Building Operator Certification – Level I

A Partnership of the NYC Department of Education Division of School Facilities, International Union of Operating Engineers, and the City University of New York

Department of Education
Dennis M. Walcott, Chancellor

The City University of New York

Class 13

Heating Distribution Efficiency

Objectives

- Identify heating system distribution principles and operating practices that matter to efficiency
  - *Function of steam traps, failure modes and monitoring*
  - *Relation to boiler plant control and pressure-cycling*
  - *Start-up practices and why some parts of building may overheat (system balance)*
- Identify zoning and control opportunities
  - *Be able to identify and document zone layouts and zone controls*
- Be able to draw a schematic distribution sketch, relating piping and valving to a building floor plan and heating zones
  - *Be familiar with the 2-pipe steam cycle, components and schematic layouts*

Agenda

- Boiler room visit - practice developing schematic drawing
- Hydronic distribution principles - steam and water systems
- Discussion of zoning and control
- Review & Class Reading Assignments

Exercise – Boiler Room Visit

Objective

- See elements important to boiler operation and efficiency, in particular as related to the distribution system and zoning
- Practice developing schematic sketch – for distribution system

Activities

Follow the instructor to the boiler room. Divide into two groups.

- **Activity 1A**: **Zone Layout Exercise** - Identify how steam piping is routed from the boiler room out to building zones.
- **Activity 1B**: **Photo Sheet Exercise -** Use the hand-out to identify boiler plant components. Help each other to identify and understand all components shown.
- **Activity 2**: **Zone Map Sketch**
  On the white board, each group to draw a sketch that that associates the boiler plant piping schematic to a building floor plan.

Time

- 45 minutes: 25 min for 1A + 1B, 20 min for 2

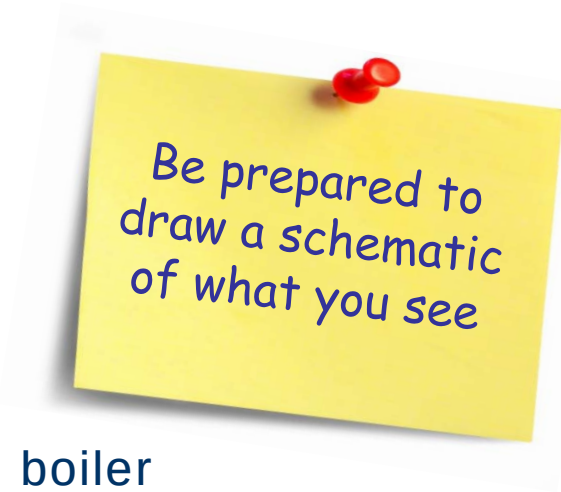
Section 1
Exercise – Boiler Room Visit

Elements for Inclusion in Steam Distribution Schematic

STEAM HEADER

ZONE VALVES, NUMBERED AND LABELED

BUILDING FLOOR PLAN WITH
HEATING ZONES INDICATED



You can also use this time to review elements of the boiler plant that you needed more time with from last week

Classroom Section - Section 2

- HEATING SYSTEM DISTRIBUTION PRINCIPLES
- LOW-PRESSURE STEAM OPERATION

Section 2 Distribution Principles

Steam

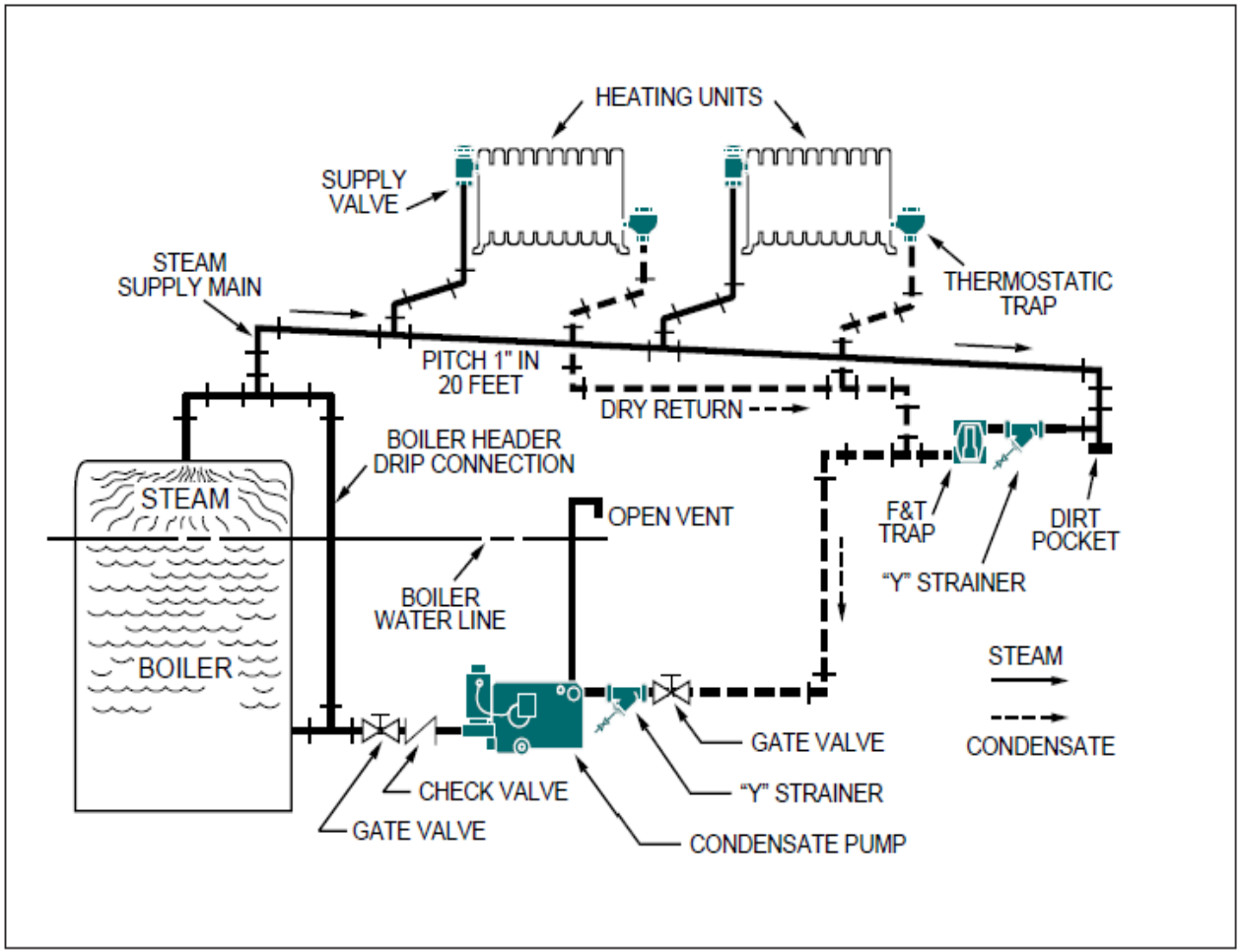
- Volumetric expansion at change of state. What pressure indicates. Condensing steam in terminal units.
- Balance in steam system - when steam arrives at various points
- Steam is either being supplied or not -- limited control range.

Circulating Hot Water

- Circulation via pumping. Closed system - pump to overcome friction losses in piping.
- Balance is a function of different pressure drops in different circuits
- Can vary temperature of water and/or flow rate for close control

Steam Distribution - basic layout

Two-pipe steam heating system

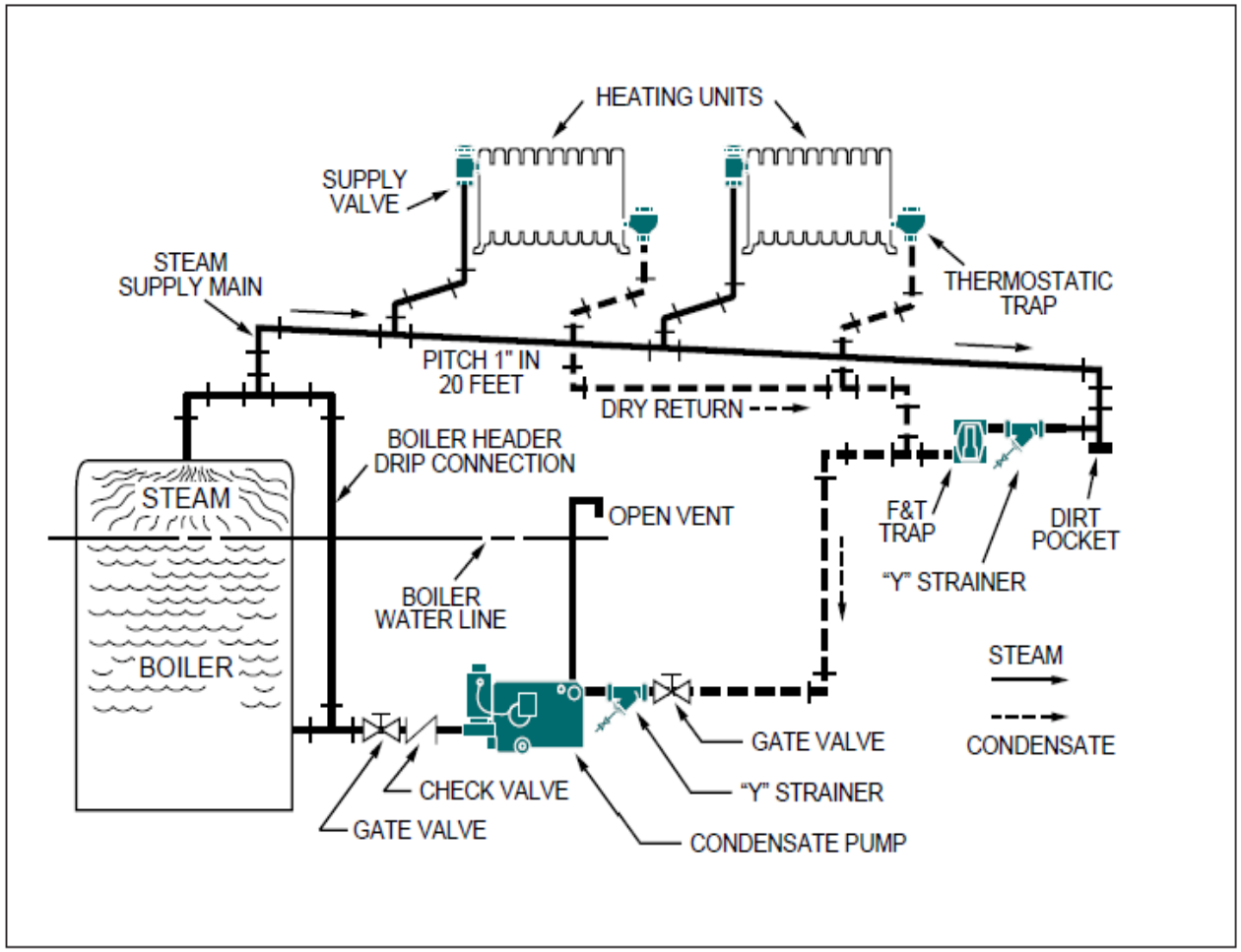


Layout varieties –

- dry/wet returns
- All-gravity (no return pumps), receivers, vacuum pumps
- Note VENTING at receiver

Steam Distribution – the steam cycle

Two-pipe steam heating system

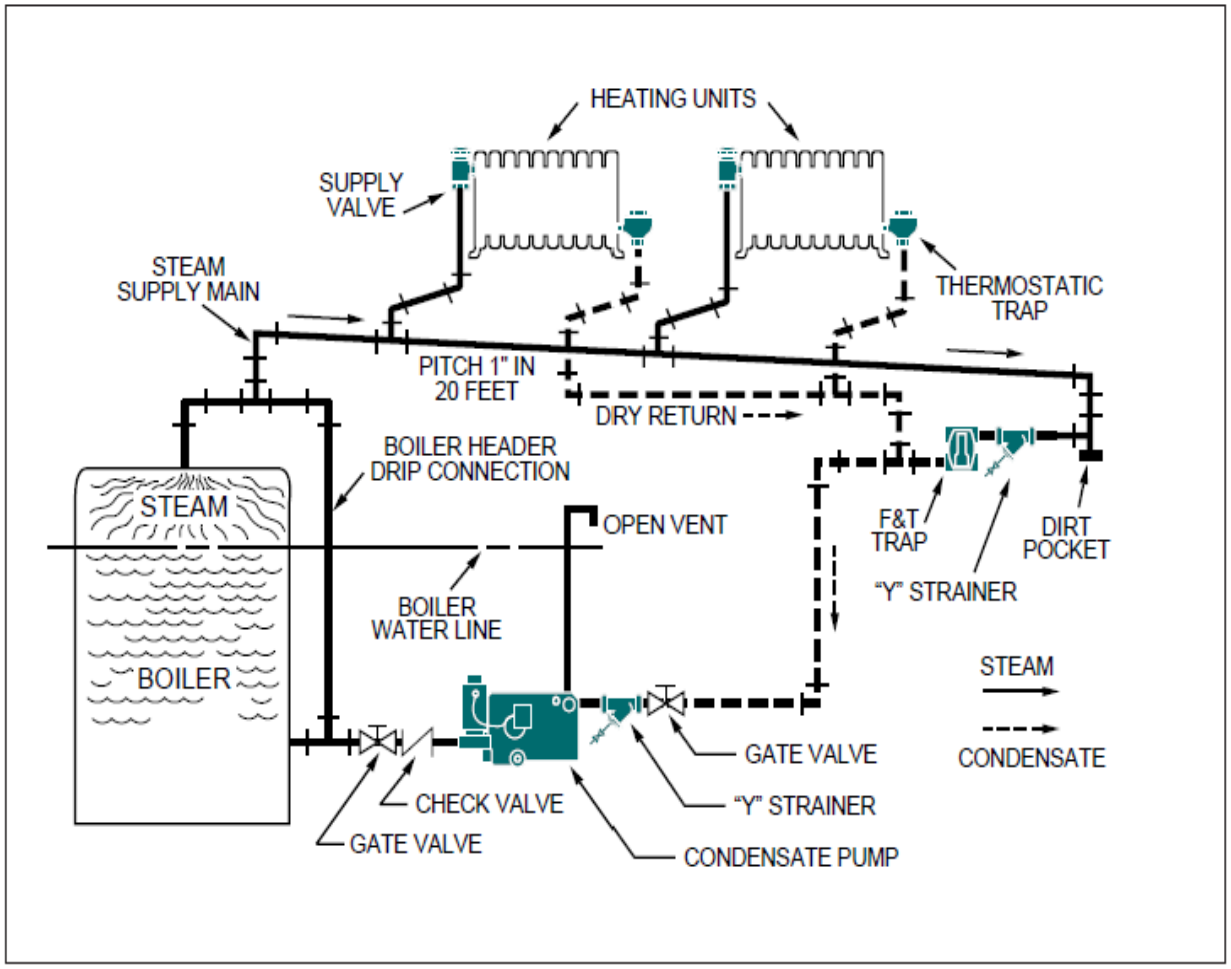


Steam cycle - Envision how the steam expands and condenses as it moves through the system

- Why such a long time to make steam pressure?
- Once pressure starts to increase, why does it rise so quickly?

Steam Distribution – Pressure

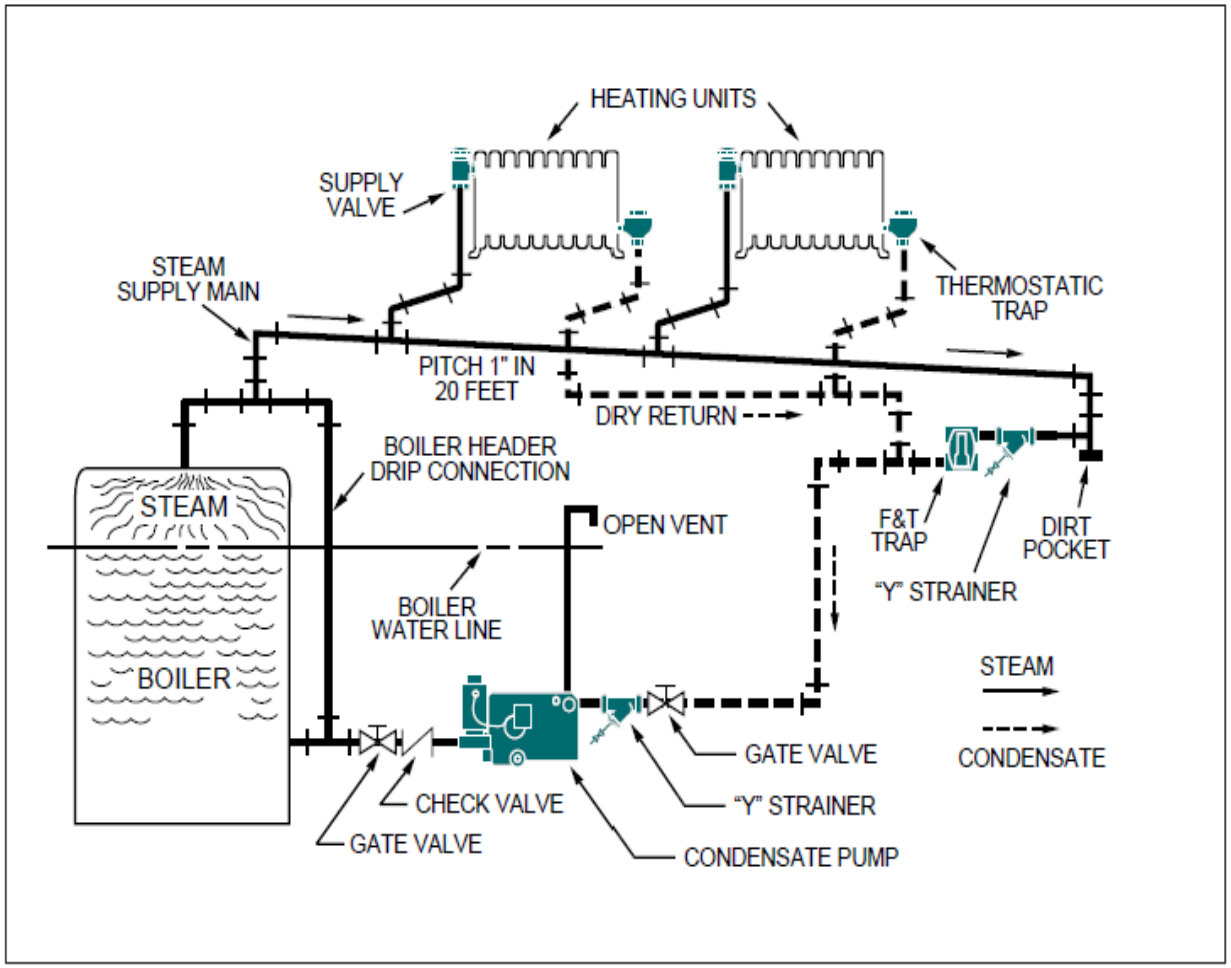
Two-pipe steam heating system



- How is pressure created in the steam system?
- When is pressure created in the system?
- How much pressure do we need?
- The key to low operating pressure is the condensate return system.

Steam Distribution – Morning Start-up

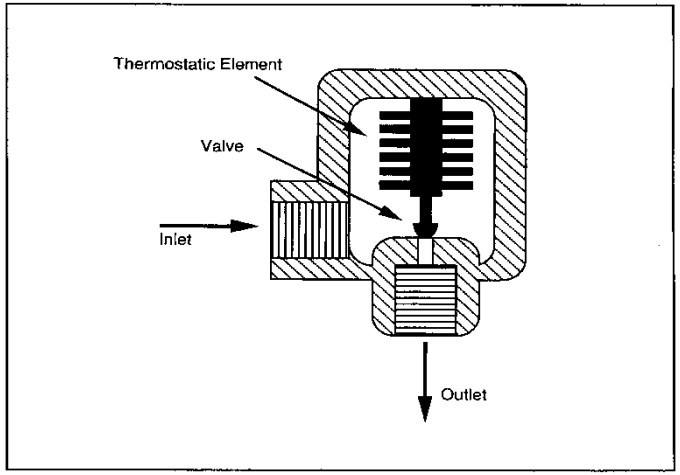
Two-pipe steam heating system



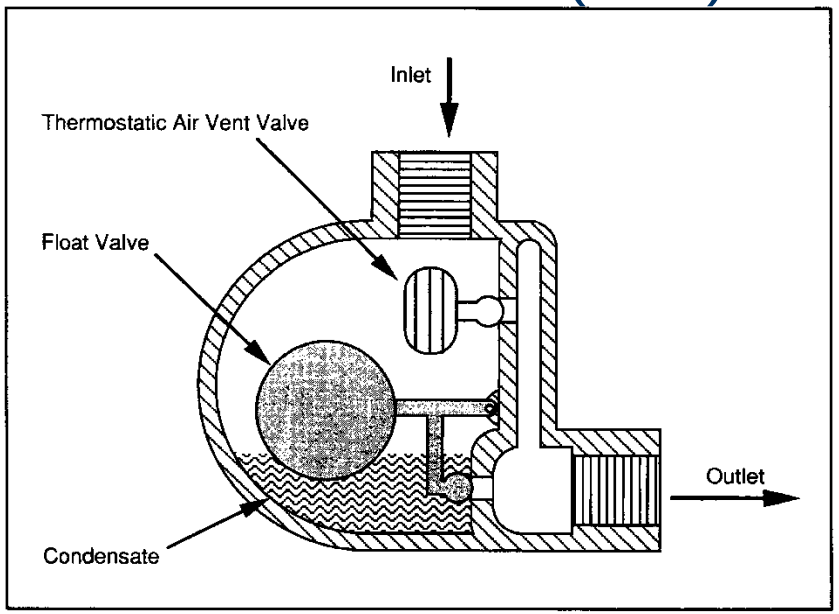
- Let's discuss what is happening in cold morning start-up
  - High rate of condensation
  - induced vacuum conditions in piping
  - erratic boiler water level & cycling
- Easy to overshoot
- System Balance - Does steam reach everywhere at same time?

Steam Distribution – Steam Traps

Thermostatic Trap



Float & Thermostatic (F&T) Trap



Function of Steam Traps

- Allow air and condensate to pass but make all steam condense in terminal unit (radiator, heat exchanger)
- What are the signs of failed-closed and failed-open?

Steam Distribution – Steam Traps

Thermostatic Trap on Radiator

Operation of Trap	Entering Temp	Exit Temp	dT
Normal	212F	187F	15F
Failed Open	212F	212F	0
Failed Closed	120F	120F	0

F&T Trap on Main Drain Line

Operation of Trap	Entering Temp	Exit Temp	dT
Normal - High Flow	212F	212F	0
Normal – Low Flow	212F	187F	15F
Failed Open	212F	212F	0
Failed Closed	120F	120F	0

Steam Distribution – Steam Traps

Failed Open Steam Traps - Problems

- Live steam vented at condensate receivers, very long time to make steam pressure (severe, widespread trap open failures)
- Live steam in returns causes other traps in line to close (possibly causing no-heat call)
- Unable to make vacuum and vacuum pump life is shortened
- Track the Temperature Trend at main return to condensate receiver(s) and/or vacuum pumps.

Steam Distribution – Some key issues

How much make-up water?

- Closed System – should be minimal leakage and make-up
  - except for steam from Con Ed steam
- Where do systems leak from?
  - Vented receivers – flash steam or worse
  - Dripping and vaporizing at valves – you may not see it
  - Buried returns – you may not see it
- Why should I care about leakage?
  - Energy
  - Oxygen & minerals in fresh water and equipment life
- How can we tell how much leakage?
  - **Meter the make-up water from City Water**

Steam Distribution – some key issues

- What does “good insulation” look like?

- **Removable insulating jackets** are a very nice way of insulating components or parts of components that were previously left bare because of periodic access requirements

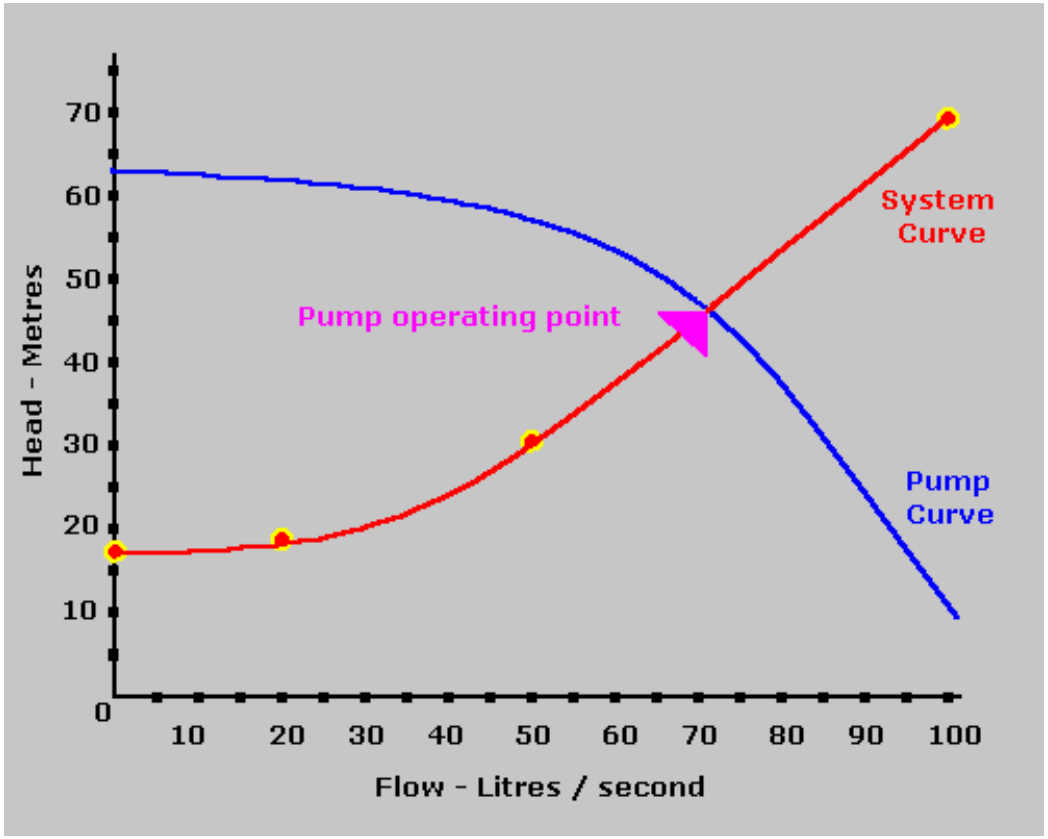
Section 3

- CIRCULATING HOT WATER SYSTEMS
- ZONING AND CONTROL

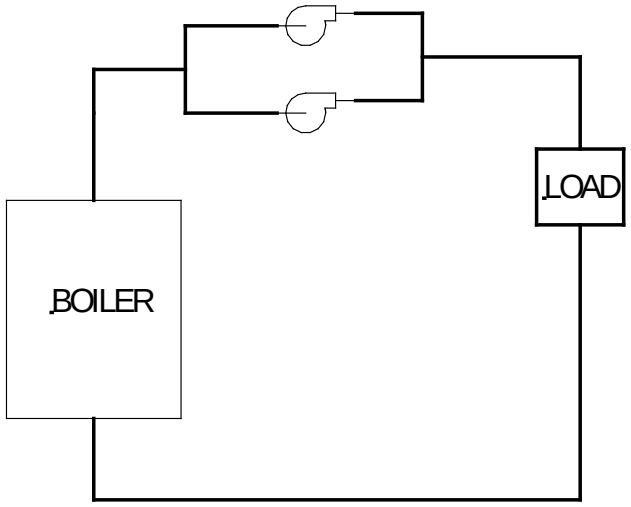
Circulating Hot Water Distribution - circulator pumps

- Pump supplies specific volume of flow at any given pressure (blue curve)
- Required pressure is from system piping (the system curve – red)
- As valves throttle down, resistance (pressure drop) increases, flow decreases, riding up along the pump curve
- ***If balancing valves are throttled***, energy can be saved by slowing down pump speed (or down-sizing pump).

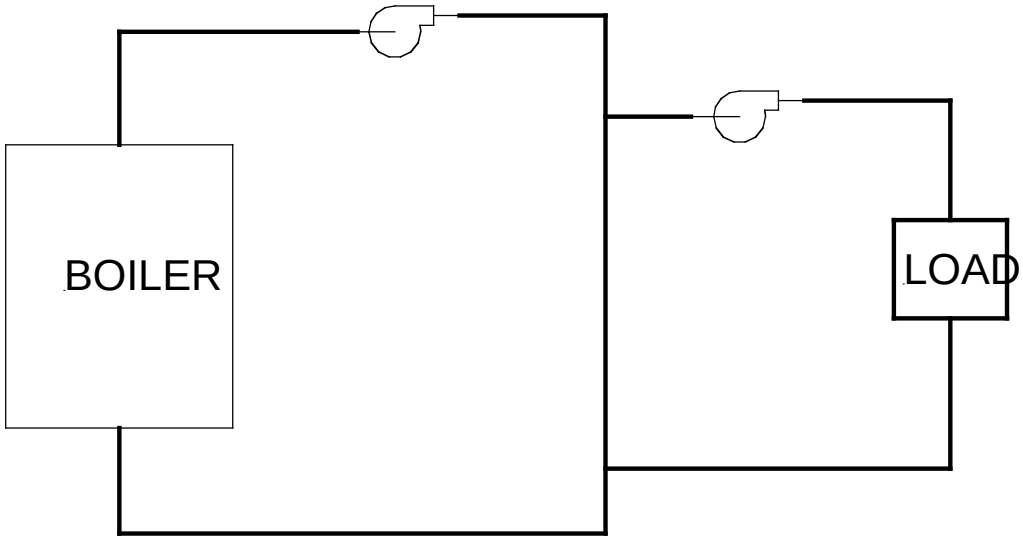
Pump Curve



Circulating Hot Water Distribution – pumping arrangements

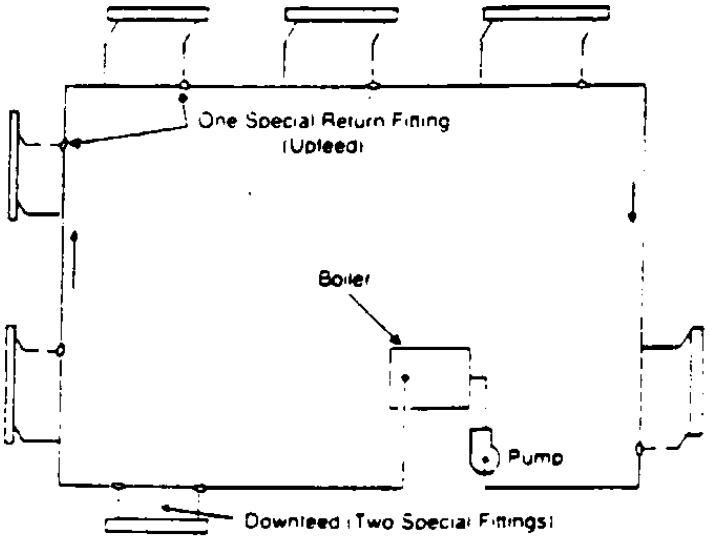


SINGLE ZONE W/PARALLEL PUMPS

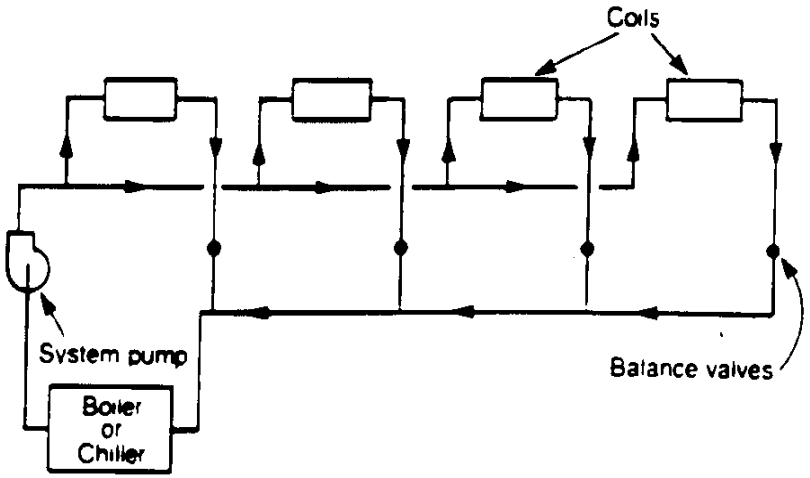


PRIMARY/SECONDARY PUMPING

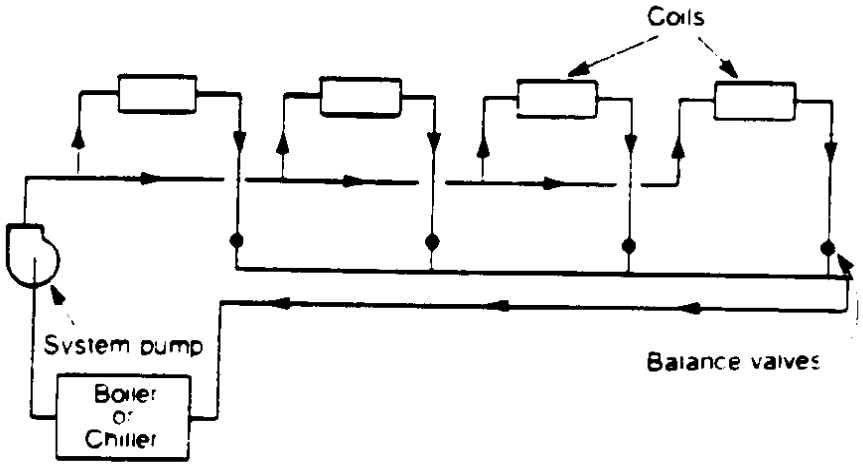
Circulating Hot Water Distribution - Piping layouts and balance



One-Pipe System



Direct Return Two-Pipe System



Reverse Return Two-Pipe System

Circulating Hot Water Distribution – control

Why Is Circulating Hot Water easier to control than steam?

Control by temperature (reset)

Control by flow (variable speed pumping)

Zoning & Control

What do we mean by a heating zone?

- area that can be independently supplied / controlled
- some characteristic within one zone
  - – one floor is a zone
  - - south side of one floor
  - - same schedule or use is one zone

Consider how your building is zoned:

- What kind of controls?
- Remember manual valves count too!

Steam Heating - Zoning & Controls

Would everything be just fine if only your pneumatic controls were in good working order?

What your pneumatics can and can't do:

- Maintain good calibration for any length of time
- Avoid temperature overshoots, especially in mild weather
- Close off parts of the building that are NOT in use, while other parts require heating (eg – afterschool program)

DISCUSS !!

Steam Heating - Zoning & Controls

Manual Control of Zones with Steam Valves

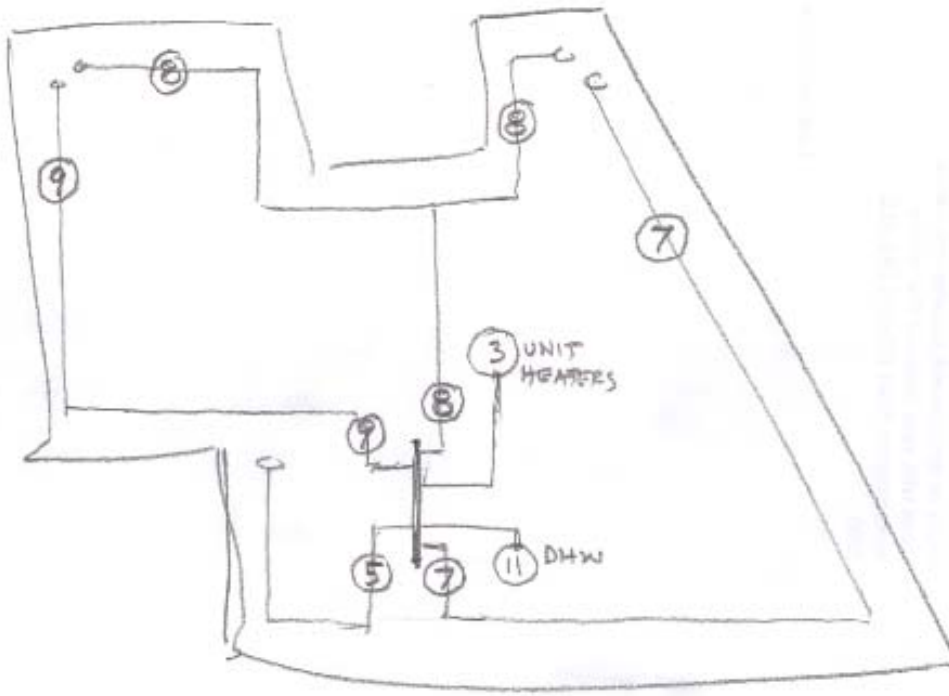
- Close steam valves at equipment: air handler, etc.
- Close steam valves in boiler room: zone valves on header
- Close off parts of the building that are NOT in use, while other parts require heating (eg – afterschool program)
- When does it make the most sense to do this?
- Where can you do this in your school?

Steam Heating - Zoning & Controls

What can we say about this sample building's zoning?

Is there one zone that looks like it might heat-up first and overheat?

Can we control for differing morning and afternoon conditions? (south and east)
What can we say about zone 7?



Practical Project – Part 1C
HVAC System Schematic

- Sketch of your HVAC System (Boiler Plant)
- Zone Map of the zones in your building
- HVAC Survey Form
- Mechanical Equipment List
- Review of Project Instructions – Yellow Sheets
- Review of Example Sketch – Course Book

Mechanical Equipment List

Need to verify the full Mechanical Equipment List for each building.

This is important for equipment replacement planning and for the budgets of Dept of Ed. The CEs are important as the best source of this information on the equipment condition.

This information will be used by the CE again in the near future. You should retain a copy of this equipment condition information so you are prepared to inform the DCAS inspector when they come for their annual visit.

Follow the instructions on the form.
Make sure that you complete the information in each column.

Review and Class Reading Assignments

- **IUOE Indoor Air Quality Solutions - Chapter 12, 13**
  Important to read this text for the IUOE IAQ Certification test.

- **FEMP 9.11**

- **Practical Project 1-C HVAC System**
  Bring in for peer group review next week