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Glossary

ACH	Air changes per hour.
Actual demand	The amount of demand registered on your electric meter. Use this amount to evaluate the power requirements and load factor of your facility.
Air handling unit	Equipment used to condition and circulate air as part of a heating, ventilating, and air-conditioning (HVAC) system.
Automatic setback	Widely used control strategy in which the system is cycled off during unoccupied (night and weekend) hours, and the temperature in each zone is allowed to drift away from the occupied setpoint.
BAS	A Building Automation System is a network of sensors, controls, switches, relays, and other electronic devices designed to allow communication of building automation and control systems for applications such as heating, ventilating, and air-conditioning control, lighting control, access control, and fire detection systems and their associated equipment.
Building Operations Map	A document that contains major energy-using systems and occupancy types by area and examines current conditions and building uses. It is used to identify ways to optimize setpoints and equipment scheduling to achieve efficiency improvements, with the end goal of precisely matching energy systems to actual consumption.
Billing demand	The amount of demand for which you are billed on your electric utility's bill. This is usually either equal to the Actual Demand, or the Ratchet Demand, whichever is larger.
BTU	British thermal unit. The amount of energy it takes to raise one pound of water one degree Fahrenheit.

Approximately the amount of energy released by completely burning a wooden kitchen match.

CFM

Cubic feet per minute. Fan capacity is measured in terms of the cubic feet. The amount of air a fan moves depends on the diameter and shape of the blades, speed at which the blades turn (revolutions per minute or rpm), horsepower (hp) of the motor, and overall fan design. These factors determine the air moving capacity of a fan. $CFM = \text{air speed (feet per minute)} \times \text{area (square feet)}$.

Data logger

Small electronic instrument that records measurements over time.

Data trending

Repeated measurements over time used to track changing trends.

Data visualization

Graphical representation of data.

Demand charge

Electric utility charge for commercial customers that reflects their share of the utility's generation, transmission, and distribution capacity. Based on customer's maximum or peak rate of using energy.

Discharge air

Conditioned supply air that is forced into the occupied space through a register or vent.

EUI

An **Energy Use Index** is a representation of annual energy usage per square foot of a facility or energy consumed by individual pieces of equipment. May appear in any basic or common unit (i.e. kWh/ft², BTU/ft², therms/ft²).

KWh

Kilowatt-hours. One thousand Watt-hours. A Watt-hour is the total energy consumed by using energy at a rate of one Watt for a period of one hour.

KW

Kilowatt. One thousand Watts. A Watt is a rate of consumption of useful electrical energy.

Mixed air

The air distribution system can include a return air system so that conditioned supply air is returned to the AHU where it is mixed with supply air, re-

filtered, re-conditioned, and re-circulated throughout the building.

OSA

Outside air temperature.

Outdoor air

Outside air that is drawn into a building's HVAC system through the air intake by the air handling unit (AHU).

Relative humidity

The percentage of humidity in the air.

Return air

Conditioned outside/supply air that is drawn from the occupied space by ducted returns or plenum returns and is then returned to the air-handling unit by ductwork or structural conduits.

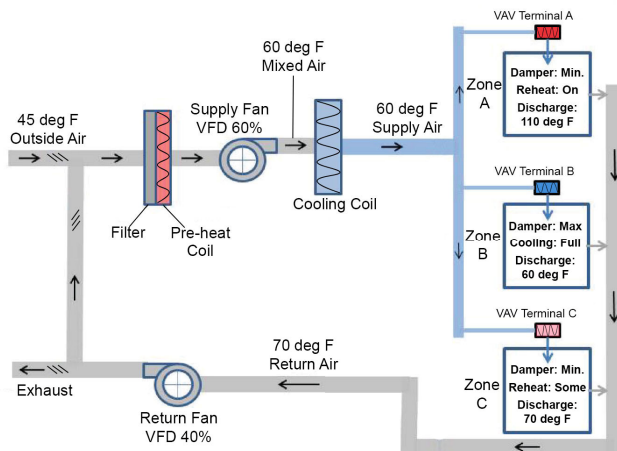
Therm

100,000 BTUs. Most often used as a unit of natural gas consumption.

Variable Air Volume (VAV)

Air handling system that conditions the air to constant temperature and varies the outside airflow to ensure thermal comfort. Air flow is varied to match heating and cooling loads.

HVAC Systems: VAV with Reheat **Answer**

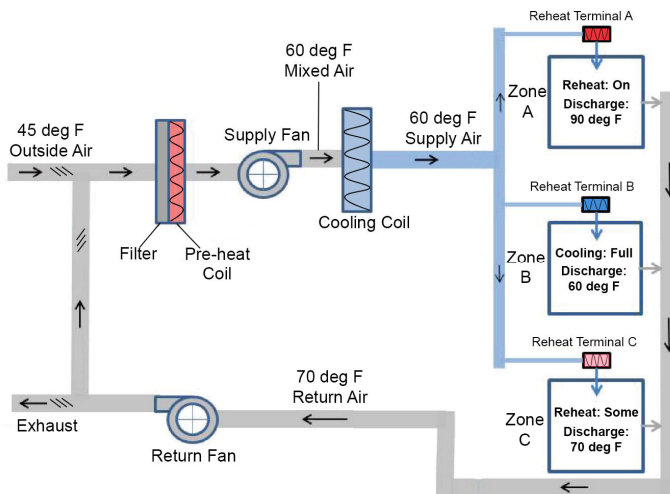


The central fan supplies cool air to the VAV boxes, and the VAV boxes modulate flow as needed to cool the space. When heating is needed, the VAV boxes reduce flow to minimum and use the reheat coil to control discharge temperature.

Question: If the primary SAT were fixed at 55 °F (instead of reset to 60 °F), would the heating energy for Zones A and C increase or decrease?

In this example, if the primary SAT were fixed at 55 °F (instead of reset to 60 °F) the heating energy for Zone A and Zone C would increase.

HVAC Systems: Constant Volume with Reheat Answer



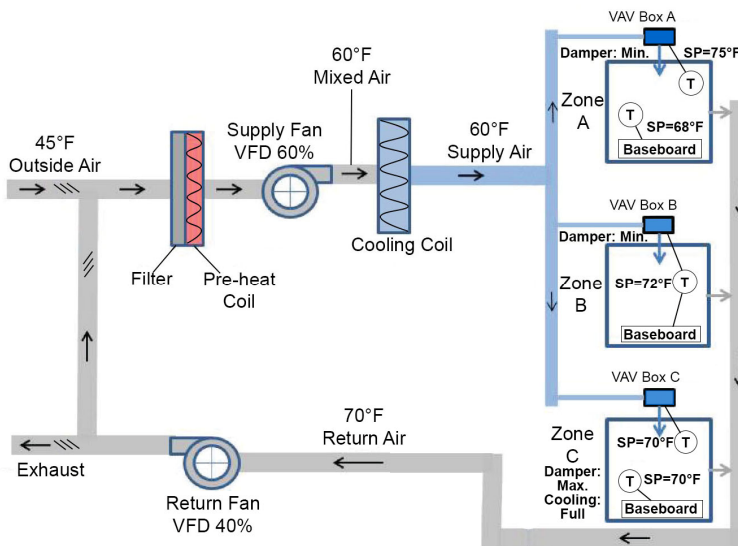
The central fan supplies cool air to the reheat boxes, and the reheat coil is used to control discharge temperature. CV fan systems with reheat are generally no longer allowed in new construction because of their high energy use.

Question: In the scenario described below, how much cooling is needed from the cooling coil and why?

No cooling is required by the cooling coil because the economizer is modulating to produce air that matches the setpoint temperature for the supply air.

HVAC Systems: Central AC with Perimeter Heating

Answer



The central AC in this example is a VAV system with no reheat, and the perimeter heating is baseboard. The areas served by the VAV and baseboard are open to each other. The VAV system provides ventilation and cooling, while the baseboard offsets heat loss from the building shell when needed. There are many variations of this layout that use different cooling or heating equipment, but they all produce simultaneous heating and cooling along the air border between the perimeter and interior spaces.

In Zone A, the baseboard and VAV box use separate space-temperature sensors and have setpoints that should prevent or minimize simultaneous heating and cooling.

In Zone B, the VAV box and baseboard use the same sensor, and a DDC system would control the VAV box and baseboard to prevent simultaneous heating and cooling. Hunting between heating and cooling would be prevented if a proper deadband and throttling range are programmed.

In Zone C, the baseboard and VAV box use separate space-temperature sensors and have setpoints that would cause simultaneous heating and cooling. Each thermostat is set to 70 °F causing overlap in the throttling range between heating and cooling. Even if the cooling thermostat is set to 72 °F and heating thermostat is set to 70 °F, there is little tolerance for throttling range or sensor calibration error.

Answers to: Check your knowledge questions



Question #1 – answer is B.

Question #2 – answer is A.

Question #3 – answer is D.

Question #1 – answer is B.

This may be caused by improper outdoor air temperature sensor location, failed sensor, or jammed damper blades.

Question #2 – answer is A.

Demand control ventilation saves energy by adjusting the amount of outside air based upon number of occupants in space by measuring CO₂ levels.

Question #3 – answer is D.

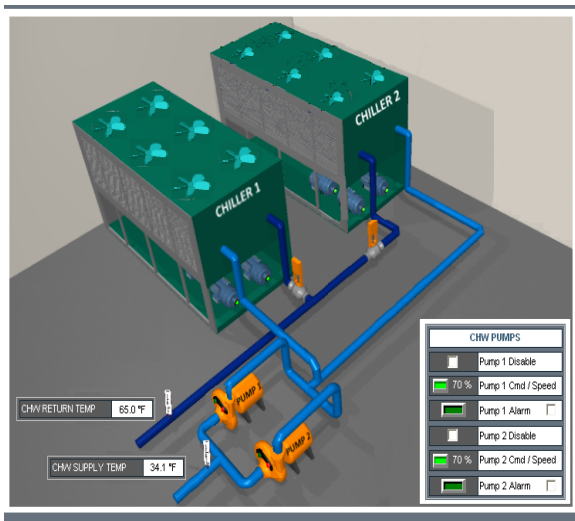
Data loggers are ideal for (“all of the above”): identifying anomalies and unnecessary energy use, identifying sources of problems (i.e., stuck dampers, faulty sensors), and determining EUIs for end-use equipment.

Class Activity: Central Plant BAS Review

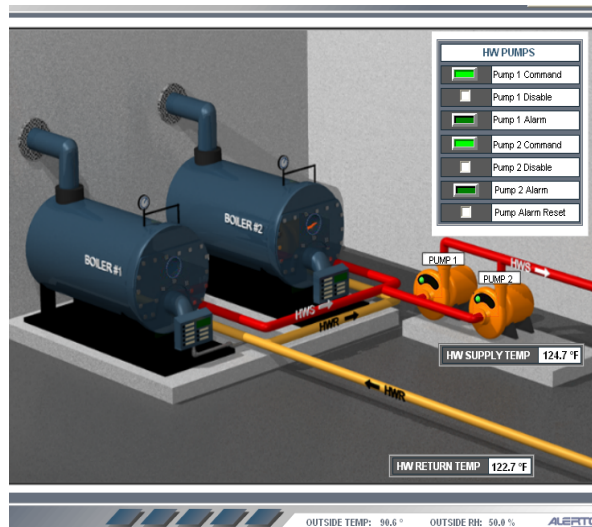
Answers



BAS Screen Shot: Chiller Plant



BAS Screen Shot: Boiler Plant



1. What are the operational issues/problems for this facility?

- *Low chilled water supply temperature setpoint*
- *Both chilled water pumps may be operating unnecessarily.*
- *High boiler lockout temperature*
- *Possible too low chiller lockout, or no lockout (shouldn't operate all year)*
- *One degree separation between heating/cooling setpoints*
- *Heating setpoint higher than cooling*
- *Economizer fully open with high OAT*
- *CO₂ sensors are not reading correctly*
- *Only 2 degree delta between HW supply and return (excess flow symptom).*

2. How is energy being wasted?

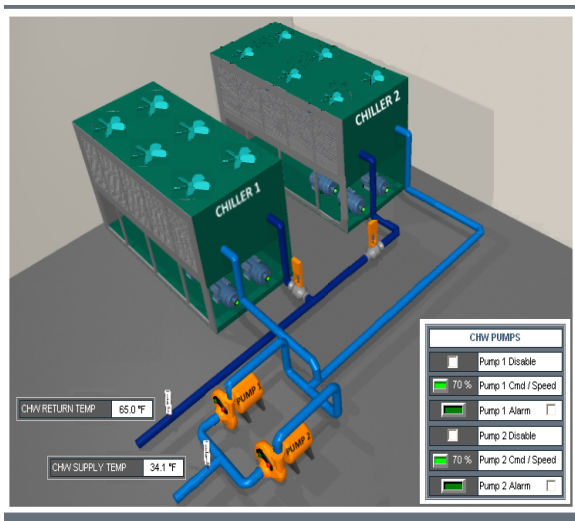
- *Excess flow/unnecessary pump energy*
- *Boilers enabled all year long (heating possible all year round)*
- *Simultaneous heating and cooling with one degree separation between heating/cooling setpoints*
- *Demand Controlled Ventilation (DCV) control logic will sense spaces more densely occupied with falsely high CO₂ level and will provide more ventilation air than what is required.*
- *Electric lighting in stairwell on when not needed*
- *Economizer bringing in 90°F air. This air will need to be cooled before being supplied to the spaces.*
- *Chiller on in cool weather when economizer should provide cooling.*

Class Activity: Central Plant BAS Review

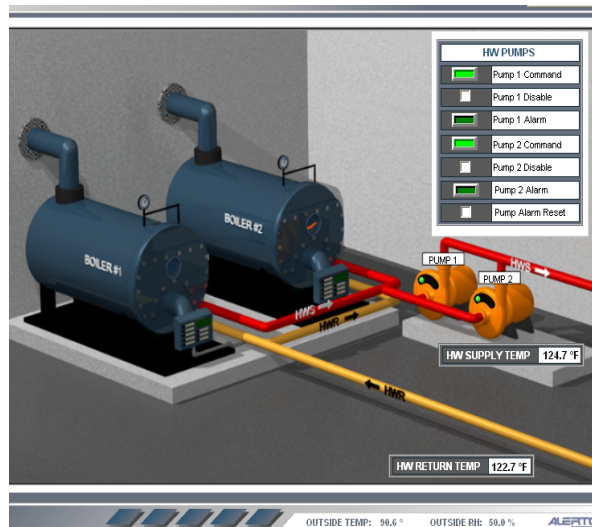
Answers



BAS Screen Shot: Chiller Plant



BAS Screen Shot: Boiler Plant



3. What are possible causes for each of the observed conditions?

- *Control logic/setpoints not optimized*
- *Boiler lockout temperature too high*
- *CO₂ sensors out of calibration*
- *Critical control sensors not calibrated (OST, MAT, RAT)*
- *Daylighting controls not functioning/not installed*
- *No chiller lockout*
- *Economizer controller failed or not programmed correctly*
- *Chiller possibly needed for data center or other process (not a problem but a cause).*

4. What are the no-cost/low-cost opportunities for operational improvement for this facility?

- *Increase chilled water supply temperature*
- *Lower boiler lockout temperature*
- *Review chilled water pump control logic*
- *Increase separation between heating/cooling setpoint to four degrees*
- *Review control logic for economizer and reset*
- *Calibrate CO₂ sensors*
- *Install daylighting controls in stairwell and other applicable spaces.*
- *Install smaller packaged cooling for data center if appropriate – not necessarily low-cost but probably a quick payback.*

5. Identify the energy and operational benefits of each improvement.

- *Energy savings, lower maintenance costs, improved occupant comfort, fewer maintenance calls, chance of over-ventilation decreased*
- *Since this is a civic center, the city's desire to save energy/money may boost public image.*