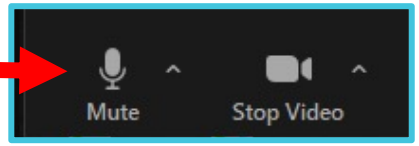
Using Zoom!

Mute yourself! Have a question? Use the chat feature.

Controls accessed at the bottom

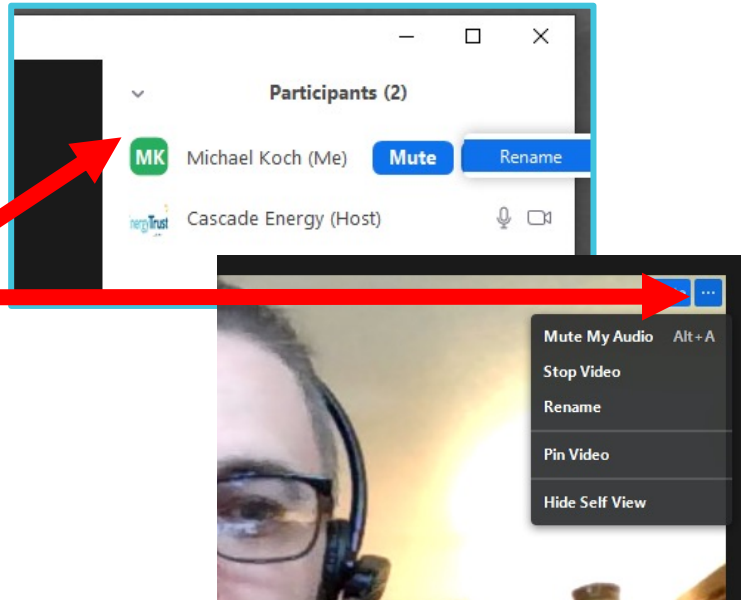


Rename yourself: "Name (Company)"

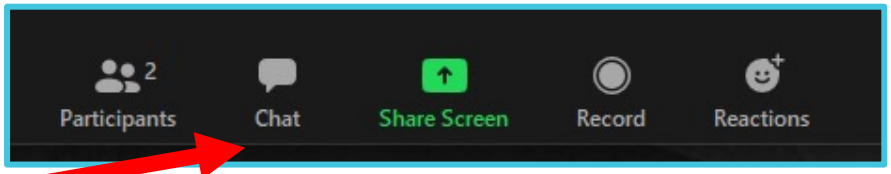
Right click on your picture or 3 dots

OR

Controls accessed at the right after clicking 'Participants' at bottom.



Access Chat at the bottom



This session will be recorded for those not in attendance!

Better Plants
U.S. DEPARTMENT OF ENERGY

REFRIGERATION SYSTEM VIRTUAL IN-PLANT TRAINING

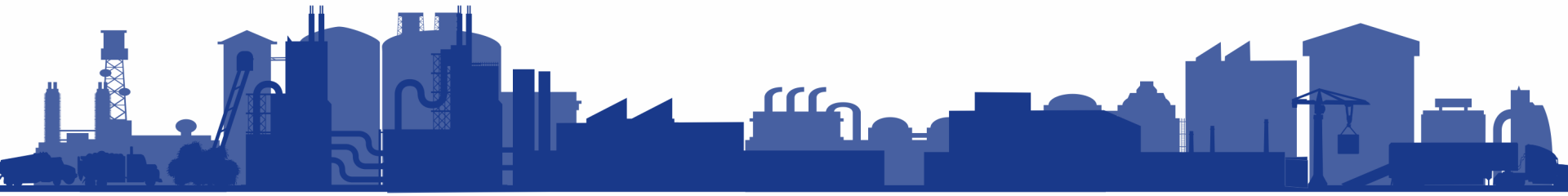
SESSION 4 – JAN 31, 2023

U.S. DEPARTMENT OF ENERGY

Energy Opportunity Poll

1. Evaporative condensers drive towards ___ bulb temperature.
2. If you know dry bulb temp and relative humidity, how could you find wet bulb temp?
3. A condenser pump down in the compressor room is called a _____ pump.
4. How could you save energy on a throttled condenser pump?
5. True or False: Acid treating condensers for scale removal is risk free and highly successful.
6. A system with 70°F liquid from the condensers at 135 psig head pressure has about ____ psi of air in the ammonia.
7. What could go wrong with a purger?
8. Who should do condenser inspections?

Session 4: Condensers Continued

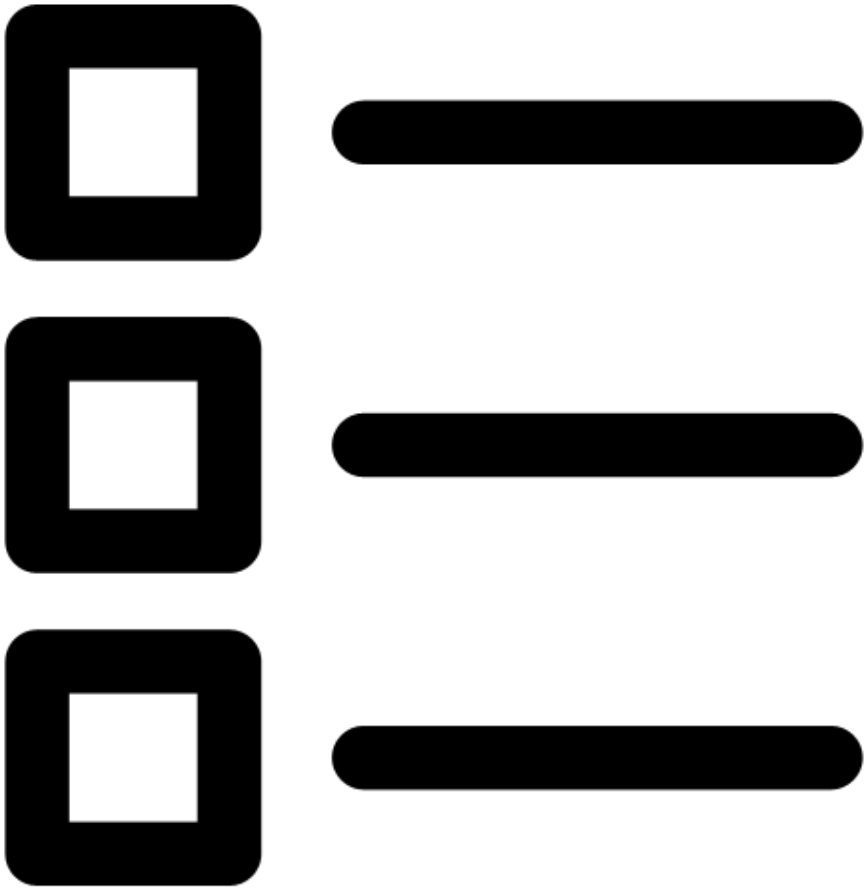


Today's Agenda – Session 4

- Condenser check sheet review
- Condensers capacity control

- Condenser/compressor energy balance
- Condensers tool introduction
- **Q & A**

Review Condenser Check Sheets



Condenser Efficiency Opportunity Flow

1. **Condenser Maintenance**—Ensure condensers are operating at peak performance to reduce condenser approach.

2. ***Condenser Capacity Control—Ensure condensers are operating efficiently at part-load conditions.***

3. **Condenser/Compressor Energy Balance**—Ensure condensing pressure settings are set to minimize total compressor and condenser power.

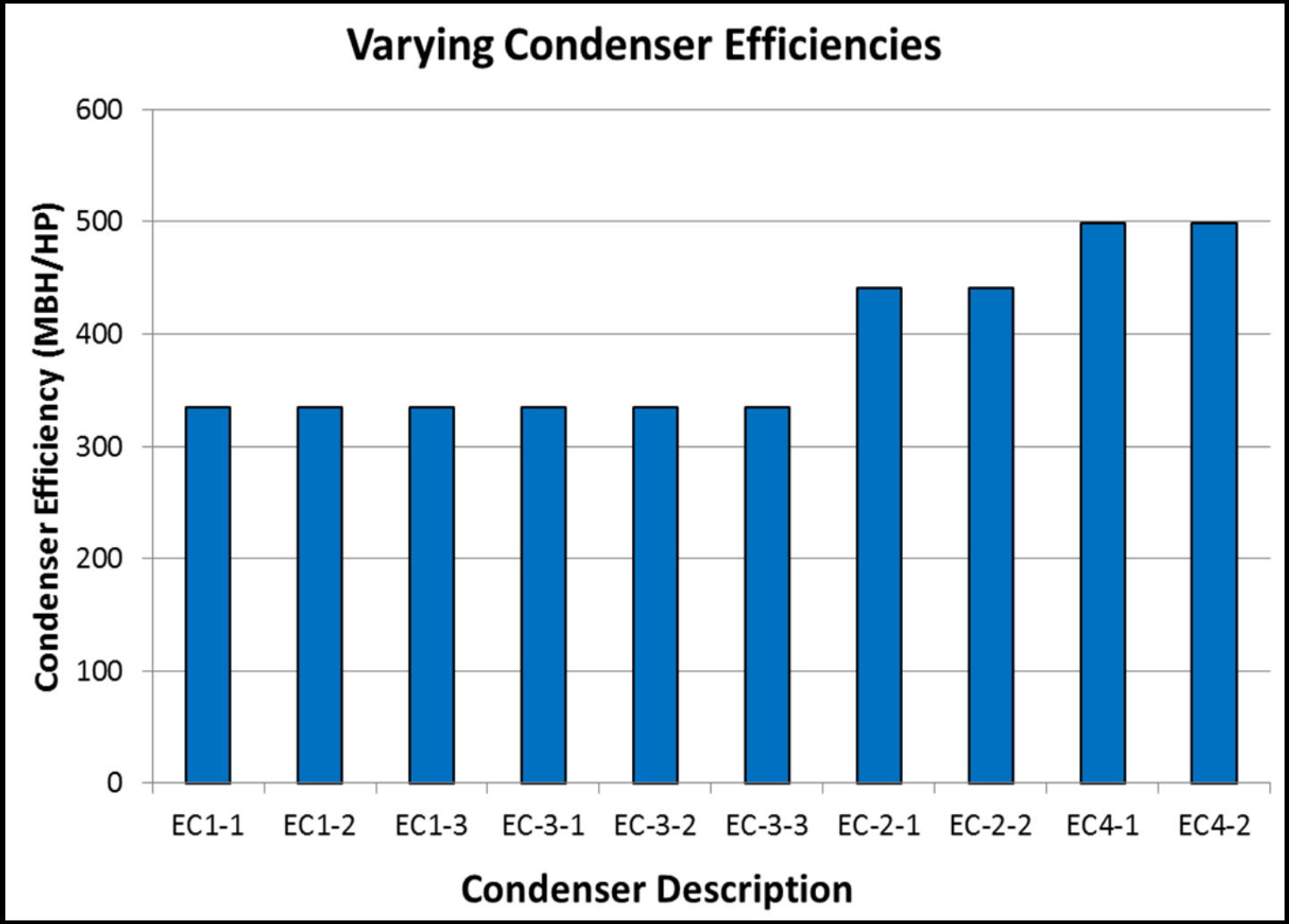
Calibration—Do Controls Tell the Truth?

Resolve Ambient Temp/ Humidity Measurement Issues

Don’t Place Instruments Here!

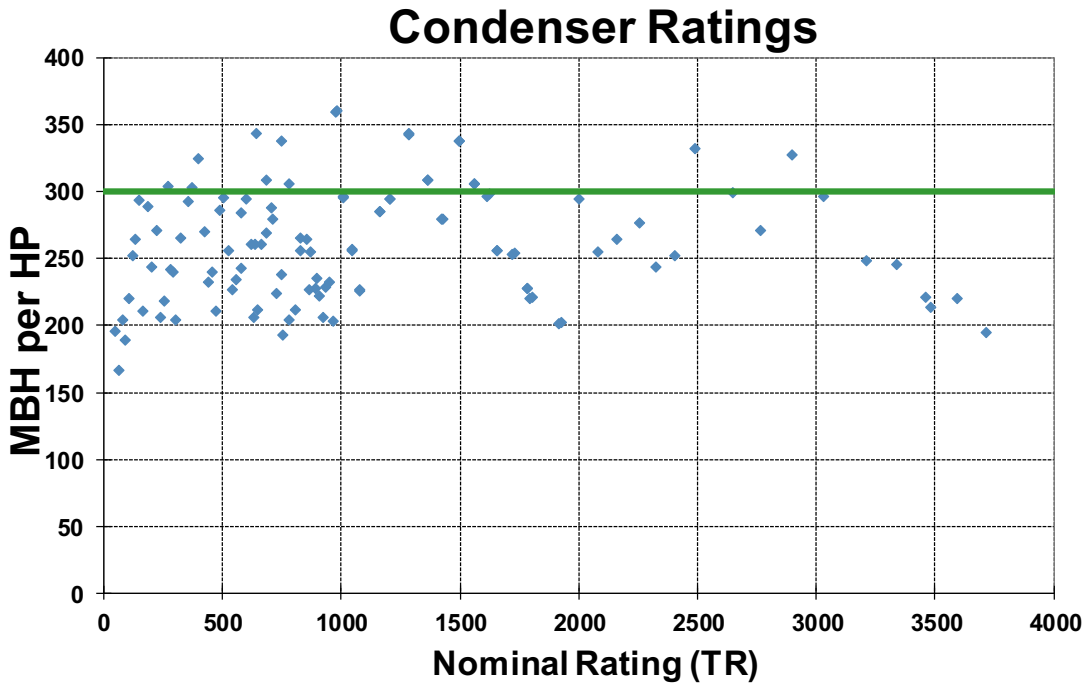
Outside Temperature Important for Pump Control

Condenser Staging



Condenser Selection

- Select efficient condensers, high MBH per hp.
- Use more surface area and less air flow (hp) to reject heat.
- Have bigger tube bundles, heavier, and more expensive.



VFD Application

Constant Torque (Compressors)

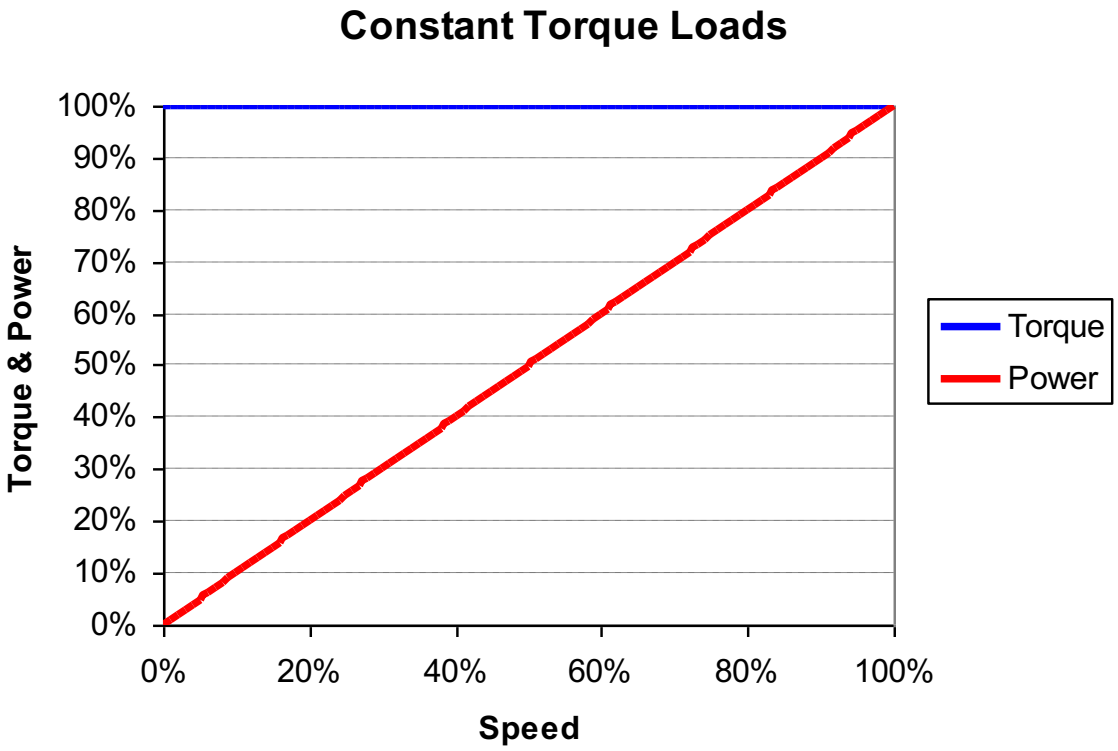
vs.

Variable Torque (Pumps and Fans)

VFD: Constant Torque Loads

Compressors

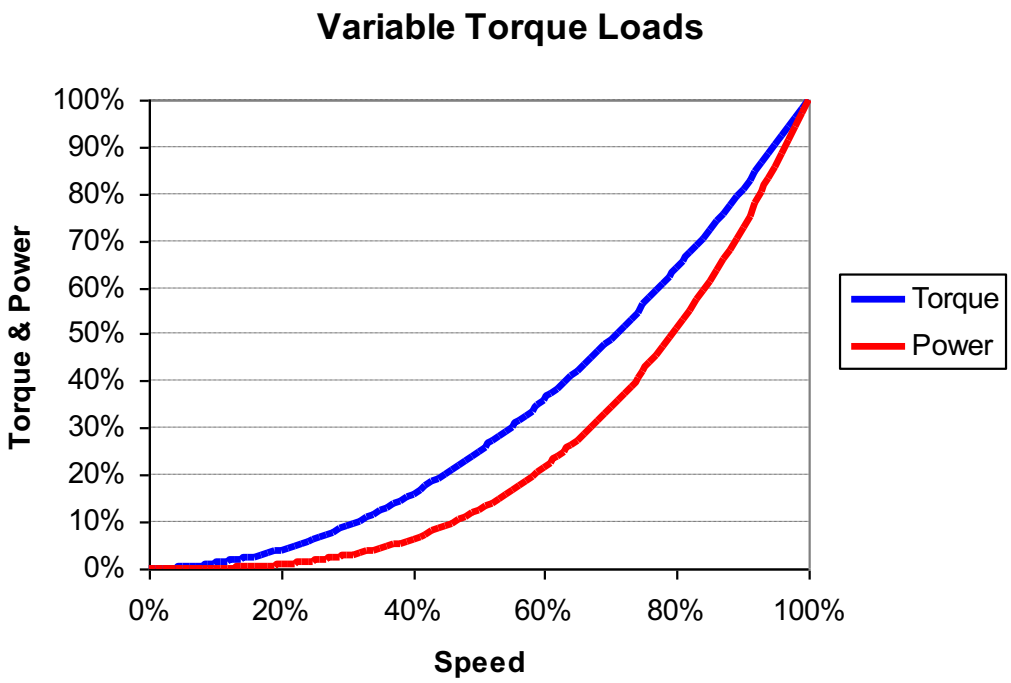
- Capacity ~ speed, power ~ speed
- Example at 50% speed: capacity and power are about 50%



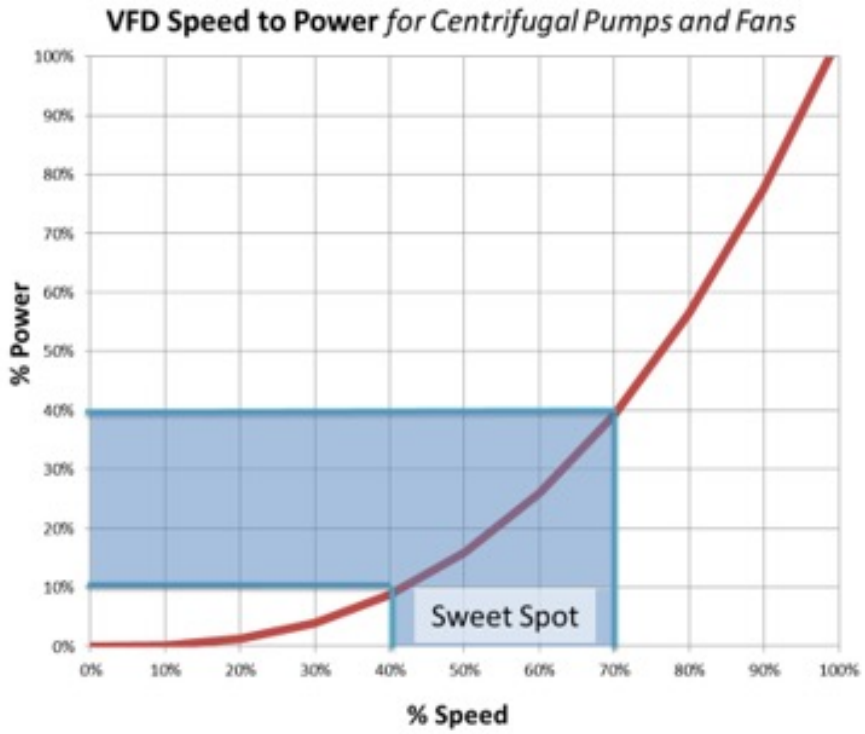
VFD: Variable Torque Loads

Fans

- Follow “affinity” or “cubic” law
- Capacity ~ speed, power ~ speed^3
- Example at 50% speed: capacity is 50%, power is 12.5%



Condenser Fan VFDs



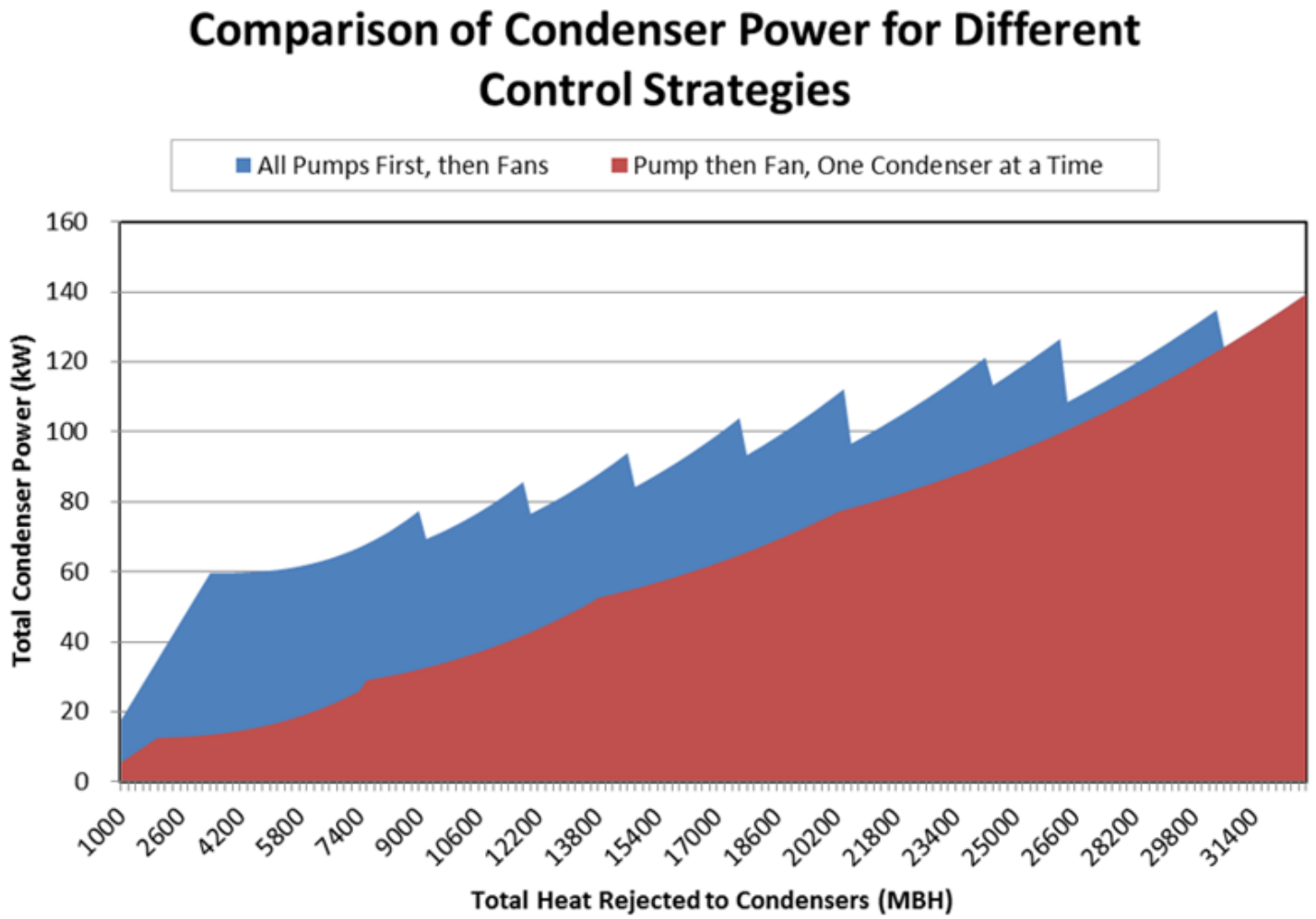
1. What % condenser fan power at 90% speed?
2. What % condenser fan power at 65% speed?
3. What % condenser fan power at 40% speed?
4. A fan draws 10 kW at 100% speed. What is the power at 55% speed?

IMPORTANCE OF GROUPED FAN CONTROL

Operate a group of condensers wet, with the fans running in the highly efficient mid-range speeds. This means operating multiple VFD-driven condensers at the same speed.

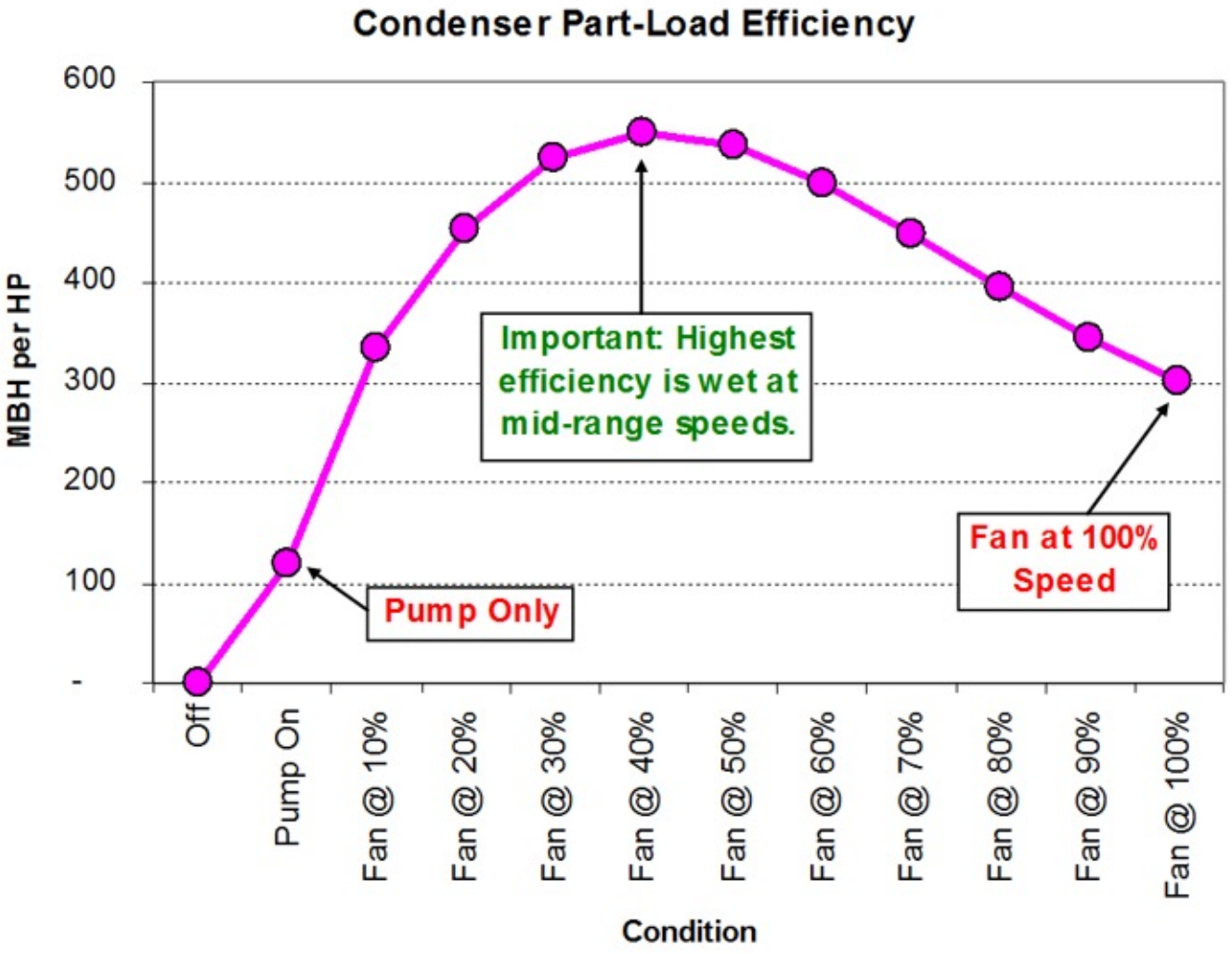
THE IMPORTANCE OF PUMP-FAN-PUMP-FAN CONDENSER SEQUENCING

Avoid operating a condenser “wet” without running the fans, because condenser efficiency in this state is poor. Condenser inefficiency can be magnified when operating multiple, large remote sump pumps without running fans. The chart below shows total condenser power for two different condenser control strategies.

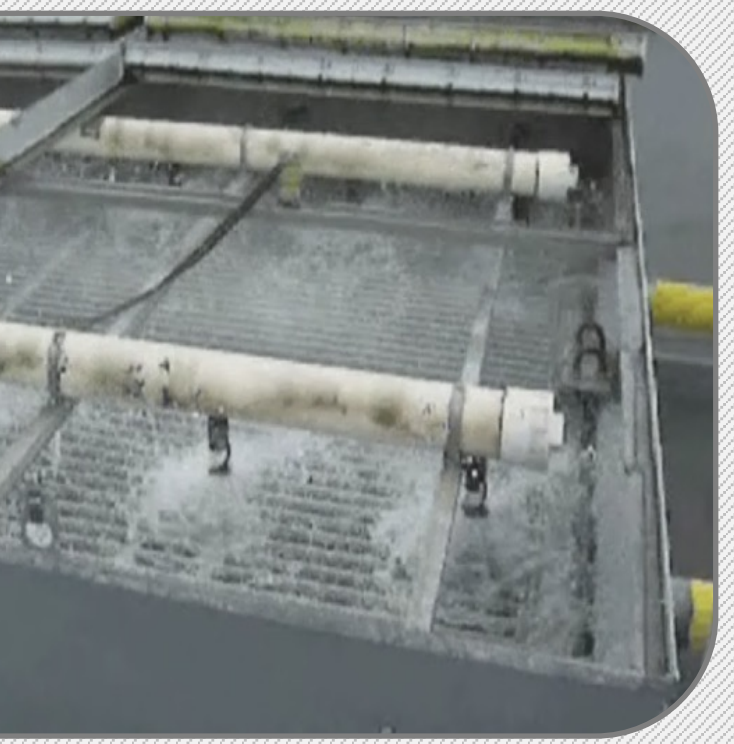


CONDENSER EFFICIENCY

The following chart shows condenser efficiency over the entire range of possible operation. Note that condenser efficiency peaks when the condenser is operating wet, with fans at mid-range speeds.



Condenser Capacity



What % condenser capacity results from running **pumps only**—no fans?

About 10%

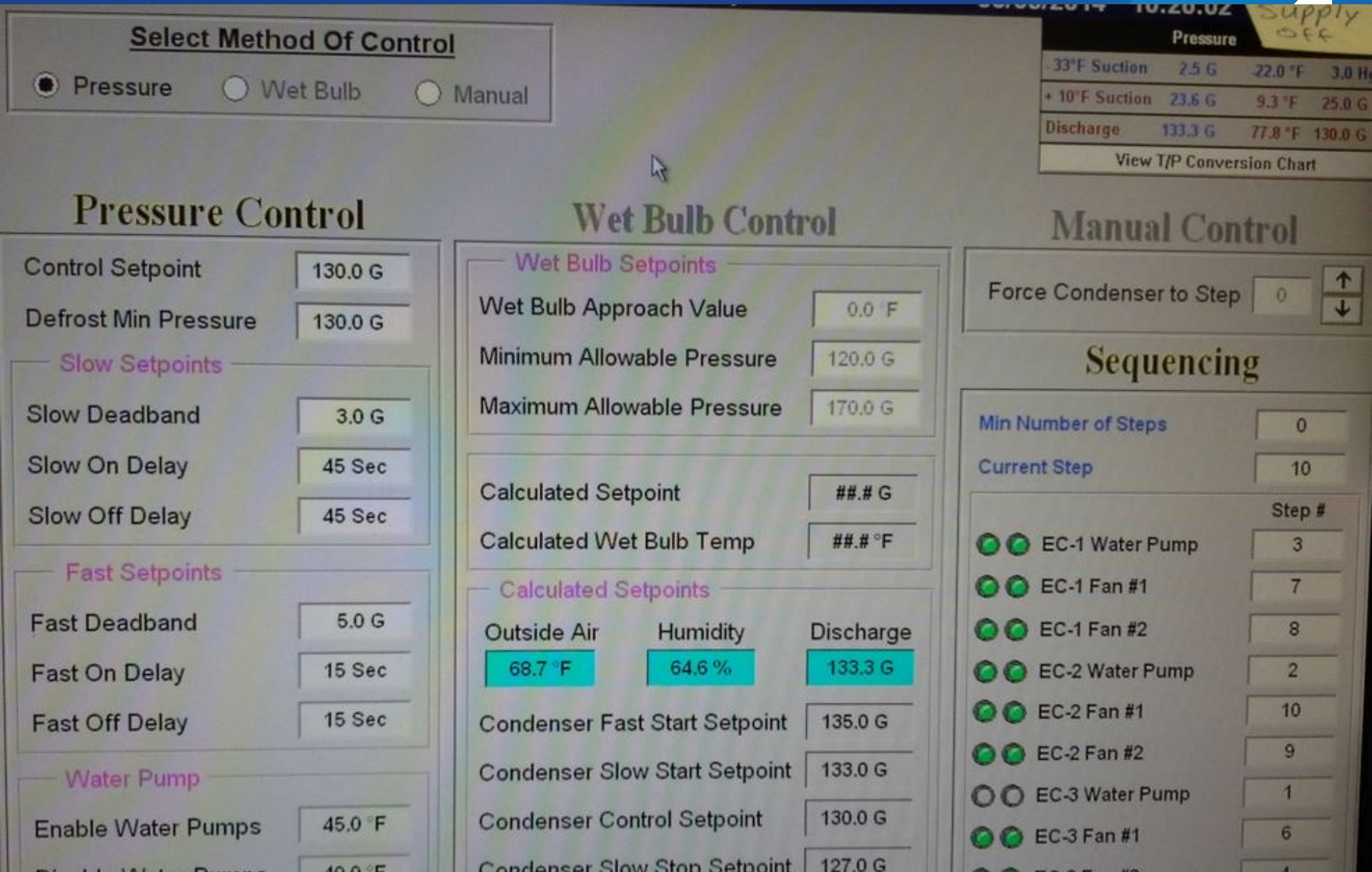
Condenser Sump and Pump Location

Pump Location:

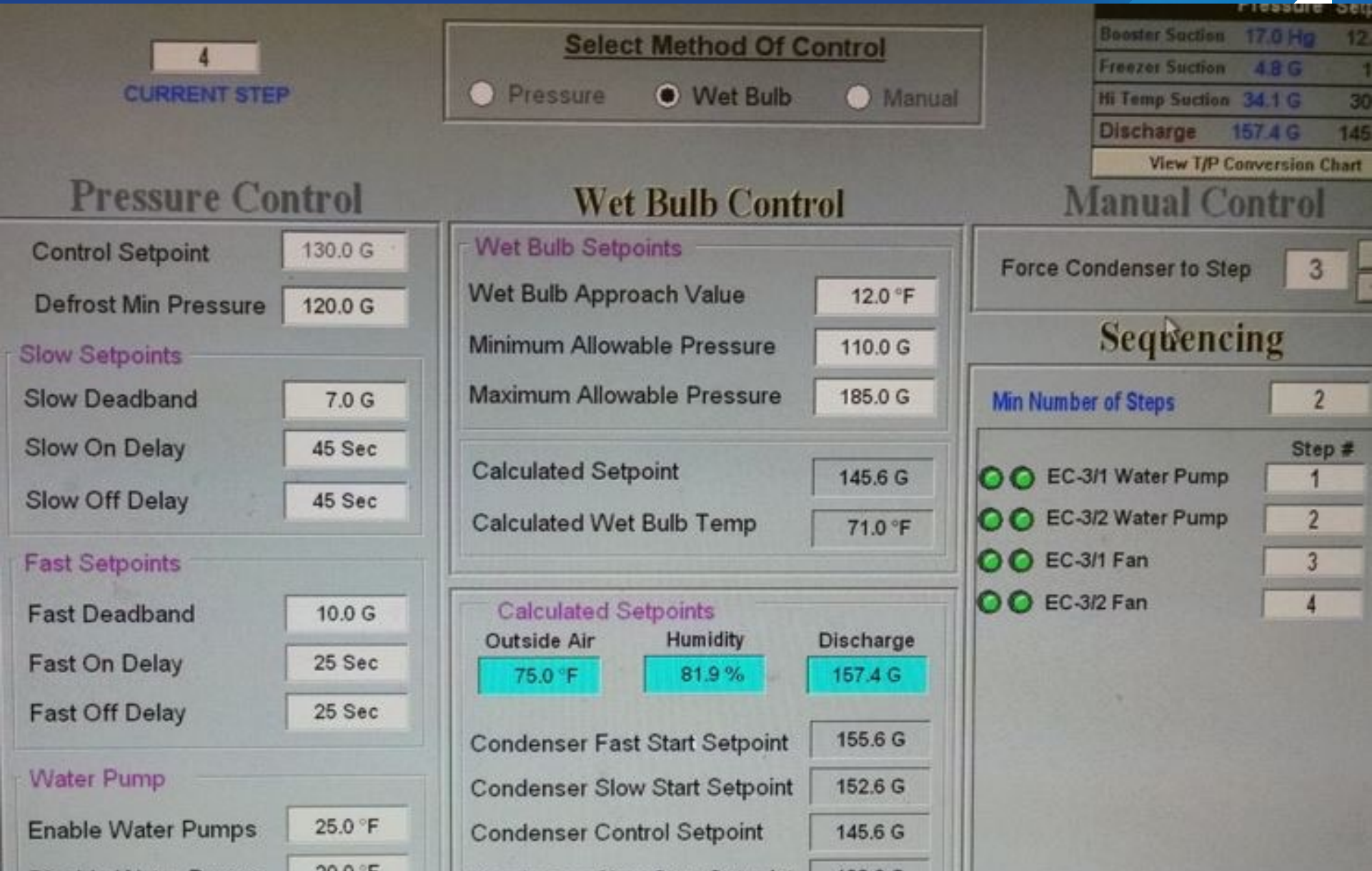
- Integral sumps (in condenser): Pump power is about 15%-20% of total condenser pump and fan power.

- Remote sumps (in compressor room): Pump power can be 35%-50% of total condenser power! *But still only give 10% capacity*

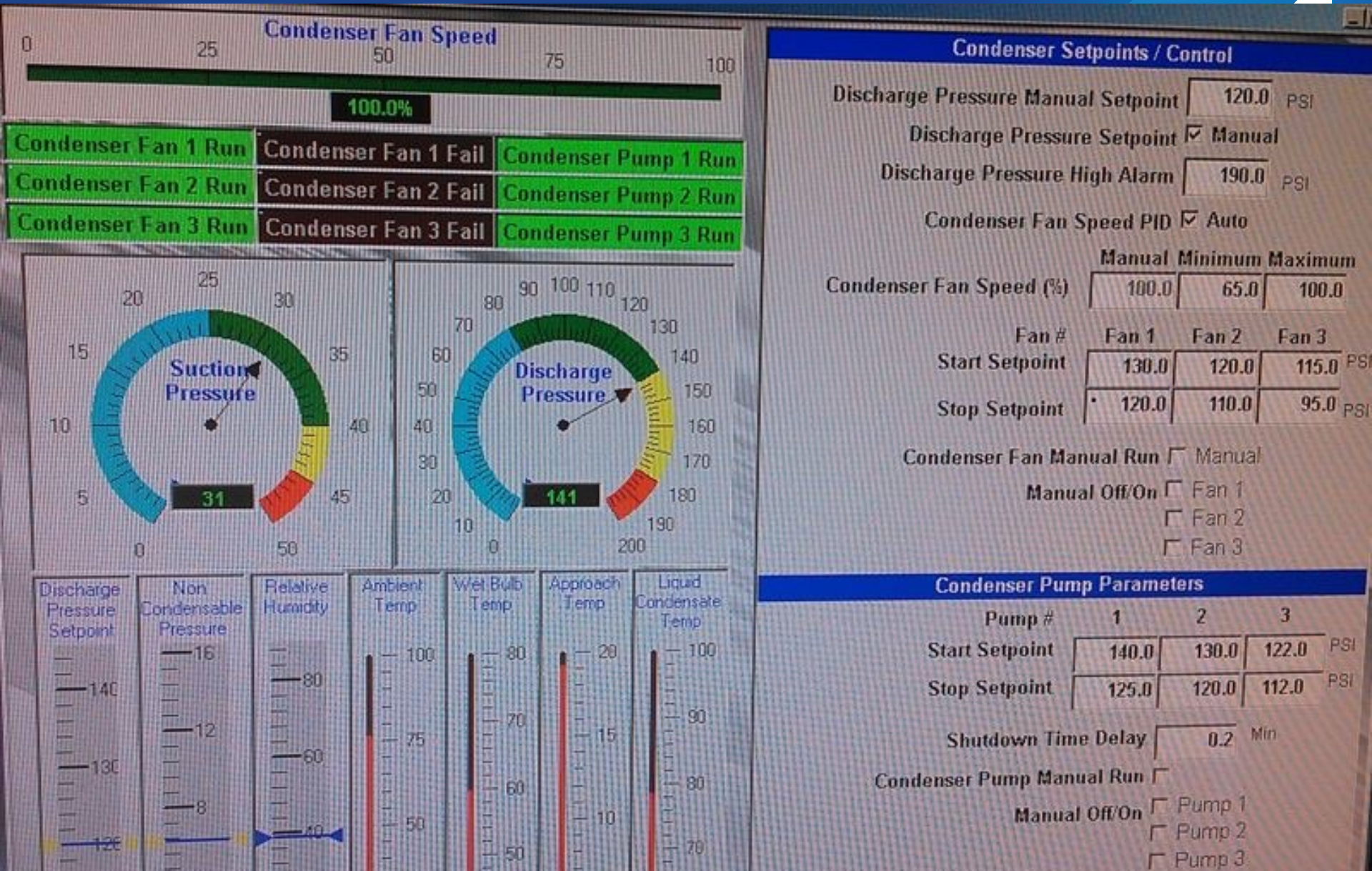
Find and Fix


Select Method Of Control
Pressure
Wet Bulb
Manual
Pressure
33°F Suction 2.5 G 22.0 °F 3.0
10°F Suction 23.6 G 9.3 °F 25.0 G
Discharge 133.3 G 77.8 °F 130.0 G
View T/P Conversion Chart
Pressure Control
Control Setpoint 130.0 G
Defrost Min Pressure 130.0 G
Slow Setpoints
Slow Deadband 3.0 G
Slow On Delay 45 Sec
Slow Off Delay 45 Sec
Fast Setpoints
Fast Deadband 5.0 G
Fast On Delay 15 Sec
Fast Off Delay 15 Sec
Water Pump
Enable Water Pumps 45.0 °F
Wet Bulb Control
Wet Bulb Setpoints
Wet Bulb Approach Value 0.0 °F
Minimum Allowable Pressure 120.0 G
Maximum Allowable Pressure 170.0 G
Calculated Setpoint ##.# G
Calculated Wet Bulb Temp ##.# °F
Calculated Setpoints
Outside Air 68.7 °F
Humidity 64.6 %
Discharge 133.3 G
Condenser Fast Start Setpoint 135.0 G
Condenser Slow Start Setpoint 133.0 G
Condenser Control Setpoint 130.0 G
Manual Control
Force Condenser to Step 0
Sequencing
Min Number of Steps 0
Current Step 10
Step #
EC-1 Water Pump 3
EC-1 Fan #1 7
EC-1 Fan #2 8
EC-2 Water Pump 2
EC-2 Fan #1 10
EC-2 Fan #2 9
EC-3 Water Pump 1
EC-3 Fan #1 6

Find and Fix


4
CURRENT STEP
Select Method Of Control
Pressure
Wet Bulb
Manual
Booster Suction 17.0 Hg
Freezer Suction 4.8 G
Hi Temp Suction 34.1 G
Discharge 157.4 G
View T/P Conversion Chart
Pressure Control
Control Setpoint 130.0 G
Defrost Min Pressure 120.0 G
Slow Setpoints
Slow Deadband 7.0 G
Slow On Delay 45 Sec
Slow Off Delay 45 Sec
Fast Setpoints
Fast Deadband 10.0 G
Fast On Delay 25 Sec
Fast Off Delay 25 Sec
Water Pump
Enable Water Pumps 25.0 °F
Wet Bulb Control
Wet Bulb Setpoints
Wet Bulb Approach Value 12.0 °F
Minimum Allowable Pressure 110.0 G
Maximum Allowable Pressure 185.0 G
Calculated Setpoint 145.6 G
Calculated Wet Bulb Temp 71.0 °F
Calculated Setpoints
Outside Air
Humidity
Discharge
75.0 °F
81.9 %
157.4 G
Condenser Fast Start Setpoint 155.6 G
Condenser Slow Start Setpoint 152.6 G
Condenser Control Setpoint 145.6 G
Manual Control
Force Condenser to Step 3
Sequencing
Min Number of Steps 2
Step #
EC-3/1 Water Pump 1
EC-3/2 Water Pump 2
EC-3/1 Fan 3
EC-3/2 Fan 4

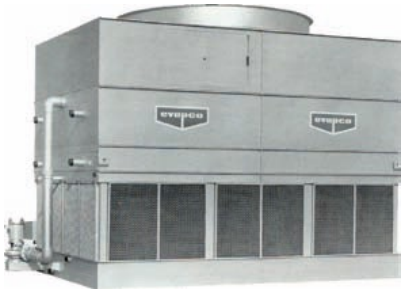
Find and Fix


Condenser Fan Speed
0
25
50
75
100
100.0%
Condenser Fan 1 Run
Condenser Fan 1 Fail
Condenser Pump 1 Run
Condenser Fan 2 Run
Condenser Fan 2 Fail
Condenser Pump 2 Run
Condenser Fan 3 Run
Condenser Fan 3 Fail
Condenser Pump 3 Run
Suction Pressure
31
Discharge Pressure
141
Discharge Pressure Setpoint
Non Condensable Pressure
Relative Humidity
Ambient Temp
Wet Bulb Temp
Approach Temp
Liquid Condensate Temp
Condenser Setpoints / Control
Discharge Pressure Manual Setpoint
120.0
PSI
Discharge Pressure Setpoint
Manual
Discharge Pressure High Alarm
190.0
PSI
Condenser Fan Speed PID
Auto
Manual
Minimum
Maximum
Condenser Fan Speed (%)
100.0
65.0
100.0
Fan #
Fan 1
Fan 2
Fan 3
Start Setpoint
130.0
120.0
115.0
PSI
Stop Setpoint
120.0
110.0
95.0
PSI
Condenser Fan Manual Run
Manual
Manual Off/On
Fan 1
Fan 2
Fan 3
Condenser Pump Parameters
Pump #
1
2
3
Start Setpoint
140.0
130.0
122.0
PSI
Stop Setpoint
125.0
120.0
112.0
PSI
Shutdown Time Delay
0.2
Min
Condenser Pump Manual Run
Manual Off/On
Pump 1
Pump 2
Pump 3

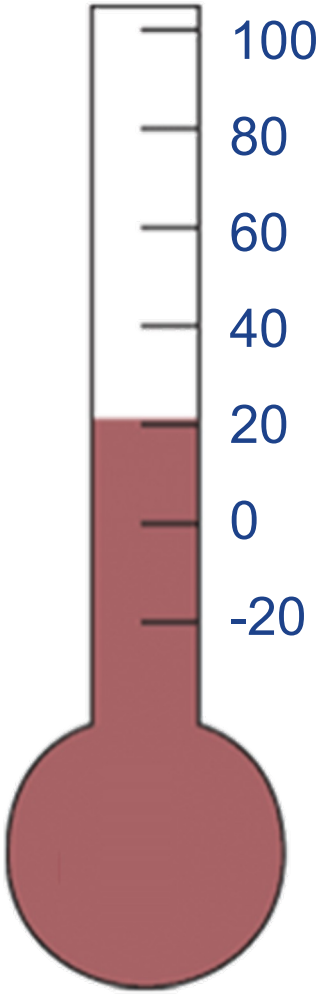
Condenser Efficiency Opportunity Flow

1. **Condenser Maintenance**—Ensure condensers are operating at peak performance to reduce condenser approach
2. **Condenser Capacity Control—**Ensure condensers are operating efficiently at part load conditions
3. ***Condenser/Compressor Energy Balance—Ensure condensing pressure settings minimize total compressor and condenser power***

Condensing Approach to Wet Bulb

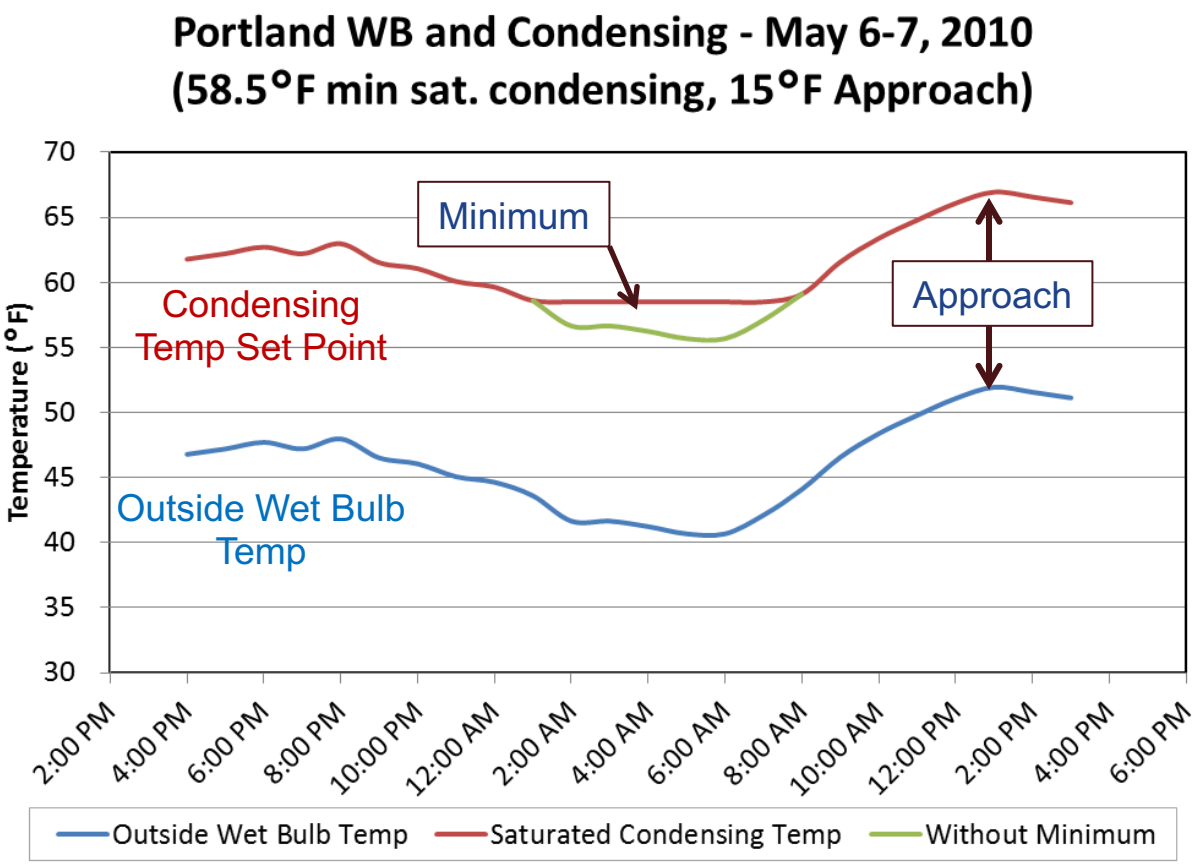


60°F Head



45°F WB

What is Wet Bulb Approach?



Wet Bulb Approach

Why use wet bulb approach (WBA) controls?

- The goal is to reduce total compressor and condenser power.
- Fixed setpoint controls use too much condenser power at times, and not enough at other times.
- WBA control keeps condenser power in line with compressor power.
- WBA reduces condenser power during periods of reduced load.

Wet Bulb Approach

Wet bulb approach settings:

- WBA control has the biggest benefit with VFD fans
- A common approach set point is 12°F, but varies from system to system

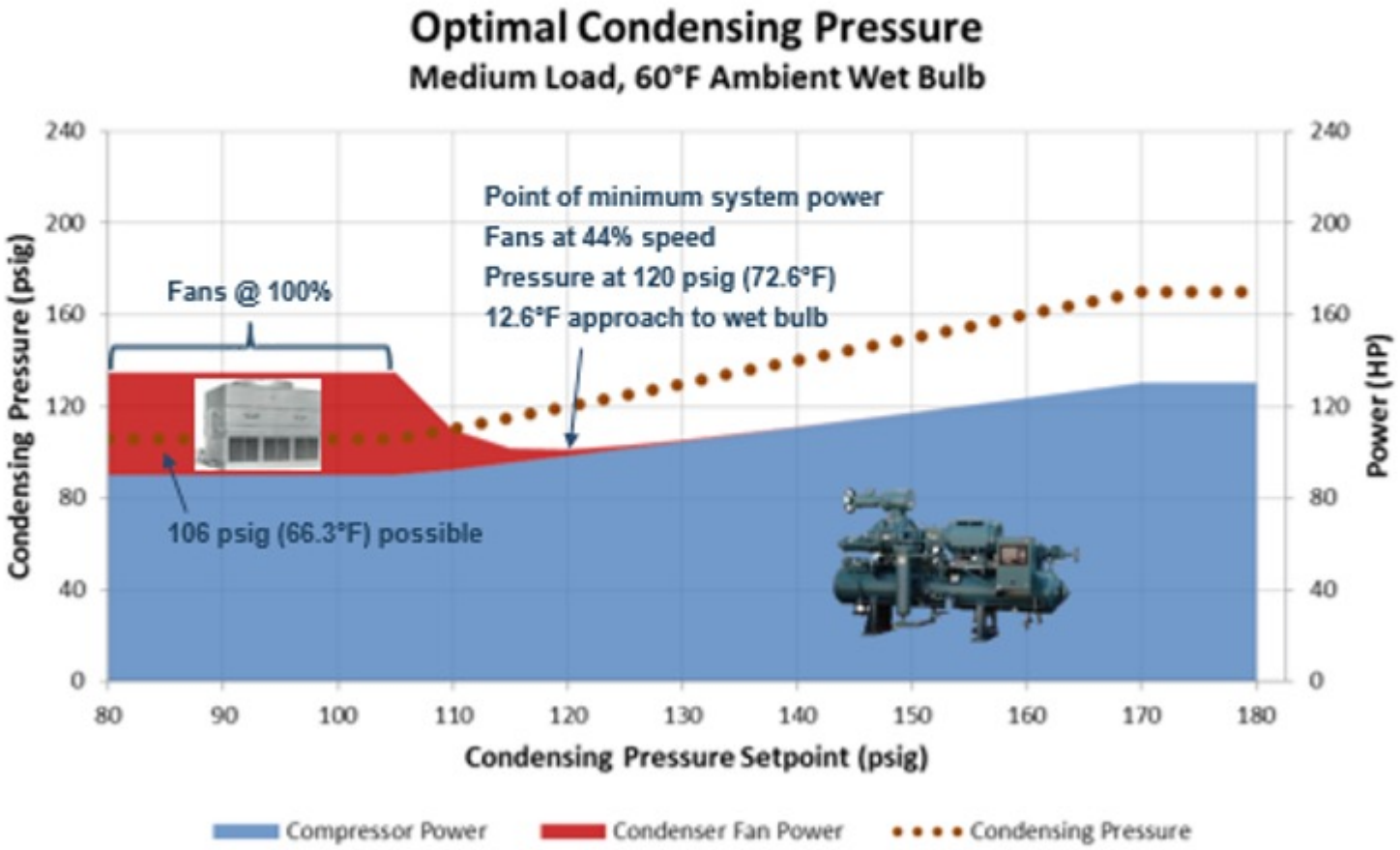
Example—Wet Bulb Approach

Given: 50°F wet bulb temperature, 12°F WBA setting

Find: Condensing set point in psig

COMPRESSOR/CONDENSER ENERGY BALANCE

The following graph shows the importance of finding the condensing pressure setpoint that will best balance compressor and condenser power.



Condenser Selection—Closer Approach to WB

- Old school = selecting condensers based on condensing 25°F above design wet bulb. I.E. 100°F (197 psig) condensing at 75°F wet bulb.

- New school = 15°F above design wet bulb. I.E. 90°F (166 psig) condensing at 75°F wet bulb.

1. The best place for the ambient temp and RH probe is _____.
2. Run the (most or least) efficient condensers first.
3. Compressors are (constant or variable) torque devices.
4. A compressor at 50% speed uses about ____% power.
5. Condenser fans are (constant or variable) torque devices.
6. A condenser fan at 50% speed uses about ____% power.
7. Running the pump only (fans off) gives about ____% condenser capacity.
8. What's wrong with running all pumps first (PPPFFF)?
9. What is more important: compressor power, condenser power, total comp and cond power?

Survey

- How is DOE INPLT going for you so far?
- Tom will post a link to the survey in the chat window.
- Please hit the survey, then take a LOOONG break.

https://bit.ly/3oVDjxC

BREAK

Review—Top Condenser Action Items

- Optimize condensing pressure
- Optimize water delivery (pumps and nozzles)
- Run the most efficient condenser first
- Check part-load performance
- Revisit water treatment
- Remove non-condensables/troubleshoot purger
- Resolve ambient temp/humidity measurement issues
- Optimize operation for cold weather
- Adjust fan belt tension properly
- Correct piping issues

Next Steps

- Continue developing your list of energy saving opportunities!

- Talk with your team about what to focus on first.
  - Any top priorities? What can you get done now?

Stick around after this to ask questions for Steve and our team!

Go to kahoot.it

Kahoot!

Join from your phone

Open for Questions!

- Unmute yourself and ask away
- Send a chat
- Email: steve.koski@cascadeenergy.com