Grundfos Technical Institute

Choose the Right Pump for the Application

Jim Swetye

April 27, 2016

www.grundfos.us/training

WELCOME

- Participants are in a listen-only mode.

- To ask a question during the event, use the chat feature at the bottom left of your screen. Technical questions will be answered by ReadyTalk. Questions for our speakers can be asked at any time and will be answered during the Q&A at the end of the session.

- Visit pumpsandsystems.com in the coming days to view the answers to all of the questions asked during the Q&A session.

- Visit pumpsandsystems.com in the coming days to access the recording of the webinar.

Presenter: Jim Sweyte

Jim Swetye is Senior Technical Trainer with Grundfos Pumps Corporation in Ohio

He holds a Bachelor of Arts from Hiram College, Ohio and a Master of Science in Education/Curriculum Leadership from Emporia State University, Kansas

He has been in the industry for 37 years

Jim specializes in pumping systems for commercial HVAC, residential hydronics, industrial and municipal applications.

He is the former Vice President of Knowledge and Education at the Hydraulic Institute, is a certified trainer for Pump Systems Matter, and is a current co-chairman of the Educational Marketing Executive Committee of Pump Systems Matter

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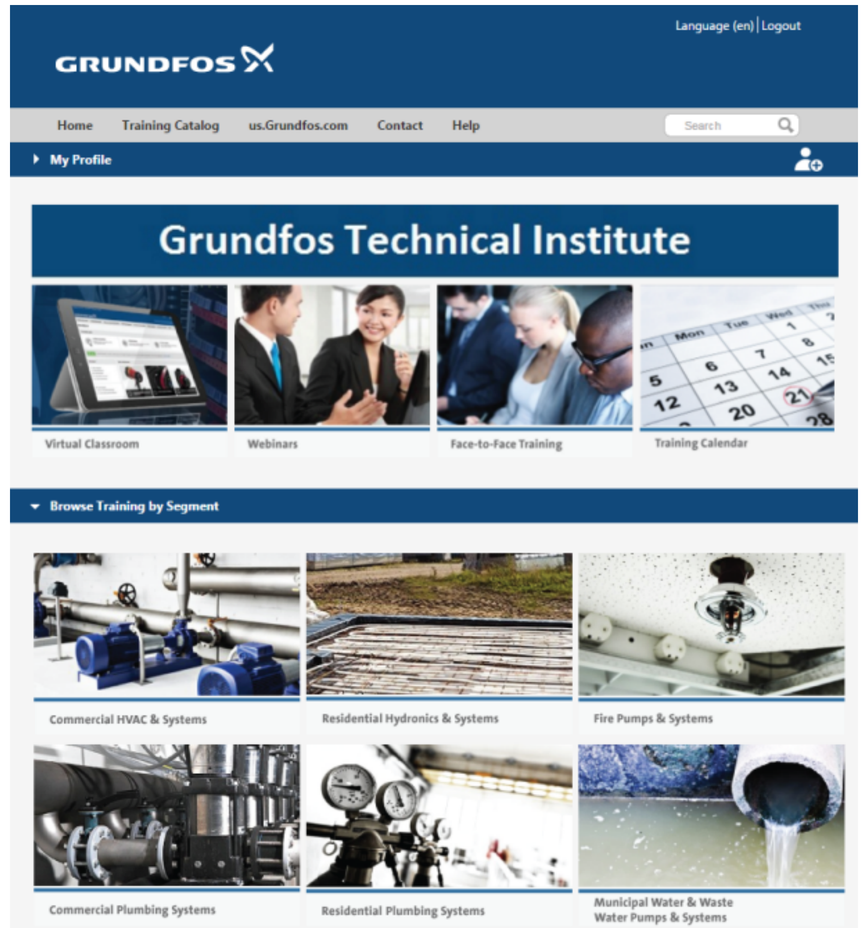

Before we get started . . .

- I need a pump to move 100 USgpm of water at 100 feet of Total Dynamic Head
- Which of the following pumps are capable of operating at that duty point?

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ANSI B73.1 horizontal frame mount
ANSI B73.2 vertical inline
API-610
Axial piston
Bilge
Boiler feedwater
Canned motor
Cantilever
Chain
Chopper
Column sump
Condensate return
Coolant
Diaphragm
Double suction split case – vertical
Double suction split case – horizontal
End suction close coupled
End suction frame mounted

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Fire
Foam
Fuel
Hard metal
Helical rotor
Hose
Immersible solids handling
Lobe
Machine tool
Magnetic drive
Manure pit
Metering
Non-metallic
Peristaltic
Piston
Plunger
Progressing cavity
Radial piston
Recessed impeller

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Regenerative turbine
Residential circulator
Residential submersible
Rotary gear
Rubber lined
Screw
Self-priming
Sinusoidal
Slurry
Submersible solids handling
Submersible turbine
Syringe
Trash
Vertical column sump
Vertical inline
Vertical inline multistage
Vertical lineshaft turbine
Vortex
Waterwell

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Sinusoidal
Slurry
Submersible solids handling
Submersible turbine
Syringe
Trash
Vertical column sump
Vertical inline
Vertical inline multistage
Vertical lineshaft turbine
Vortex
Waterwell

The answer:

ALL OF THEM!!

So how can we make a rational decision on the best one for the application?

Learning Objectives

By the end of this course you will be able to:

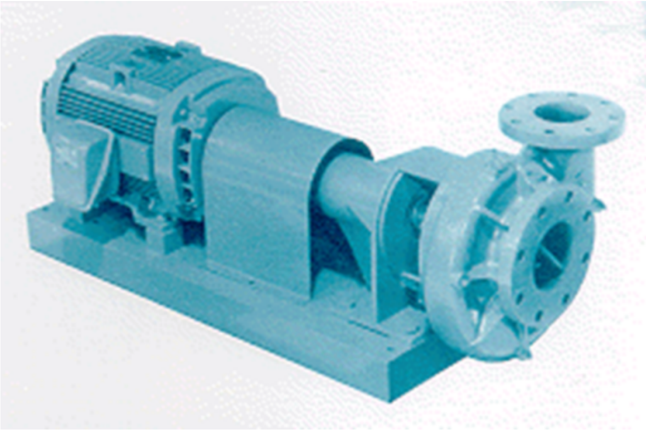
1. Identify the six pump types most often used for Commercial HVAC applications, and explain the characteristics of each
2. Explain the distinctions between above-grade mounted and below-grade mounted pump applications
3. Select pump types for the primary Commercial HVAC applications for hydronic hot water, steam, and chilled water systems by following a logical, repeatable process
4. Describe the critical role of Life Cycle Costing in determining the best pump type for the application
5. Use the new knowledge to aid you in writing technical specifications

This is NOT a course on how to select pump sizes and optional features. It focuses only on choice of pump *type*.

Checklist for selection of pump type for Commercial HVAC

Check	Item	Topic
☐	1	Centrifugal for hydronic hot water, chilled water, or steam - or Dosing for chemical treatment
☐	2	Liquid
☐	3	Flow rate
☐	4	Total dynamic head
☐	5	Check selection software
☐	6	Above or below grade source
☐	7	Above grade installation piping limitations
☐	8	Suction lift for below grade source
☐	9	NPSHa
☐	10	Power source
☐	11	Availability
☐	12	Serviceability
☐	13	Materials of construction
☐	14	Life expectancy
☐	15	Initial price
☐	16	Customary pump type for specific application
☐	17	Life Cycle Cost analysis

Step 1 – Centrifugal or Positive Displacement?



Step 2 - Starting with liquids

These are the primary liquids for this webinar:

- Water – hot
- Water - chilled
- Water/glycol solutions
- Condensate water
- Deaerated boiler feed water
- Treatment chemicals

General Purpose Commercial HVAC Pumps

General Purpose Commercial HVAC Pumps

1. **End Suction**
    a) Frame mounted
    b) Close coupled/Motor mount/Monobloc

General Purpose Commercial HVAC Pumps

1. **End Suction**
   a) Frame mounted
   b) Close coupled/Motor mount/Monobloc
2. **Split Case - Double Suction**
   a) Horizontal mount
   b) Vertical mount

General Purpose Commercial HVAC Pumps

1. **End Suction**
    a) Frame mounted
    b) Close coupled/Motor mount/Monobloc
2. **Split Case - Double Suction**
    a) Horizontal mount
    b) Vertical mount
3. **Vertical Inline**
    a) Inline/Circulators
    b) Top Suction/Top Discharge

General Purpose Commercial HVAC Pumps

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    b) Top Suction/Top Discharge
4. **Vertical Multistage Inline**

General Purpose Commercial HVAC Pumps

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2. **Split Case - Double Suction**
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3. **Vertical Inline**
    a) Inline/Circulators
    b) Top Suction/Top Discharge
4. **Vertical Multistage Inline**
5. **Turbine**
    a) Lineshaft
    b) Submersible - Canned
    c) Submersible - Tubed

General Purpose Commercial HVAC Pumps

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   a) Frame mounted
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   b) Top Suction/Top Discharge
4. **Vertical Multistage Inline**
5. **Turbine**
   a) Lineshaft
   b) Submersible - Canned
   c) Submersible - Tubed
6. **Dosing**
   a) Diaphragm
   b) Plunger/Piston

End suction

Frame mounted

Coupling guard not shown

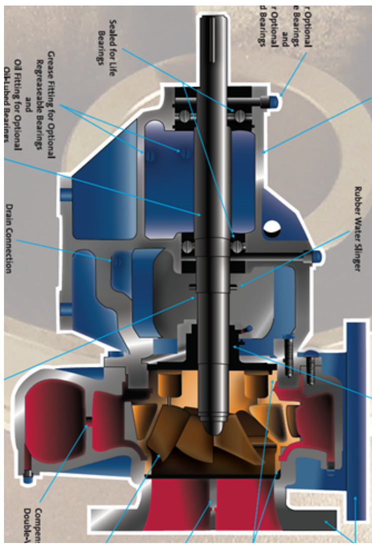
Close coupled – Horizontal or vertical

Split case - double suction

Horizontal

Vertical

Vertical Inline



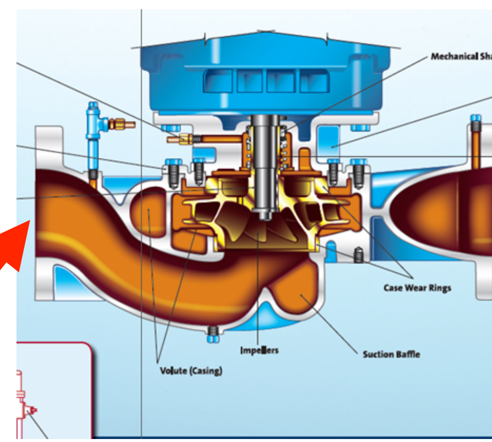
Discharge

Suction

Horizontal end suction pump displayed with shaft in vertical position

Suction

Discharge



Discharge

Suction

Vertical inline pump displaying the "wrapped" suction inline concept

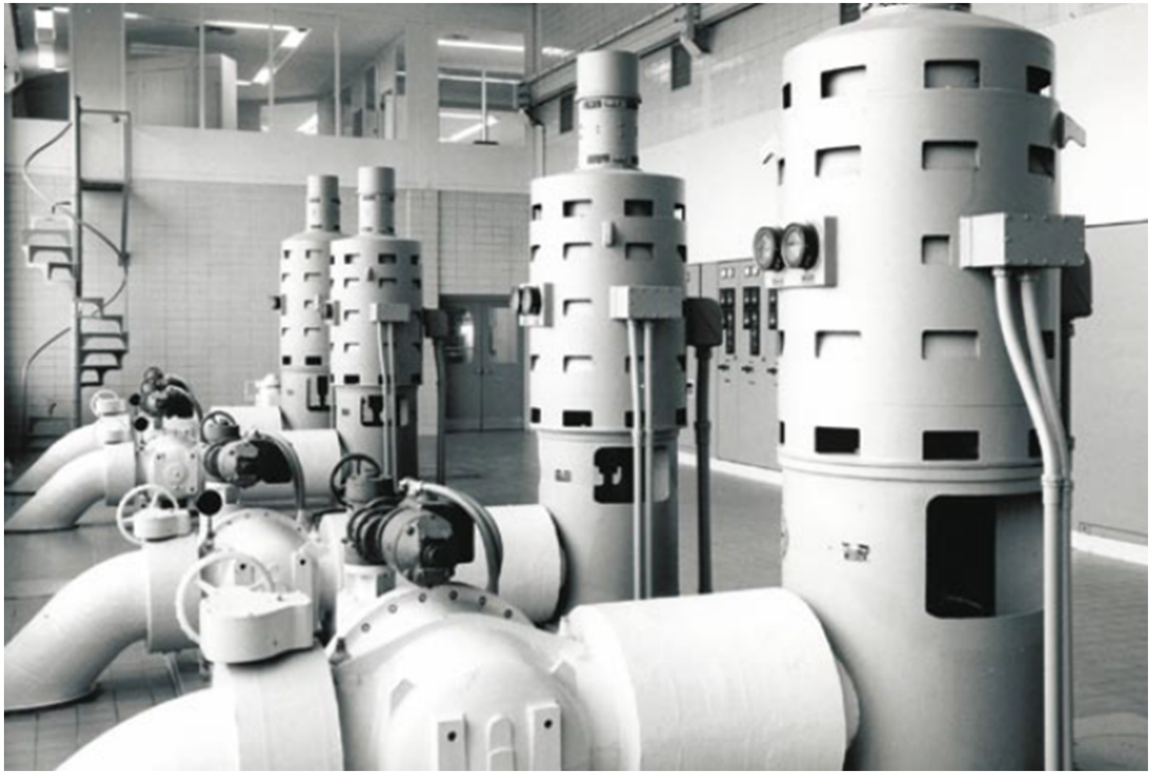
A note on "Inlines" and "Circulators"

Are these inline pumps, or are they circulators?

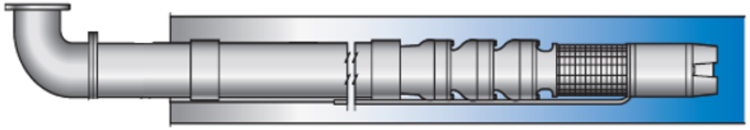
Top Suction/Top Discharge

Vertical multistage inline

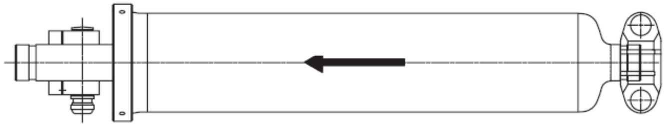
Vertical lineshaft turbine



Submersible turbine



Open bottom sleeve for use in sump



Tubed version for inline piping

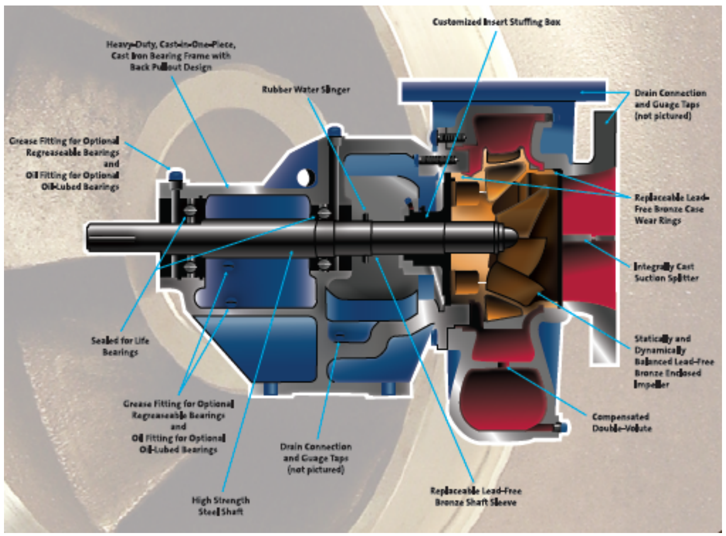
Dosing Pumps – For chemical metering

Diaphragm style

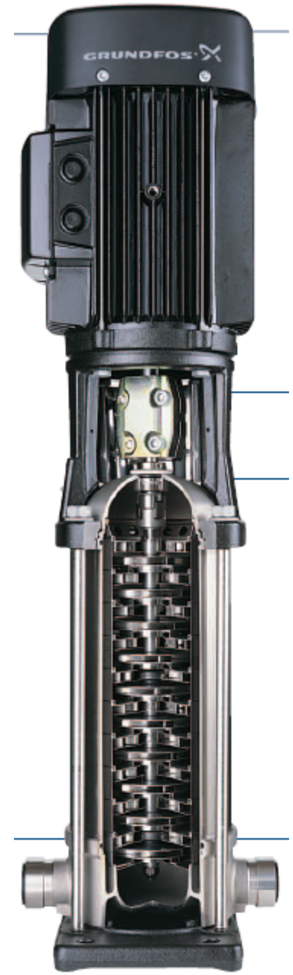
Plunger or piston style

Step 3 - What is the flow rate?

Step 4 – What is the total dynamic head?

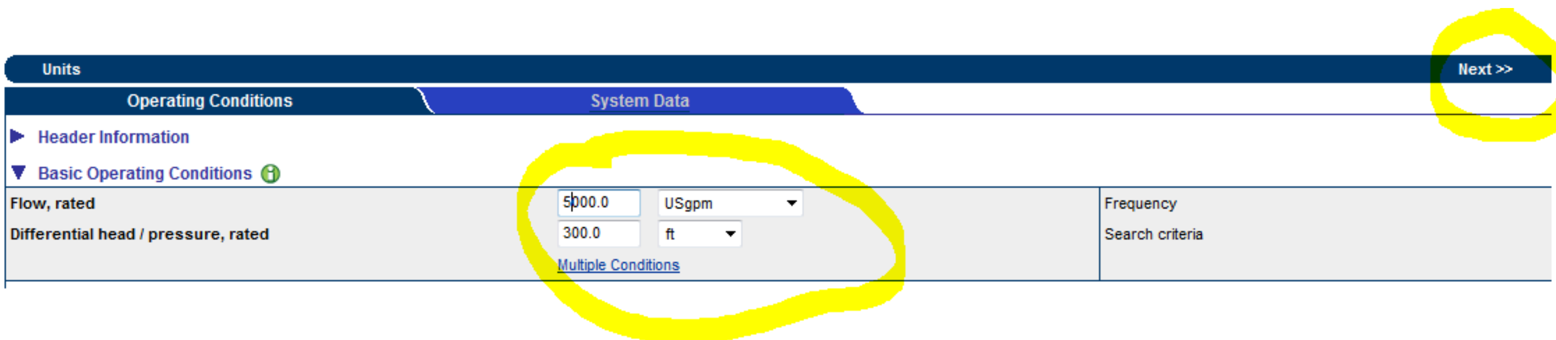


Single stage (one impeller)



Multi-stage
(Many impellers)

Step 5 - Pump selection software – A tool to quickly eliminate unsuitable types



Using the selection software

Product Line (All)		Maximum Flow (USgpm)	Maximum Head (ft)
End Suction, Close-coupled, LC, (PC10)		7000.0	440.0
End Suction, Split Coupled, LCS (PC14)		7000.0	440.0
End Suction, Split Coupled, Integrated VFD, LCSE (PC24)		7000.0	440.0
End Suction, Frame Mounted, LF, (PC11)		7000.0	440.0
End Suction, Frame-Mounted, Integrated VFD, LFE (PC21)		7000.0	440.0
End Suction, Close-coupled Vertical, LCV, (PC20)		7000.0	440.0
In Line, Close-coupled, VL, (PC16)		4000.0	440.0
In Line, Split Coupled, VLS, (PC17)		4000.0	440.0

A Note on Centrifugal Pumps Sizes in HVAC

1. Because of the ΔTs invloved, chiller pumps tend to be much larger than hydronic hot water heating pumps

2. Why? ***Remember the formula***: USgpm = Btu/hr ÷ (500 x ΔT)

3. Since this is all multiplication and division, let's focus on the ΔT

4. AC systems have lower ΔTs (often in the 2° to 4° F range)

5. Heating systems have higher ΔTs (often in the 20° to 40° F range)

A Note on Centrifugal Pumps Sizes in HVAC

Let’s do the math:

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a) Question #1 - What USgpm is required for a chilled water system with 1,000,000 Btu/hr at 2° F ΔT?

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c) Question #2 - What USgpm is required for a hydronic hot water heating system with the same 1,000,000 Btu/hr but at 40° F ΔT?

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c) Question #2 - What USgpm is required for a hydronic hot water heating system with the same 1,000,000 Btu/hr but at 40° F ΔT?

d) Answer #2 – 1,000,000 ÷ (500 x 40° F) = 50 USgpm

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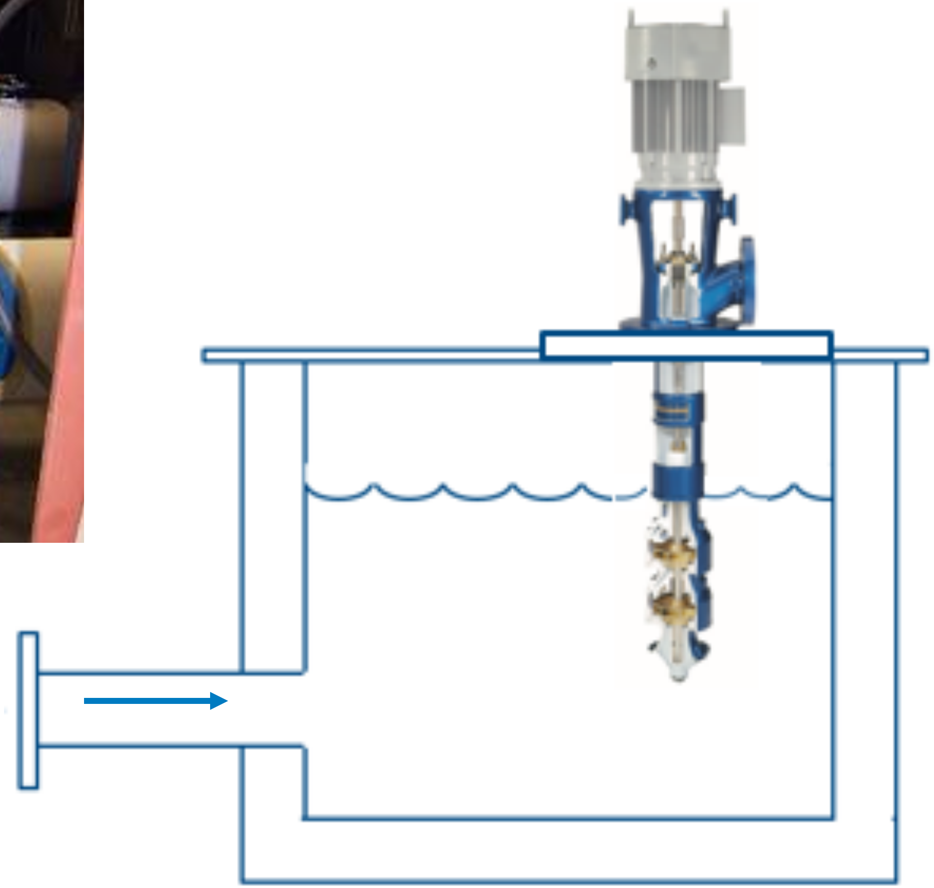
d) Answer #2 – 1,000,000 ÷ (500 x 40° F) = 50 USgpm

<u>And that is why chiller systems often use larger horizontal split case pumps while hydronic hot water heating systems often use smaller circulators</u>

Step 6 - "Above grade" versus "suction lift" applications



Step 7 - Above grade - Foot print/dimensional limitations at job site


A

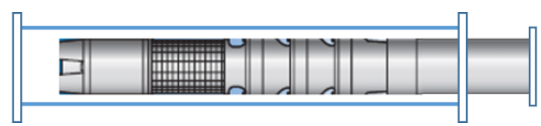

B


C

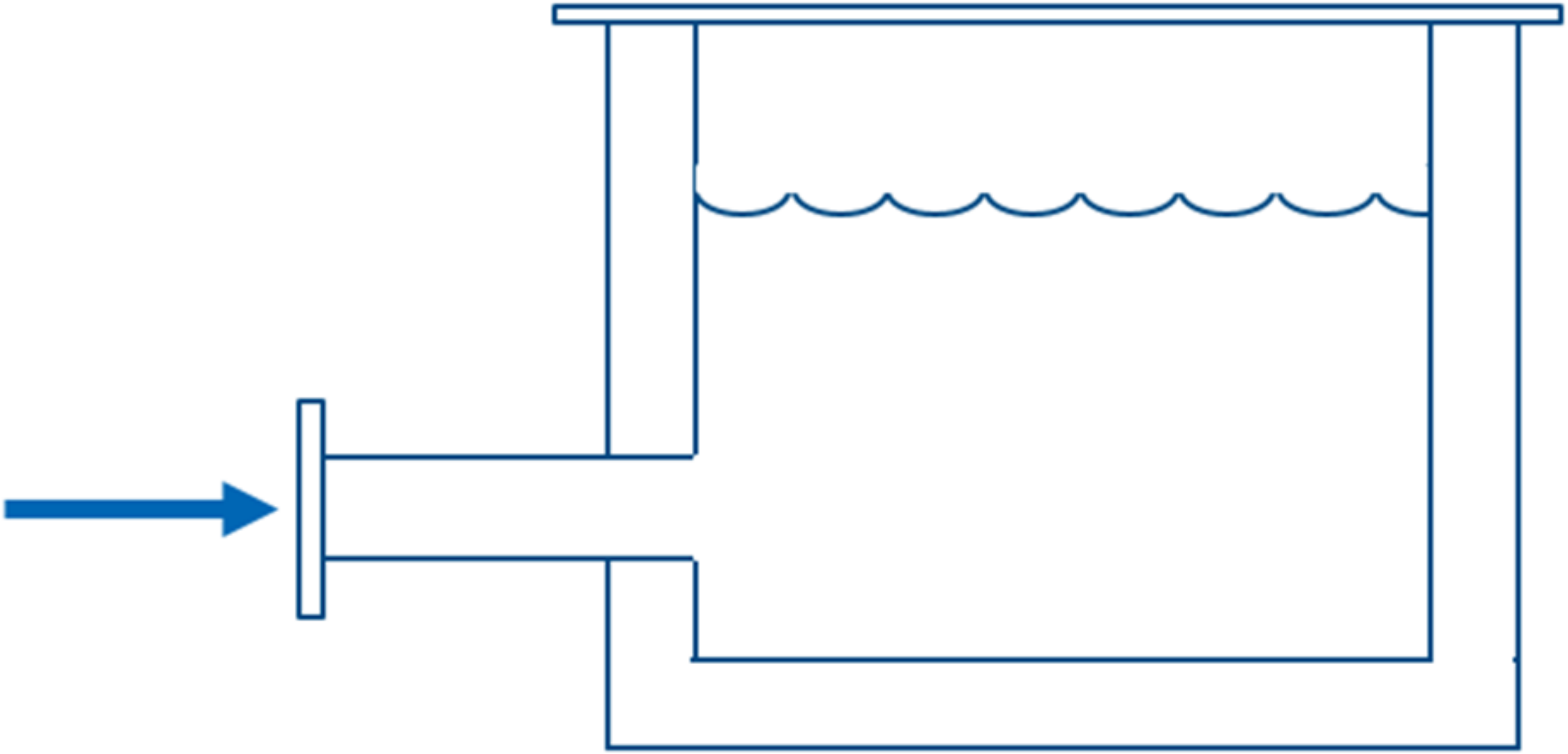

G


D


E


F

Step 8 - Below grade location and suction lift



Step 9 - NPSHa Issues

Impeller damage as a result of insufficient NPSHa

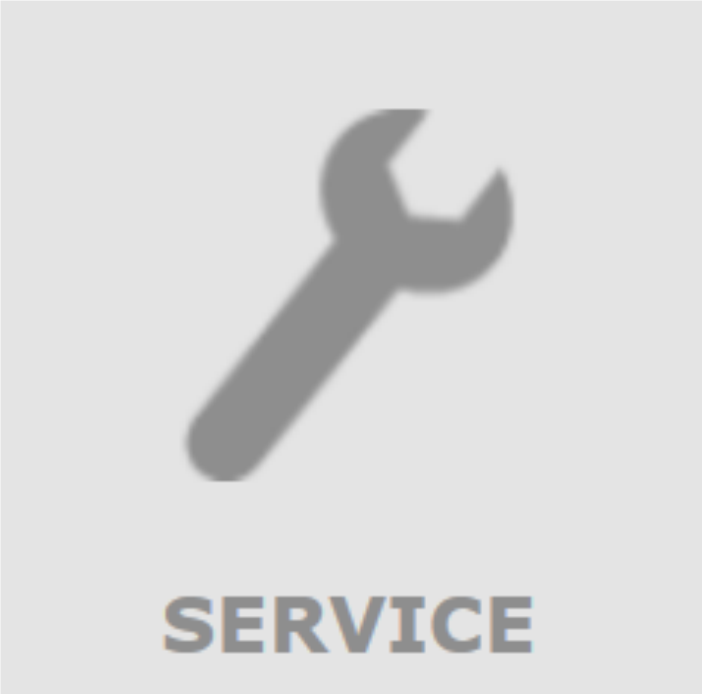
Step 10 - Power source

Source: tva.com

Step 11 - Availability

- In some situations, the need for a pump NOW is a legitimate reason to choose a less-than-optimal pump.
- Examples are when life, health, or property are at risk – in which case any appropriate available pump that will get the job done is likely the best choice.

Step 12 - Serviceability

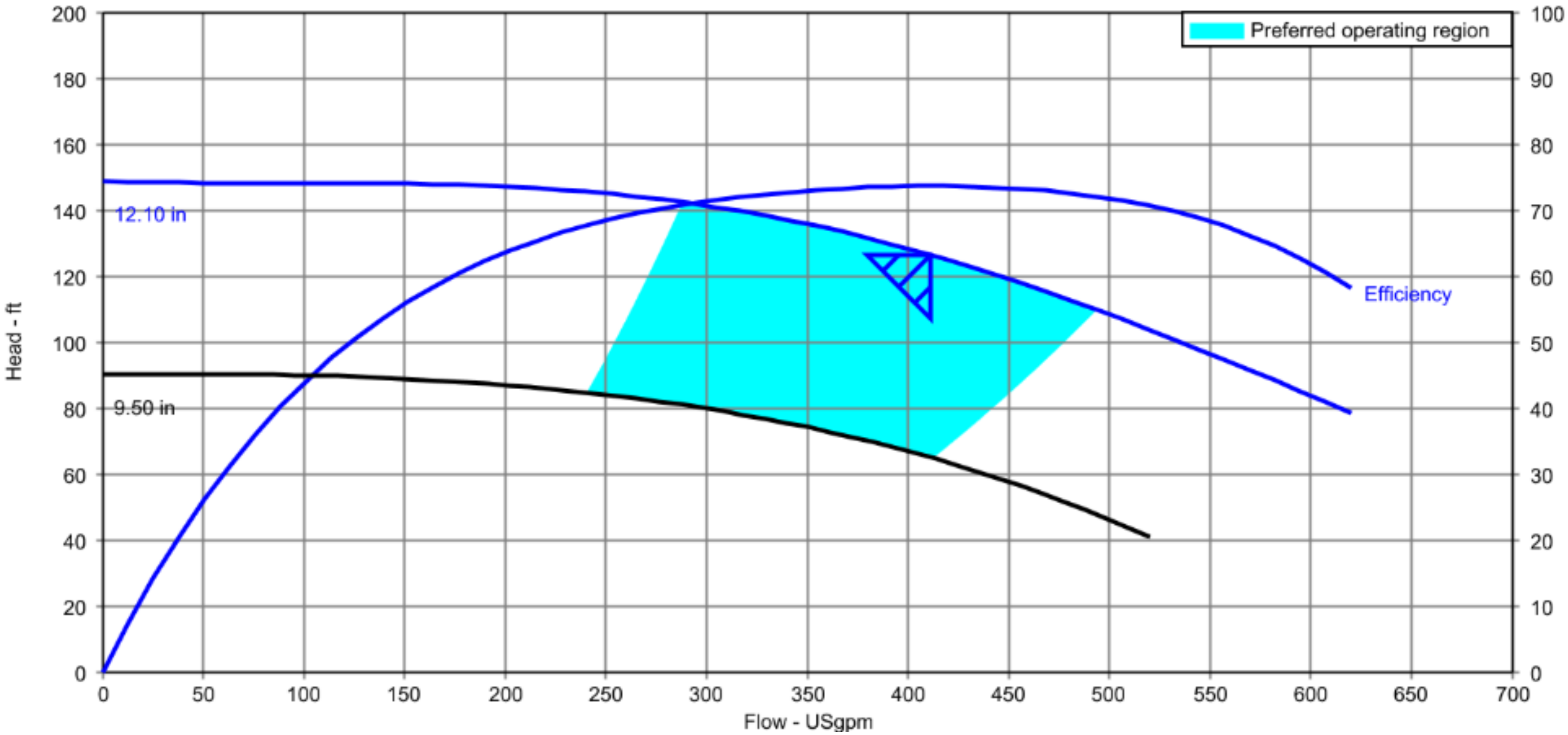


Step 13 - Materials of construction

All of the types of centrifugal pumps in this module can be found in a wide variety of materials of construction, although not all material types are available from all manufacturers.

Step 14 - Life expectancy

Life expectancy and Preferred Operating Range



Step 15 - Initial purchase price

High	Lineshaft turbine
↑	Split case – Vertical mount
	Split case – Horizontal mount
	Submersible turbine
	End suction – Frame mount
	Vertical inline multistage
↓	Vertical inline
Low	End suction close coupled

It is not just the pump

When comparing the up-front cost, it is not just the initial purchase price that must be considered. It is the total up-front cost and differentials, including:

1. Motor and possibly base, coupling, and guard
2. Piping
3. Valves
4. Controls
5. Electrical
6. Excavation and site prep
7. Foundations
8. Etc.

Primary Commercial HVAC Applications

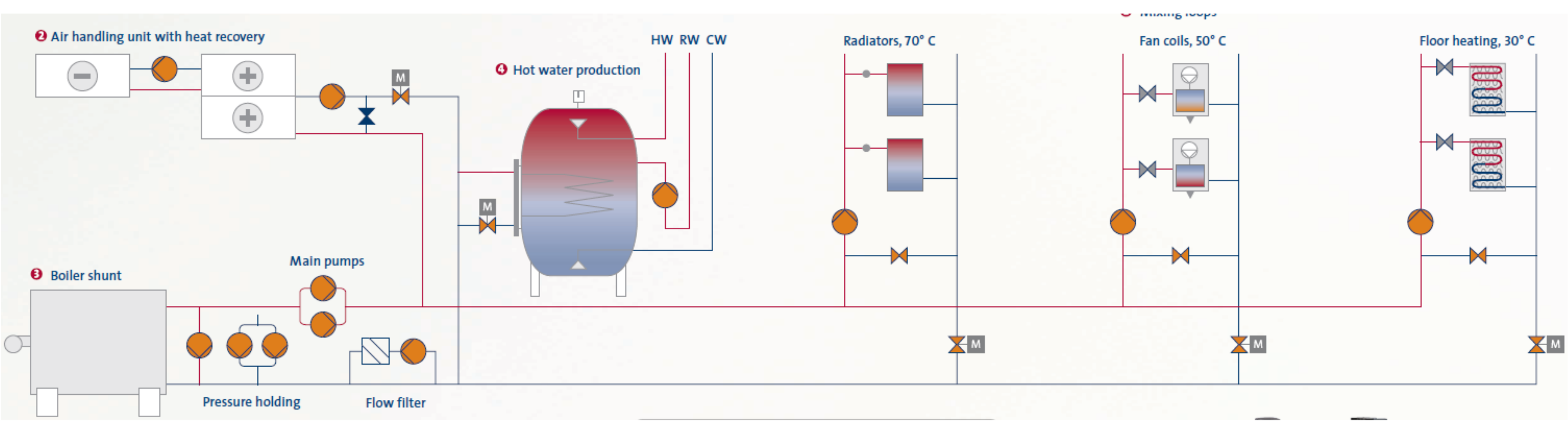
We will look separately at:

- Hydronic hot water
- Chilled water
- Steam systems

Step 16 (a) - Hydronic Hot Water Heating

Customary pump type choices for typical applications

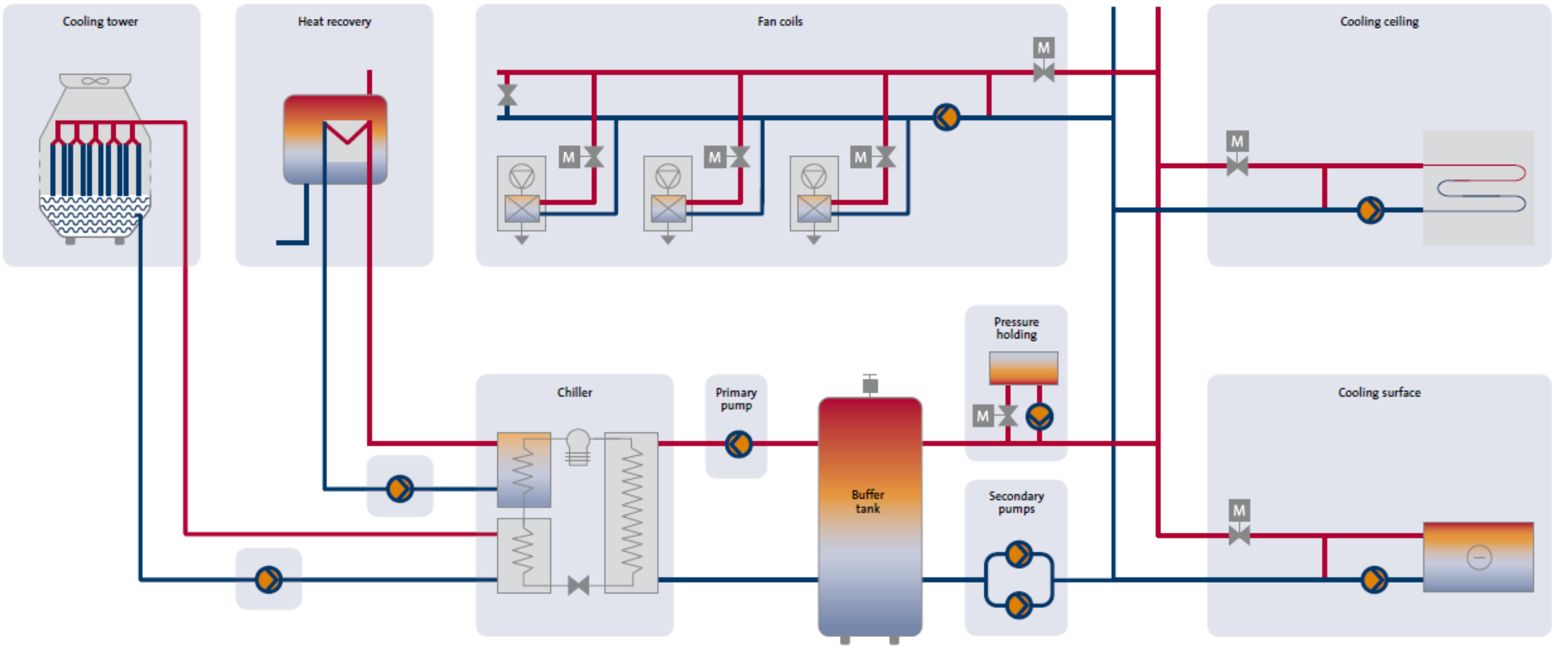
Application	Ciculators	Vertical Inline	End Suction	Vertical Multistage Inline
Main pumps	X	X	X	
Boiler shunts	X	X	X	
Filter pumps		X		
Mixing loops	X	X		
Heat surfaces	X	X		
Heat recovery	X	X		
Domestic hot water production	X	X		
Domestic hot water recirculation	X	X		
Pressure holding				X



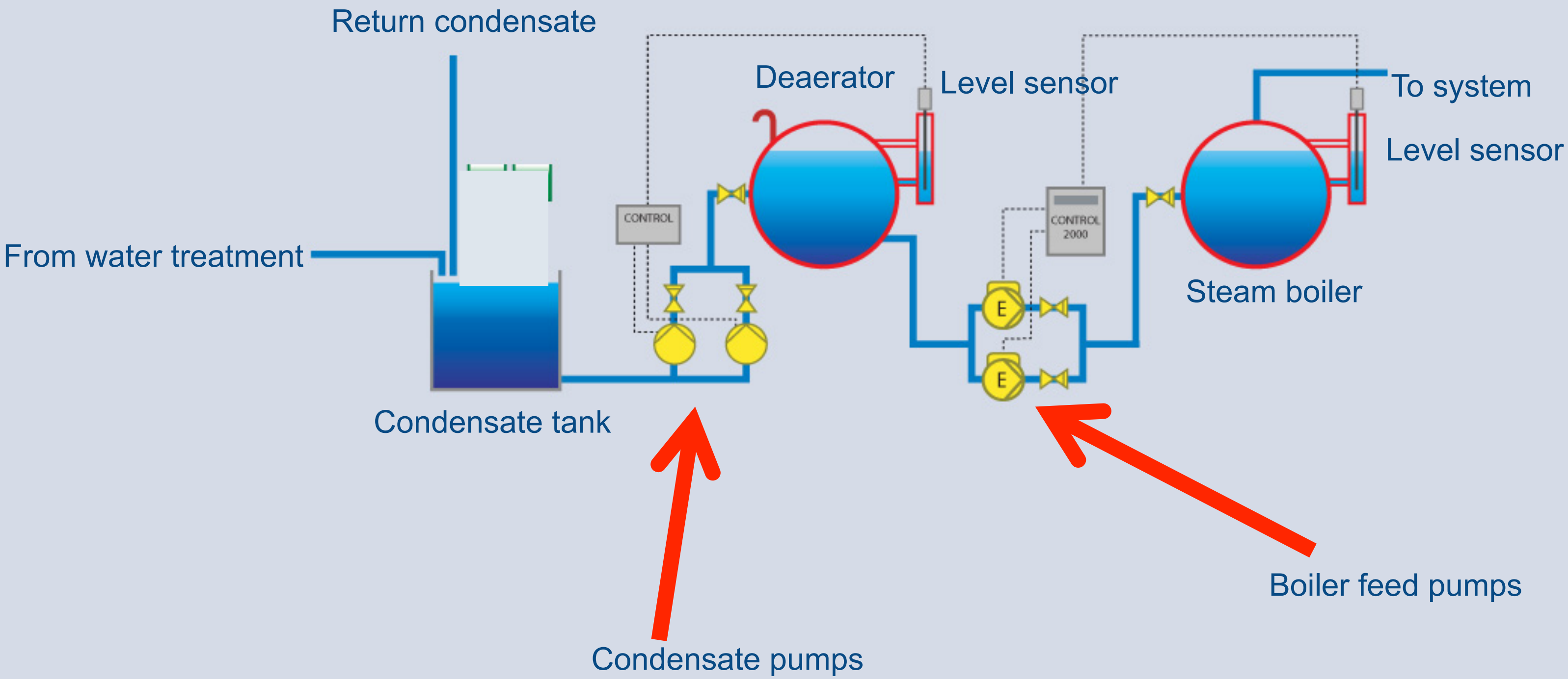
Step 16 (b) - Chilled Water

Customary pump type choices for typical applications

Application	Ciculators	Vertical Inline	End Suction	Split Case	Vertical Multistage Inline	Vertical turbine
Primary pumps		X	X	X		
Secondary pumps		X	X	X		
Cooling tower		X	X	X		X
Cooling surfaces	X	X				
Cooling ceilings	X	X				
Fan coils	X	X				
Heat recovery	X	X	X			
Pressure holding					X	



Typical Steam Boiler System – Primary Components



Steam Systems

Condensate pumps

- Low head – usually single stage
- Sometimes supplied with a receiver tank
- Usually two pumps in parallel to provide redundancy, and for peak demand

Boiler feed pumps

- High head – usually multi-stage pumps
- Usually two or more pumps in parallel

Step 17 - Life Cycle Cost (LCC) Analysis

There are eight constituent parts to an LCC analysis:

1. Initial costs, purchase price (pump, system, pipe, auxiliary services)
2. Installation and commissioning cost (including training)
3. Energy costs (predicted power cost for system operation, including pump, driver, controls, and any auxiliary equipment
4. Operation costs (labor cost of normal system supervision)
5. Maintenance and repair costs (routine and predicted repairs)
6. Down time costs (loss of production)
7. Environmental costs (contamination from pumped liquid and auxiliary equipment)
8. Decommissioning/disposal costs (including restoration of the local environment and disposal of equipment)

Life Cycle Cost Software

Life Cycle Cost

Units Save Curve Preferences Print

Instructions: Define Flow and Operation values and Recalculate

▼ Load Profiles and Energy Costs

Expected pump life: 20 years	Load Profile #1	Load Profile #2	Load Profile #3	Load Profile #4	Load Profile #5	Total
Flow: (•) USgpm ( ) % of rated flow	500.0	600.0	800.0			-
Operation: (•) hours per year ( ) % of year	2,000	2,000	2,000	0	0	6,000
Energy cost, present value ($ per kWh)	0.1000	0.1000	0.1000	0.1000	0.1000	-
Enable	☑	☑	☑	☑	☑	-
Speed, rated (rpm) (•) Synchronous ( ) Variable	1,780	1,780	1,780	0	0	-
Head (ft)	194.2	180.5	139.6	0.00	0.00	-
Efficiency (%)	65.87	67.01	61.04	0.00	0.00	-
Based on duty point (rated power) (hp)	37.21	40.79	46.18	0.00	0.00	-
Motor efficiency (%)	94.00	95.00	94.00	100.00	100.00	-
Drive/gear efficiency (%)	100.00	100.00	100.00	100.00	100.00	-
System curve	System Curve #1	System Curve #1	System Curve #1	System Curve #1	System Curve #1	-
Energy, total (kWh)	1,180,621.9	1,280,743.9	1,465,289.3	0.00	0.00	3,926,655.1
Energy cost, per year	$ 5,903.11	$ 6,403.72	$ 7,326.45	$ 0.00	$ 0.00	$ 19,633.28
Energy cost, total present value	$ 118,062.19	$ 128,074.39	$ 146,528.93	$ 0.00	$ 0.00	$ 392,665.51

▼ Life Cycle Cost

Additional Annual Costs ($)		Additional One-time Costs, Year 0 ($)		Interest and Inflation Rates	
Routine maintenance cost	1,000.00	Initial investment cost	17,000.00	Interest rate, %	3.00
Repair cost	1,000.00	Installation and commissioning cost	2,000.00	Inflation rate, %	3.00
Operating cost	1,000.00	Other one-time costs (Year 0)	1,000.00	**Total Net Present Value Costs**	
Downtime cost	1,000.00	**Additional One-time Costs, Year 20 ($)**		Total energy cost	: $ 392,665.51
Environmental cost	1,000.00	Decommissioning cost	1,000.00	Total additional annual cost	: $ 120,000.00
Other annual costs	1,000.00	Other one-time costs (Year 20)	100.00	Total additional one-time cost	: $ 21,067.96
Total, present value	: $ 120,000.00	Total, present value	: $ 21,067.96	Total life cycle cost	: $ 533,733.48

How would you boost water through this inline piping circuit?

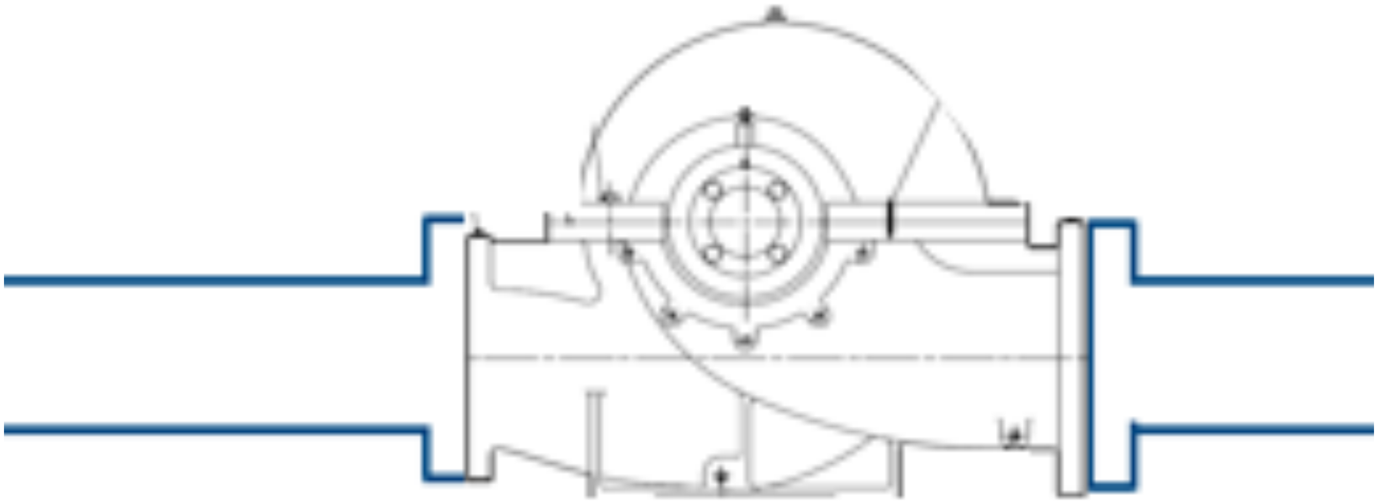
If the water source is inline piping as part of an open piping circuit, and you need to move it away to a process, which pump types would you consider?

End suction – frame mount?
Split case – horizontal?
Vertical Inline?
Turbine – lineshaft?

End suction – close coupled?
Split case – vertical?
Multistage vertical inline?
Turbine – submersible?

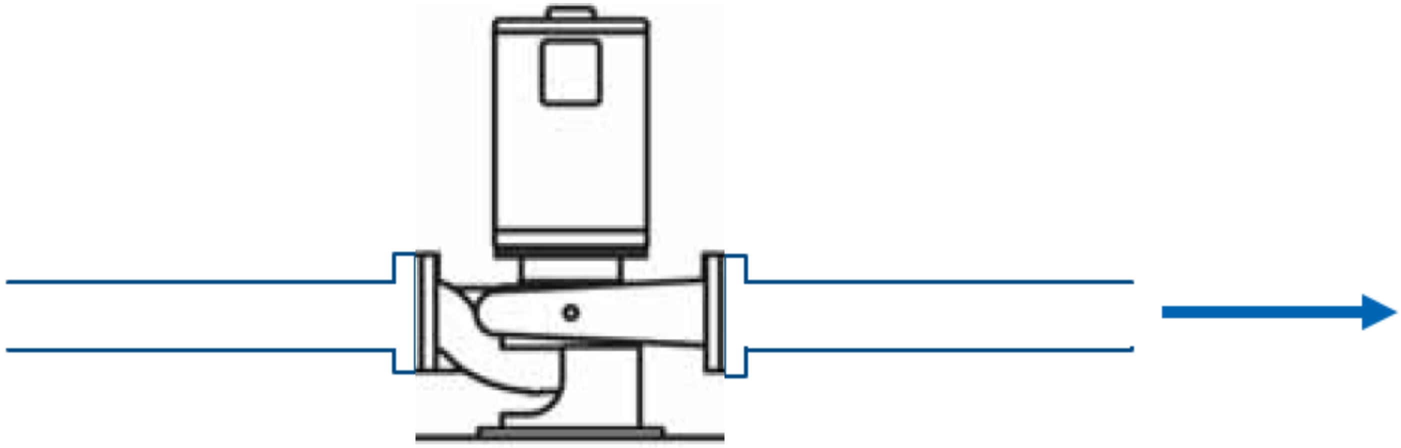
Source unknown

Split case – horizontal mount

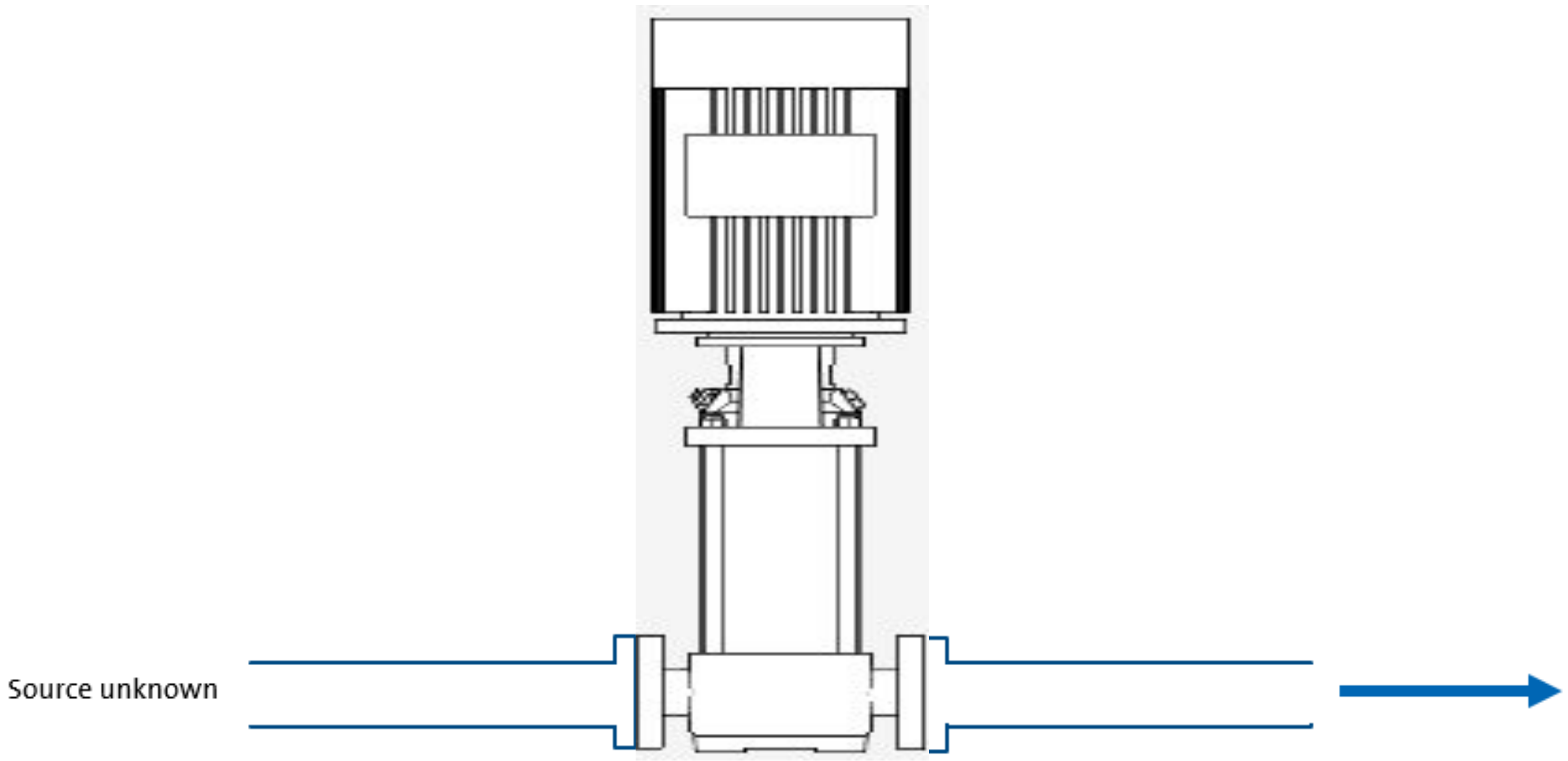


Split case – vertical mount

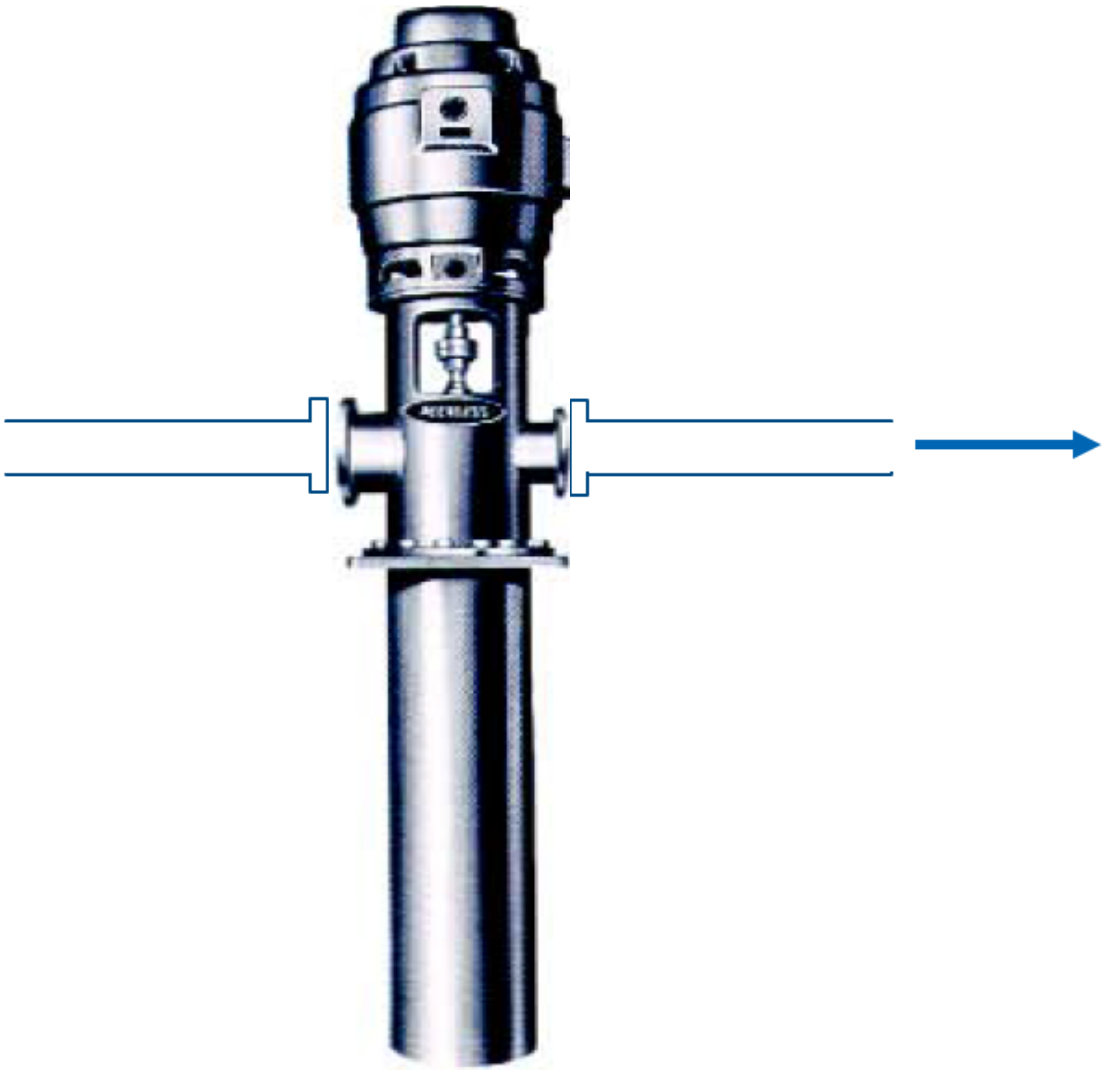
Vertical inline



Multistage vertical inline

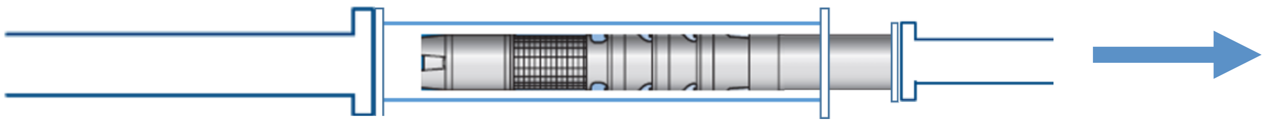


Turbine – lineshaft with T-Head



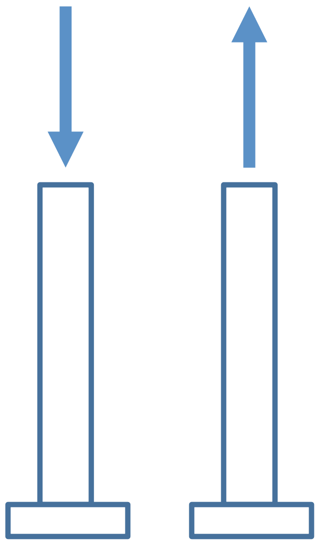
Source unknown

Turbine – submersible in a can



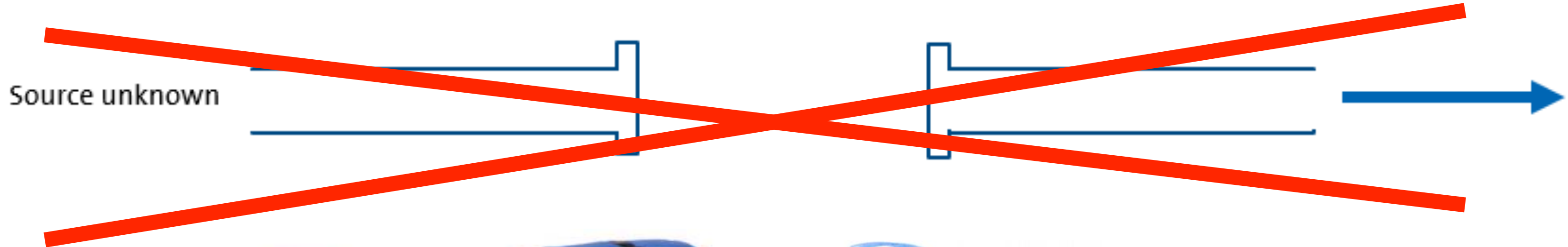
Source unknown

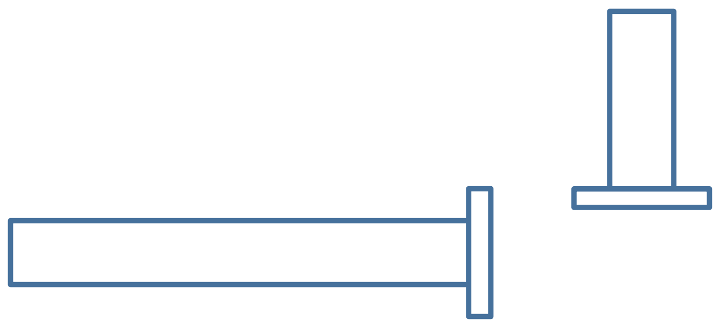
Top Suction/Top Discharge



This pump is a variant of the vertical inline

End suction – frame mount or close coupled



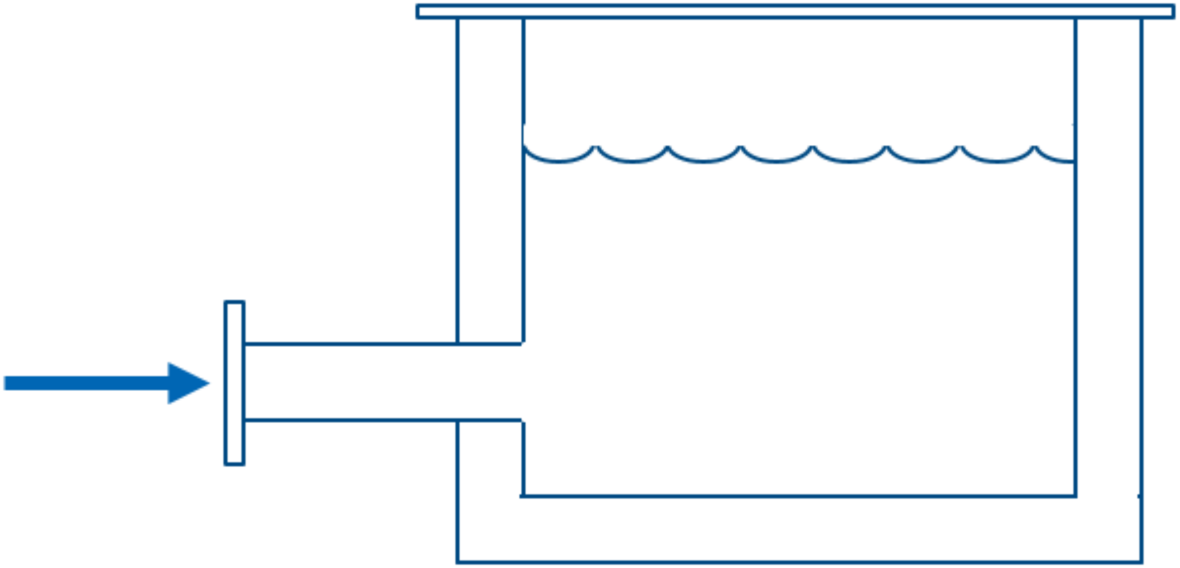


Given an opportunity for perpendicular suction and discharge piping, this is often the pump of choice.

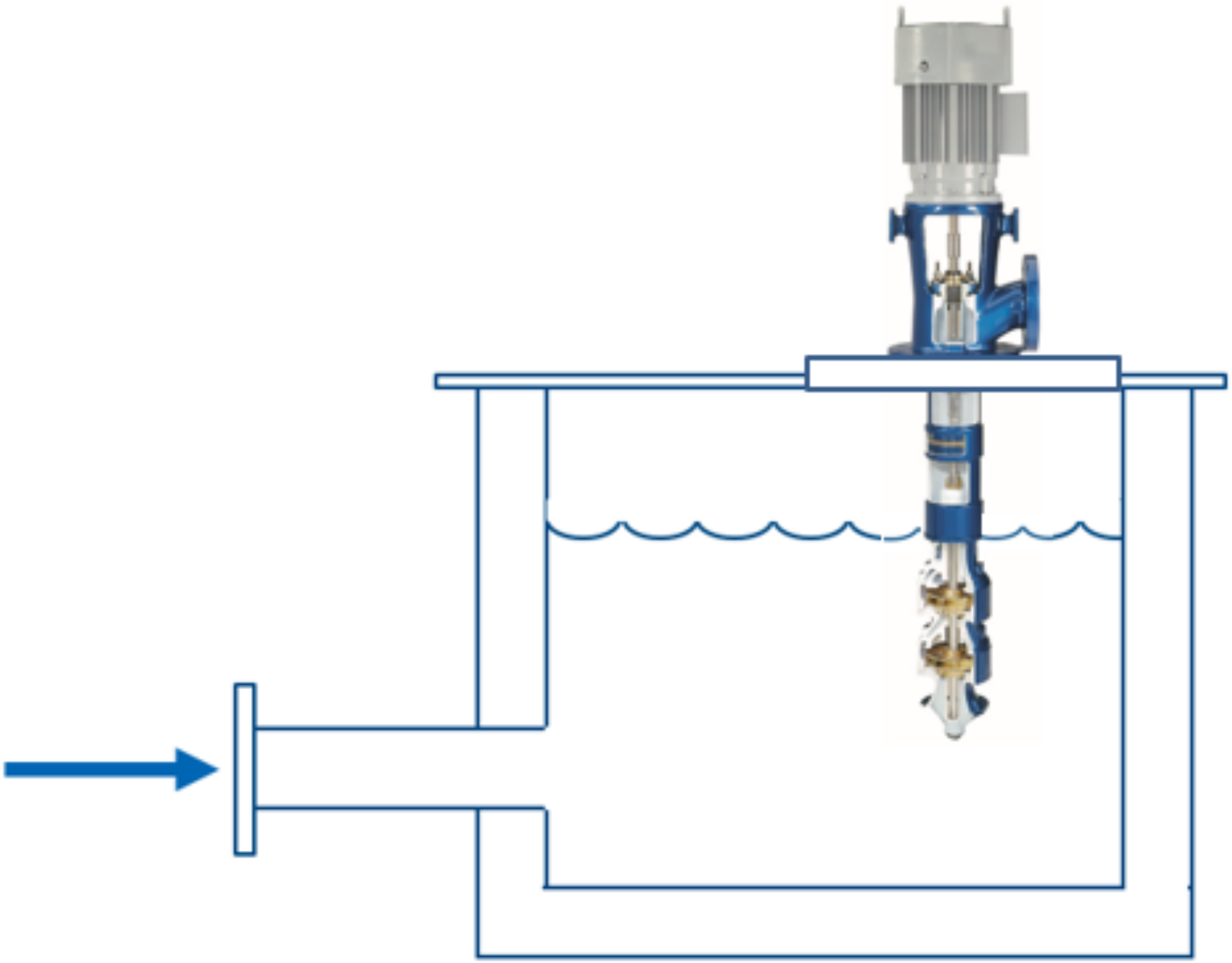
How would you get water out of this sump?

End suction – frame mount?
Split case – horizontal?
Vertical Inline?
Turbine – lineshaft?

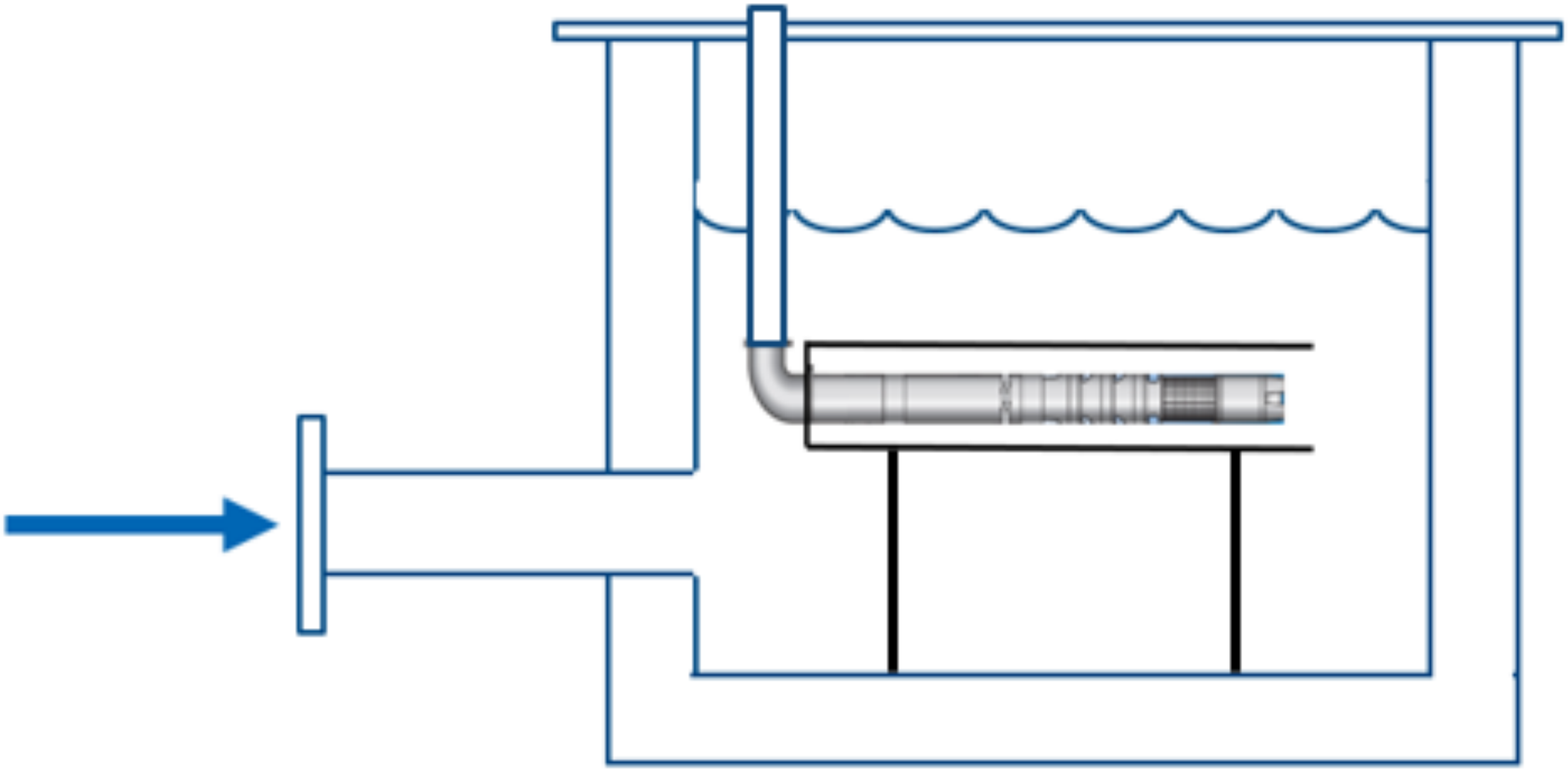
End suction – close coupled?
Split case – vertical?
Multistage vertical inline?
Turbine – submersible with sleeve?



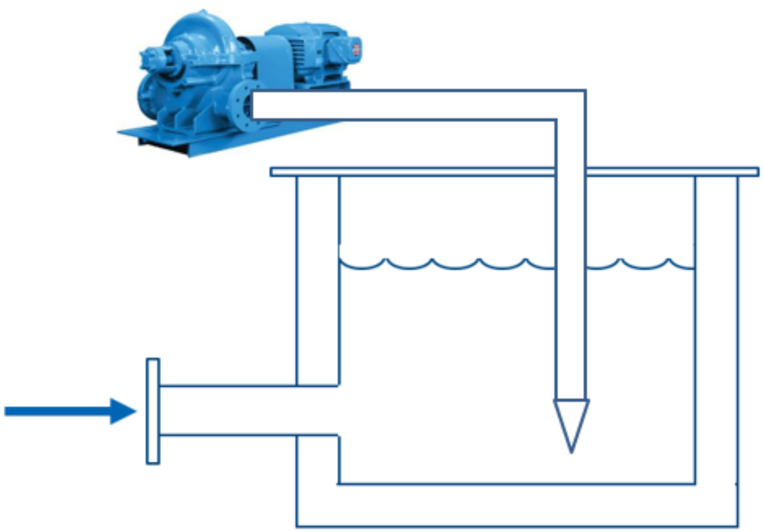
Turbine - lineshaft

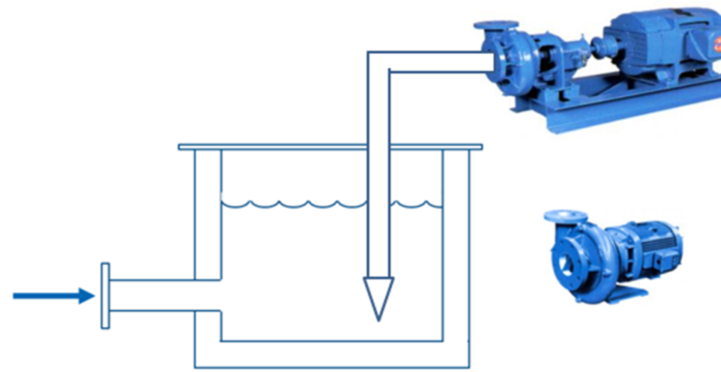


Turbine – submersible with sleeve



Split case and End suction pumps





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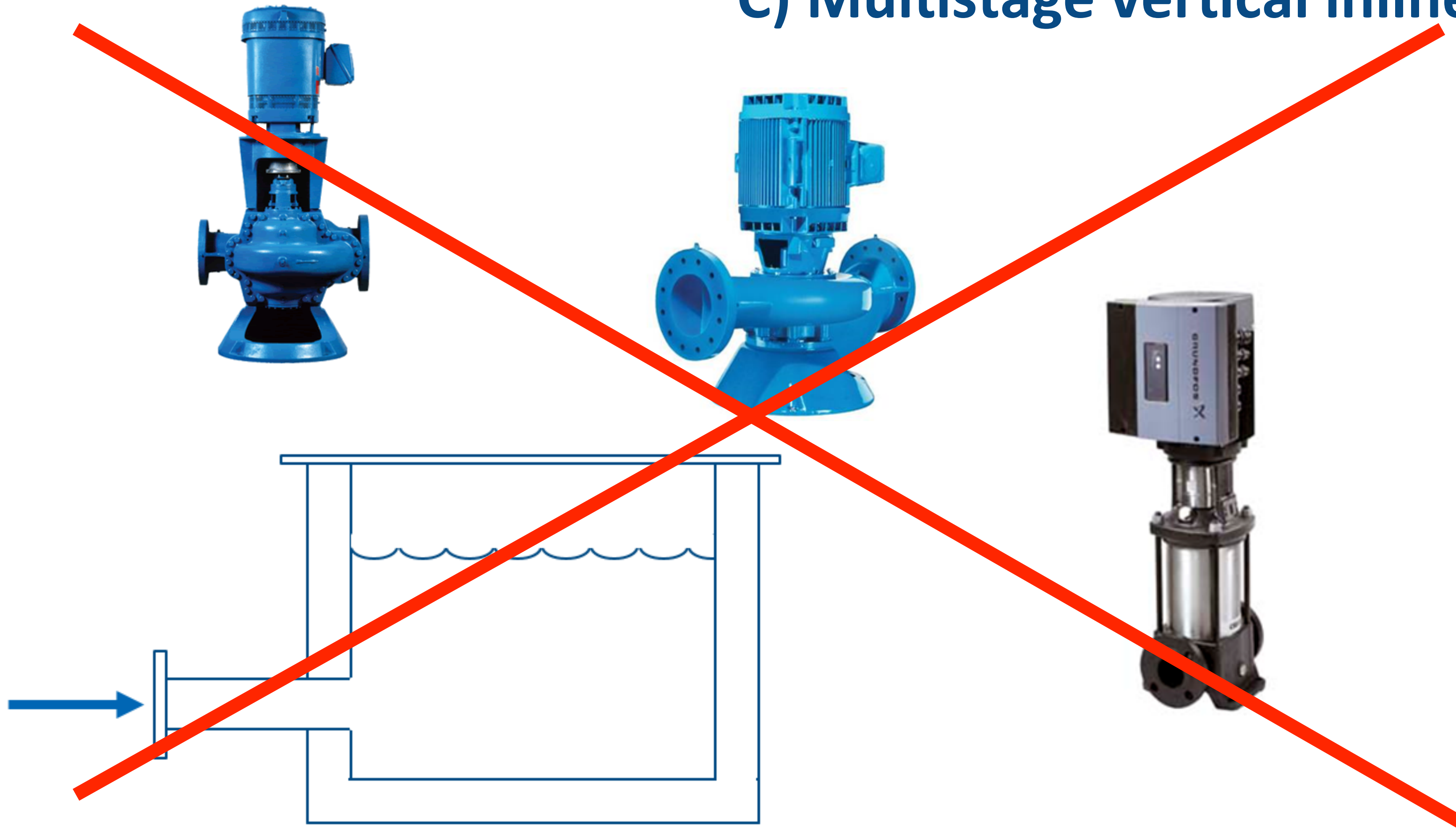
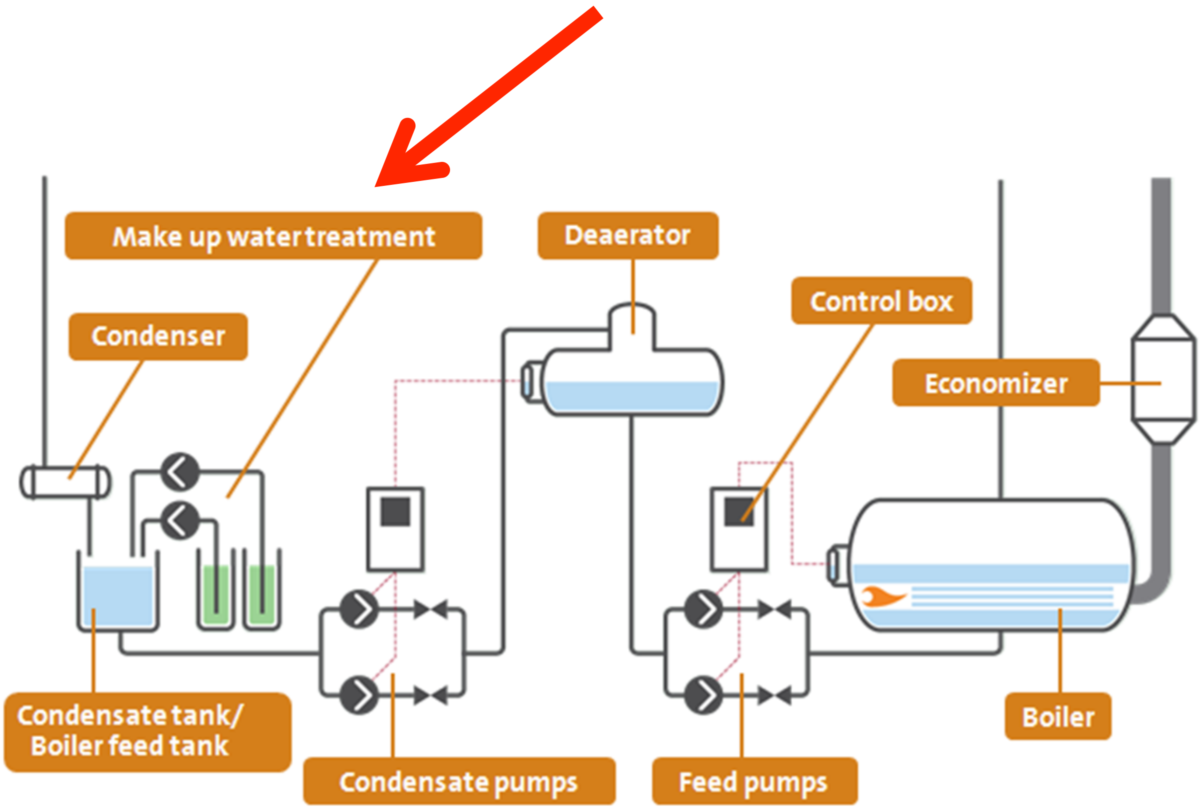
A) Split case – vertical

B) Vertical inline

C) Multistage vertical inline



Dosing Pumps for Steam Boiler Water Treatment System



Dosing pumps are primarily used to inject chemicals into the condensate tank to reduce effects of corrosion in the system

Summary of Learning Outcomes

You should now be able to:

1. Identify the six pump types most often used for Commercial HVAC applications, and explain the characteristics of each
2. Explain the distinctions between above-grade mounted and below-grade mounted pump applications
3. Select pump types for the primary Commercial HVAC applications for hydronic hot water, steam, and chilled water systems by following a logical, repeatable process
4. Describe the critical role of Life Cycle Costing in determining the best pump type for the application
5. Use the new knowledge to aid you in writing technical specifications

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Thank you!

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