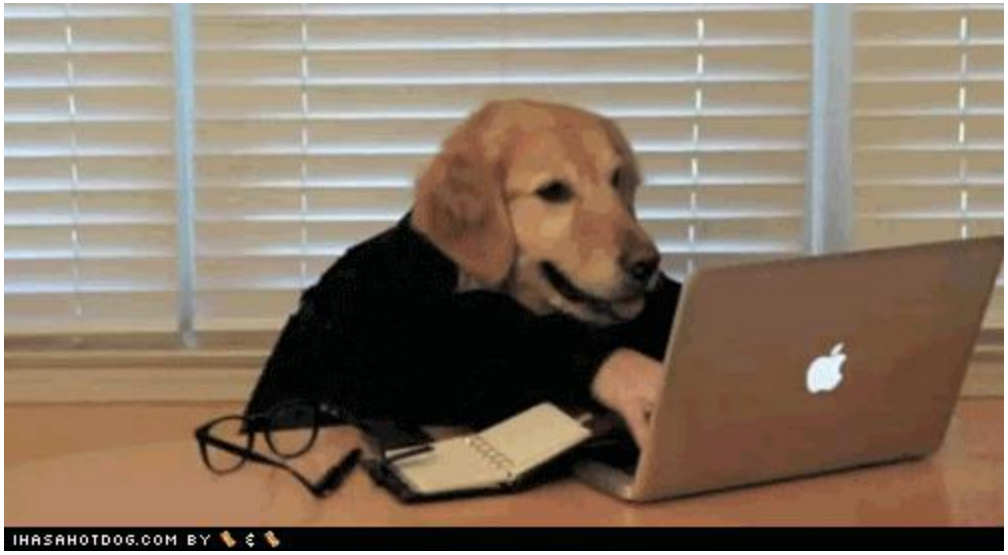
Rewinding

- 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?



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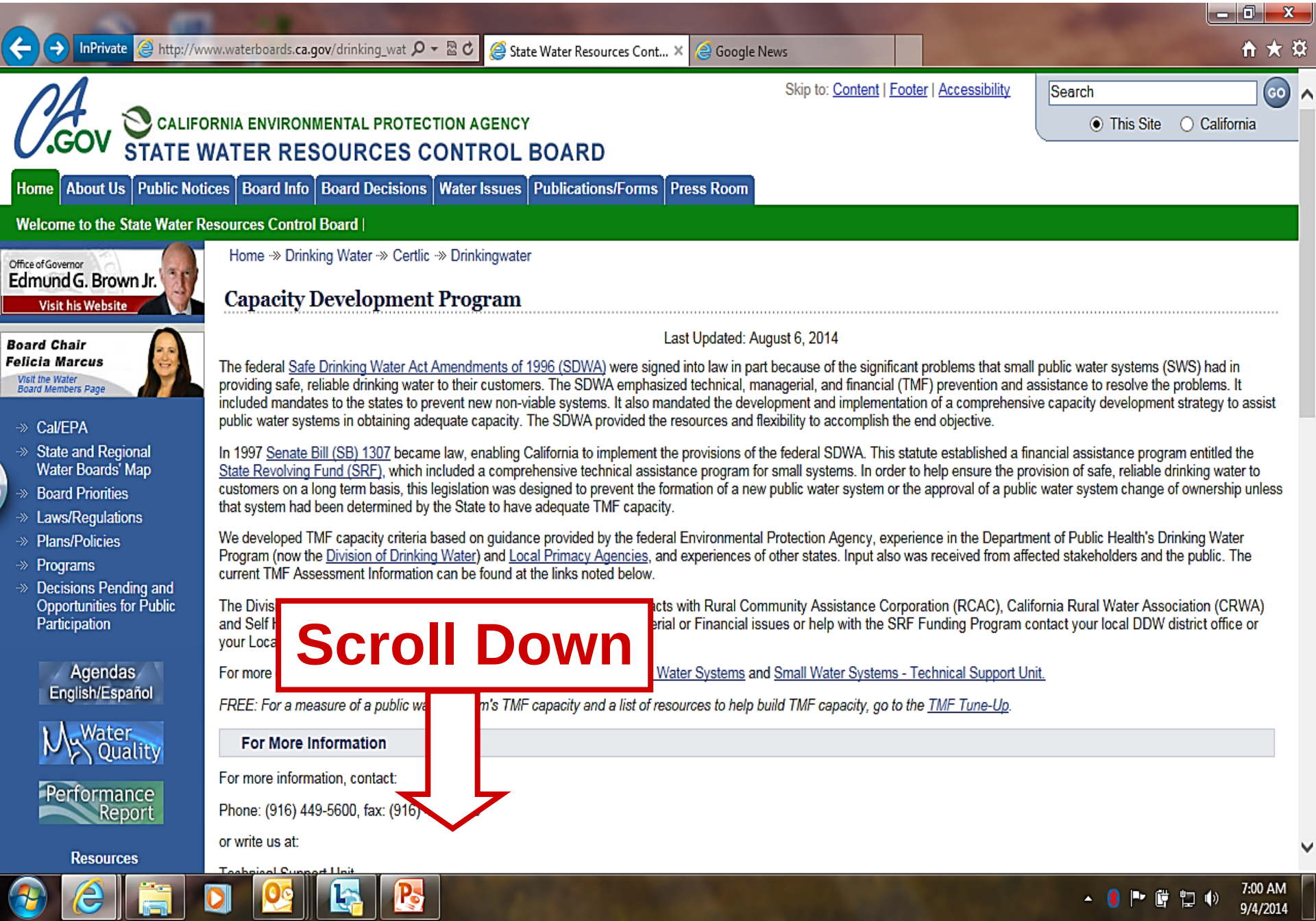
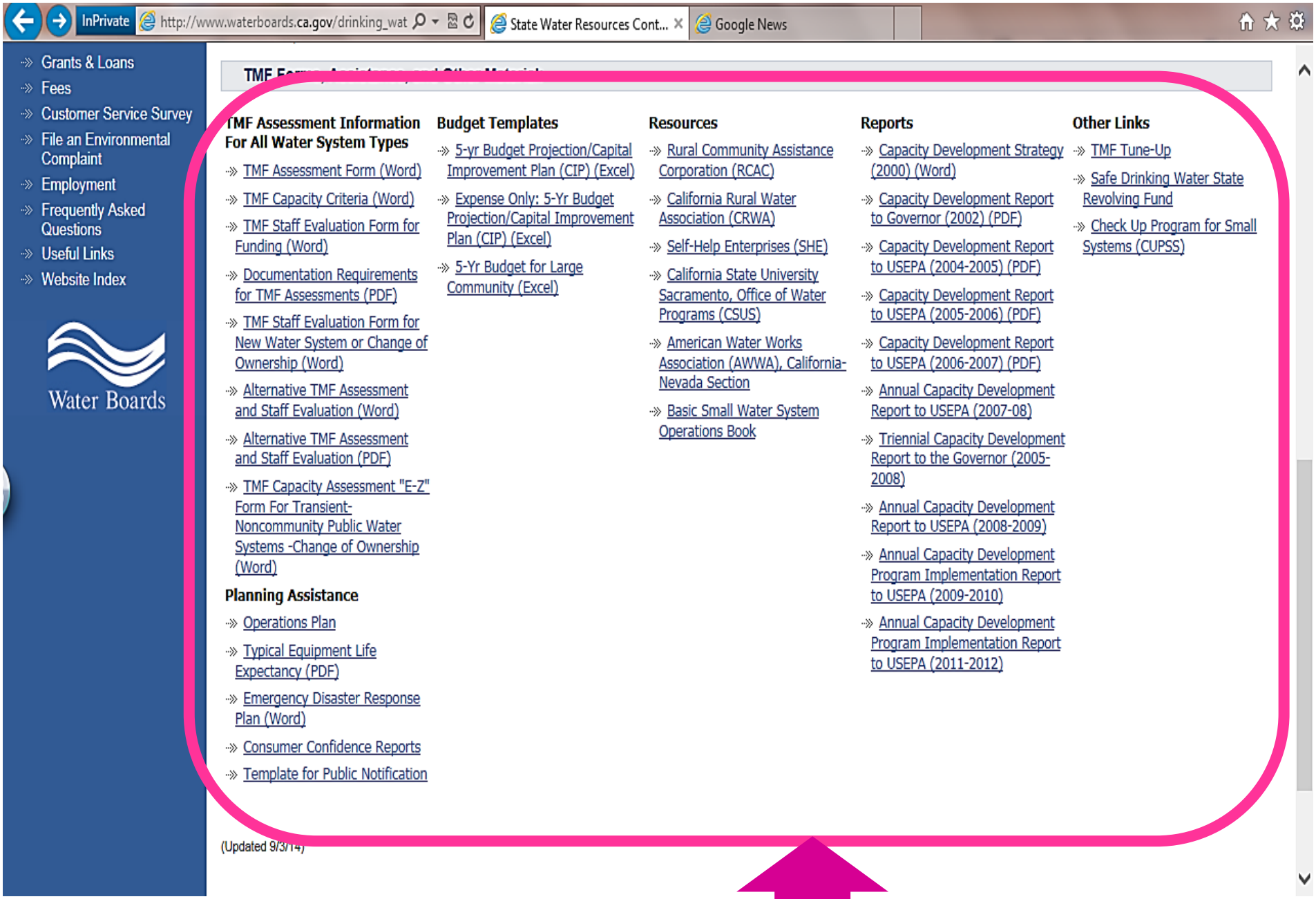
http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/TMF.shtml





LINKS TO RESOURCES

Thank You For Attending!

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(575) 527-5372

Thank You For Attending!

We look forward to seeing you in future online classes!

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