

Grundfos Technical Institute



Introduction to Boiler Feed Systems
Jim Swetye
March 23, 2016

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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 Sweyte 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



Learning Objectives

After this course you should be able to:

- Cite the types and sizes of boilers
- Identify the components of a steam boiler system
- Name the eight possible applications for pumps in a steam boiler system
- Explain the four methods for controlling the steam boiler water level and feed pump operation
- Describe the concepts and processes involved in steam boiler feed pump selection



Boiler types

Steam



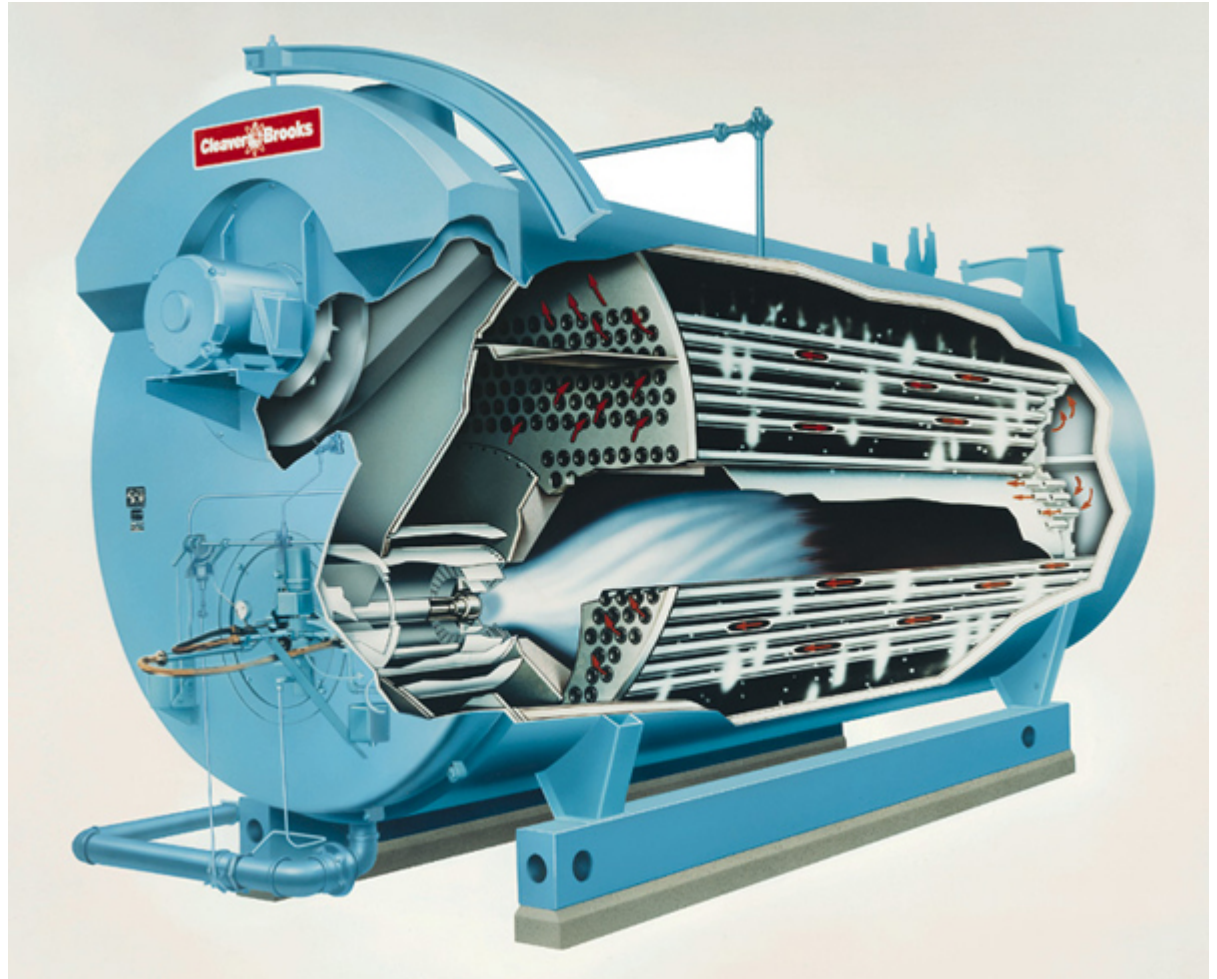
Hot water



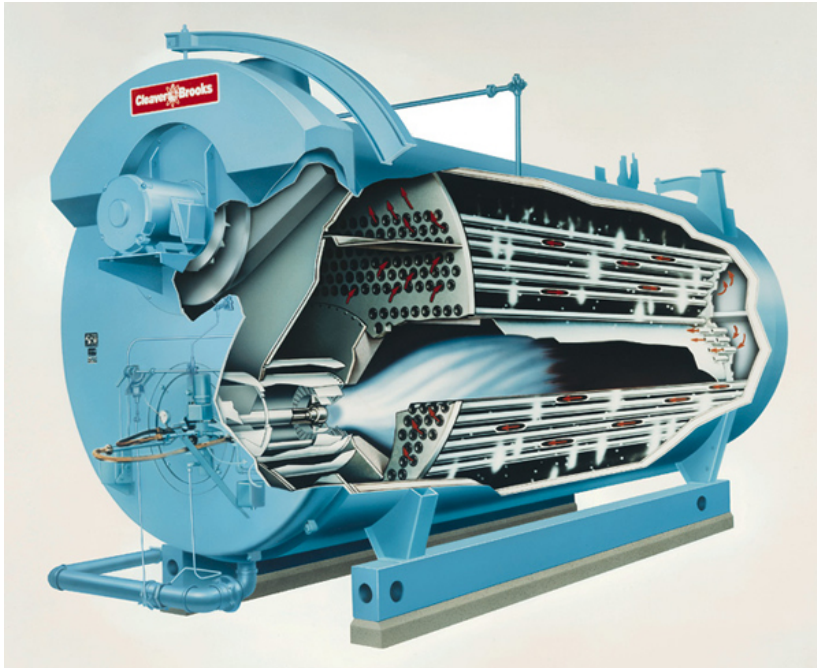
Thermal oil



Boiler Types – Steam or Hot Water

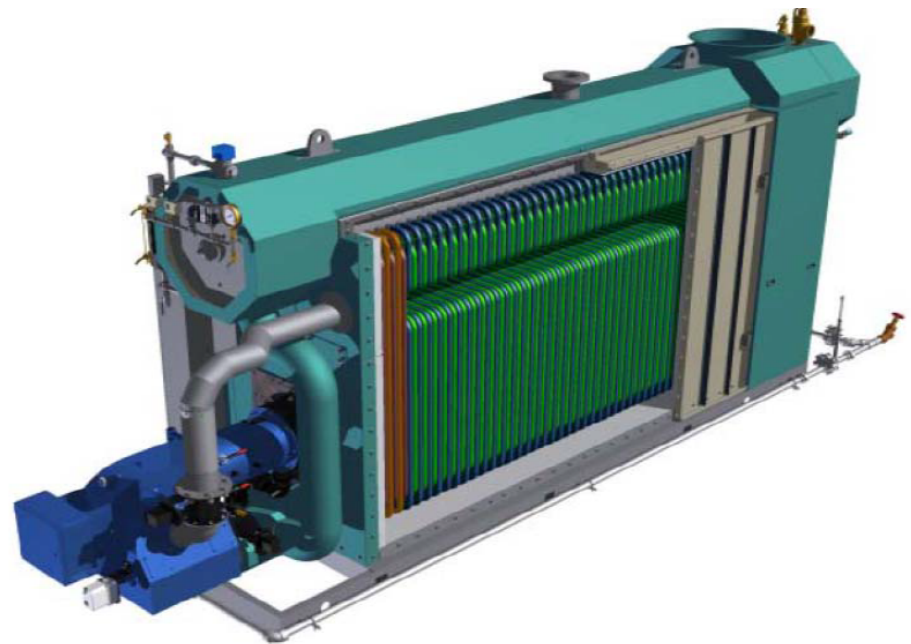


Item 9 - Steam boilers - Continued



Fire tube boiler has
fire within the pipes

Water tube boiler has
water within the pipes



Item 9 - Steam boilers - Continued

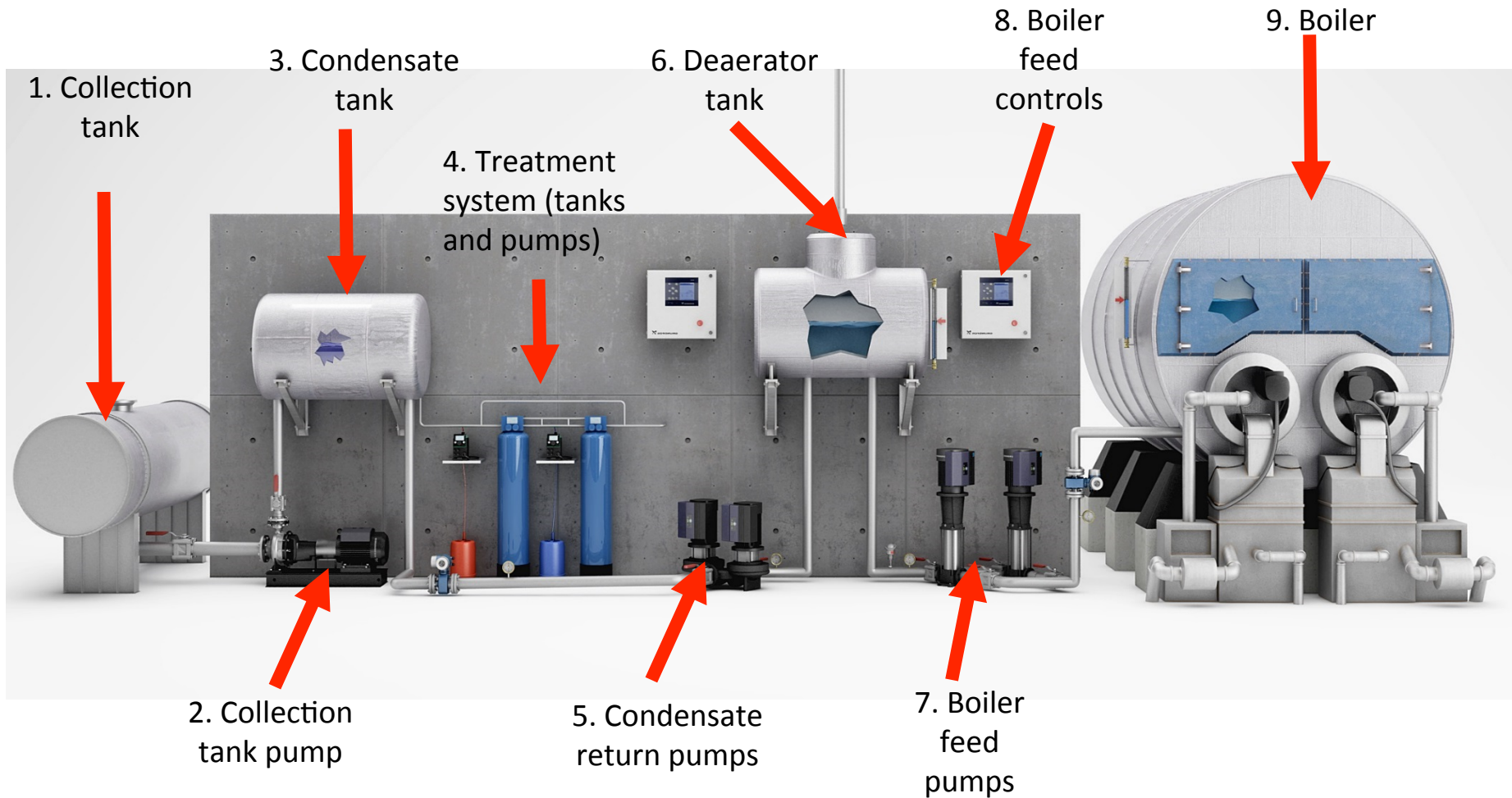


Steam Generator

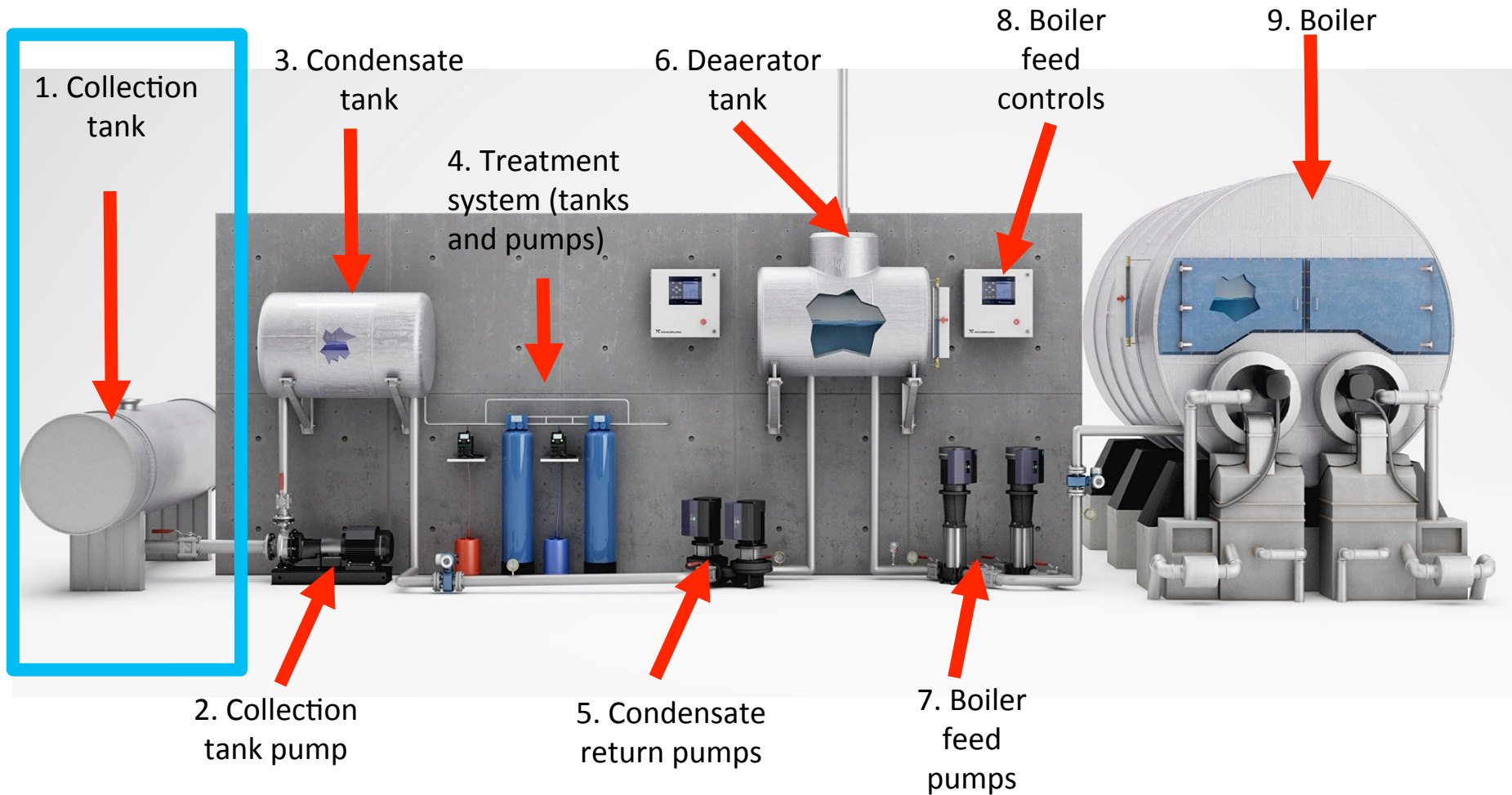
A note on steam boiler sizes

Size Range	Typical Maximum Flow	Pressure Range	Typical Pump Type Used	Where Used?
Small	250 GPM	145 to 435 psi	Vertical multistage	Commercial buildings and industrial applications
Medium	500 to 2500 GPM	1015 to 1160 psi	Regenerative turbines and others	Steel mills and other large industrial applications
Large	5000 US gpm and higher	Up to 4000 psi	Multistage segmental ring pumps and others	Power plants

Steam boiler – Pump System



Item 1 - Collection tank



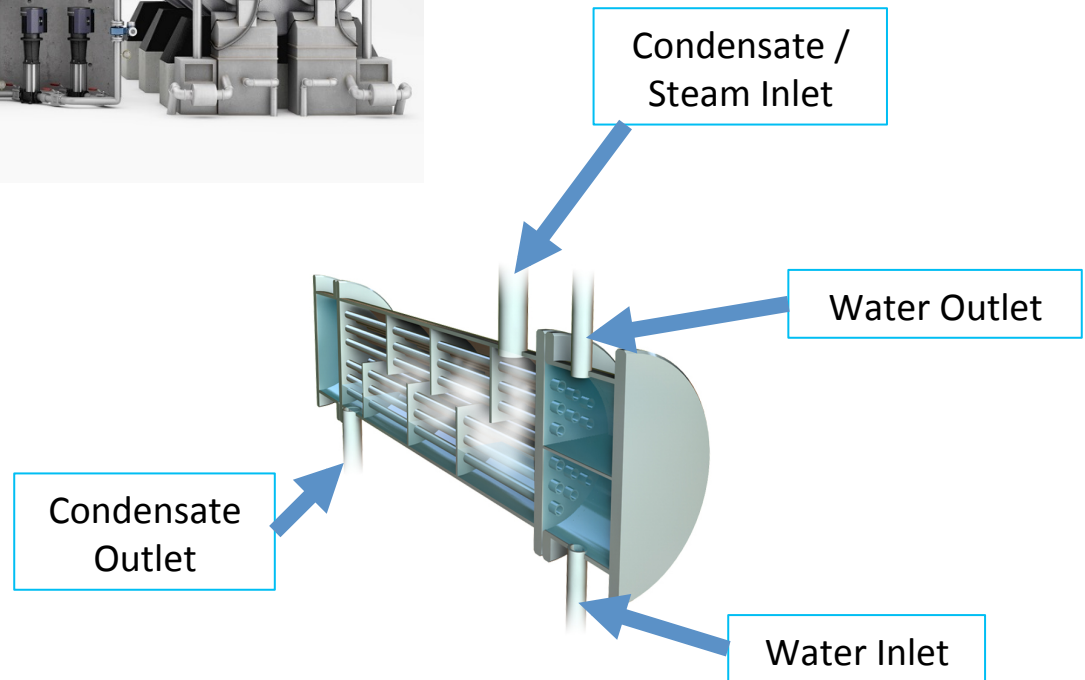
Item 2 - Collection tank pump



2.
Collection
tank pump

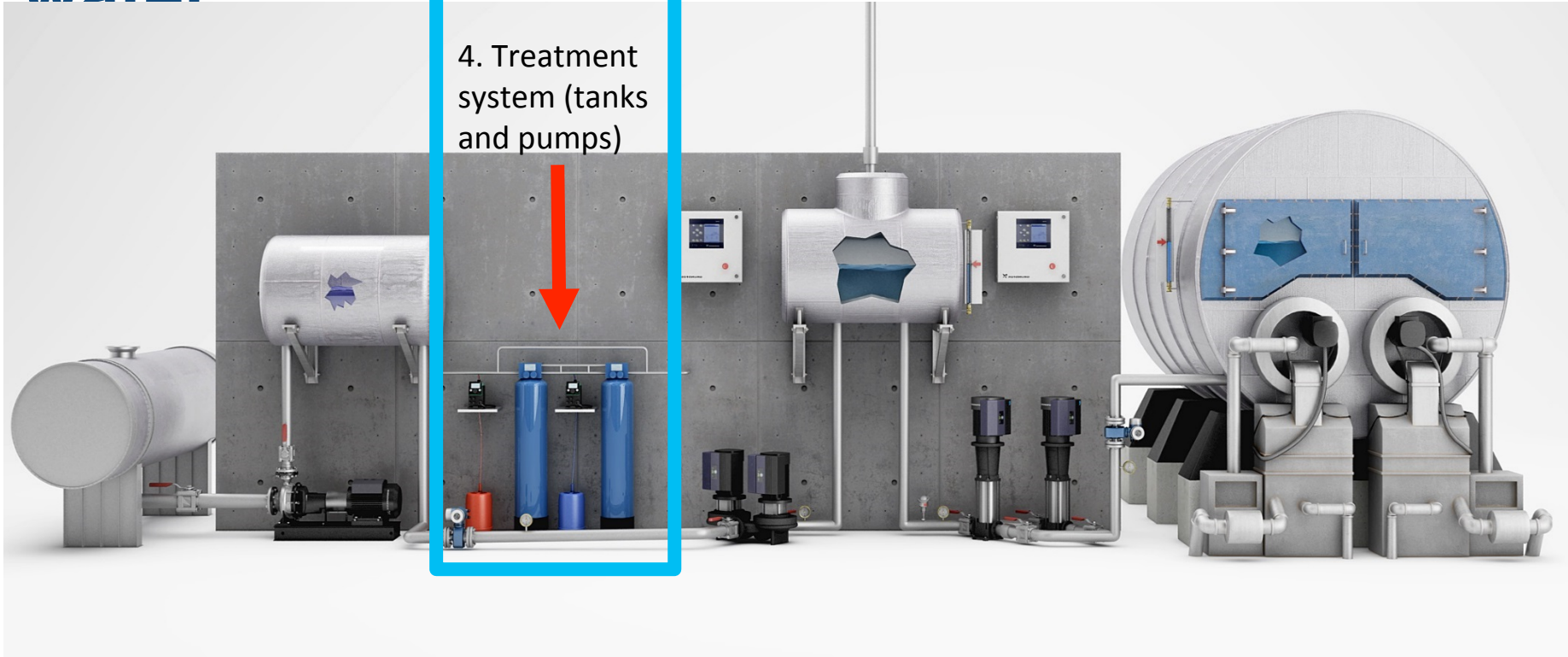


Item 3 – Condensate tank or condenser



Item 4 – Water Treatment and make up water

4. Treatment system (tanks and pumps)

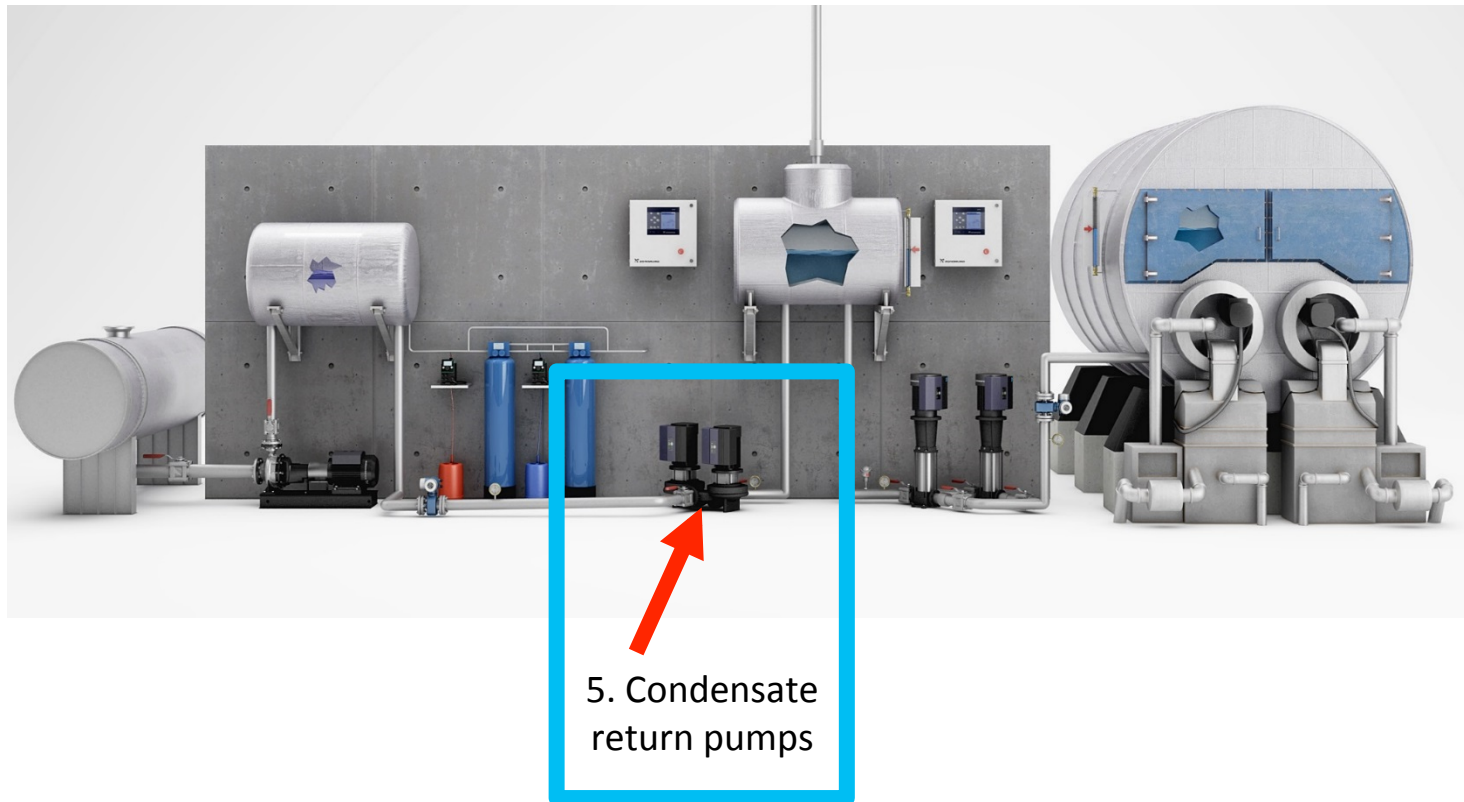


Diaphragm type

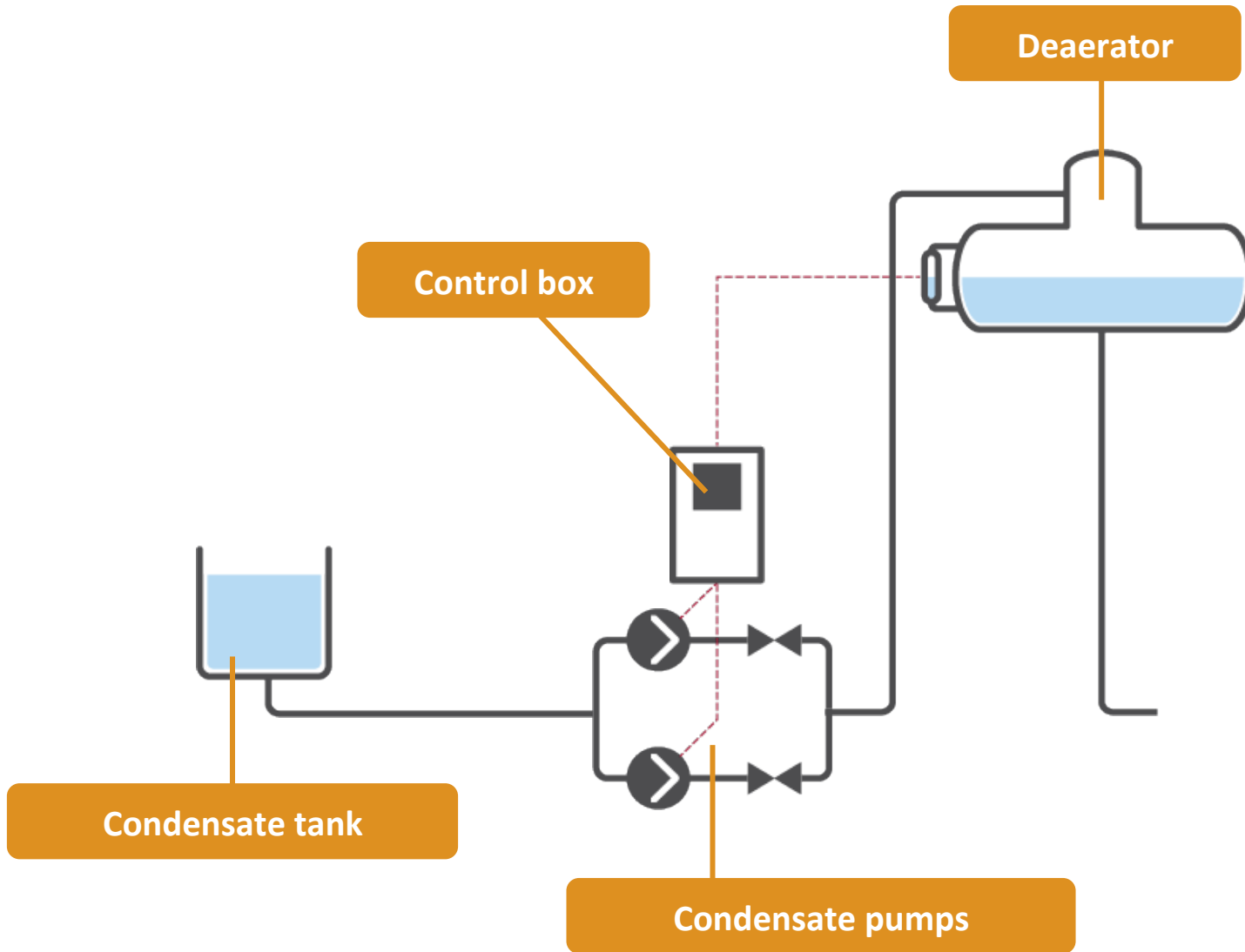


Plunger or piston type

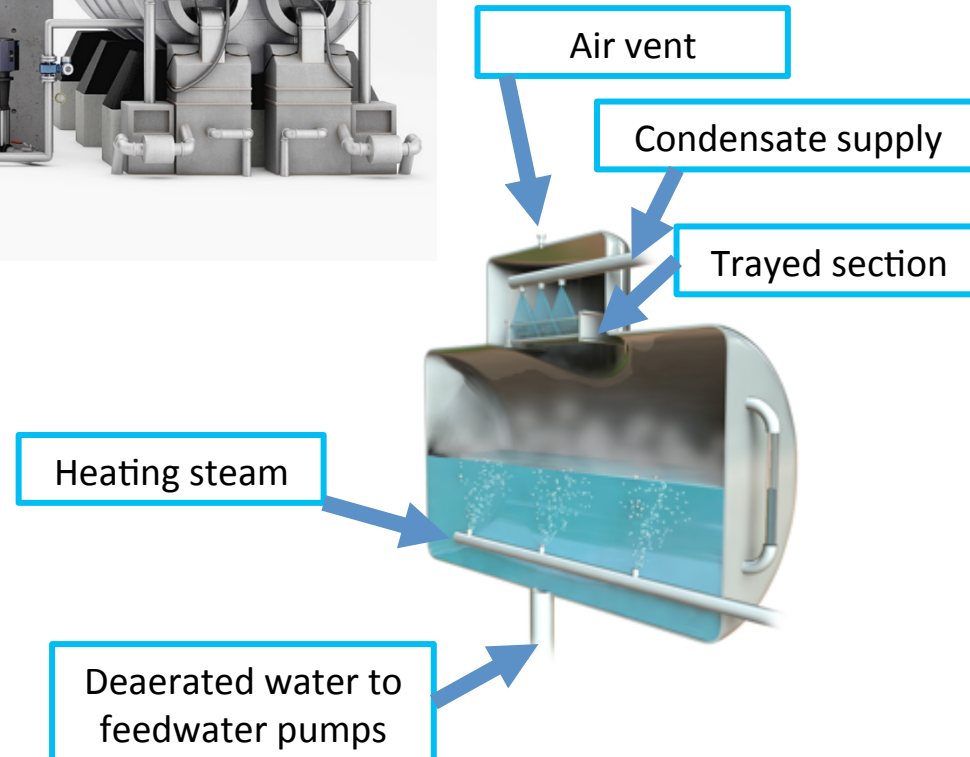
Item 5 - Condensate return pumps



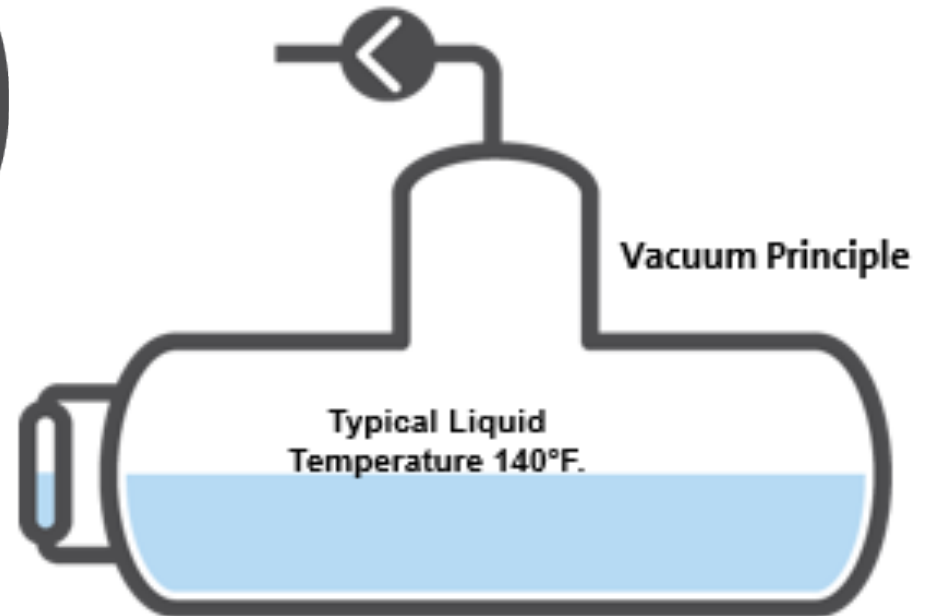
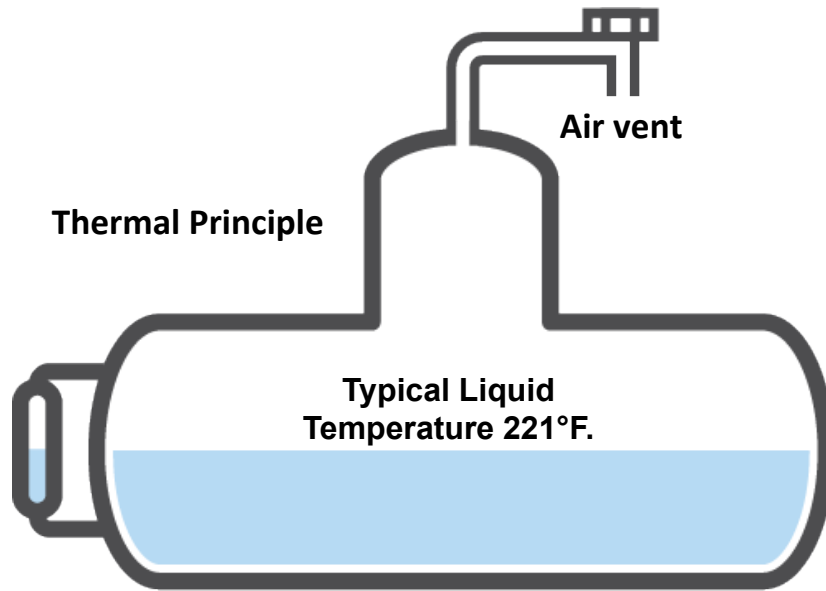
Item 5 – Condensate pumps - Continued



Item 6 – Deaerator tank

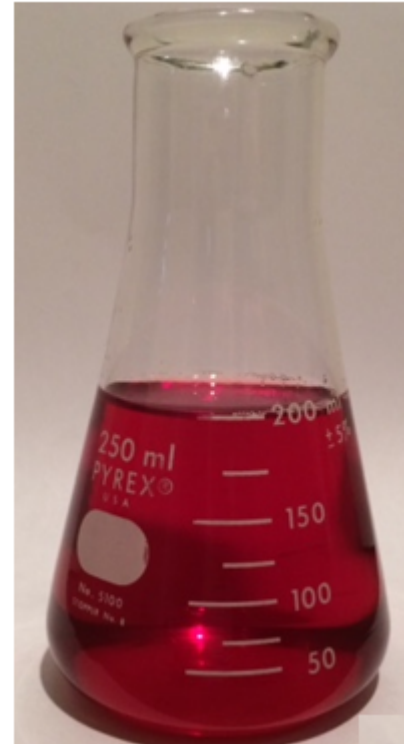


Item 6 - Deaerator tank - Continued

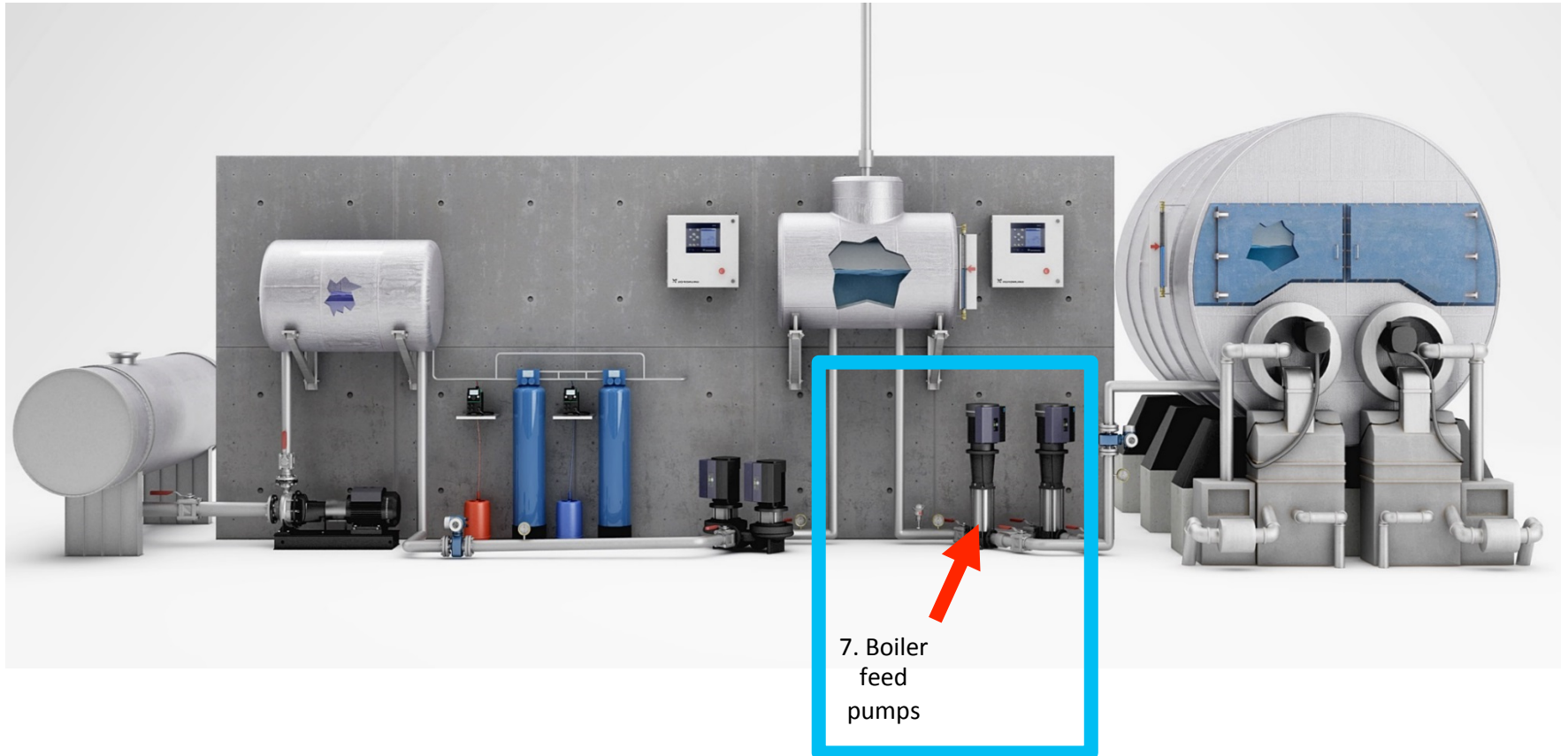


Item 6 – Deaeration - Continued

Use of scavenging
chemical treatment
to remove gasses

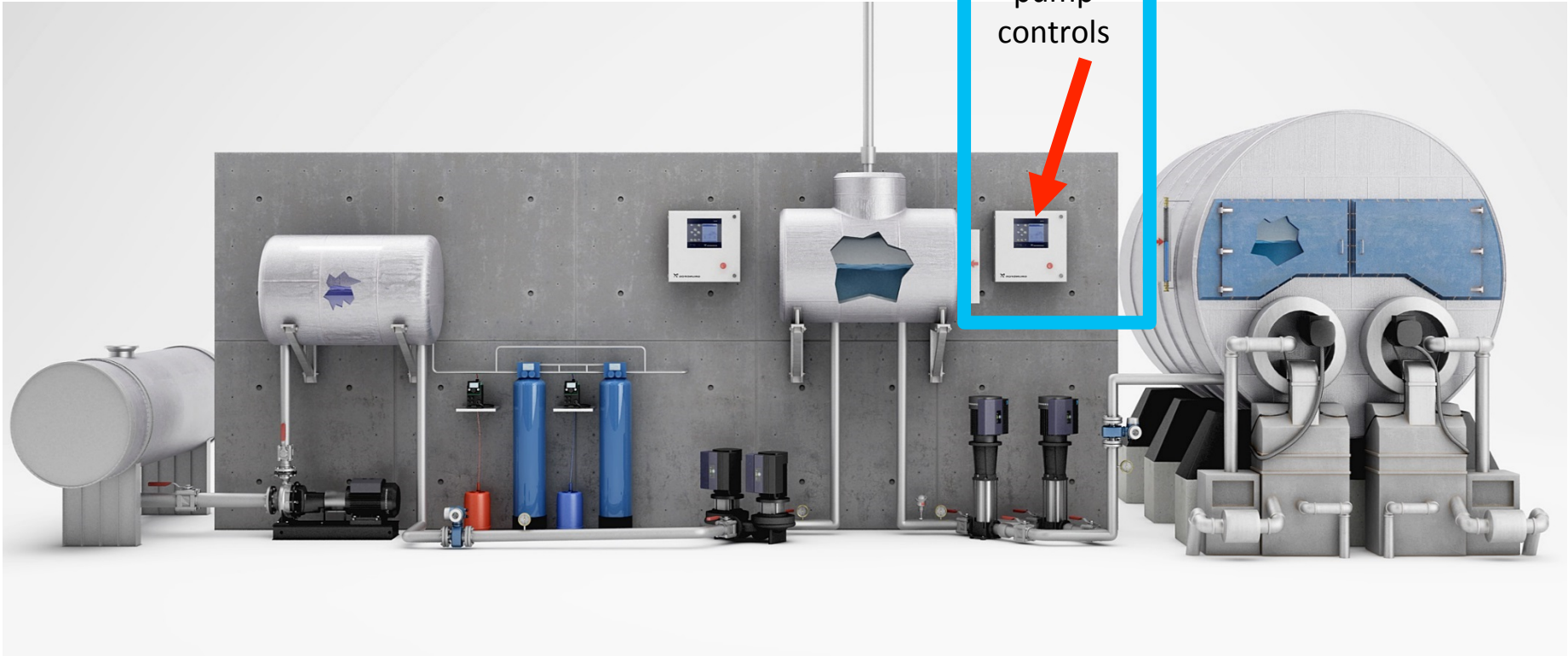


Item 7 - Boiler feed pumps



Item 8 – Boiler feed pump controls

8. Boiler
feed
pump
controls



Item 9 - Steam boilers

9. Boiler



High pressure solutions



Multistage
pump

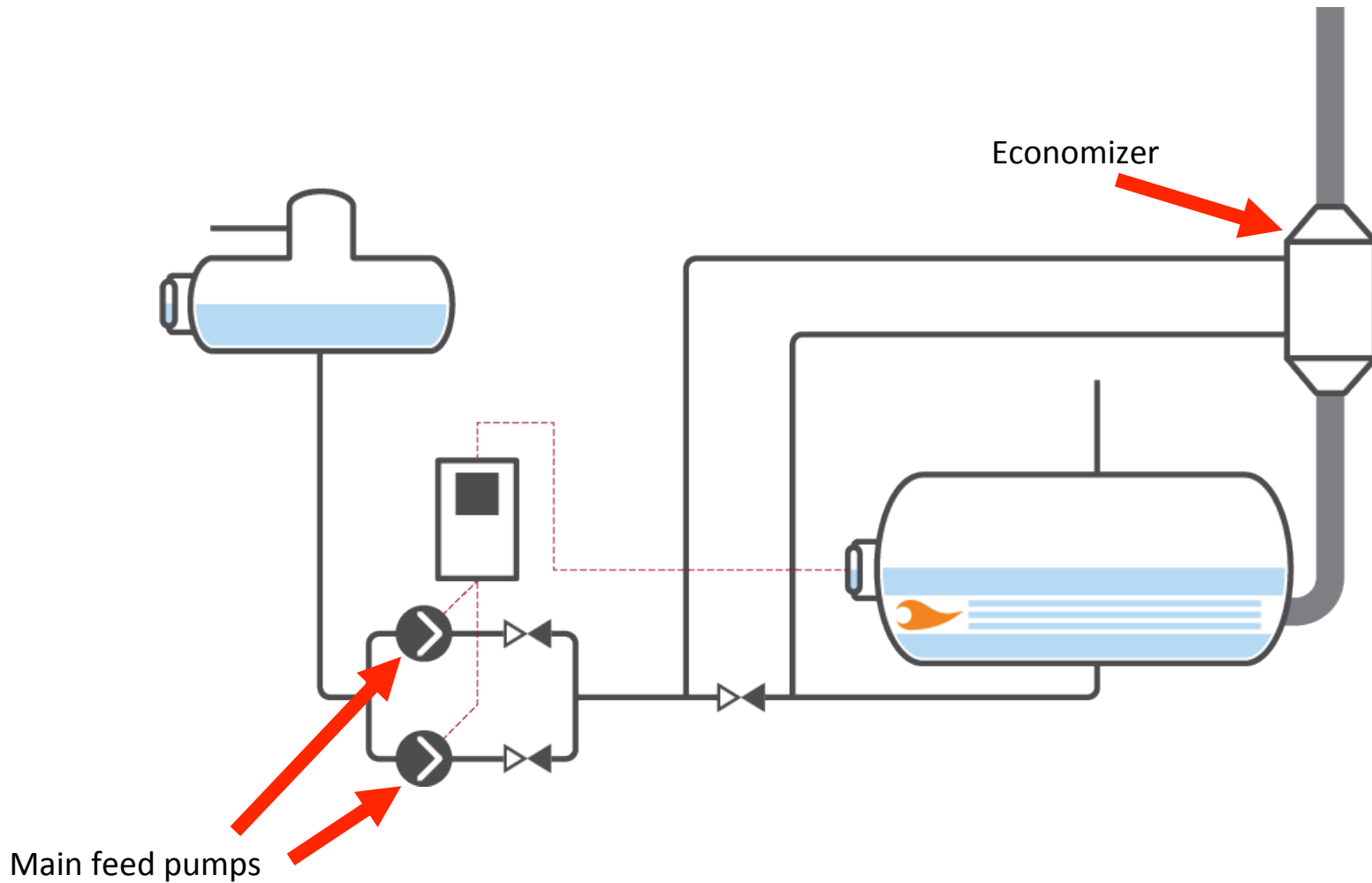


Series connected
pumps



Pump with
frequency converter

Economizers

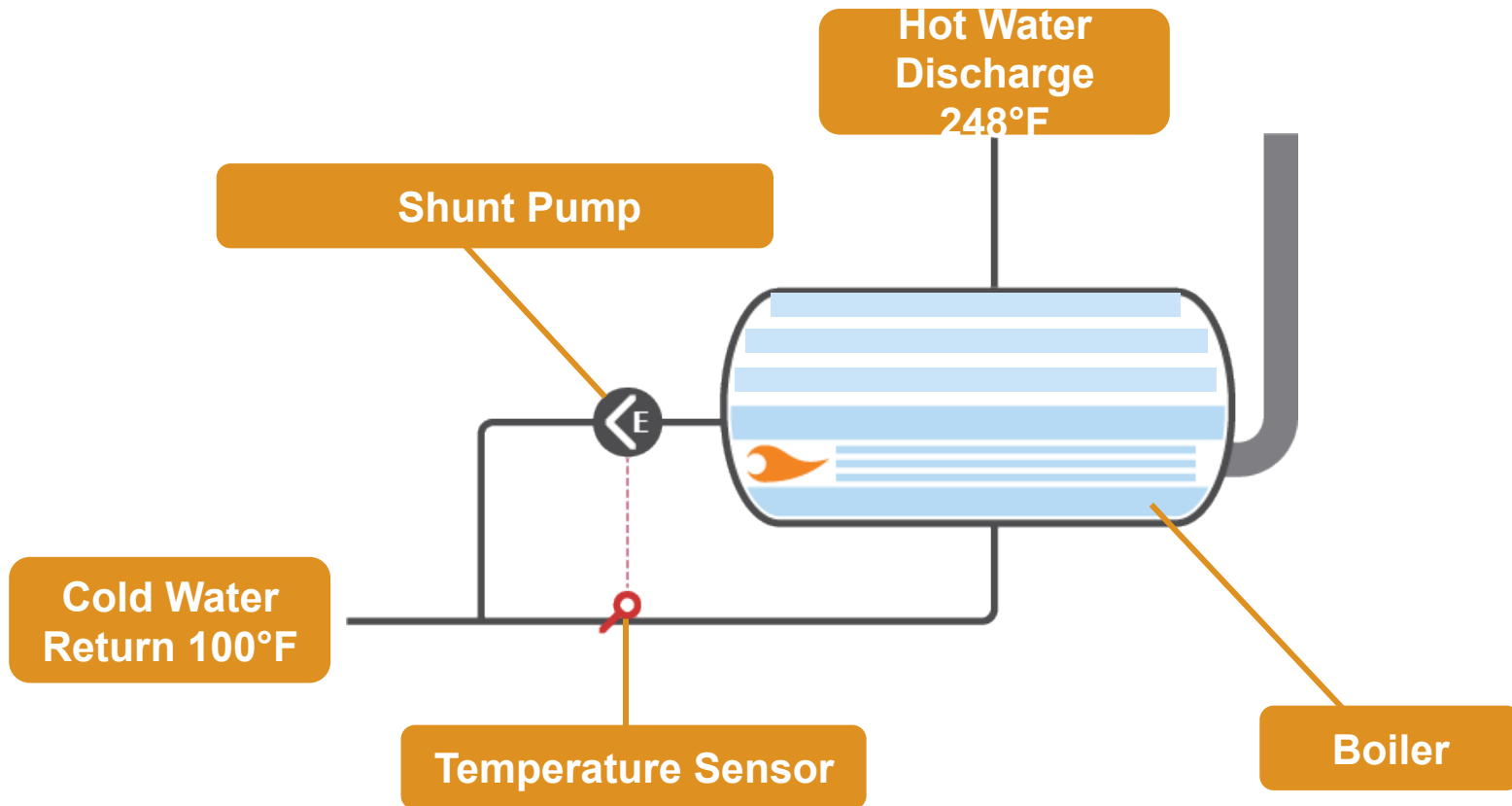


Feed water systems for multiple boiler installations

A bank of boilers



Boiler Shunt Pump



What are all of the pumps that might be involved in steam boiler installations?

<u>Item</u>	<u>Pump Name</u>
1.	Collection tank pumps
2.	Water treatment pumps
3.	Condensate return pumps
4.	Deaerator tank recycle pumps
5.	Deaerator vacuum pumps (vacuum deaerator tanks only)
6.	Boiler feed pumps
7.	Economizer pumps
8.	Shunt pump

How to Control the Level in the Boiler



Boiler feed and level control



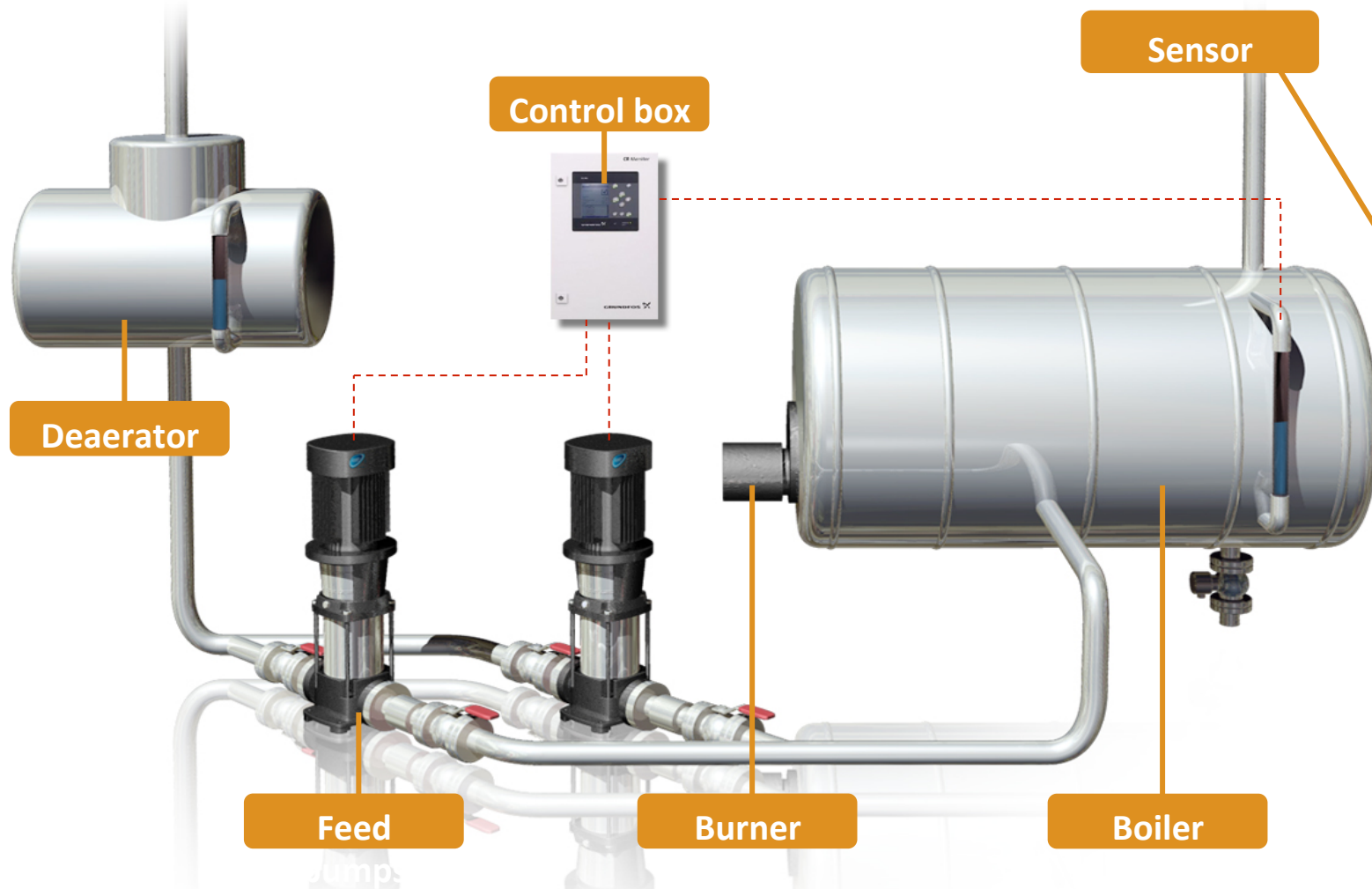
Image from OSHA/Western Iowa Tech Community College

Boiler Feed Control Methods

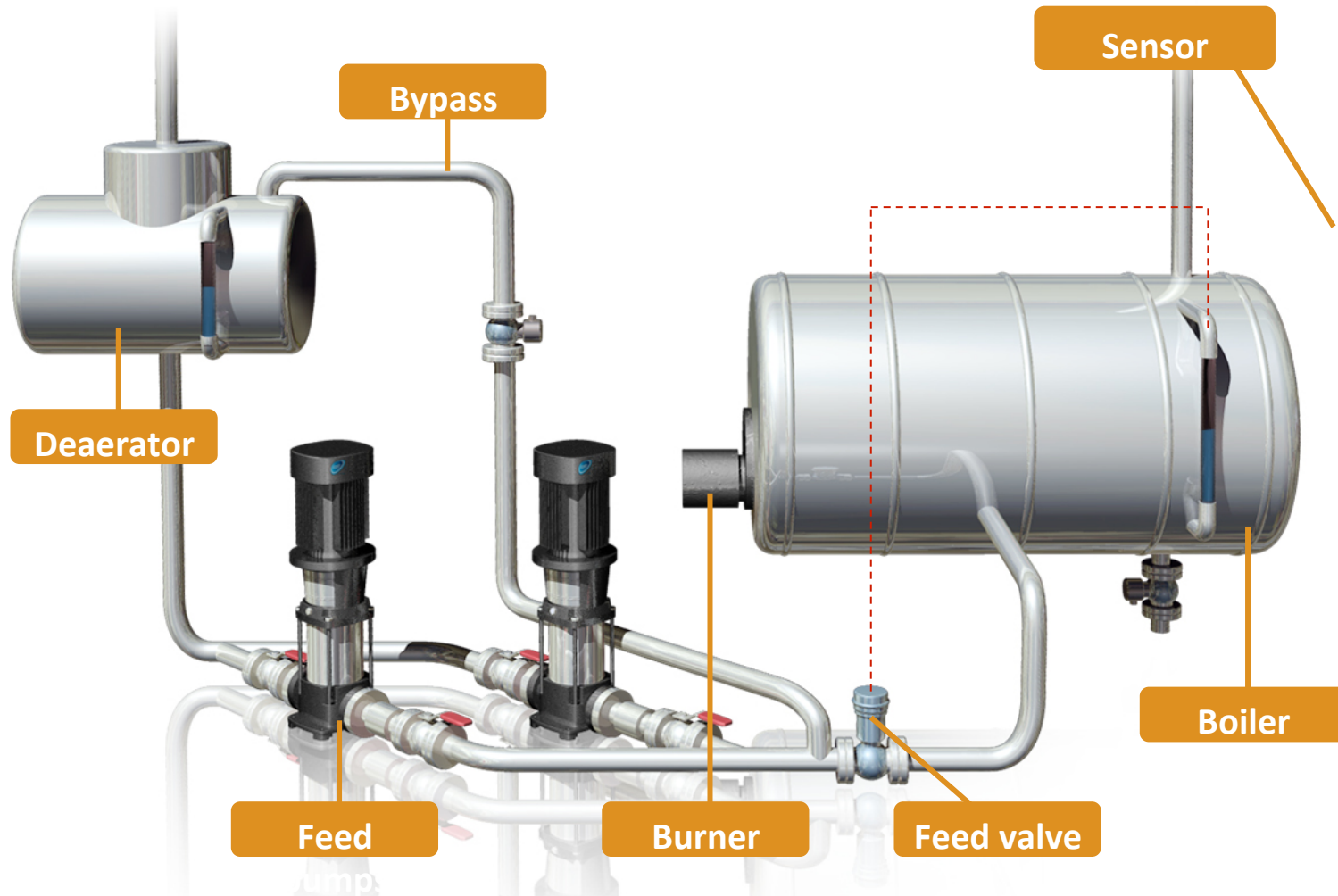
<u>Method#</u>	<u>Name</u>
----------------	-------------

- | | |
|----|--|
| 1. | On / Off control and fixed speed pumps |
| 2. | Feed control valve and fixed speed pumps |
| 3. | Feed control valve and variable speed pumps |
| 4. | Variable speed pumps only (no control valve) |

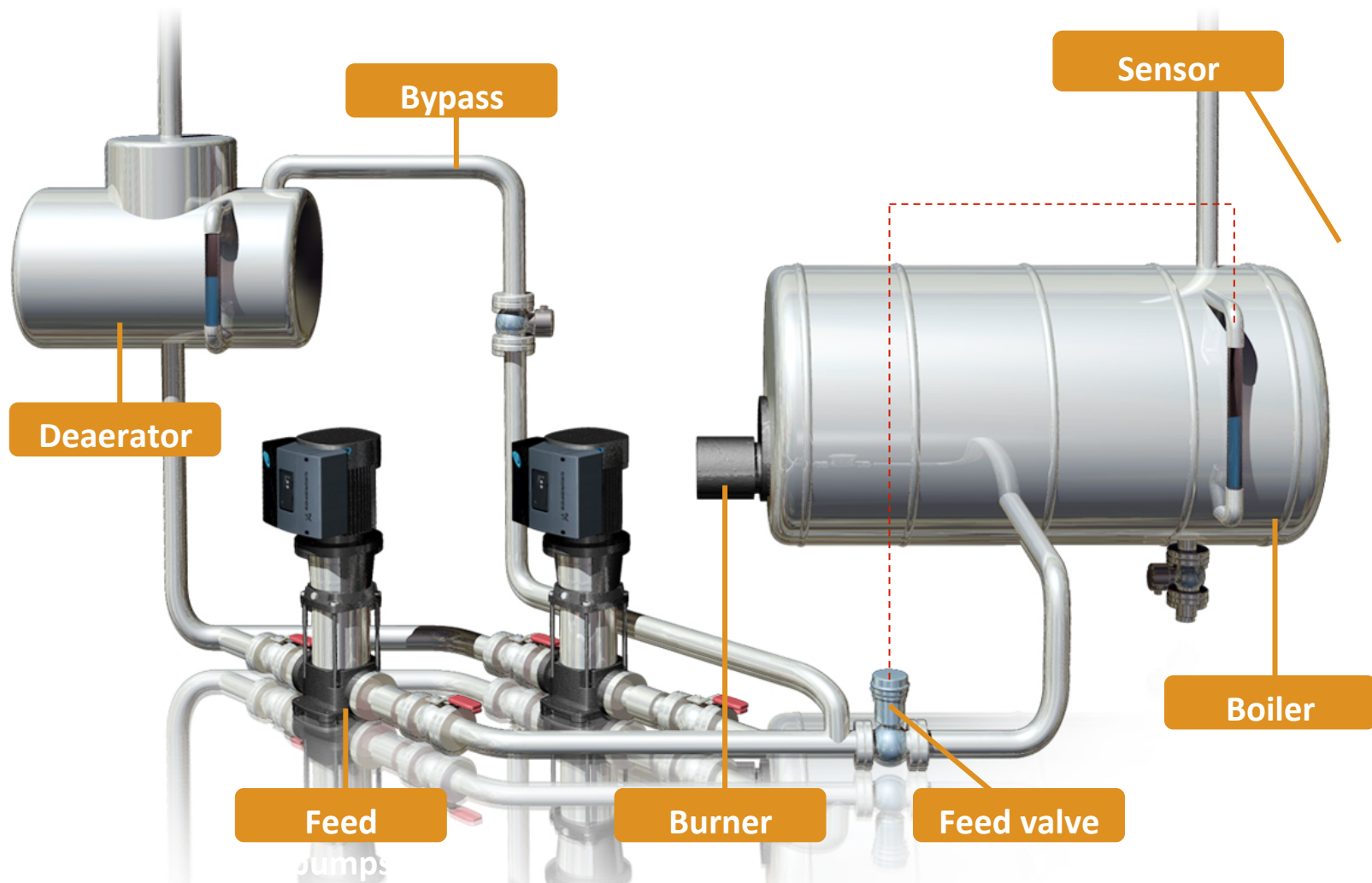
Control Method #1 - On/Off Control with fixed speed pump



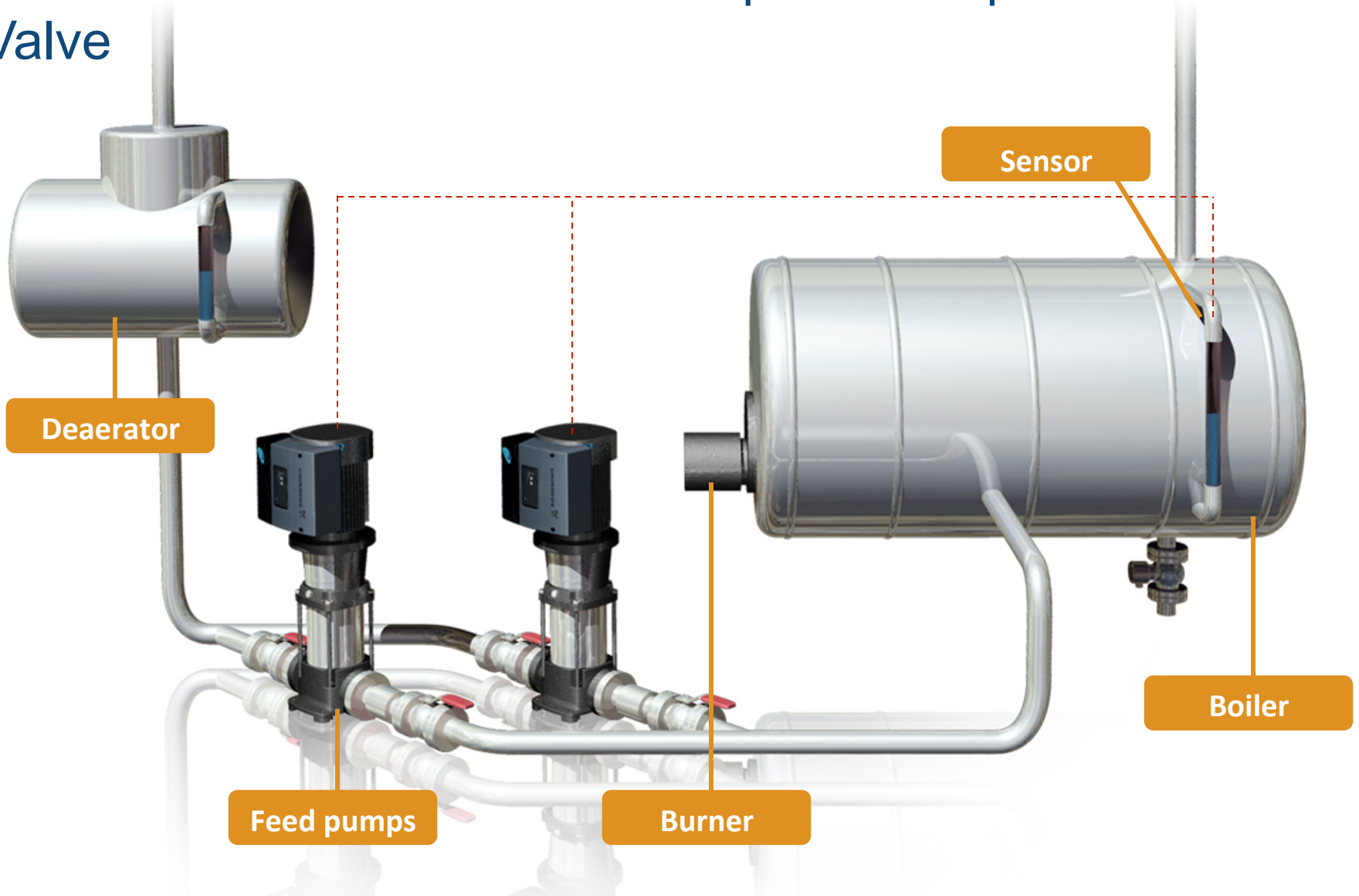
Control Method #2 - Feed Valve with fixed speed pumps



Control Method #3 - Feed Valve with Variable Speed Pumps



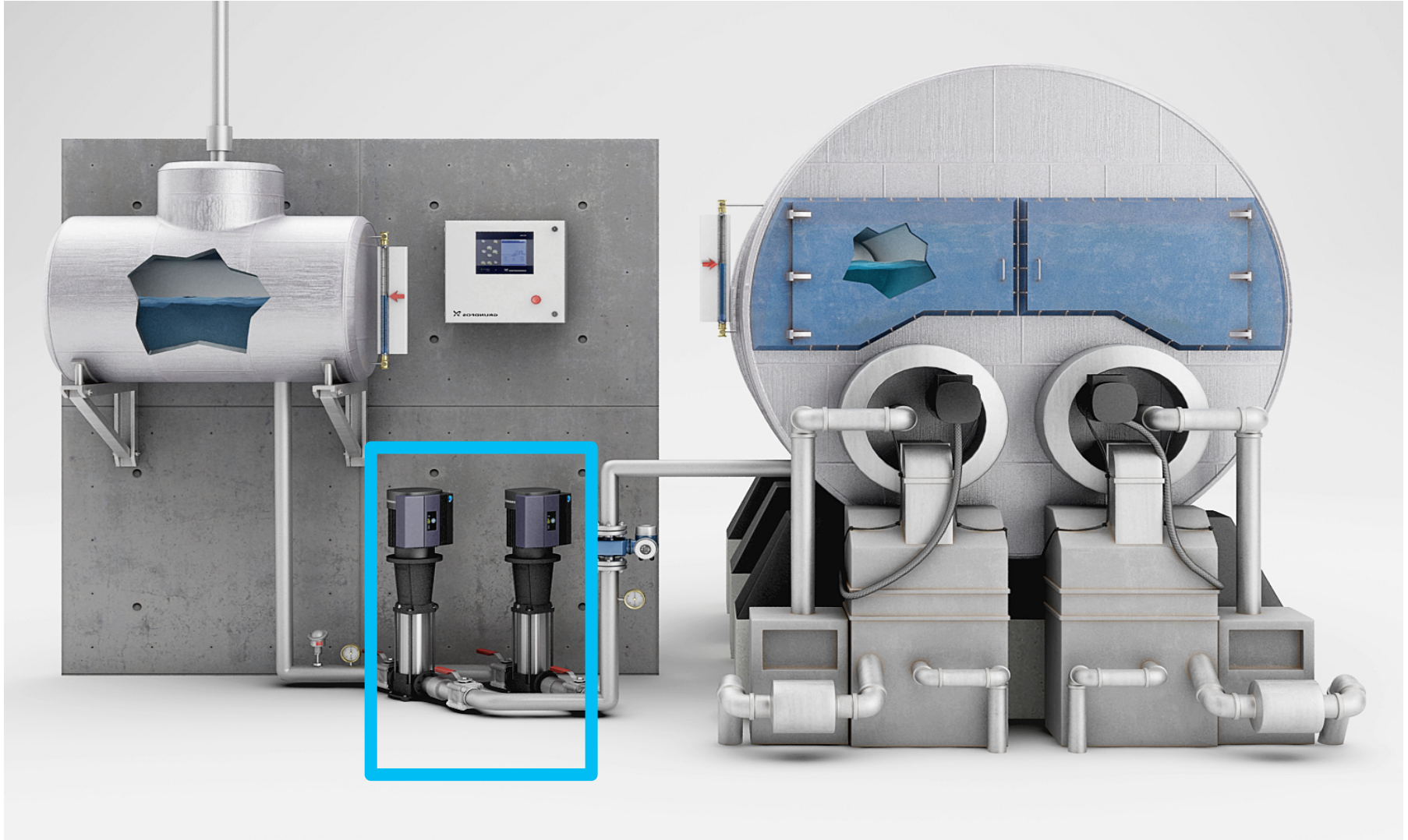
Control Method #4 - Variable Speed Pumps Less Feed Valve



Summary of Control Methods

Method #	Name	Uses feed valve?	Pump Speed Type	Duty	Is orifice flow by-pass line required?
1	On / Off control and fixed speed pumps	No	Fixed	Intermittent	No
2	Feed control valve and fixed speed pumps	Yes	Fixed	Continuous	Yes
3	Feed control valve and variable speed pumps	Yes	Variable	Continuous	Yes
4	Variable speed pumps only (no control valve)	No	Variable	Continuous	No

Selection complexity for boiler feed



Checklist - Boiler feed pump selection process

Step Action

<input type="checkbox"/>	1	Determine control method to be used
<input type="checkbox"/>	2	Calculate BASE flow rate
<input type="checkbox"/>	3	Add for by-pass flow if required
<input type="checkbox"/>	4	Sum of base flow and by-pass flow is the total flow required
<input type="checkbox"/>	5	Calculate BASE pumping head
<input type="checkbox"/>	6	Add for all suction piping head components
<input type="checkbox"/>	7	Add for all discharge piping system head components (including feed valve if required)
<input type="checkbox"/>	8	Sum of all head components = total pumping head
<input type="checkbox"/>	9	Determine deaerator tank water temperature
<input type="checkbox"/>	10	Perform NPSHa calculation
<input type="checkbox"/>	11	Make preliminary pump selection
<input type="checkbox"/>	12	Check NPSHr versus NPSHa
<input type="checkbox"/>	13	Assure material compatibility - chemical and temperature
<input type="checkbox"/>	14	Make final pump selection

Flow Rate - What does ASME Code say?

Boiler feed pump conditions of service (including the flow rate) should be specified by the boiler manufacturer

Base flow calculation equation

Boiler operating horsepower X 0.069 X C



Base flow calculation equation

Boiler operating horsepower X 0.069 X C



C = 2.0 for On/Off intermittent operation

C = 1.5 for continuous feed operation

Base flow calculation equation

Boiler operating horsepower X 0.069 X C



C = 2.0 for On/Off intermittent operation

C = 1.5 for continuous feed operation

For some continuous feed systems, add orifice flow for recirculation back to deaeration tank

Calculating required feed pump head

Pressure in
DA tank

Elevation of
DA tank

Friction loss –
suction side

+ Suction side head
+ Discharge side head
= Total Dynamic Head

Friction loss –
discharge side

Elevation of
boiler

Safety
factor

Safety factor

PACKAGED BOILER

CBLE
MODEL NO. SERIAL NO.

MAX WORKING PRESS. PSI DATE

INPUT BTU/HR GAS GPH OIL

GAS PRESS. AT MANIFOLD IN. W.C. (SEA LEVEL)

National Boiler Inspection Code - Section 1, states:

- The pump must be capable of delivering pressure that is 3% above the boiler safety valve setting

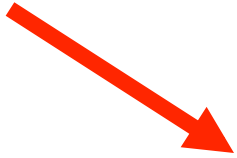
Safety factor

PACKAGED BOILER					
CBLE	MODEL NO.	CBI-700-600-150	SERIAL NO.	T1087-3	
MAX WORKING PRESS.		150ST	PSI	DATE	2009
INPUT	24,494,000	BTU/HR	NAT	GAS	GPH OIL
GAS PRESS. AT MANIFOLD		22"	IN. W.C. (SEA LEVEL)		

National Boiler Inspection Code - Section 1, states:

- The pump must be capable of delivering pressure that is 3% above the boiler safety valve setting
 - But does it mean at the design flow?
 - Or does it mean at shut-off flow?

Determining the head for the feed pump



Formula based on Safety Valve setting:

- Pump head in feet = Maximum pressure X 2.31 X 1.03 ÷ Liquid Specific Gravity

Example:

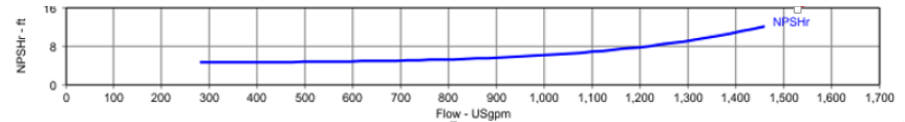
- Head = 100 psi X 2.31 X 1.03 ÷ 0.955 = 249 feet

To this 249 feet we must add for all head components attributable to the suction and discharge sides of the pump.

NPSH – Formula for calculation

To avoid cavitation, NPSHa must be greater than NPSHr

NPSHr is obtained from the pump curve

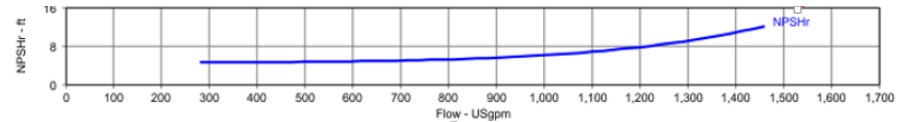


Add two to four feet of safety factor to the NPSHr stated on the curve

NPSH – Formula for calculation

To avoid cavitation, NPSHa must be greater than NPSHr

NPSHr is obtained from the pump curve



Add two to four feet of safety factor to the NPSHr stated on the curve

Formula for calculation of NPSHa:

+ Absolute pressure in deaerator tank

± Elevation of minimum water level in tank above feed pump

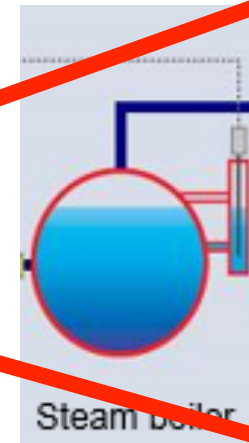
- Vapor pressure of water in deaerator tank

- Suction line friction loss

= Net Positive Suction Head Available

NPSH, temperature, vapor pressure and the deaerator tank

- Temperature of the boiler



- Temperature of the water in the deaerator tank



Pump Materials - Water Quality



Scale

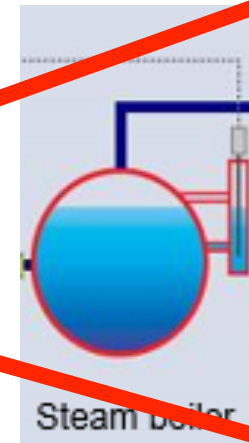


Corrosion



Pump materials - Temperature

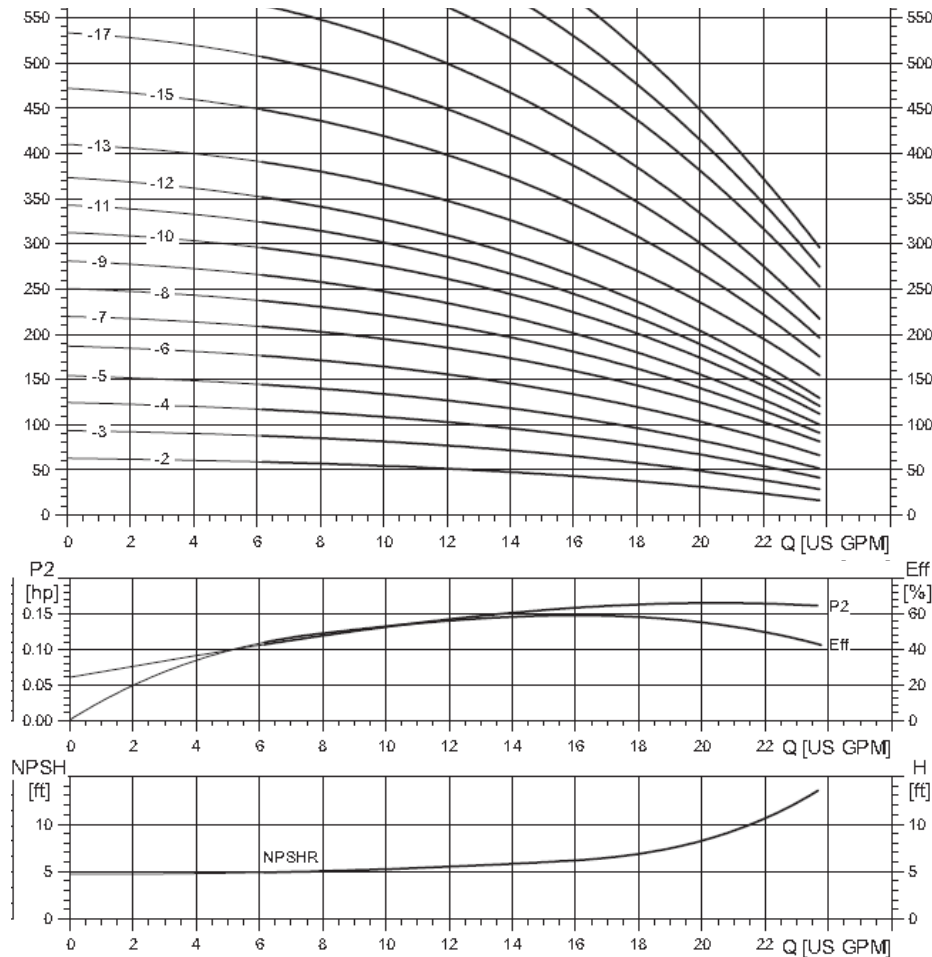
- Temperature of the boiler



- Temperature of the water in the deaerator tank



Boiler feed pump selection summary



Learning Objectives

You should now be able to:

- Cite the types and sizes of boilers
- Identify the components of a steam boiler system
- Name the eight possible applications for pumps in a steam boiler system
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Questions & Answers

Use the chat feature to submit questions



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Thank you!

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