

# Pumps (and Piping)

Design, Performance and Commissioning Issues

Open and Closed Systems



**Instructor:**

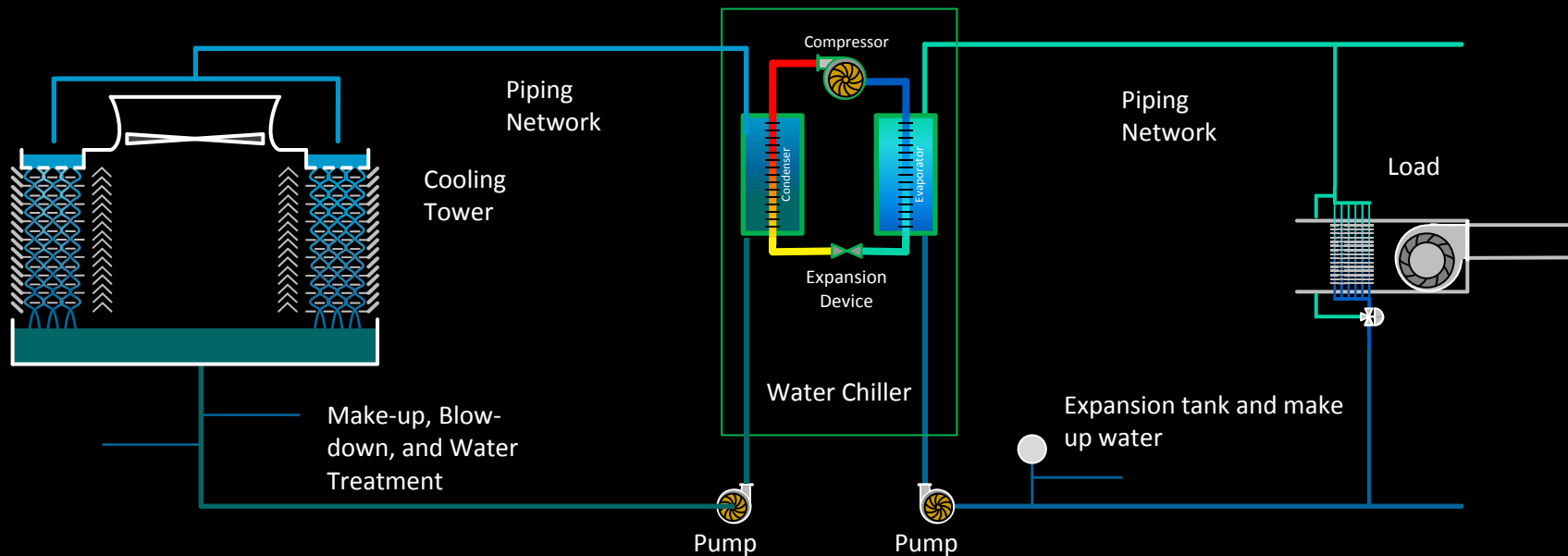
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Senior Engineer

Facility Dynamics Engineering

April 4, 2017

# Central Plants Typically Have Open and Closed Systems Associated with Them



Typically an open system

*More than one interface with the atmosphere or a compressible gas*

Typically a closed system

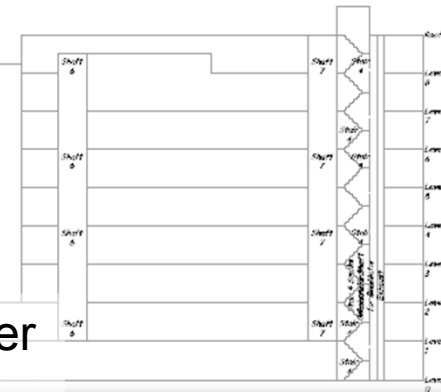
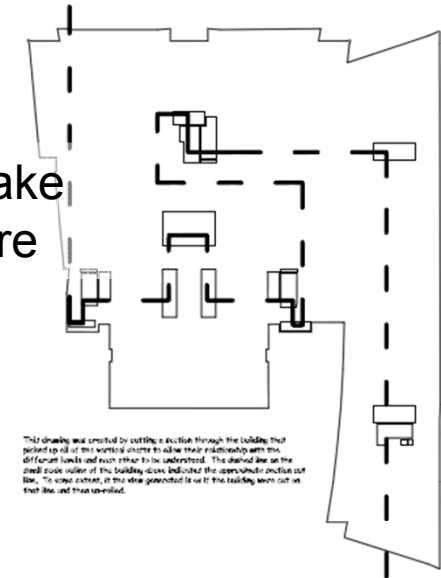
*Only one interface with atmosphere or a compressible gas*

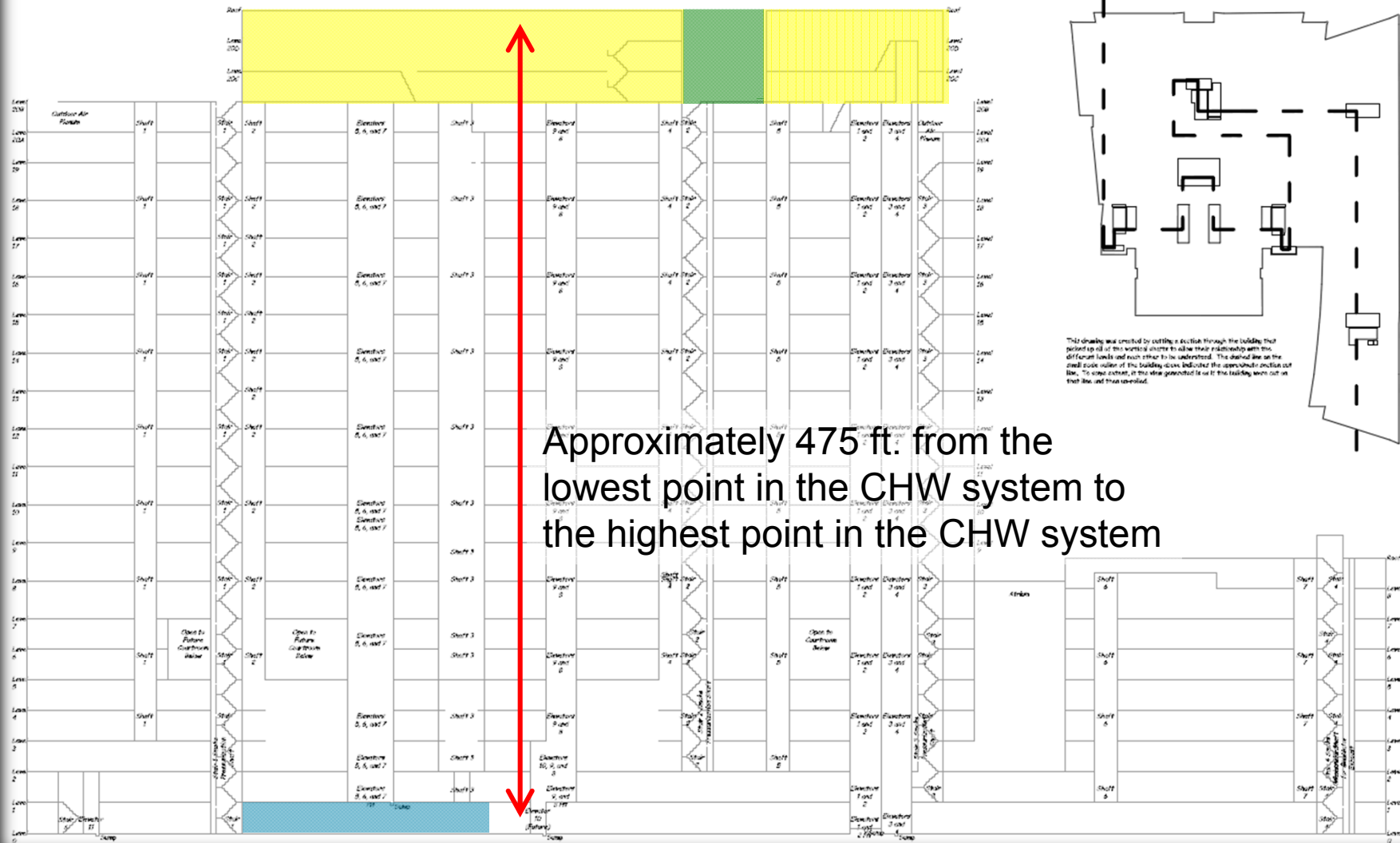
Air handling units  
are here

Cooling towers and make  
up connections are here

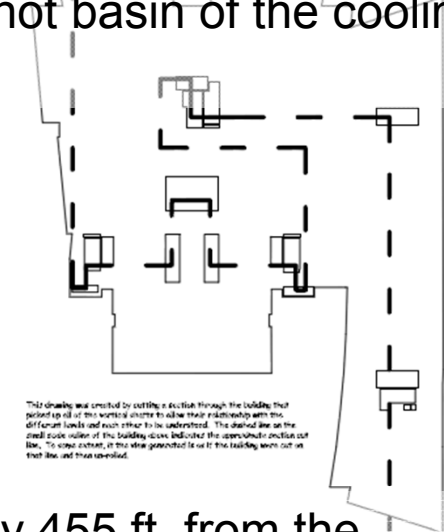
Piping mains run up  
and down this chase

Chillers, pumps, and chilled water  
make up connection here



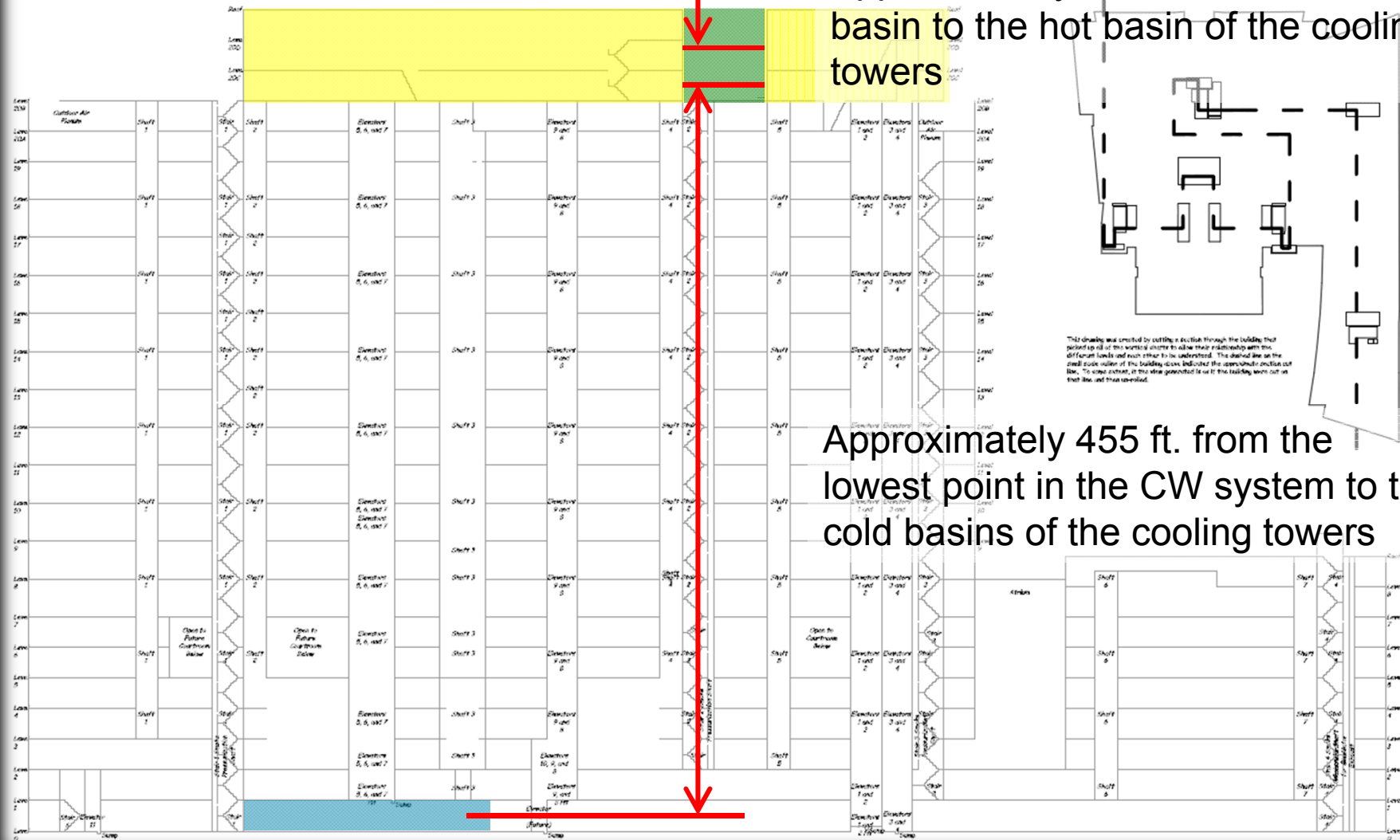


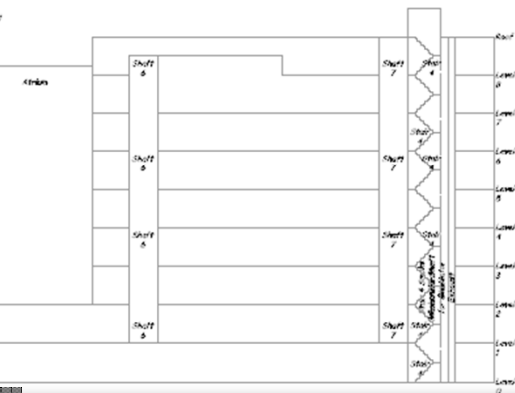
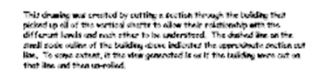
Approximately 15 ft. from the cold basin to the hot basin of the cooling towers

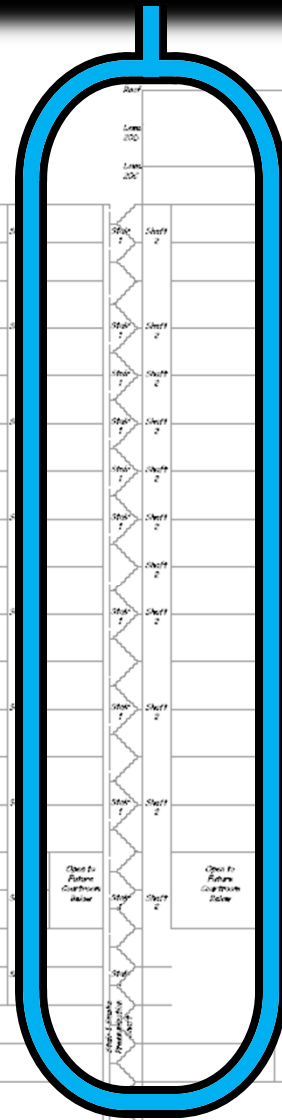


This drawing was created by cutting a section through the building that passed up all of the working stories to allow their relationship with the different levels and main shaft to be understood. The dashed line on the small scale plan of the building shows indicated the approximate section cut line. To some extent, in this view generated it is in this building, were cut on their line and then generated.

Approximately 455 ft. from the lowest point in the CW system to the cold basins of the cooling towers

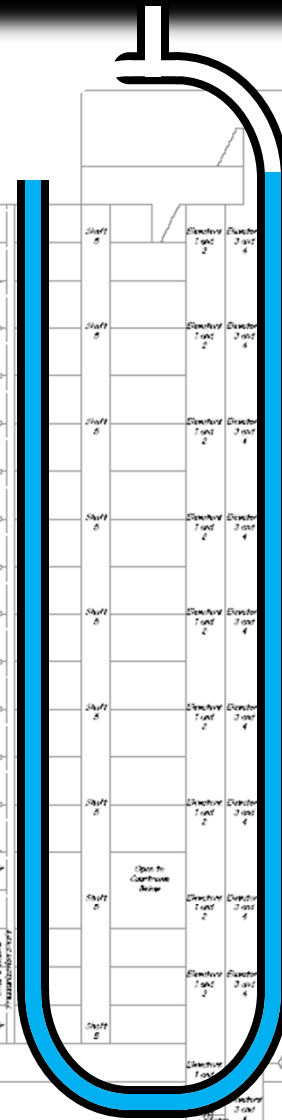






The closed chilled water system could be completely filled from a connection at the high point in the system

Closed Chilled Water System

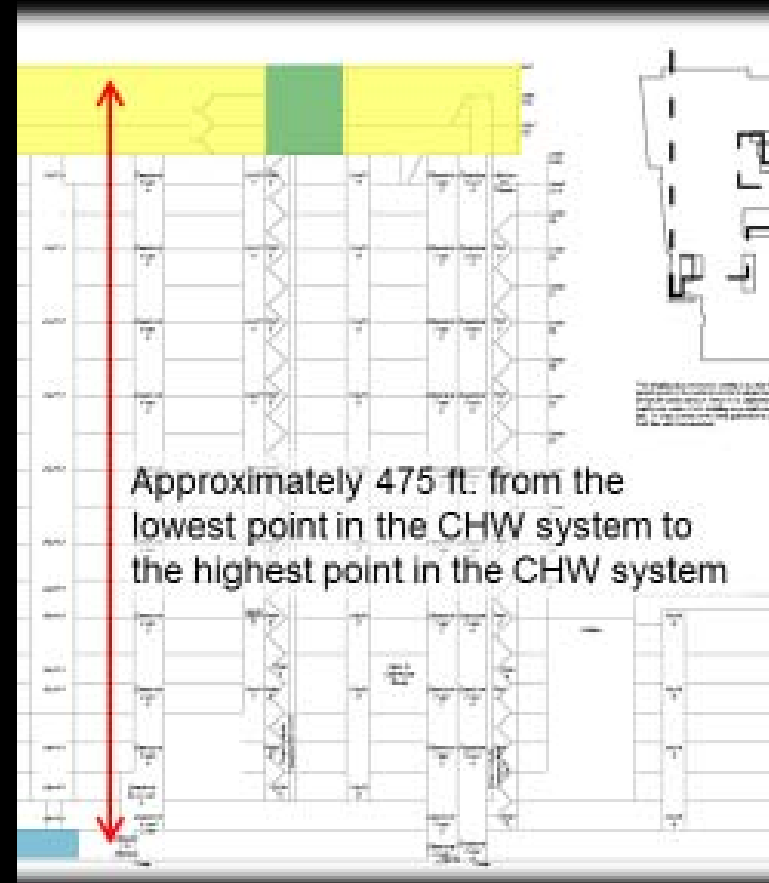


The open condenser water system could only be filled to the rim of the open basin from a connection at the high point in the system

Open Condenser Water System

# A Couple of Questions

- What pressure should be used as a fill pressure for the chilled water system and why?





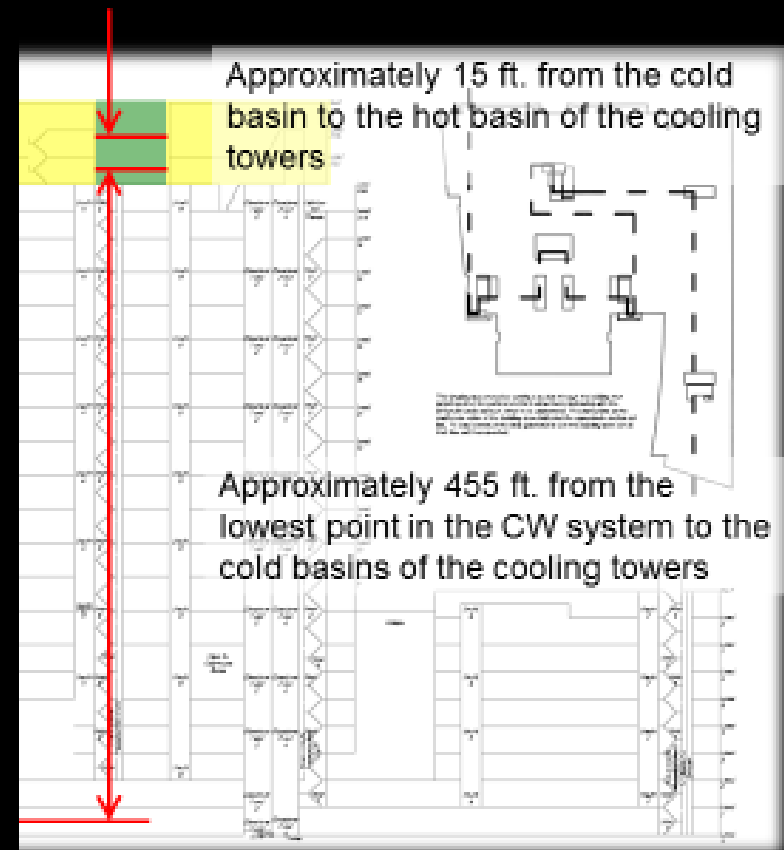
# A Couple of Questions

- What pressure should be used as a fill pressure for the chilled water system and why?
- If the evaporator pumps serving the chillers are rated to produce 30 ft.w.c. of head at design conditions, what would an appropriate range be for the pressure gauges on the pump?

Standard Ranges			
psi Ranges (A)			
Range Code	Specific Range (psi)	Figure Intervals	Minor Divisions
010	30" Hg to 0	5	0.2
020	30" Hg to 15 psi	5/5	0.5/0.2
030	30" Hg to 30 psi	10/5	1/0.5
040	30" Hg to 60 psi	10/10	1/1
050	30" Hg to 100 psi	30/10	2/1
060	30" Hg to 150 psi	30/20	5/2
070	30" Hg to 300 psi	30/50	5/2
080	0 to 15 psi	3	0.1
090	0 to 30 psi	5	0.2
100	0 to 60 psi	10	0.5
110	0 to 100 psi	10	1
120	0 to 160 psi	20	1
130	0 to 200 psi	20	2
140	0 to 300 psi	50	2
150	0 to 400 psi	50	5
160	0 to 600 psi	50	5
180	0 to 1000 psi	100	10

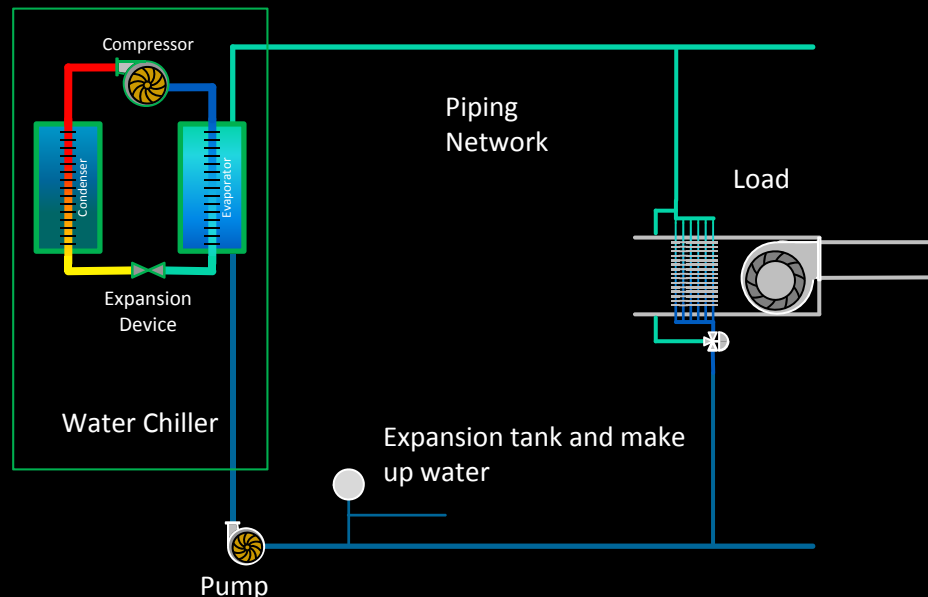
# Some More Questions

- How much head needs to be included in the condenser water pump selection to lift water through an elevation change?
- Assuming the condenser pump is at the lowest point in the system, what would the gauge on its suction connection read when the system was not operating?
- Would this reading change when you started the pump?



# Closed Systems

- Interface is at the expansion tank
  - Open or diaphragm type
    - Different sizing issues
    - Different piping issues
- Pressure tends to hold constant at the expansion tank
- Expansion tank typically at the distribution pump suction connection
- Air separation may or may not be at the expansion tank
- Fill pressure needs to be sufficient to vent air at high points



- Make up typically connected at the expansion tank
  - Very little required once filled
  - Limited water treatment
  - Monitor volume and pressure



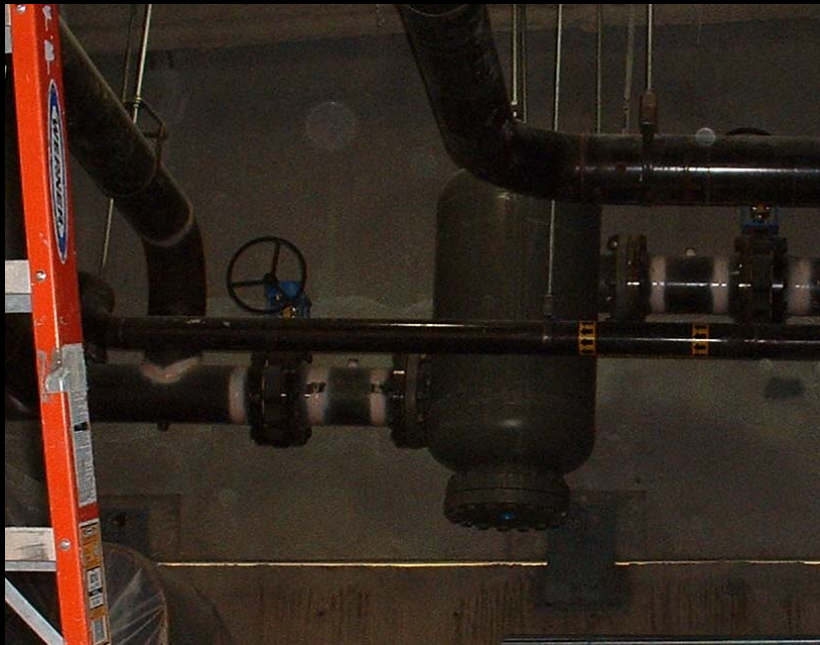
## Non-Diaphragm Expansion Tank



# Diaphragm Expansion Tank



# Air Separators





# Makeup Connections





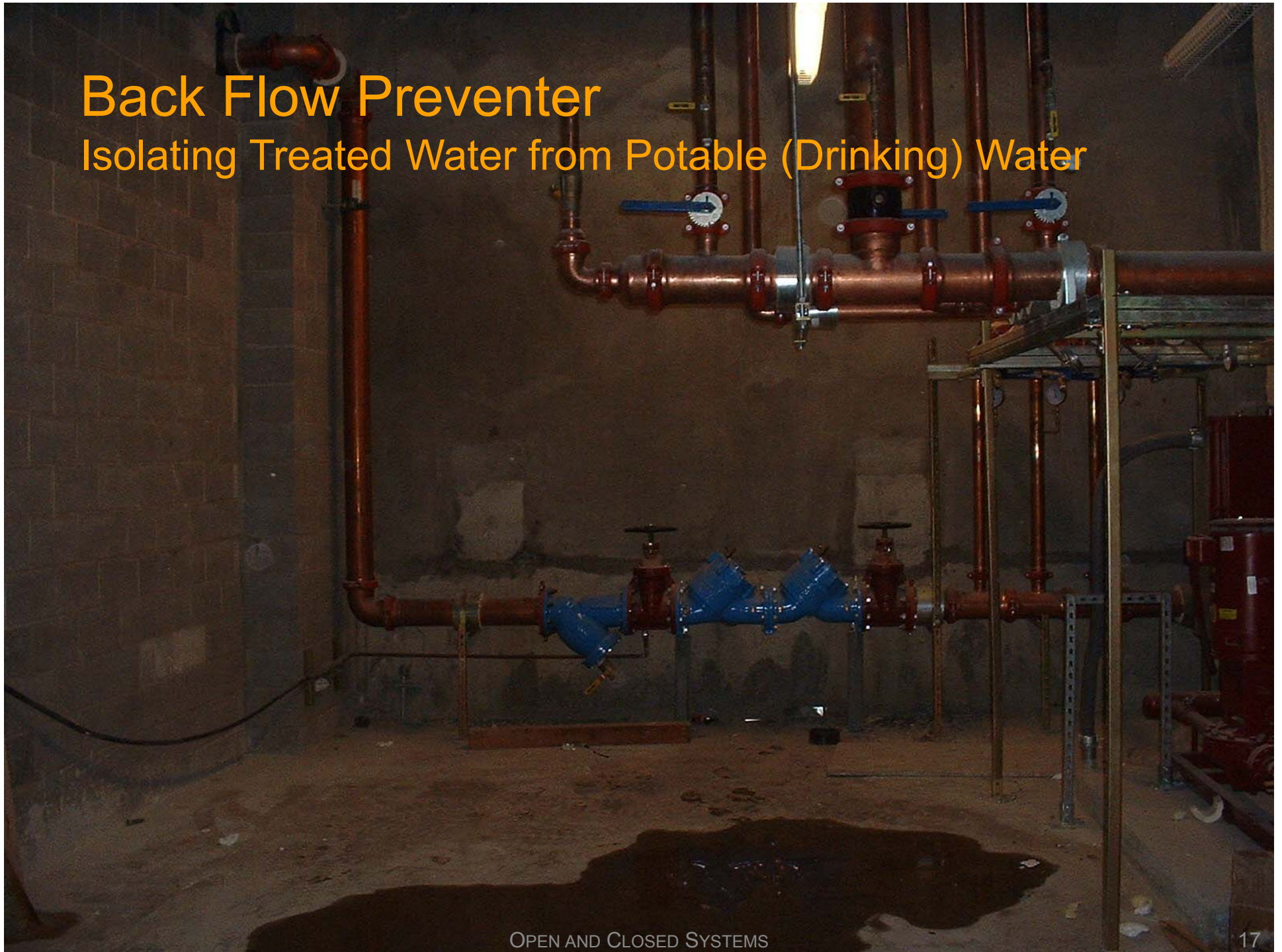
# Water Treatment via Shot Feeder





# Back Flow Preventer

## Isolating Treated Water from Potable (Drinking) Water



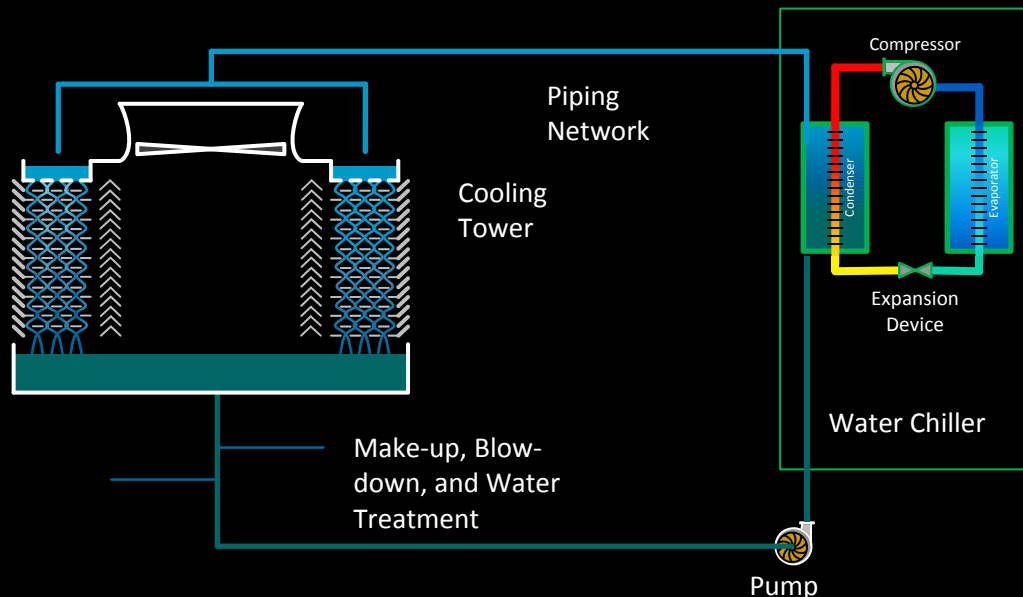


# Back Flow Preventer

## Isolating Treated Water from Potable (Drinking) Water



# Open Systems



- Water treatment requirements more significant
- Chilled and hot water systems can be open systems

- Interfaces are at the cooling tower return and supply points
  - Cold water typically connected to a sump or cold basin
  - Hot water distributed by spray nozzles or orifices in a “hot basin”
- Pump head must lift the water between the basins
- Make-up requirements more significant
  - Evaporation
  - Blow-down



# Water Treatment





# Side Stream Filtration



# Cooling Tower Make-up Piping and Meter





# Cooling Tower Blow-down Piping and Meter

# Cooling Tower Opportunity

[http://youtu.be/EVtO-y\\_NKN8](http://youtu.be/EVtO-y_NKN8)

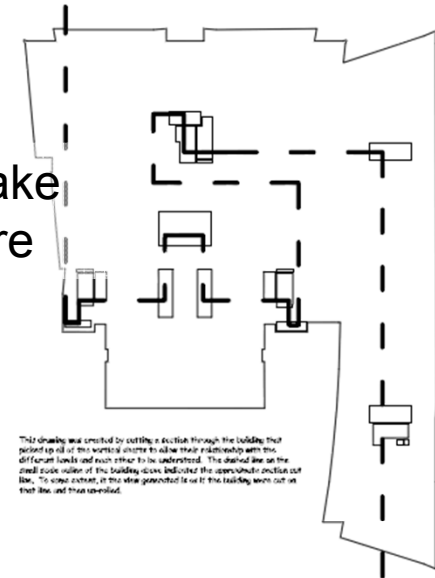


are here

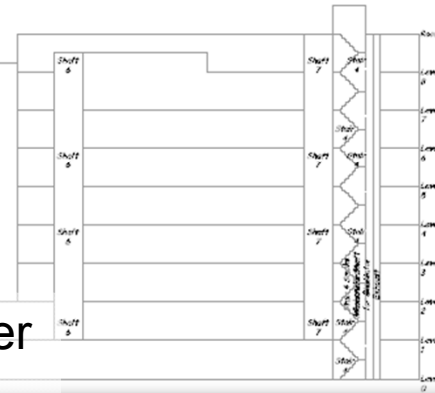
# Cooling towers and make up connections are here

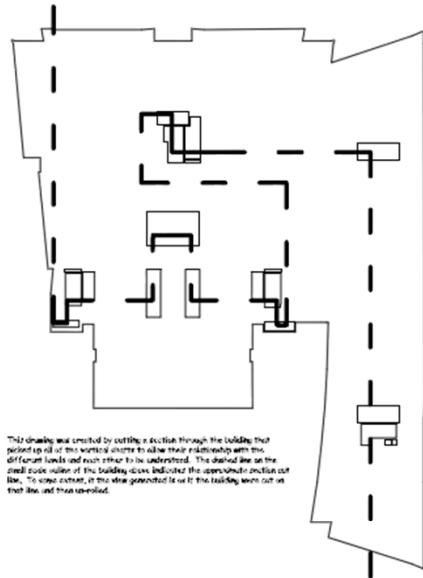
Piping mains run up and down this chase

Chillers, pumps, and chilled water make up connection here

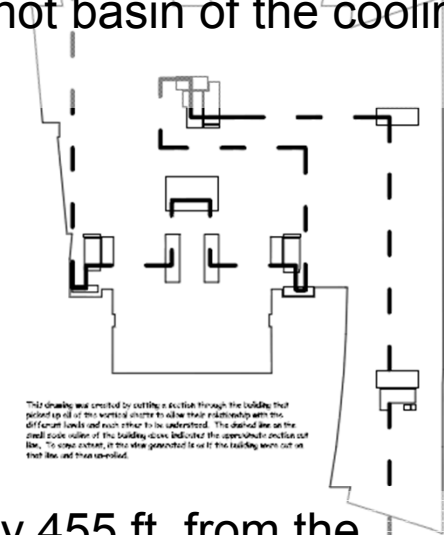


This drawing was created by cutting a section through the building that passed up all of the vertical stairs to allow their relationship with the different levels and each other to be understood. The dashed line on the small scale outline of the building above indicated the approximate section cut line. To some extent, it is the view generated if we if the building were cut on that line and then unrolled.





Approximately 15 ft. from the cold basin to the hot basin of the cooling towers



Approximately 455 ft. from the lowest point in the CW system to the cold basins of the cooling towers

