BUILDINGENERGY BOSTON

What We Wish Everyone Knew: Using Commissioning Discoveries to Make Buildings Better

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Northeast Sustainable Energy Association (NESEA) | March 20, 2024

Buildings are starting out compromised

- Some common issues – some more preventable than others
- See these on a significant percentage of projects
- How do we minimize this at scale?

https://commons.wikimedia.org/wiki/File:Leaning_Tower_of_Pisa_%284%29.jpg

Learning Objectives

1. Discover how commissioning supports the design and construction process, and use that understanding to improve how different parties interact and communicate with the construction team.

2. Leverage insights from the most common design issues encountered to improve on mechanical, electrical and plumbing designs

3. Identify what to look for and how to avoid some of the less common, but more significant design issues discovered on past projects to avoid them in the future

4. Understand key points where owner, commissioning agent and designer involvement in a project can make the difference between successes and failure

Who We Are

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DIRECTOR OF ENGINEERING

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SENIOR ENGINEER

Who Are You!

Who is in the audience today?

- Engineers
- Architects
- Owners and Maintenance providers
- Contractors
- Sustainability consultants
- Other?

Presentation Organization

Intro

- Defining the problem

Lighting Controls

- Problems and Solutions
- Example

Plumbing Systems

- Problems and Solutions
- Example

Mechanical + Control Systems

- Problems and Solutions
- Example

Conclusions & Questions

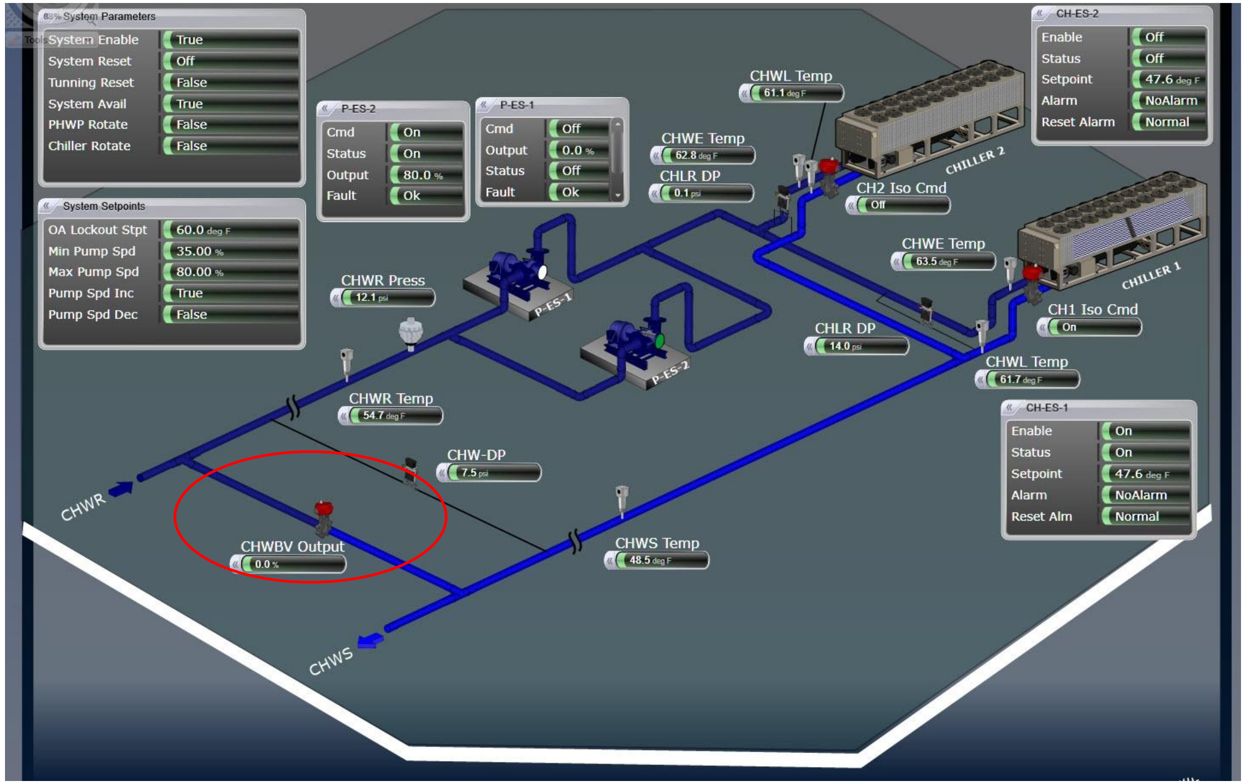
Taitem

DEFINING THE PROBLEM:

3:30

Buildings are starting out already compromised

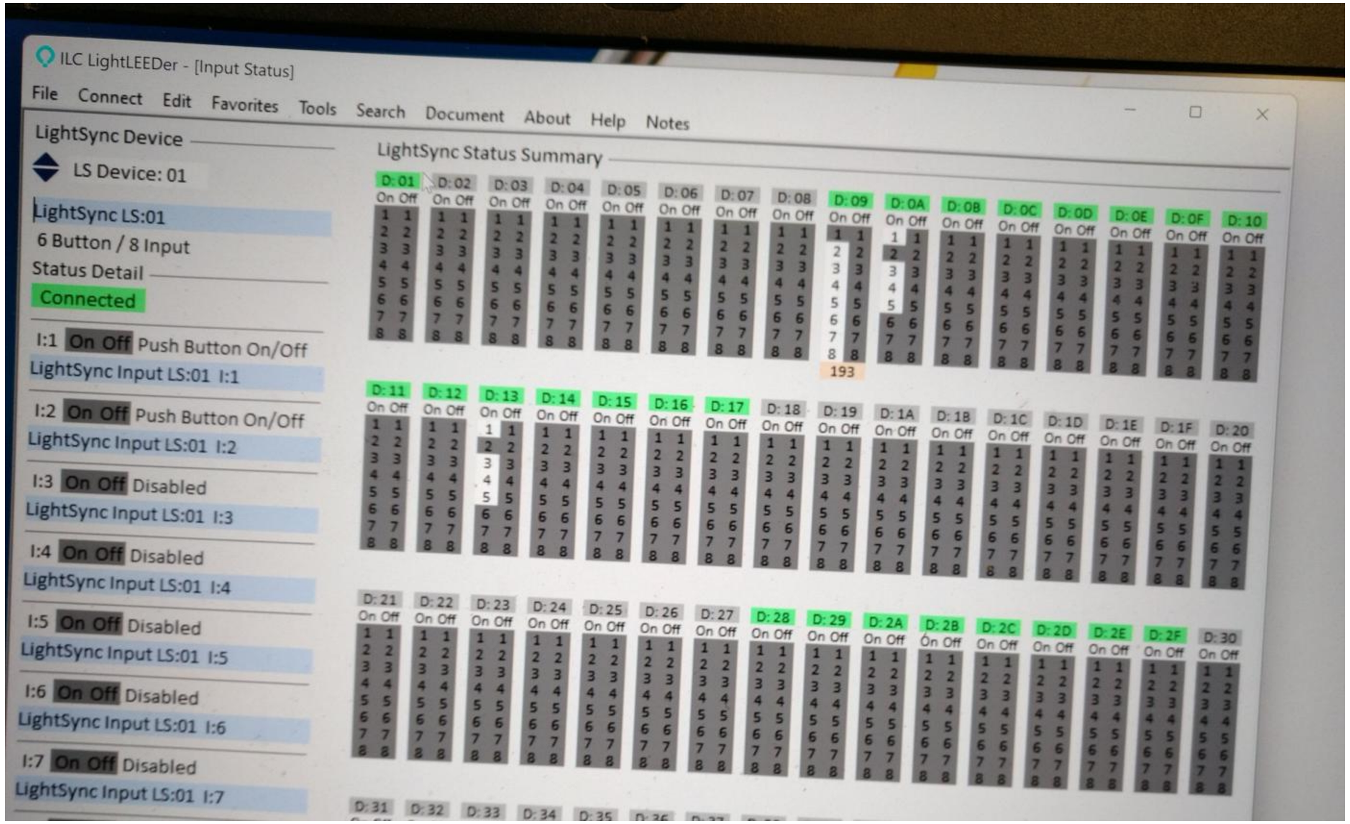
What do we mean by this?



Lighting Controls

Lighting Controls

- Increasingly sophisticated & networked
  - More capabilities!



- But…does complicated =

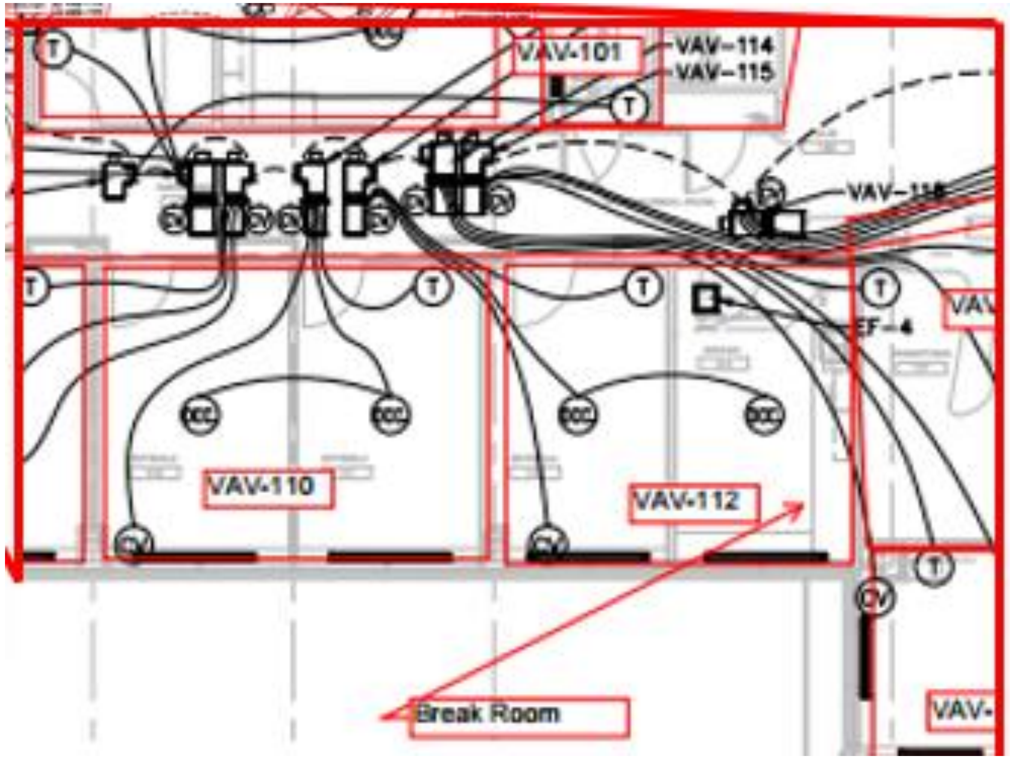
better or more energy efficient?

Lighting Controls

- What do we need to do to make these work?

- Clear upfront understanding of owners goals, and local requirements
- Clear basis of design/intended sequence
- Work closely with the system vendor
- Substitutions may not be practical
- Include training in the specs for the owner
  - And tools to adjust, and follow up training

Occupancy and HVAC integrations



Lighting control zones vs. VAV thermal zoning

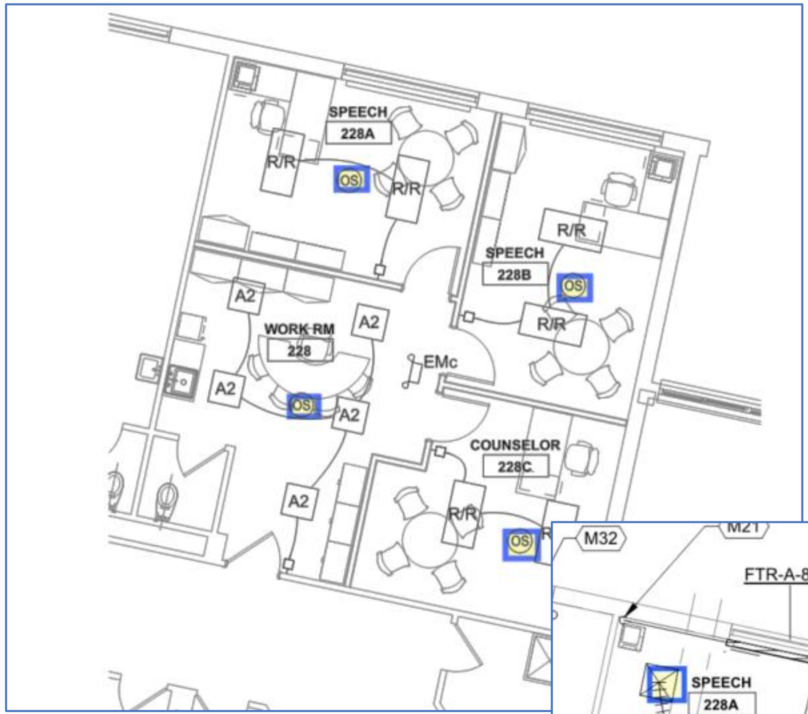
- Issue: Morning Warm up, Nuisance Triggers, Controls Integration, **and what about zones with two rooms?**

Suggestions:

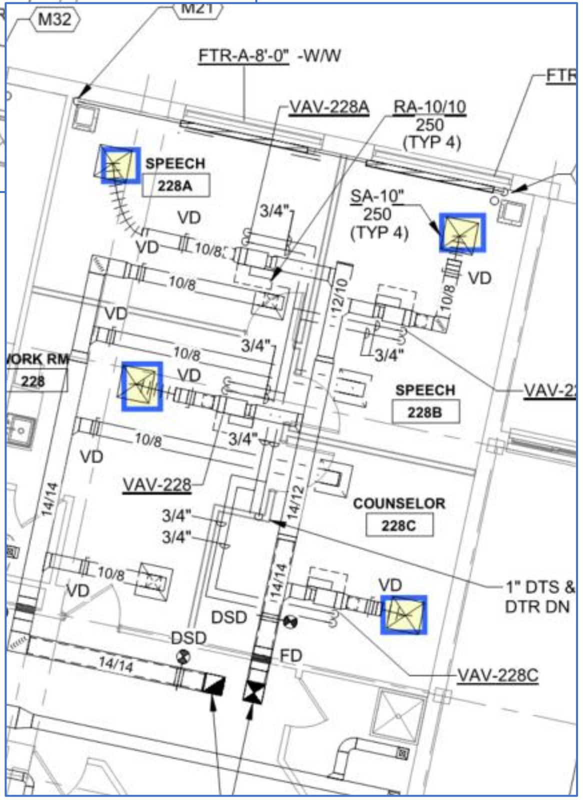
Scheduled pre-warm,
Reduced daytime setbacks
Primarily use to control ventilation

Installation Issues:

- Sensor locations:
  - Proximity to HVAC: 50%
  - Open door/nuisance triggers: 15%
  - Unexpected Furnishings: 10%
- Mechanical vs Digital Switches: 15-20%
- Failure to Program: 75%
- Bonus: Small movement vs. large movement sensors



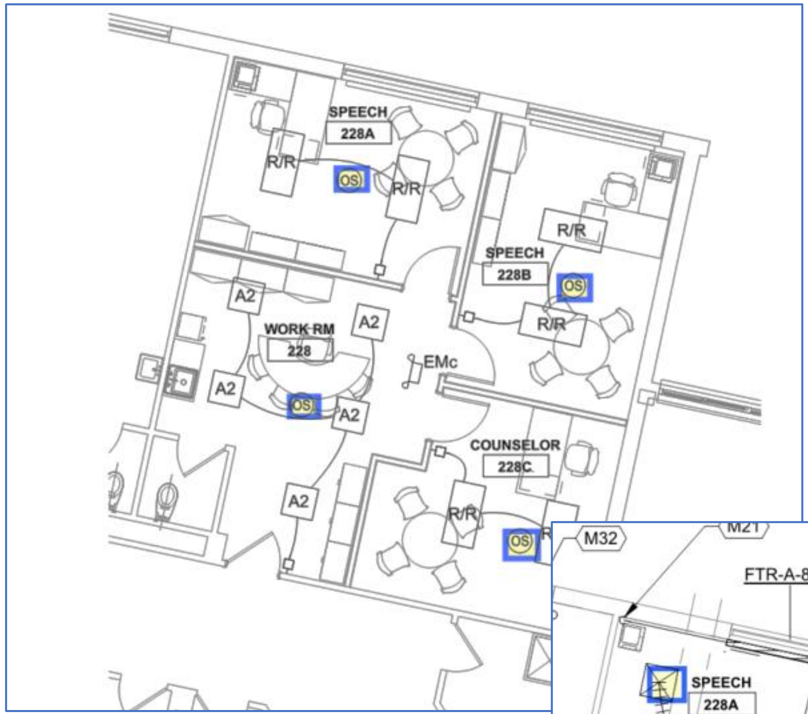
Lighting Controls drawing



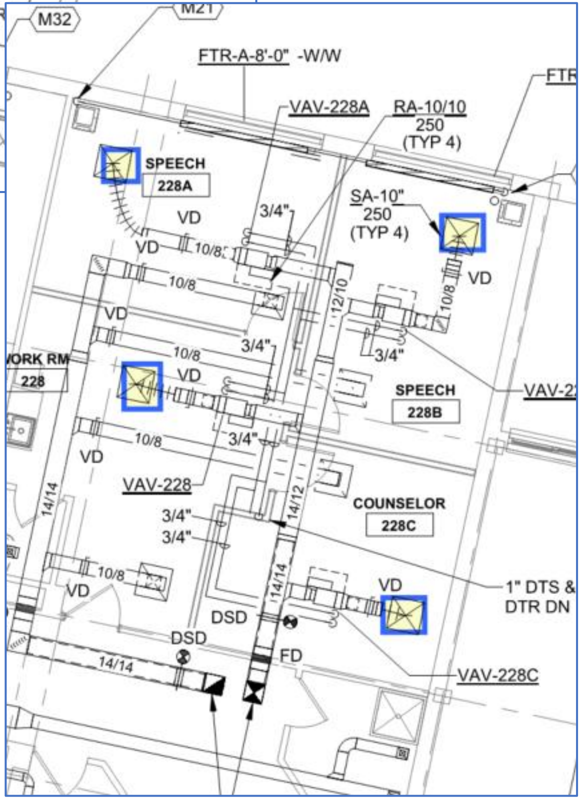
Ductwork (diffusers) drawing

Installation Solutions:

- Sensor locations:
  - 5-8’ from HVAC,
  - 12’ from other ultrasonic sensors
  - Mask sensors as needed
  - Predict furniture/user locations (outlets and ethernet)
- Use digital touch switches with controllers
- Owners/Users – we need your feedback!
- Try to have visually different sensors



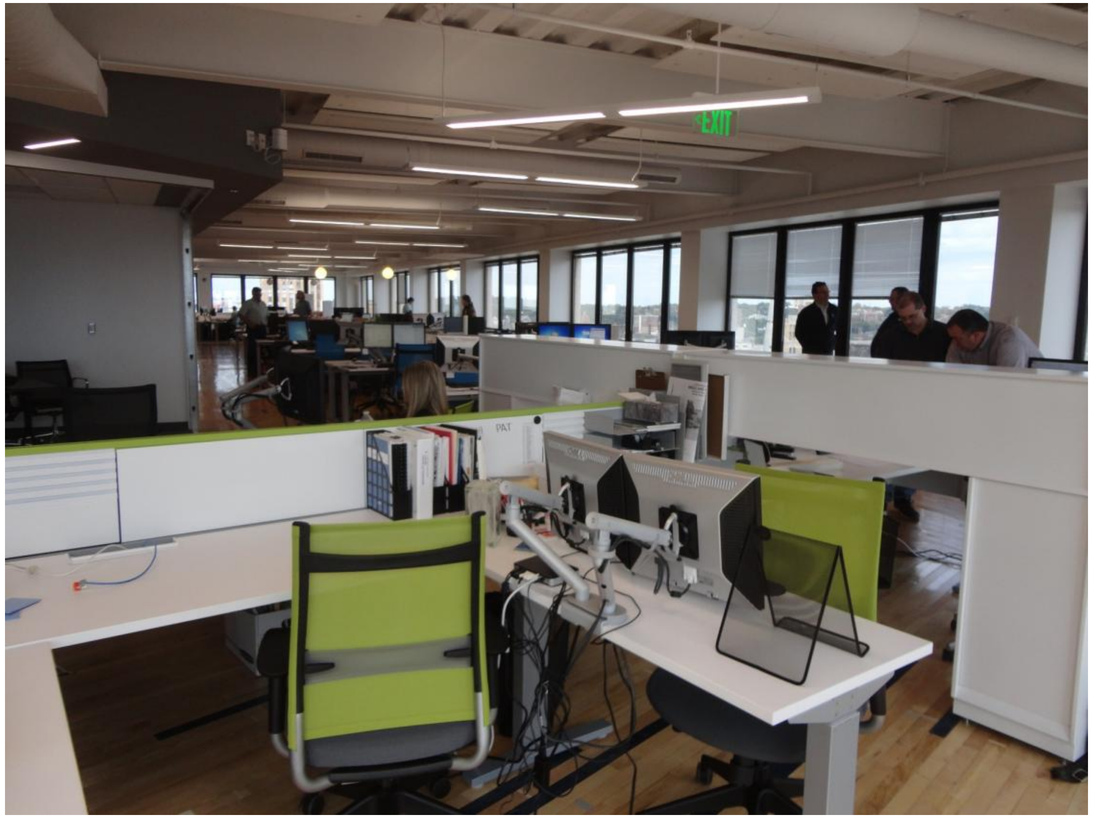
Lighting Controls drawing



Ductwork (diffusers) drawing

Daylight Harvesting

- Non-trivial to install and configure correctly: 90%+ failure rate
  - Multiple projects have reported that they won’t do it again after bad experiences



- Solutions?
  - Still working on solutions other than ensuring testing, training and calibration are well defined in scope


15:00
Lighting Control
EXAMPLE

Vacancy sensor lighting controls

- Ceiling dual tech occupancy/vacancy sensor, with wall mounted on/off switch.
- Requested sequence:
  - Lights are turned on manually,
  - Auto off after 10 minutes
  - Occupants can manually turn off sooner

The Issue(s):

- Sensor powered by wall switch
- System left in default occupancy mode
- Ceiling sensor located right by HVAC diffuser
- Mechanical (not digital) on/off switch used

- Solutions:
  - controllable relay, permanent power to sensor, careful coordination of sensor placement

Plumbing

Heat Pump DHW

Local systems

CONSIDERATIONS

- Hybrid Heat Pump operation modes
- Return water temperatures/expected loads
- Supply water setpoints

DESIGN CONSIDERATIONS

- Peak demand charges
- source of air to transfer heat from

Suggestions:

- Specify the desired mode on drawings
- Design for minimal recirculation load, minimum supply and return water temperatures.
- ducted air kits,
- pro/con analysis of demand charges and coincident peaks

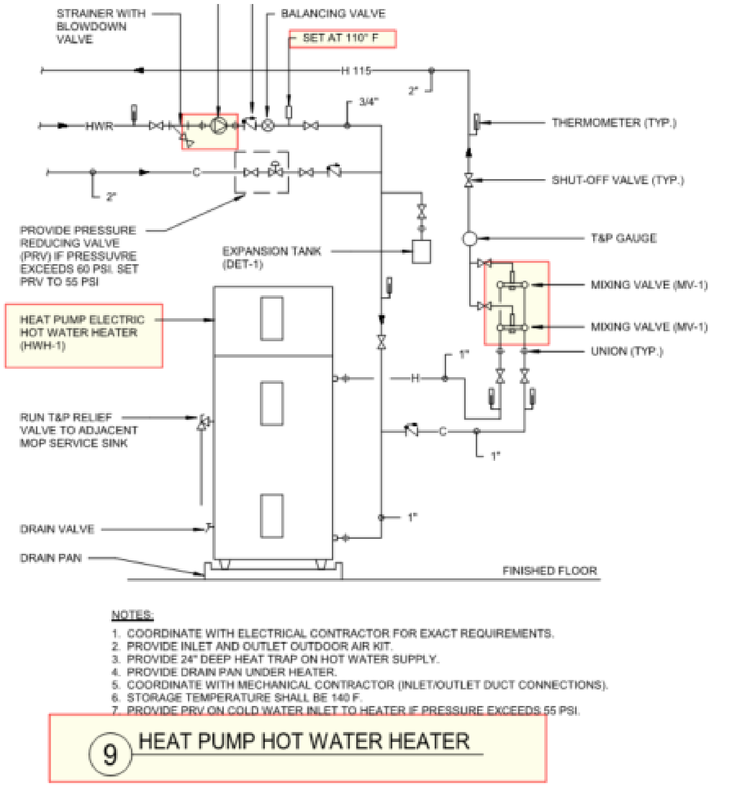
Change Mode of Operation

Press the "MODE" button to select operating mode.

Modes of Operation

- Energy Saver
- High Demand
- Heat Pump
- Electric
- Vacation

Mode	Efficiency	Recovery
Electric	Very Low	Fast
Heat Pump	High	Very Slow
High Demand	Low.	Very Fast
Energy Saver	Very High.	Fast
Vacation	Very High	None



Heat Pump DHW

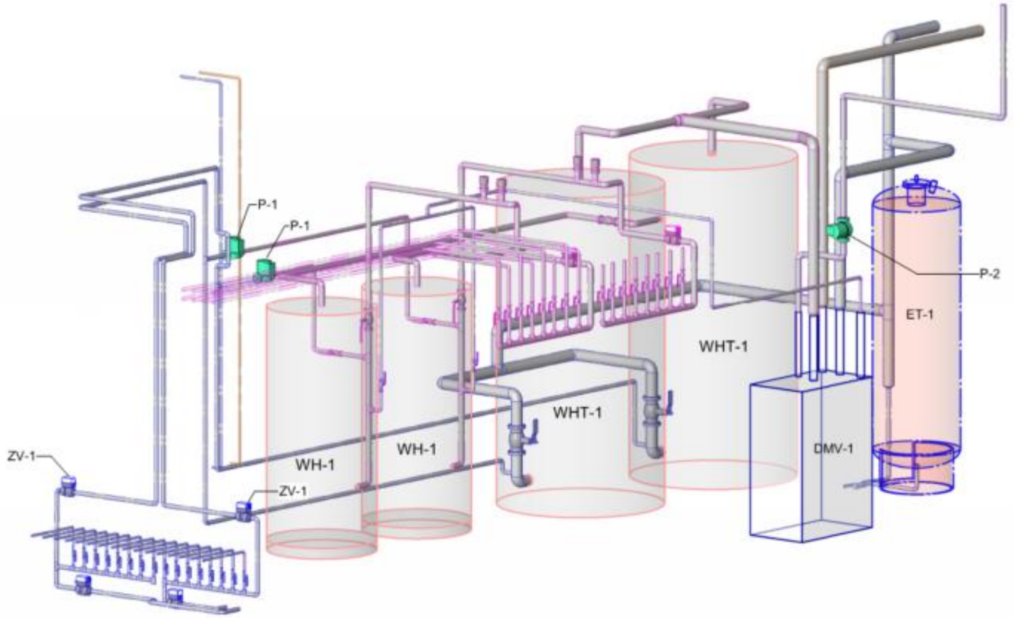
Central HP systems

DESIGN CONSIDERATIONS

- Efficiency & return water temperatures (recirc?)
- Stratification and storage
- Lower max temperature
- Backup systems and how they integrate
- Unit specific sequences and operating characteristics

Suggestions:

- Careful design
- coordination with manufacturer and installer
- extra testing and monitoring

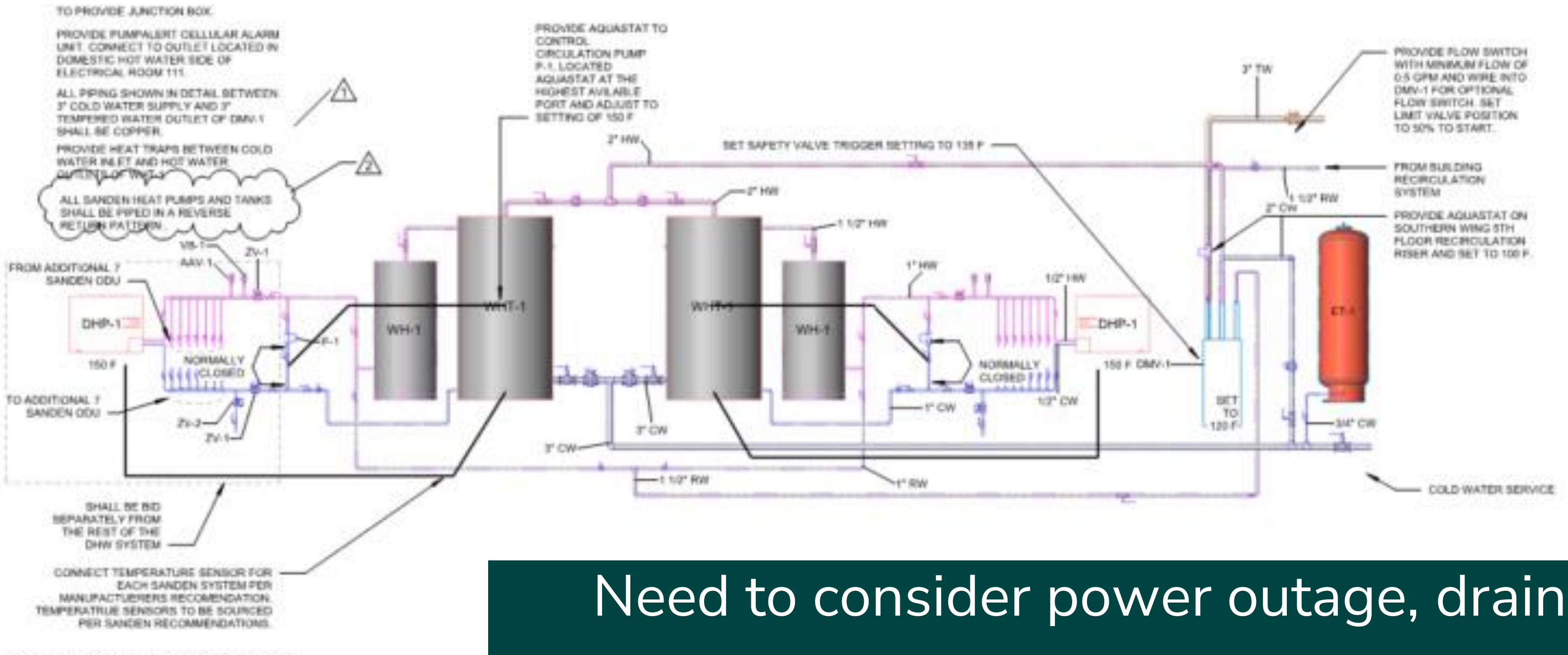


Heat Pump DHW – CO_2 based

22:00

FREEZE PROTECTION

- Consideration with newer heat pump systems – exterior potable water



2 WATER HEATER SCHEMATIC
1/4" = 1'-0"

Need to consider power outage, drainback systems

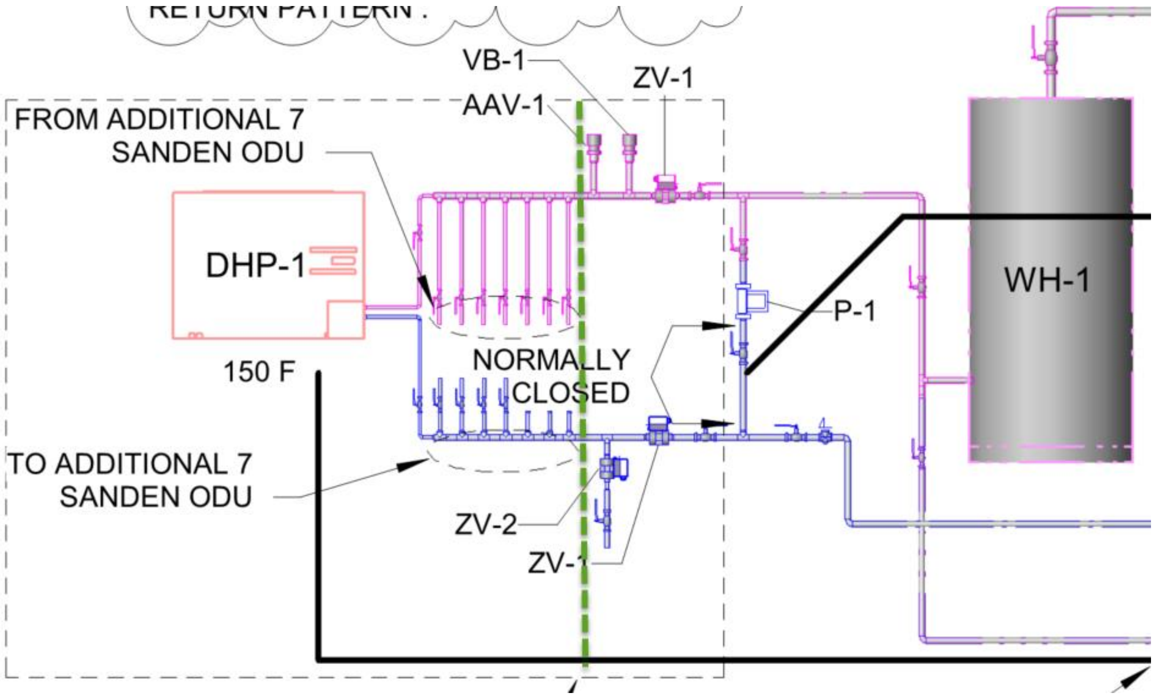
22:00

Plumbing

EXAMPLE

Auto-drainback freeze protection sequence

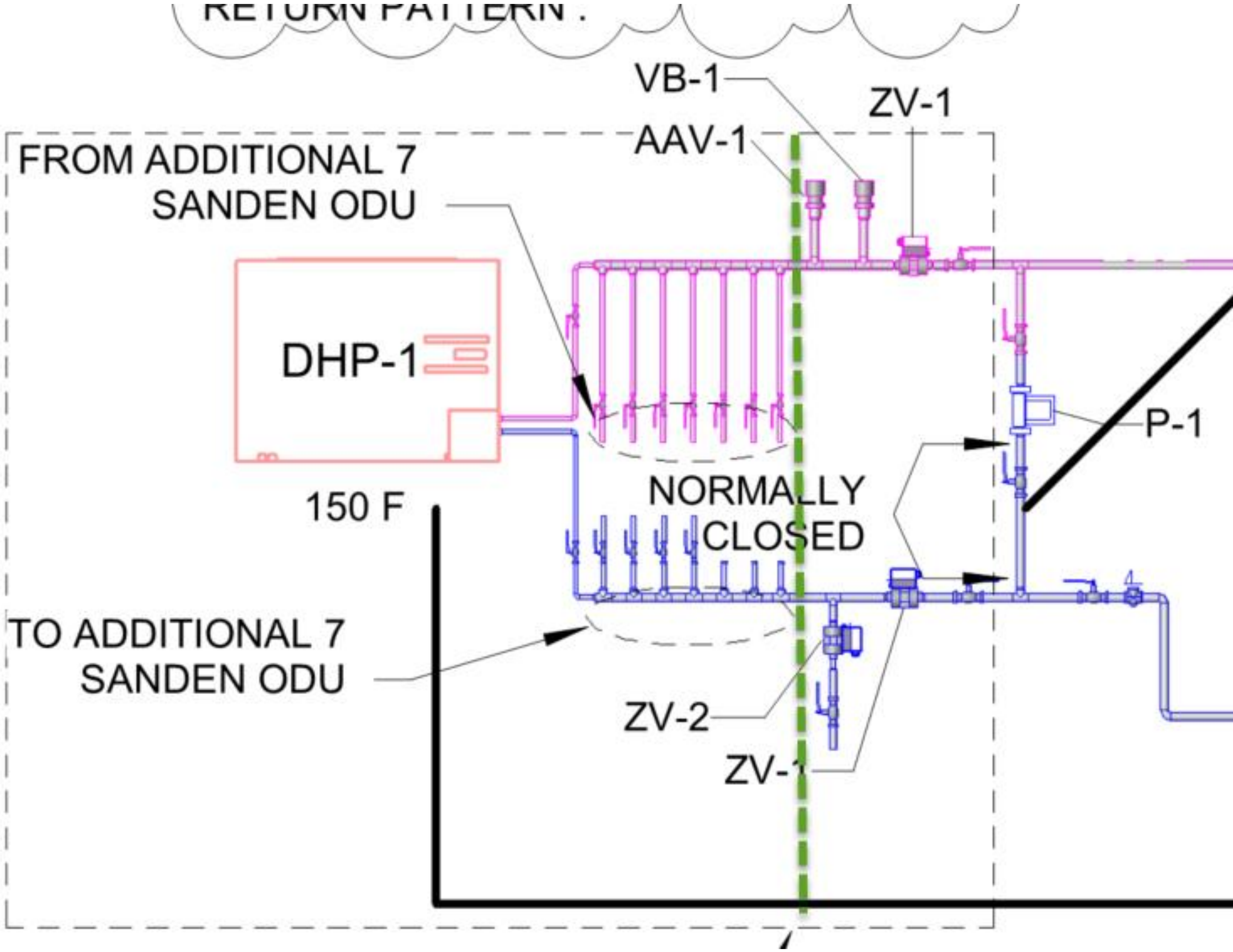
- How it works:
  - Two sets of valve, with a spring return (normally open/normally closed)
  - When power is lost, a set of valves that are normally powered open where the water leaves the building to go to the heat pump outdoor units automatically close.
  - Two other valves going to drains that are normally closed open at the same time, draining the outdoor portion of the system.
  - This requires careful installation and slope of the outdoor piping.



Auto-drainback freeze protection sequence

23:30

- What issues would you expect?
  - Water caught in the system?
  - Incorrectly installed valves?
  - Other?
- The drainage of the system actually worked great…



Main issue was actually on refill of the system

26:00

- When power was restored, the valves all reverted, trapping a large amount of air in the system.
- More than could be handled by the automatic air vent
- Heat pumps were getting air bound and faulting out in error.

Solutions?

SOLUTION

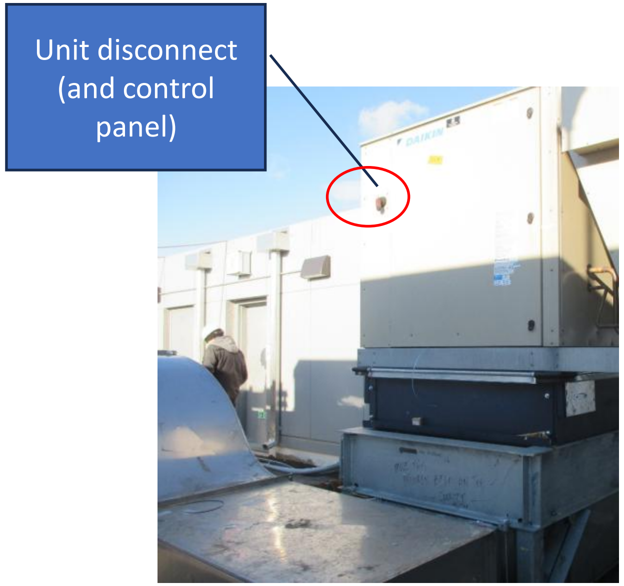
- Customized delay offsets in some of the valves to purge and fill system automatically

→Water fully fills the system and starts to drain before upper vent valve closes

MECHANICAL

Maintenance Access

- Issues:
  - Busy Ceilings – Can't find/access equipment: 60%+
  - Solution: Identification Stickers, Access Doors
  - High Roof Curbs/Ductwork Obstructing Equipment Access: 30-40%
  - Solution: Catwalks and Duct Bridges
  - Above Ceiling Clearances for Controls, Filters, Replaceable Components, etc.: 30%
  - Solution: Build Clearances into design as graphic elements on plans, access doors in ceilings.



27:00

Substitutions and Value Engineering (VE)

- 40-50% of substitutions we see introduce some new issue
  - When can you do this, when will it cause issues
    - Be wary of unanticipated side effects
  - Areas of concern:
    - Accessories
    - Integration with other systems, particularly controls
    - Technologies and limits on performance
- Almost 100% of VE changes caused issues
  - What should owners know?
- Note – not always avoidable.

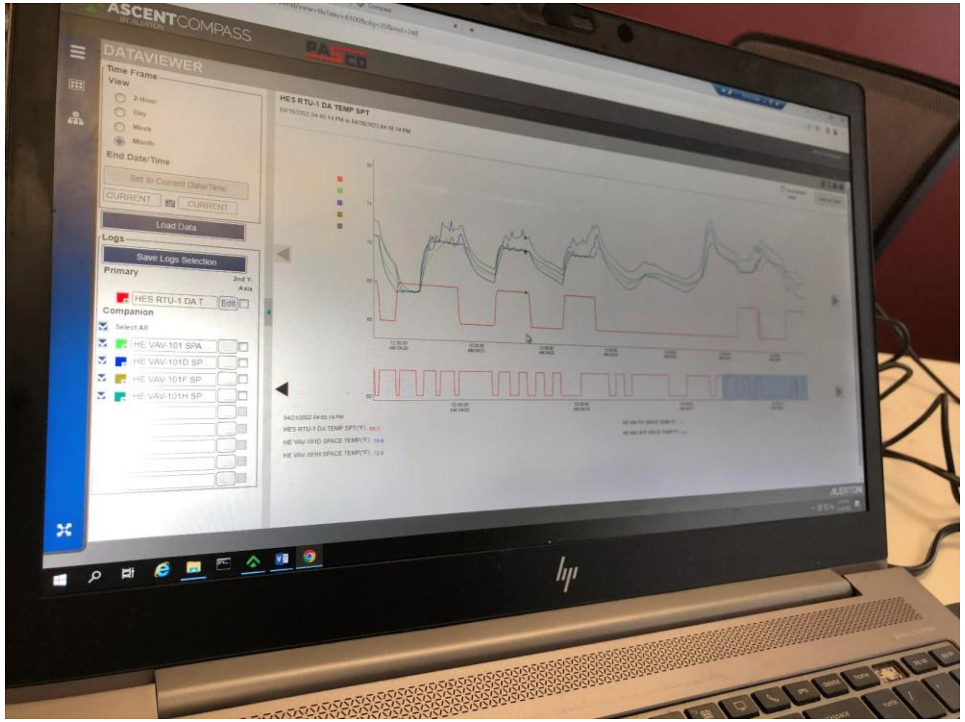
Substitutions and Value Engineering (VE)

- Solutions:
  - Investigate availability (lead times) and cost of major/critical units before bid
  - Avoid the temptation to defer design work assuming long lead times or project delays will give you time to work out details later
  - Consider including a clause in contracts allowing you to bill for extra time spent on design work due to changes from basis of design model

33:00

Considerations for Sizing

- Considerations for Sizing
  - Heating vs cooling & Oversizing: 20-30% or more of projects
    - Coil Selection
  - Availability of summer reheat (very common)
  - Peak Design Conditions
    - Are they really accurate?
    - What is the owners comfort level/primary concerns regarding temperature control?



Pet Peeves

- Unoccupied VAV operation: 90%+
  - What runs when a single space needs heat?
  - Does the entire system know its unoccupied?
  - Priority heating devices
- Zoning
  - IT closets need their own zone: 30%
  - Think for current use and schedules AND future modifications when grouping spaces
  - Large open spaces need a central control device [HPs especially]: 20-30%
- Freeze protection and safeties: 30%
  - Make sure these are thought through with new efficient systems
- Usable Thermostats and Schedule Controls: 60-90%
  - Interface that Owners/Users have has huge impact on how the system is used

Frequent Controls Issues

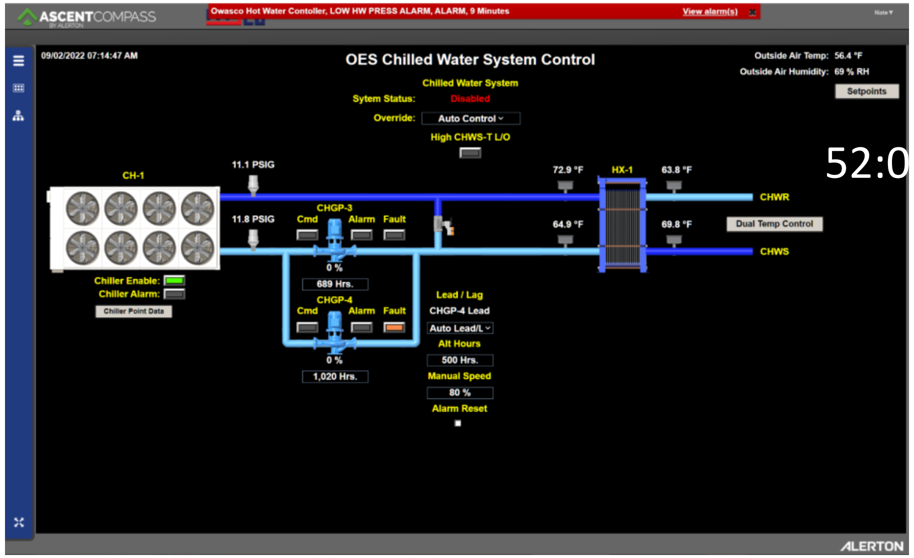
45:00

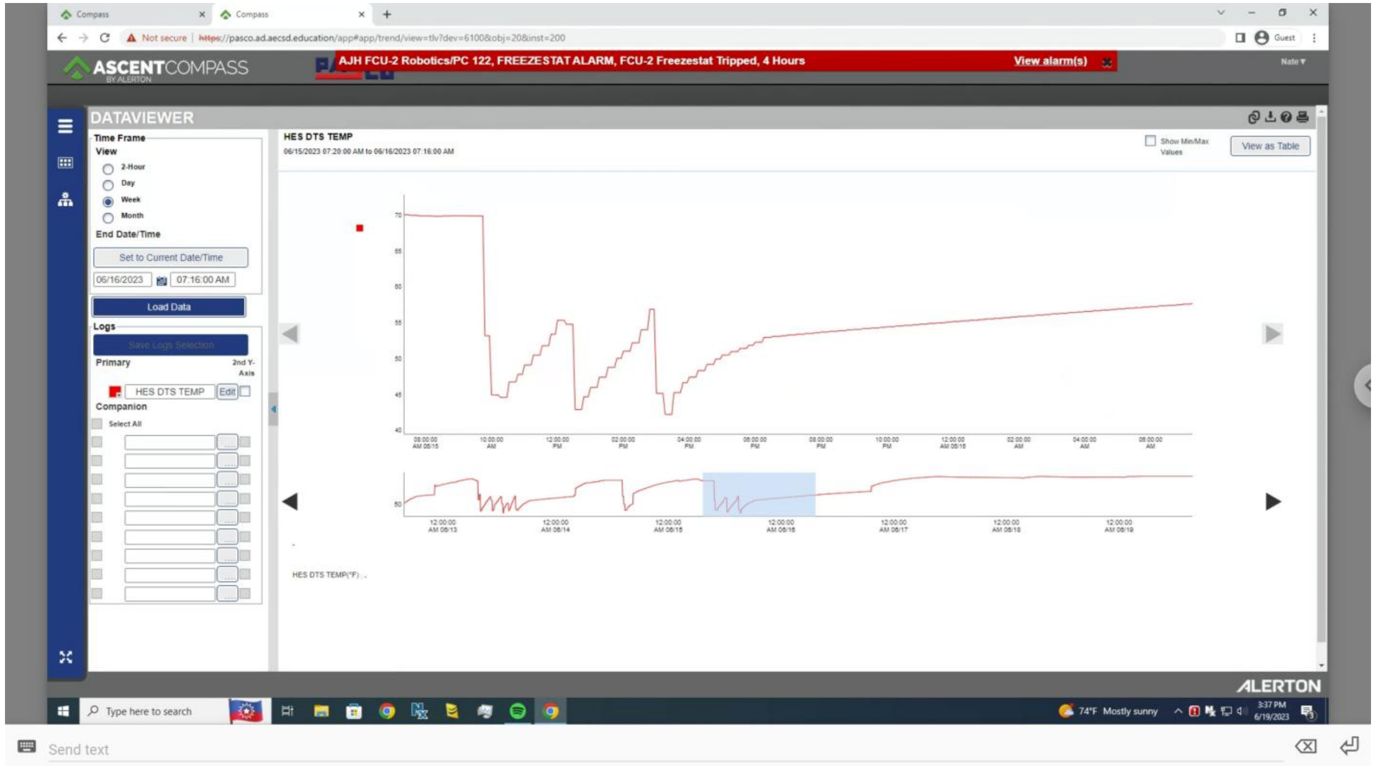
Controls Success = No Complaints (vs. efficiency/correct operation)

- Packaged controls vs. central BMS: 65%
- Control sequence extremes: 30%
  - Reliance on controls contractor VS packaged sequences VS over-constraining
  - Who owns what? 25%
- Coordination with TAB, startup, owners IT (and Cx of course)
  - Almost always see at least one coordination issues

Controls example: Chiller

- Packaged controls integration with BMS –
  - Chiller cycling – fixed supply water setpoint, enabled/disabled by BMS





- Solutions?

Frequent Controls Issues – Suggestions?

46:00

Controls Success = No Complaints (vs. efficiency/correct operation)

- Change the metric for success!
    - Dedicate resources for ongoing engineering and Cx support of efficiency and other controls goals
- Control sequences spell out key deliverables and efficiency goals (don’t over constrain, but clearly define expected results)
- Bring in IT and other controls consultants in early

- Anecdotally, ways you can help controls contractors justify spending more time on a project up front work well
    - ‘I have to do it, they are coming to test next week’
    - ‘That’s a little trickier to program, but it will be worth having for our service contract’

Mechanical/Controls

EXAMPLE

47:00

This Room!

- What potential issues have you noticed?
- What do you think might be causing those issues?
- Potential Solutions?

Conclusions

53:00

Lots of things go wrong during construction!

Recent project we worked on:

<u>New Construction, Multifamily Building</u>

All Electric, High Efficiency. Not a bad project!

Some of the issues we discovered:

- Heat Pumps
  - Leaks: 5-10%
  - Controls : 90% at some level
- ERVs
  - Incorrect units: Rare, 5%
  - Factory default controls: 80%+
- DHW System
  - Coordination between primary and backup system: 100%/TBD
  - Inaccurate submittal information: 10%
- Lighting Controls
  - Controls were not set up until after occupancy: 10%/60+% have setup related issues

All preventable, but some more easily than others…

COMMISSIONING AGENTS DON'T SOLVE EVERYTHING

We can be the eyes, ears and experience for an owner, but at the end of the day, all we can, and should, do is make suggestions.

We are just one part of a team that helps ensure the systems are operating correctly!

- Still need design engineer
- Still need owner involvement
- Need installers there to help us!
- Focused on larger systematic issues

54:00

HOW CAN WE USE THIS INFORMATION TO IMPROVE AS AN INDUSTRY?

What are your ideas?

QUESTIONS

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