AABC Commissioning Group

AIA Provider Number 50111116

Effective Building Automation Controls Integration

Course Number: CXENERGY1732

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April 27, 2017

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Course Description

This presentation focuses on design and construction phase design review with an emphasis on ensuring controls integration between traditional building automation systems and packaged control technologies in new construction and renovation projects. Laboratory facilities present unique challenges for traditional building automation systems and packaged laboratory controls. We cover the steps necessary to ensure functional, safe and efficient controls integrations across building systems.

Learning Objectives

At the end of the this course, participants will be able to:

1. Identify the steps necessary to ensure proper controls integration.
2. Identify the targeted areas of design review.
3. Understand the role of commissioning during design review and the construction phase.
4. Identify potential energy savings strategies thru controls integration.

Why Should We Integrate Lab Controls?

Thought Process #1 – Do Not Integrate:

- Stand-Alone controls protect my facilities staff.

- Integration of systems is an added cost to the Owner.

- Integrated systems are more difficult to service. Whom do I call when something doesn't work?

- I don't want to be inundated with data or have my network slow down.

Why Should We Integrate Lab Controls?

Thought Process #2 – Integrate Everything:

- Integrated systems provide an elevated level of safety for the occupants.

- Integration of systems will allow for energy savings strategies to be implemented.

- Integrated systems are more difficult to service. Whom do I call when something doesn't work?

- Give me all the data possible.

What are the steps necessary to achieve a successful controls integration?

- Teaming with a bought-in Owner and Design Team

- Development of a strong OPR

- Live in the specs

- Organization of design and submittal reviews

- Push for a controls integration meeting

Teaming with a bought-in Owner and Design Team

- It doesn't help if the CxA review comments never make if from the Owner to the Design Team or to the contractor.

"*Further review is needed to determine if the control contractor can communicate to the Synex ModSync via BACnet communications. This feature is listed as an option for the panel, but it is unclear if add-on hardware such as an optional communication card is necessary, or that BACnet over FC Bus is available. A point list from ModSync is also required to generate a full list of I/O points to be integrated into the control system. Design team and contractor should coordinate communication between vendors."*

- The comment above was identified during submittal review of a condensing boiler system, but no action was taken at that time by the Owner or Design Team.

The results:

- 2 additional site-visits plus expenses by all team members
- 6 months in project delays and turnover to the Owner

Development of a strong OPR

- This is the time to define what systems are required to be integrated to the BAS

- Define systems
- Define read vs. write points
- Define communication protocols
- Push for a controls integration meeting

Live in the specs

- Every system specification section needs to be reviewed
    - Are related spec sections identified in all sections?

- Is integration type in all spec sections identified?

- Is there a requirement in the submittal sections of the specs to provide I/O lists and identification of read vs write points?

Organization of design and submittal reviews

- Highlight the system being reviewed
    - Basically, all of them
- Identify the system integration type
    - Is BACnet or Lon Talk an issue? Is the term Hardwired a cause for concern?
- Identify your concerns
- Start tallying integration points and where they live in the contract documents

Push for a controls integration meeting

- Push the Owner and Design Team to incorporate a Controls Integration Meeting

- All equipment providers and the contractor need to be present

- Use the data you've collected to drive meeting results and identify potential points of failure

- The ultimate goal is to discuss controls integration at the time of or prior to submittal's from the contractors

Identify the targeted areas of design review

- Are all systems covered by the specs?

- How are communication protocols specified, are they consistent?

- Is communication possible? If hardwired points are identified, is it possible the systems have these hardwired I/O? Is it on their radar?

- Is clear delineation over whom controls what components identified?

- Is there a provision for supplying an integration points list or read/write points list as a submittal requirement?

Are all systems covered by the specs?

Spec Requirements

- The following spec sections indicate integration with Controls
  - 13851 – Fire Alarm Systems
  - 15191 – Fuel Oil Distribution
  - 15444 – Packaged Booster Pumps
  - 15446 – Sump Pumps
  - 15513 – Condensing Boilers
  - 15623 – Dedicated Heat Recovery Chillers
  - 15629 – Modular Air-Cooled Water Chillers
  - 15635 – Refrigerant Monitoring and Safety Equipment
  - 15840 – Air Terminal Units
  - 16215 – Electrical Power Monitoring and Control

Where do we have potential for missing integration?

Spec Requirements

- Other sections that do not mention integration but appears to be needed based on points list in spec and/or on drawings
  - 15122 – Meters and Gages
  - 15490 – Domestic Water Heating System
  - 15738 – Split System Air Conditioning Units

- Other sections that may need integration based on review of the OPR
  - 02810 – Irrigation System
  - 16145 – Lighting Control Devices

How are communication protocols specified?

- What approved manufacturers are specified and what communication protocol do they use?

- Does this protocol match other specification sections?

- What networking option is specified?
  - /Ethernet
  - /Arcnet
  - /MSTP
  - /RS-232

Is integration even possible?

- Hardware points available?
    - Are enough available?

- Are the points writable?

- Can multiple systems monitor the same points or does that cause communication issues?
    - Fire Alarm
    - Power Monitoring

Whom is controlling what?

- Are the specs and drawings clear about whom is controlling what components?

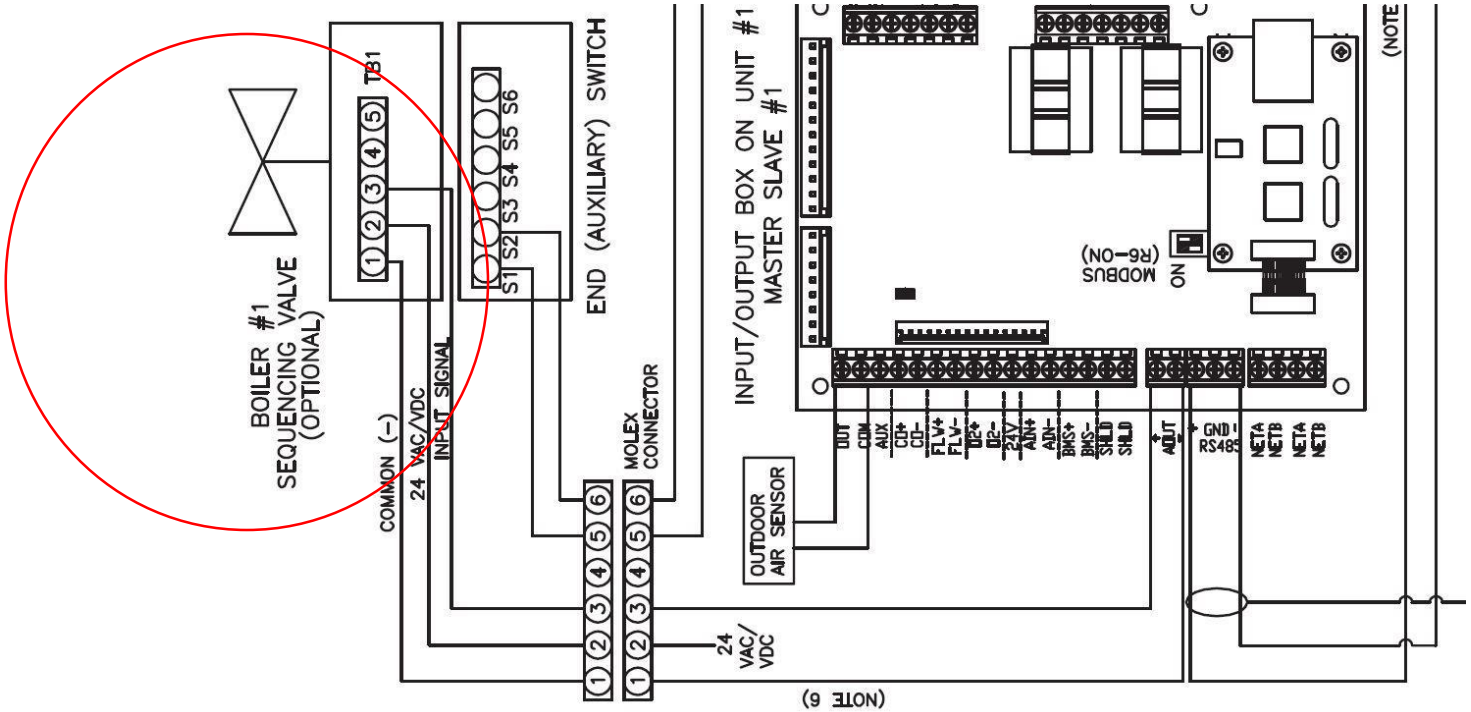
- Are submittal review comments geared towards clarifying potential conflicts?

- Are communication protocols possible? If hardwired points are identified, is it possible the BAS can accept those inputs? Is it on their radar?

- Is clear delineation over whom controls what components identified?

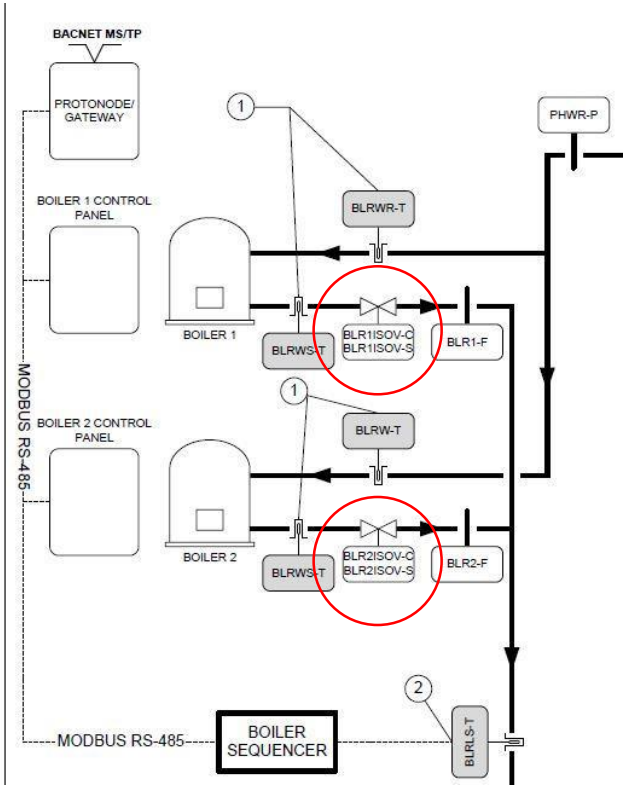
Whom is controlling what?

- Boilers were submitted with an optional control valve



Whom is controlling what?

- BAS controls were submitted with their own control valve and sequence of operation



Whom is controlling what?

- The boilers came with the optional control valves that had a proprietary wiring harness tied to the boiler control panel
- The BAS could not integrate too, or control the isolation valves
- The sequence of operation for boiler control could not be achieved as valve status via the end-switch was the “trigger point” to enable the boilers
- This resulted in project delays, design modifications, change orders for programming, re-visits to complete the work, re-testing of the FPT.

- Is a points list a submittal requirement?

BST System Parameters		Boiler Parameters	
• Cmore BST mode	• BST header temp	• Comm addr	• Fire rate in
• BST setpoint	• BST outdoor temp	• Unit Status	• Fire rate out
• BST setback setpoint	• BST fire rate output	• Fault status	• Unit type
• BST setback start	• BST Unit Ignited	• Outlet temp	• Unit size
• BST setback end	• BST Active Setpoint	• Ffwd temp	• Boiler Isolation Valve State
• BST auto master	• Next turn on fire rate	• Inlet temp	• Network remote setpoint
• BST Unit outlet temp	• BST sp high limit	• Exhaust temp	• Run cycles
• BST num units enabled	• BST sp low limit	• Air temp	• Run hours
• BST units faulted	• BST temp high limit	• Flame strength	• O2 Level
• Master Unit Address	• BST setpoint mode		

- Is a points list a submittal requirement?

Configuration Options	Typical Applications
Indoor/Outdoor Reset A change in the outside air condition results in a Process Application proportionate change in header temperature – a function of the adjustable reset ratio (0.3 – 3.0).	**Indoor/Outdoor Reset Hydronic Heating** **Process Application**
Constant Setpoint Delivers fixed supply water temperature at set points of 50°F-220°F (dependent upon boiler maximum temperature limit).	**Water Source Heat Pump** **Domestic Water Generation** **Supplemental Heat Recovery Equipment** **Swimming Pool Heating**
4-20mA Signal Header temperature responds linearly to an external 4-20mA control signal.	**Computer Controlled Building Management** **Industrial Process** **Greenhouse Application**
Network Communications Enables EMS or BAS system to drive boiler plant setting for header set point temperature via Modbus connection to BST. Also provides communication link between the boiler and the BST to allow direct communication. This enables the EMS/BAS to query and capture faults of BST and 20 BST System operating parameters as well as 18 operating parameters of each individual boiler.	**Computer Controlled Building Management** **EMS Data Logging & Trend Analysis**

What does our design review look like?

- Highlight the system being reviewed
- Identify the system integration type
  - Is BACnet or Lon Talk an issue?
- Highlight concerns
- This must be performed for every system!

System: HW System – Dedicated Heat Recovery Chiller
Integration Type: Hardware and either BACnet or Lon Talk.

Specific Concerns: Spec section 236442 Dedicated Heat Recovery Chillers does not indicate that hardwired points are available as required. The Contractor is required to coordinate actual components to achieve the contractual requirements and the design intent.

INTEGRATION POINTS		
Specification Points List	**Drawing Points**	**Controls Submittal Points List**
Notes: 230905.1.1.B.5 – Related Sections – Chillers, AHU's, VAV's and other mechanical equipment are specified in Division 23 sections. 230905.3.11.A – System Points List Notes Hot Water system. 236422.2.9.G.1 – Chiller communication interface with building automation system using BACNET or LonTalk protocol matching BAS protocol.	Notes:	Notes:
Graphics		
Pump Start/Stop (Each) – Binary Output		
Pump Status (Each) – Binary Input		
Pump Status (Each) – Alarm (BAS)		
CHW Supply Temperature – Analog Input	Chiller Condenser Supply Temp	
CHW Return Temperature – Analog Input	Chiller Condenser Return Temperature	
HW Supply Temperature – Analog Input	Distribution System HWS Temperature	
HW Return Temperature – Analog Input	Distribution System HWR Temperature	
Isolation Valves (Each) – Binary Output	Isolation Valves	
Chiller Enable/Disable – Binary Output (must be hardwired, not communicated)	Chiller On/Off Control	
Chiller Status – Binary Input (must be hardwired, not communicated)		

What does our submittal review look like?

- Second chance to review that all integration points are accounted for in the submittals
- Opportunity to ensure that optional integration components are selected properly

System - Domestic Heat Recovery Chiller
Integration Type - Hardwired and MSTP
Notes: Multiple points not listed in Control Submittal. Drawings reference VFD's on pumps, Spec and Control Submittal do not.

Integration Points

Specification Points List	Drawing Points	Controls Submittal Points List
Circulating Pumps (each)	Circulating Pumps (each)	Circulating Pumps (each)
Pump start/stop	Pump start/stop	Pump start/stop
Pump status	Pump status	Pump status
CHW Supply Temp	CHW Supply Temp	CHW Supply Temp
CHW Return Temp	CHW Return Temp	CHW Return Temp
HW Supply Temp	HW Supply Temp	HW Supply Temp
HW Return Temp	HW Return Temp	HW Return Temp
Isolation Valves (each)	Not Listed	Not Listed
Chiller Enable/Disable	Not Listed	Chiller Enable/Disable
Chiller Status	Not Listed	Chiller Status
Chiller General Alarm	Not Listed	Chiller General Alarm (MSTP)
Chiller KW/TON	Not Listed	Not Listed
Compressor Failure (each)	Not Listed	Not Listed
Chiller Power Usage	Not Listed	Not Listed
Chiller RLA	Not Listed	Not Listed
Chiller Runtime	Not Listed	Not Listed
	Pump VFD Fail (each)	Not Listed
	Pump VFD Speed Input (each)	Not Listed
	Pump VFD % Feedback (each)	Not Listed
	Dedicated Chiller Pressure Relief Valve	Not Listed
	Dedicated Chiller Differential Pressure Sensor	Not Listed
	Dedicated Chiller Flow Switch	Not Listed

Understand the role of commissioning during design review and the construction phase

- What should the CxA's role be?
  - We have found the only way to successfully integrate building wide systems is to take a lead role in implementation.

- How do we know when we've found integration issues?

- What are the critical points to be aware of during installation and implementation?

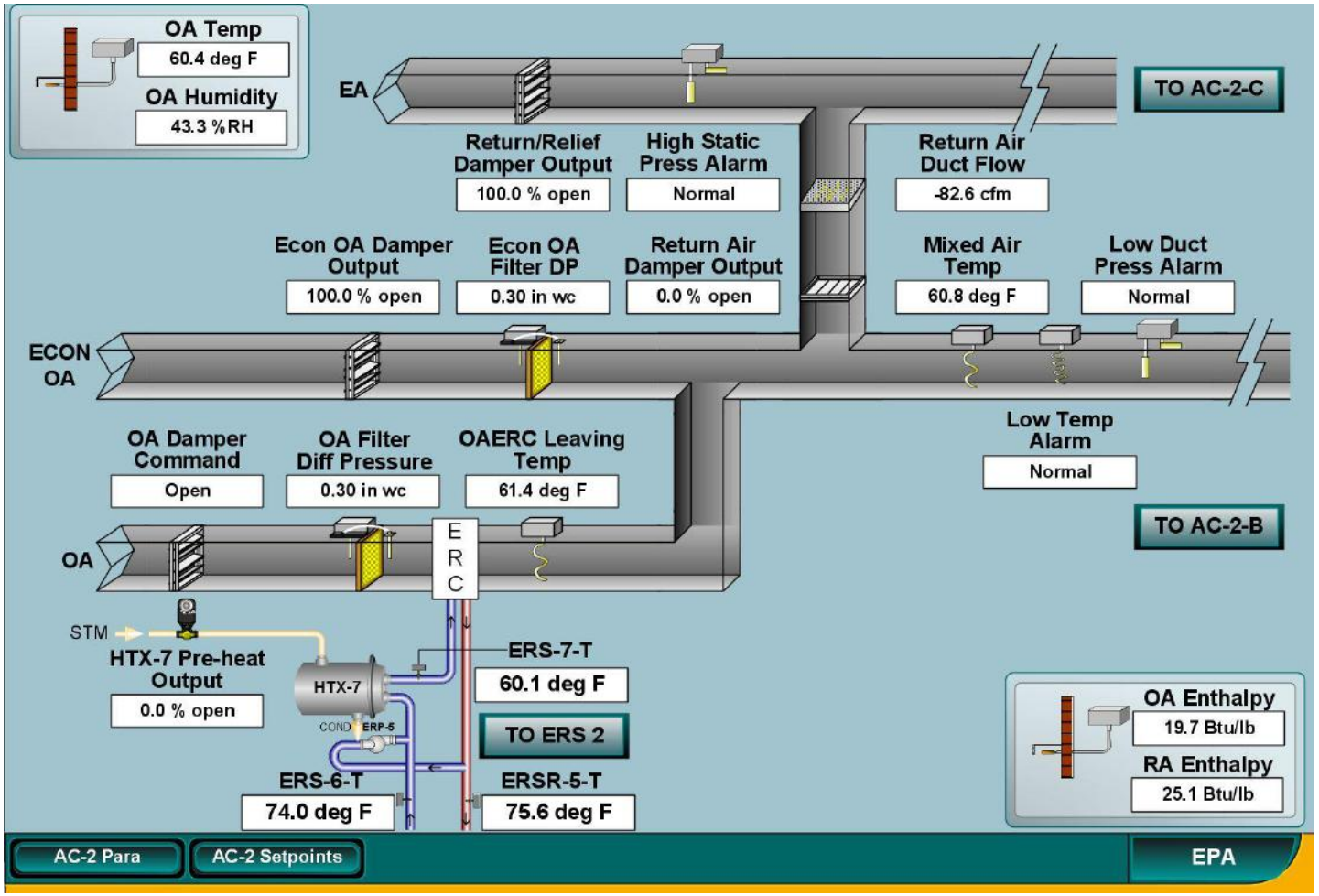
Controls Integration Meeting

- Get everyone to the table!
- If it’s not in the scope, push for it to be included early in the construction phase before submittals are all approved.
- This is a CxA lead meeting.

Define Integration Requirements with the Owner

- More often than not, more data is available than what is really needed.
- Define what needs to be available to the end user.
- Bad things happen when you ask for everything!

Too Much Data



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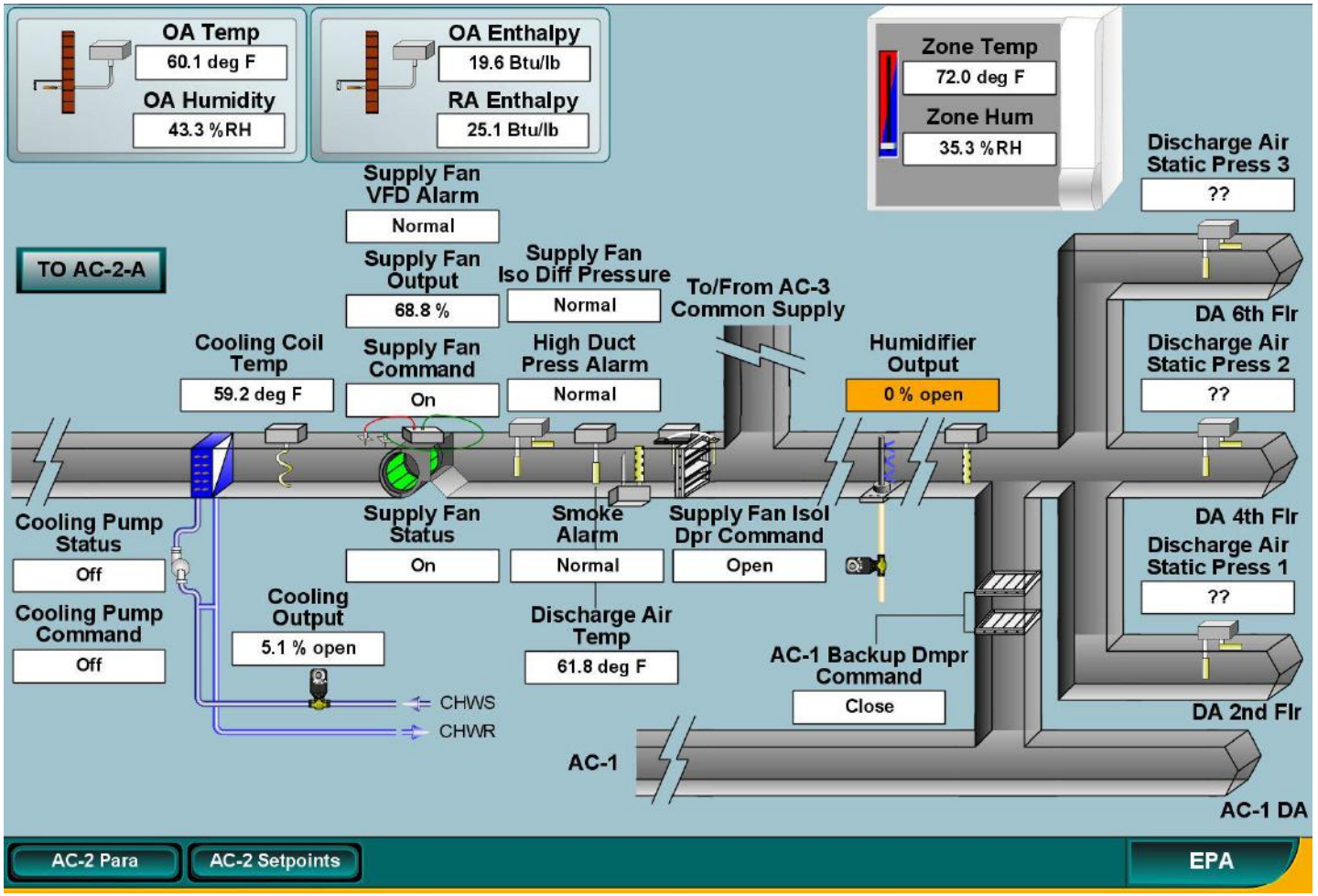

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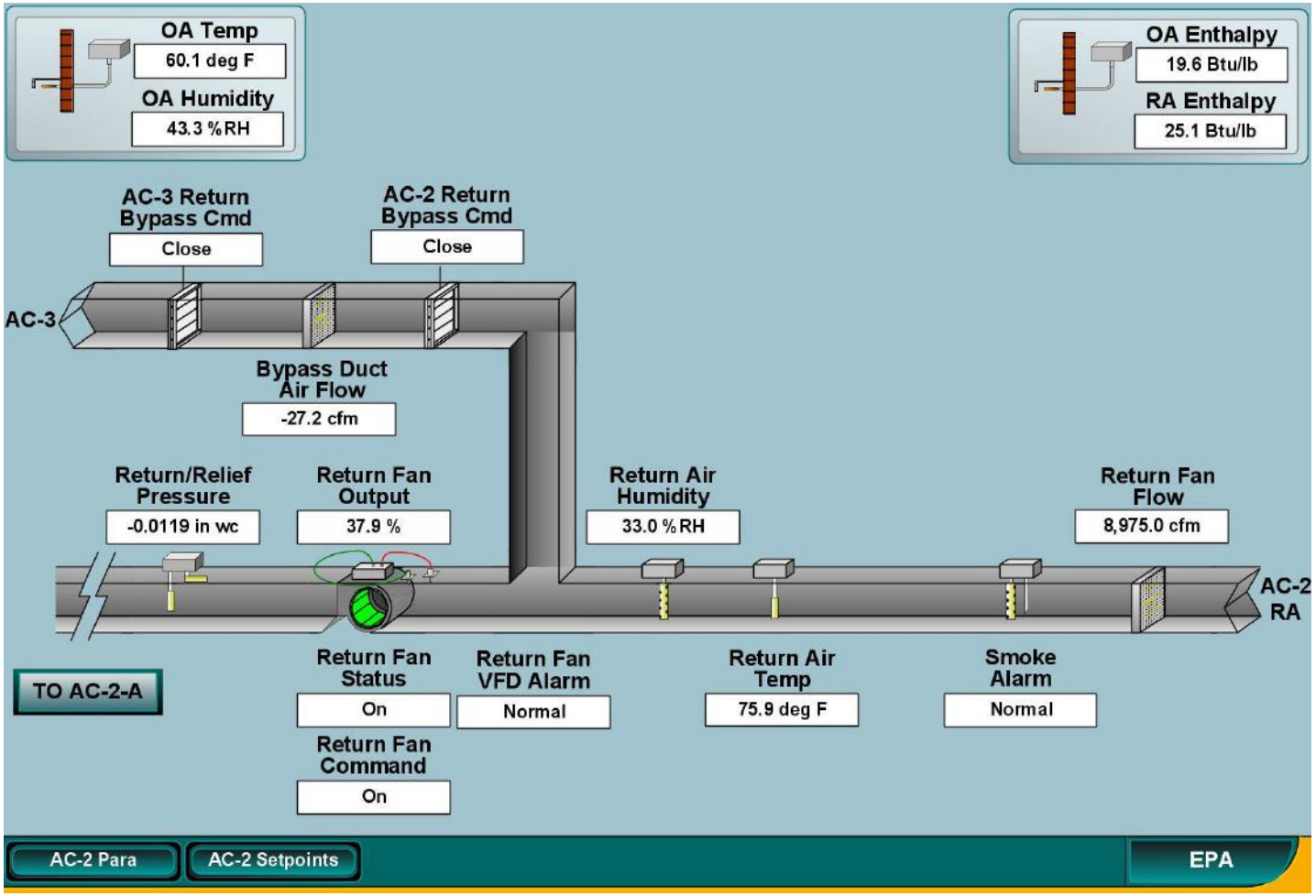

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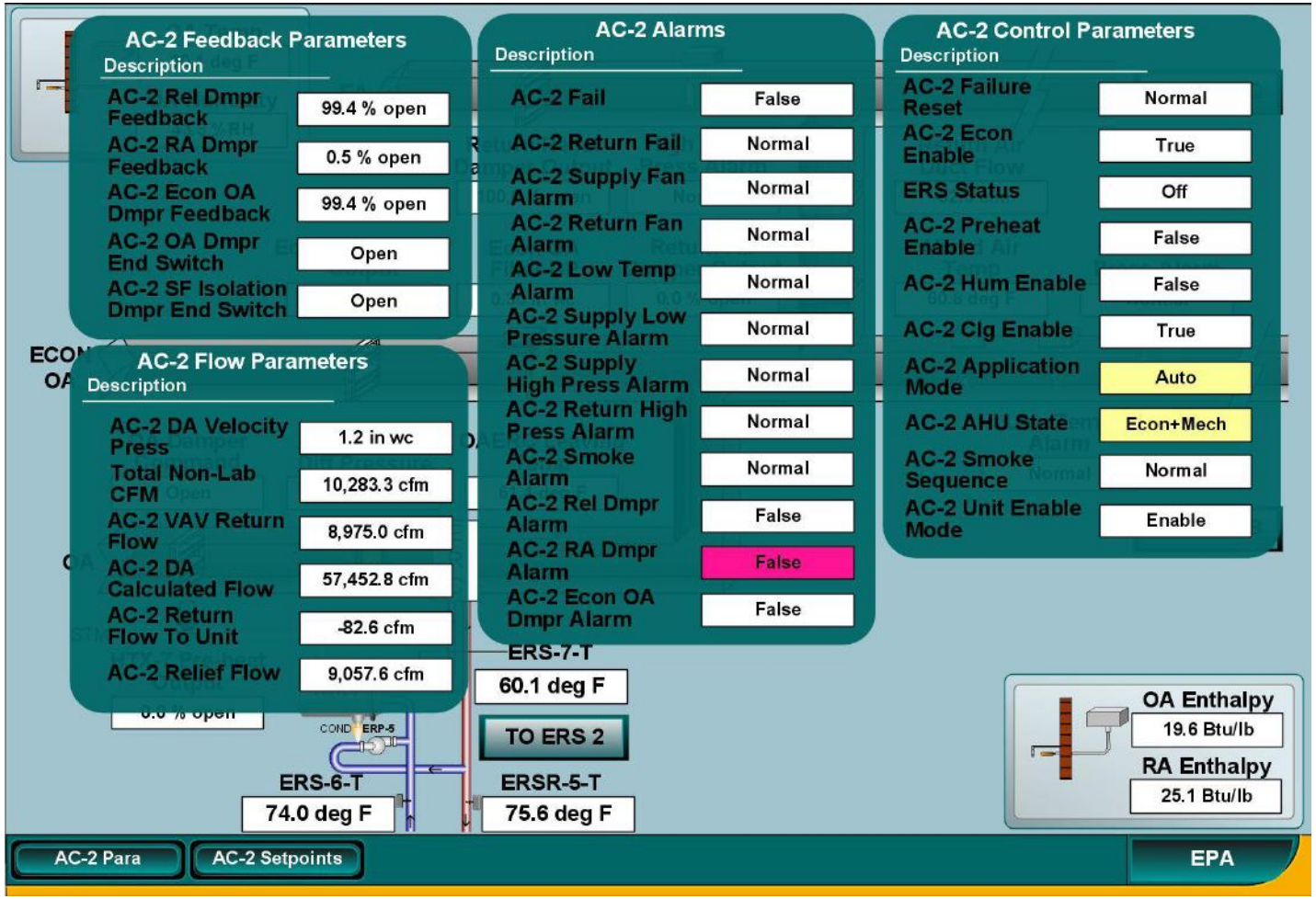

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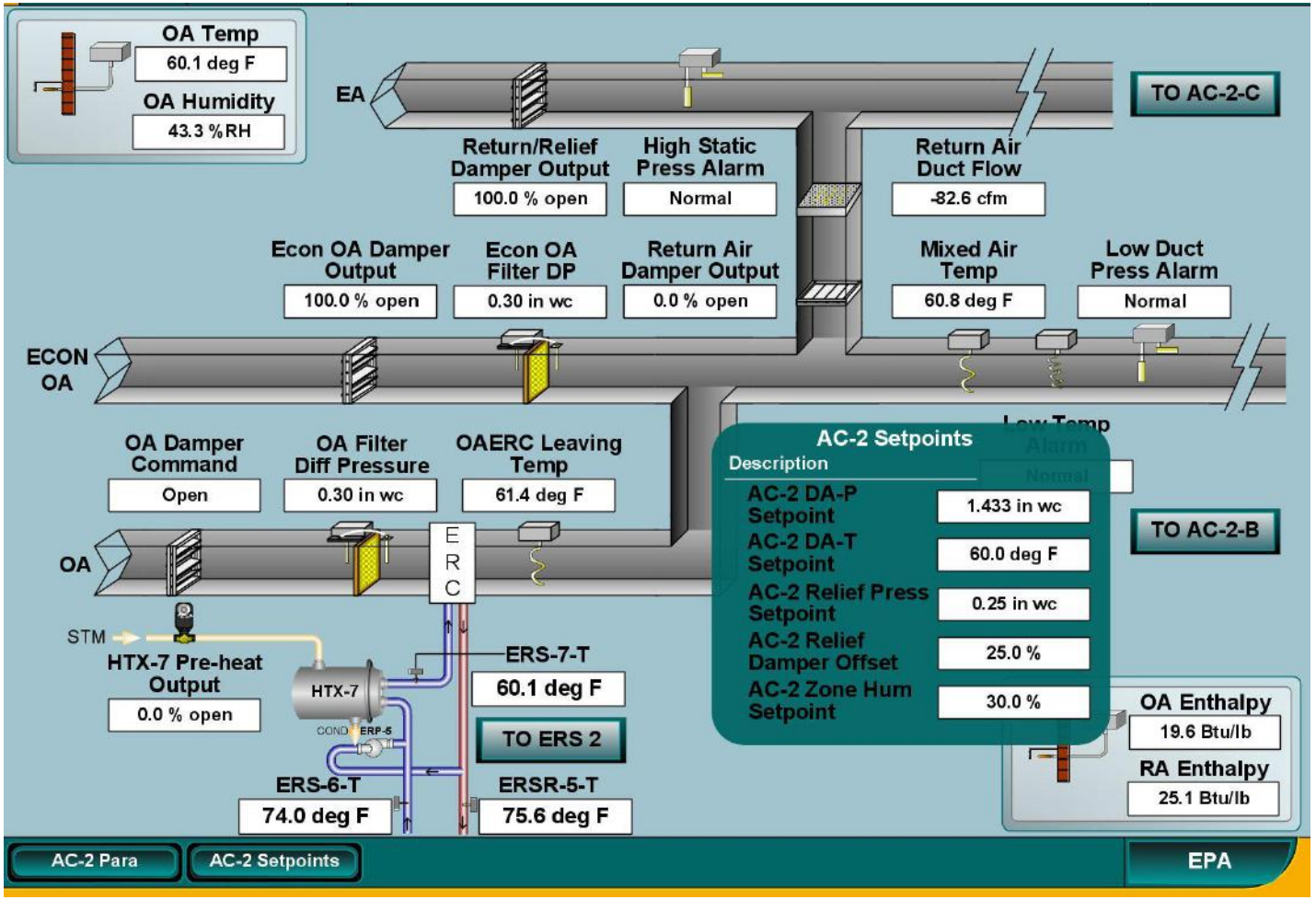


Managing Data Transmission

- Careful management of data transmission must occur.
  - Managing Data Points
  - COV Rates
- If data is not managed up-front, network speed will suffer!

Managing Data Points

- Some building automation systems are sized based off of how many data points they can handle.

- When integrating systems we need to know how many data points will be integrated
  - All I/O Points
  - Alarming
  - Trending
  - Totalizers

Managing COV Rates

- Building automation systems refresh data based on a change of value rate or COV.

- With some vendors, this value is set by default to a value of 0 or 0.1.
  - Do we want our network passing data every time an airflow or temperature changed by a value of 0.1?

- Low COV rates lead to excessive data transmission and slow down the network and graphic refresh rates.

Who’s Fault Is It?

- When a point of integration fails, who’s fault is it?
- The controls vendor is always to blame!
- How do we in the role of commissioning help the Owner understand which vendor should be their first point of contact when service is needed?

Who's Fault Is It?

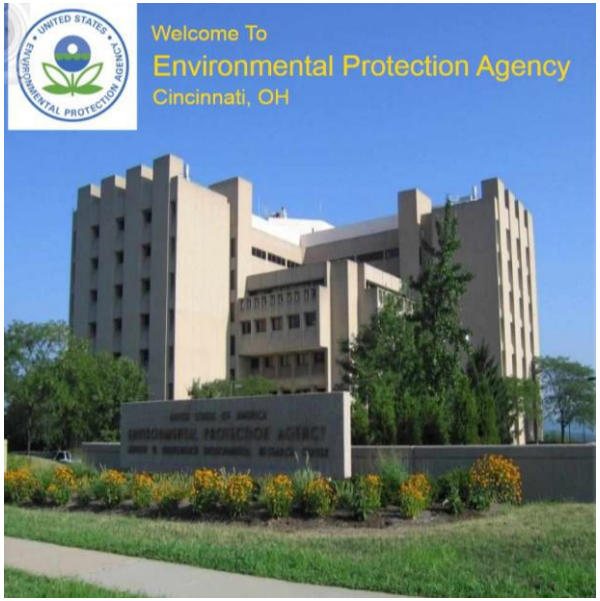
- The integration process must be watched.

- Different systems operate in different ways
  - Lab control manufacturer A – Pushes data to the BAS
  - Lab control manufacturer B – Needs the BAS to pull the data, or Poll the data

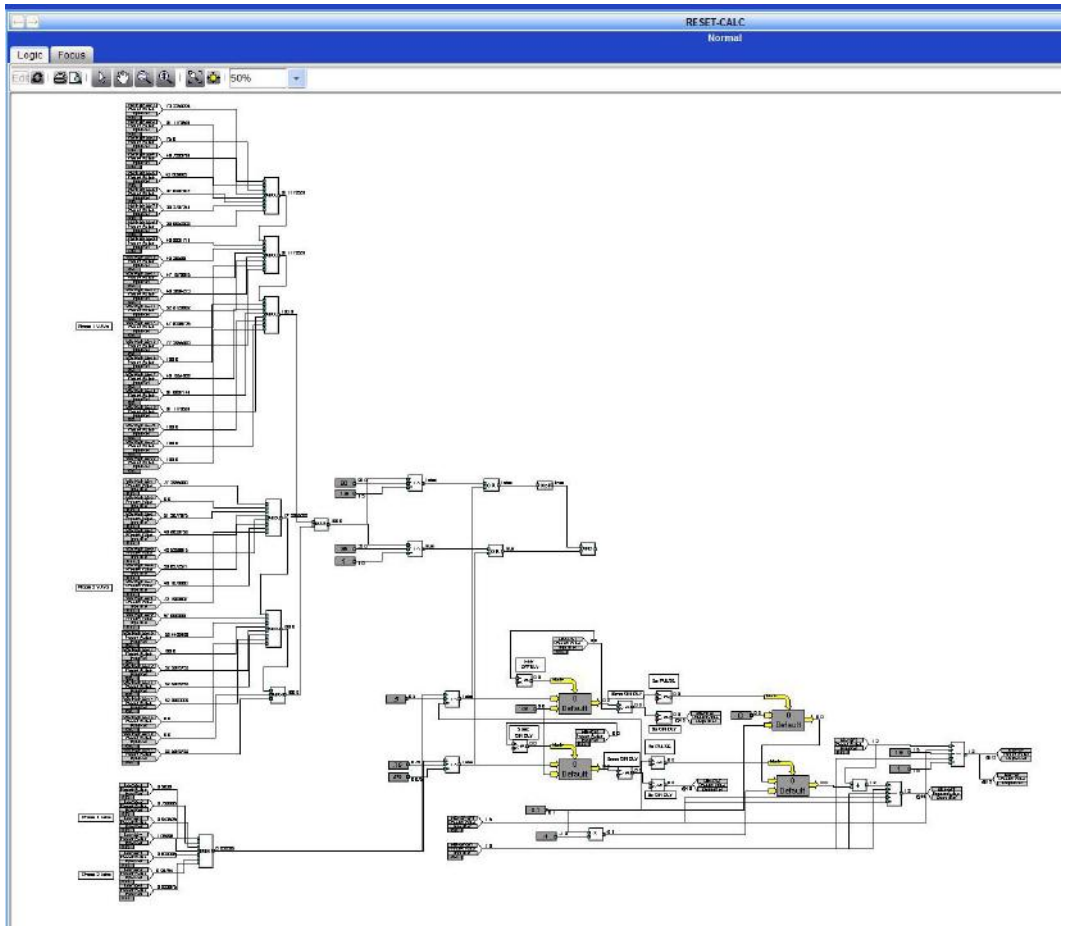
- Understanding how data flows in the network will lead you to understanding how to troubleshoot an integration failure.

Energy Savings – Example Project

- An infrastructure replacement was being conducted which included:
  - 8 AHU’s and RF’s
  - Approx. 2,000 office terminal boxes
  - Approx. 2,200 laboratory terminal boxes
  - 21 laboratory exhaust fans
  - Heating and cooling plant replacement

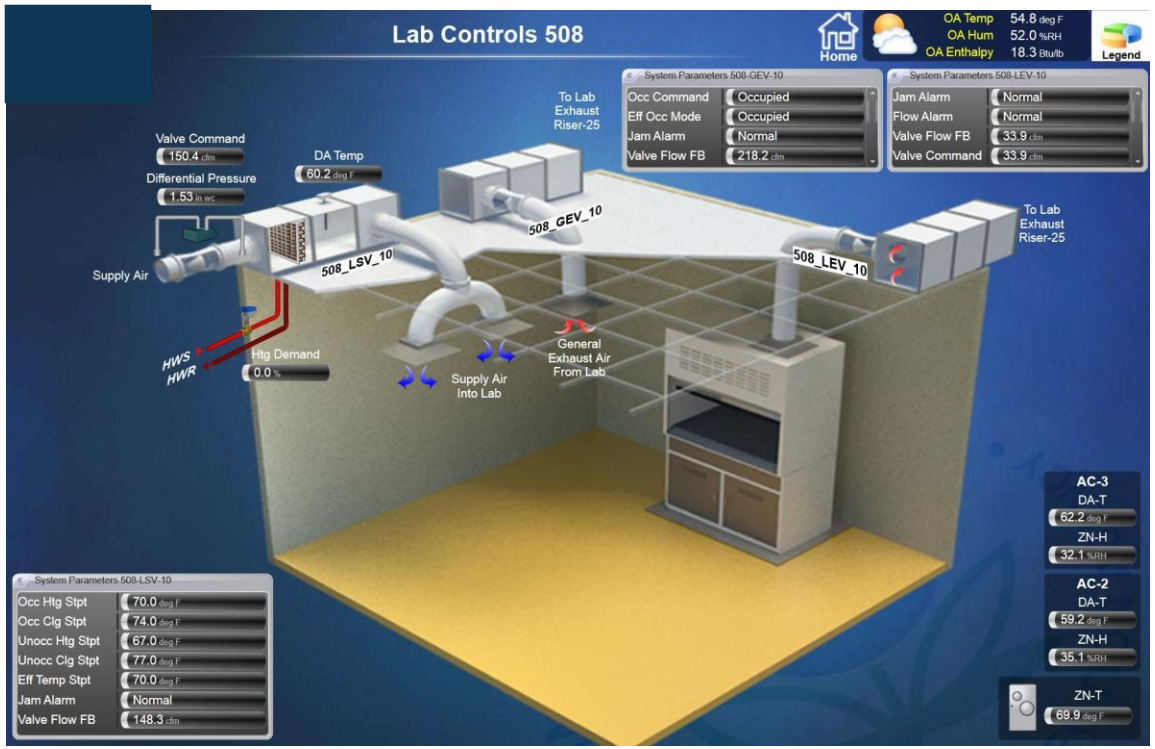


Energy Savings - Static Pressure Reset



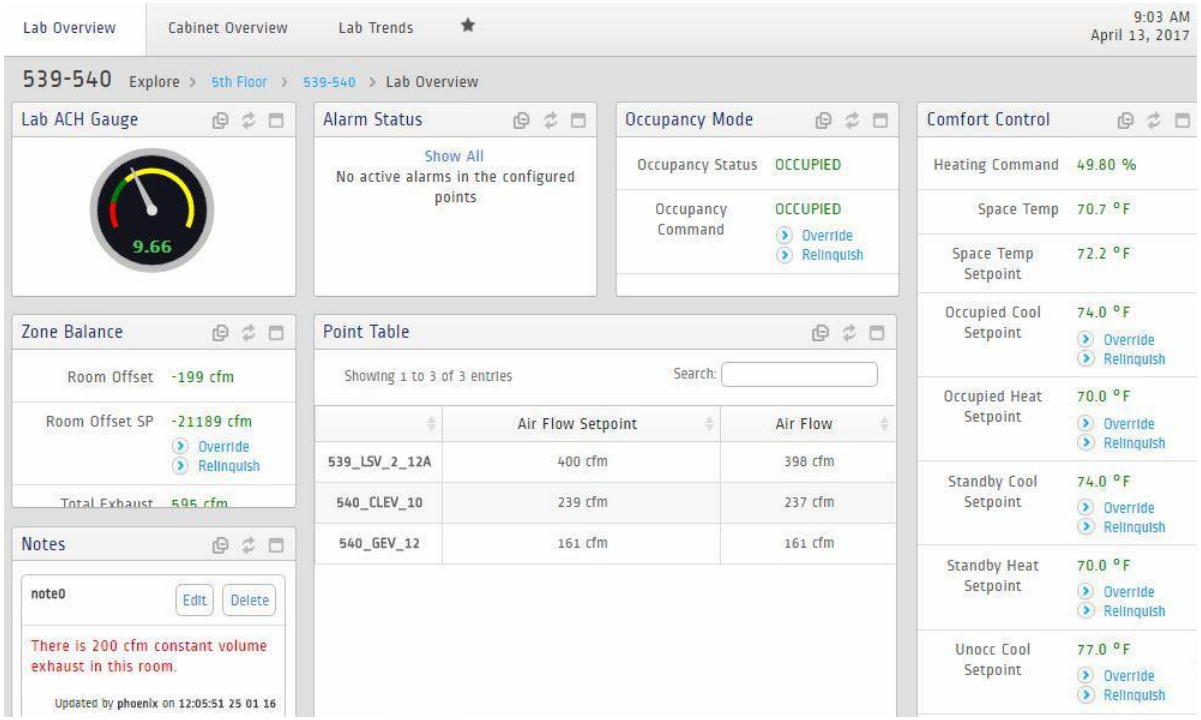
- Exhaust air valve differential pressure was Integrated from the Phoenix Control system
- Reset logic was implemented to monitor worst case air valve and reset exhaust system static pressure set-point
- The result was ~53% reduction in static pressure requirements. -1.5” to ~0.8”.

Energy Savings – Fume Hood Sash Alarm



- Fume hood controls were integrated into the BAS.
- Alarms were programmed to occur when a fume hood sash was open for >24 hours.
- Alarms triggered a service ticket to dispatch facilities staff to investigate the automatic sash closing mechanism.

Energy Savings – ACH Monitoring



- Air Change Rates were calculated and continuously monitored thru integration to the BAS.
- Alarms were programmed to occur when ACH were higher than 4 when the room was unoccupied.

Successful Controls Integration

- 9,000 data points from 280 labs
- All 9,000 data points were integrated from the laboratory control system to 2 separate control systems
  - Traditional Building Automation
  - Laboratory Control Dashboard
- 2,800 trends between the 2 systems
- No slowing or performance issues on the control system networks or remote access!

Learning
Objective Review

1. Identify the steps necessary to ensure proper controls integration.
2. Identify the targeted areas of design review.
3. Understand the role of commissioning during design review.
4. Identify potential energy savings strategies thru controls integration.

Sample Last Slide

This concludes The American Institute of Architects
Continuing Education Systems Course

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