Leveraging TAB and BAS for a Successful Cx Project

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.
Learning Objectives

• What TAB and BAS design issues to look for when doing your Cx review.
• Edit specifications to eliminate the wasted efforts and focus on the ones that deliver real value to the project.
• How to use the project specifications to encourage cooperation from the TAB and BAS contractors
• How to use the TAB conference to synchronize the efforts of the controls contractor and the TAB contractor
• Get on board with the General Contractors schedule so the Cx Tasks flow smoothly
Outline - Leveraging TAB and BAS for a Successful Cx Project

- Design Review – Specs and drawings for TAB and BAS
- Construction Phase Submittals for TAB and BAS
- Write final Cx Plan to match TAB & BAS
- Pre-TAB planning
- Construction Observations
- Controls Integration Meetings
- TAB, BAS and Cx testing together
How well do you know these guys?

- Cooperation from TAB and BAS will make your job easier
- If you’ve never worked with the TAB or BAS companies before take extra steps to get to know them.
How well do you know these guys?

Your Cx Plan Says:

“Functional performance testing does not begin until pre-functional, start-up and TAB is completed for a given system.”

It’s in your best interest to help him complete his work as fast as he can.
How well do you know these guys?

At the end of the project it’s often the TAB guy, BAS guy and you trying to finish the project.
Cx Design Review - Overview

- We often are hired during the design phase but the TAB and BAS contractors are not. Sometimes the TAB guy is hired in the middle of construction instead of after award.
- They don’t get a chance to edit or comment on their specs
- Offer to edit the TAB and BAS specs for the mechanical engineer. Most would welcome the effort. Use this to align their specs with your spec sections and Cx Plan.
- Design review is the time to add your items
• BCA website is a great resource for design review information.
• Visit Resources section
• Use “The Building Commissioning Handbook”
• BCA University has a session on TAB and another one on BAS
• Many of my ideas can be found there
• Are balancing device locations shown and specified?
• BV’s on pumps with VFDs are not needed.
• Is duct air leakage testing required? Big impact to cost and schedule.
• Suggest sampling pressure independent valves instead of assuming they are “self-balancing”. Check for plugged valves.
Spec Review – Piping Accessories

- Look for handle extensions.
- Pipe balancing and shut-off valve handles need to be extended past insulation.
Spec Review – Duct Accessories

- Balancing valve handles extended past insulation.
- Look for locking quadrant
- Require submittal of shop drawings to the TAB contractor
- Require bright colored ribbon tape on all volume dampers
Spec Review – Accuracy of TAB

Hoods are only +/- 5% accurate. Under 100 CFM even less so.

NEBB Instrumentation Accuracy - 2019
B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by [Owner] [Architect].

2. TAB firm test and balance engineer shall conduct the inspection in the presence of [Owner] [Architect].

3. [Owner] [Architect] shall randomly select measurements documented in the final report to be rechecked. **The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.**

4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

5. If the number of "FAILED" measurements is greater than 10 percent of the total and balancing shall be revised. Revise the final report and balancing device settings to include all changes and resubmit the final report.

Rather than recheck the readings, treat the TAB readings like other activities and witness a portion of the water and air balancing. I suggest a half-day each.

6. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.
Cx Design Review – TAB specs

3.38 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 230593
TAB specs – Plumbing

- HWR Balancing should be balanced by TAB not plumbing contractor
- Plumbing specs often don’t have a TAB section
- Plumbing details and drawings need to show BVs and GPMs
Design Review steps - DRAWINGS

- Verify that all drawings sheets are in the package
- Find each piece of equipment noted on the equipment schedules on the drawings
- Use a colored highlighter
- Note missing equipment
- Review controls drawings and note all that are missing.

- Setpoints are listed and follow usual industry standards.
- Alarms are listed, as well as the resulting actions that transpire from the alarm (DDC Notification, Call-Out, etc.).
- Once you have everything then compare to BOD and OPR
- Pay attention to valve locations, pipe/duct routes, etc.
- Verify service and maintenance clearances to each piece of equipment.
Cx Design Review – Drawing review

• Check to see if thermostats and sensors are shown
• Locations of flow meters, etc. with enough room for accurate measurements
• Location of SP sensor “2/3\text{rd}s of the way down the ductwork?”
Cx Design Review – Tagging all equipment

- When engineers only schedule the sizes. We need to step in and get individual tags for each piece of equipment
- Why is this important to BAS, TAB and electrician?
- Verify that equipment shown on drawing schedules is included in sequences

<table>
<thead>
<tr>
<th>GENERAL</th>
<th>HEATING</th>
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<tbody>
<tr>
<td>TYPE</td>
<td>SIMILAR TO (RTTUNING MODEL)</td>
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<tr>
<td>CUH-A</td>
<td>RFRWI-350 02</td>
</tr>
<tr>
<td>CUH-B</td>
<td>RFRWI-350 08</td>
</tr>
<tr>
<td>CUH-C</td>
<td>RFRWI-350 10</td>
</tr>
<tr>
<td>CUH-D</td>
<td>RFRWI-350 12</td>
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</table>
Cx Design Review – Tagging all equipment

- Equipment tags match
- All equipment is listed
- All equipment in system is in a sequence of operation
**Cx Design Review – VAV Box**

- Straight duct with no balancing damper.
- At least 4 ft. after VAV before the first diffuser.
- Check factory recommendations.

**Diagram:**

*Air terminal unit with discharge sound attenuator detail*

1. Maintain manufacturer’s recommended clearance in front of the air terminal unit control panel.
• Check controls drawings and specs to see if they match. Often the specs call for integral thermostats.
• BAS contractors don’t often bid off the detail sheet and might miss this
### Miscellaneous BAS Points

- The other MEP/FP engineers usually need help from the mechanical engineer to describe BAS requirements.
- Lighting controls and BAS interface
- Fire Alarm and BAS interface

#### System Points

<table>
<thead>
<tr>
<th>System Point</th>
<th>Point</th>
<th>Alarms</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>Plumbing Equipment</td>
<td></td>
<td></td>
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<tr>
<td>City Water Pressure</td>
<td>X</td>
<td>X</td>
<td>SENSOR BY PSC, TYP. FOR EA CONNECTION</td>
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<tr>
<td>Domestic Water Pressure</td>
<td>X</td>
<td></td>
<td>EACH PRESSURE AND COMMON ALARM</td>
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<td>Booster Pump</td>
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<tr>
<td>Water Heaters</td>
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<td>X</td>
<td>EACH, HIGH TEMP, LOW TEMP AND COMMON ALARMS</td>
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<tr>
<td>Sewage Ejector Pumps High Alarm</td>
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<td></td>
<td>EACH</td>
</tr>
<tr>
<td>Elevator Sump Pump High Water Alarm</td>
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<td></td>
<td>EACH</td>
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<tr>
<td>Air Compressor Pressure and Alarm</td>
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<td></td>
<td>EACH</td>
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<tr>
<td>Fire Protection System</td>
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<tr>
<td>System Inlet Water Pressure</td>
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<td>X</td>
<td>CITY SIDE OF FIRE PUMP</td>
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<tr>
<td>Building System Pressure</td>
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<td>PUMPS HEADER</td>
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<td></td>
<td>FROM PANEL DRY CONTACTS</td>
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<tr>
<td>Jockey Pump Common Alarm</td>
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<td>FROM PANEL DRY CONTACTS</td>
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<td>Emergency Power System</td>
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<tr>
<td>Each Emergency Power Transfer Switch Activated</td>
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<td></td>
<td>EACH</td>
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<td>UPS Battery Alarm</td>
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<td></td>
<td>LOW BATTERY (EACH)</td>
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<td>Fire Alarm System Signals To From BMS</td>
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<tr>
<td>FAS General Alarm</td>
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<td></td>
</tr>
<tr>
<td>FAS General Trouble Alarm</td>
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<tr>
<td>FAS Fan HOS Control</td>
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<td>2 POINTS PER FAN AS INDICATED IN ATC SEQUENCE</td>
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<tr>
<td>FAS Fan Status</td>
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<td></td>
<td>PROVIDE FAN STATUS AS INDICATED IN ATC SEQUENCE</td>
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<tr>
<td>Smoke Damper Status (FSD Included)</td>
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<td></td>
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<tr>
<td>FAS Compartmental Post Fire Purge</td>
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<td>INPUT POINT PER ZONE AS INDICATED PER DRAWINGS</td>
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<tr>
<td>50% of Damper Open</td>
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<td>PER AHU</td>
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<td>AHU Start/Stop</td>
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<td>PER AHU</td>
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<td>Energy Metering</td>
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<tr>
<td>Electricity Demand and Consumption (KW and KWH)</td>
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<td>INTEGRATE ALL POINTS EACH SERVICE (4)</td>
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<tr>
<td>Electricity Sub Meter Consumption (KWH)</td>
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<td></td>
<td>CONNECTION AT EACH METER HUB (30)</td>
</tr>
</tbody>
</table>
Airflow monitoring stations
Are they in both the BAS and the TAB scopes?
Will they fit?
LOCATION IS EVERYTHING

Ebtron air flow tube behind duct plenum structural support

Minimum OA

Maximum OA

(2) Max OA air flow tubes
DON'T LINK DAMPERS

PROBLEM – NOT ALL OA IS MEASURED

Supply cfm = 18,310
Min OA = 4,578
Fixed Exhaust = 910 cfm
Building Pressurization = 10% (of supply fan cfm) = 1,831

Return fan cfm setpoint = 
18,310 - 910 - 1,831 = 15,569

Recirculation Air = Supply cfm – OA flow = 18,310 – 4,578 = 13,732

Exhaust Air = Return Air – Recirculation Air = 15,569 – 13,732 = 1,837

ECON Damper position may not be equal to Exhaust Damper position!!
All outside air is measured
Cx Design Review – Airflow monitoring

- Variable flow needs to be calibrated at 100%, 75% and 50% by the TAB and BAS.
- Damper position settings may need to have different factors with lower flows.
Cx Design Review – Leak detection

Honeywell Refrigerant Gas Monitors (S301-IRF)
Honeywell Vulcain Refrigerant Gas Monitors give you the security you need, protecting you from dangerous gas leaks in building mechanical rooms.
Split-system AC unit in IT room.
What does this mean to the building operator? He can tell if the unit is running and if there is an alarm. No room temp., RH, etc.. And these are often rooms critical to the building functions like IT, security, elevator equipment etc..
AIR COOLED COOLING UNIT WITH REMOTE CONDENSER: AC-CC-1
With no interface with the BAS he has to go to the MRI equipment room to see what is happening.

Everything is on the tiny humidifier panel.
What does this mean to the building operator?

No interface with the BAS is shown.
Add a schematic showing temp sensors on all four sides of heat recovery wheel
VENMAR ENERGY RECOVERY VENTILATOR
WITH FACTORY PACKING
Always insist on showing temp sensors on all four sides of heat recovery wheel
Design Review – Public spaces

- Avoid accessible controls in public places.
- Notice the temperature knob is missing.
- Shut-off can be tampered with.
Final Cx Plan

• Write your Final Cx Plan to match TAB & BAS
• Know their scopes so you aren’t working against each other or without each other.
• The Cx Plan doesn’t have the power of a contract. Don’t write something you can’t enforce.

• Examples:
• TAB and BAS often put exceptions in their contract
• Witness TAB rather than recheck
• Check BAS for trending
Review submittals for TAB & BAS

- Insist on getting a submittal from TAB.
- Insist on BAS submittal arriving early in construction phase. You need time for coordination.
Prebalance Conference

• It's often called for in specs. But seldom used.
• Holding this meeting can help achieve cooperation.
• Don't rely on the specs for definition of TAB scope of work. You should ask.
• On small jobs you can do this by tele-conference
• For large jobs they should be attending your Cx meetings so maybe this is not necessary. They will want to talk about schedule. Discuss the critical rooms like ORs, labs, etc..
Sometimes it’s called a TAB Conference

• Requires submittal
• Contract documents examination report
• TAB plan
• Schedule
• Coordination

Federal government version has:

• Design Review Report
• Systems Inspection Report
• Systems Readiness Report
Certified TAB Agencies

There are 3 TAB agencies. Specs often reference these organizations and their procedures:

- **NATIONAL ENVIRONMENTAL BALANCING BUREAU**
  Procedural Standards for TAB Environmental Systems 7th Edition 2005

- **ASSOCIATED AIR BALANCE COUNCIL**
  AABC National Standards for Total System Balance 2002 Edition

- **TESTING, ADJUSTING, & BALANCING BUREAU**
  The TABB Procedural Guide Published 2003
Certified TAB Agencies

- Each TAB agency has published their procedures.
- These should be in your library.

  - NEBB
    - 7th Ed. 2005
  - AABC
    - 2002 Ed.
  - TABB
    - 2003 Ed.
TAB Conference Agenda

- Design Examination
- TAB Plan with scope
- Compare TAB scope to Cx and BAS
- Discuss what software is used for BAS, TAB and Cx
- What are the restrictions for access or use?
- Schedule for TAB, BAS and Cx
Software used by TAB, BAS and Cx

• The specs normally say the BAS contractor must allow access and all tools needed for their system.
• It’s wise to ask rather than be surprised in the field.
Software used by TAB, BAS and Cx

TAB contractors are automating too.
These platforms will help with cooperation
Ask for read only access for faster information exchange
**Schedule for TAB, BAS and Cx**

Discuss when and how many techs are needed for the FPT’s. Explain why the tech is needed and what level tech is required. Don’t schedule AHU testing while TAB is still doing terminal units.

<table>
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<th>Description</th>
<th>Area Served</th>
<th>2 YAV Status</th>
<th>Scheduled Status</th>
<th>Actual Dates</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
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<td>5.9</td>
<td>5.16</td>
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<td>7/11</td>
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<td>6/1/11</td>
<td>7/3/11</td>
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<tr>
<td>Commissions</td>
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<td>Commissions Revised</td>
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<td>6/9/11</td>
<td>TAB</td>
<td></td>
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*This was done for each system*
Cx Construction Review

[Diagram and image of pipes]
Cx Construction Review

Material List

<table>
<thead>
<tr>
<th>Tag/Name</th>
<th>Part No.</th>
<th>Quantity</th>
<th>Description</th>
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<td>BLR-C</td>
<td>R8UIC</td>
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<td>Enclosed Relay 24VAC</td>
</tr>
<tr>
<td>CT1-C</td>
<td>R8UIC</td>
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<td>Enclosed Relay 24VAC</td>
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<td>R8GTA</td>
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<td>Current Sensor</td>
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<td>Alarm Flame Safety Circuit</td>
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<td>D&amp;T</td>
<td>TE-6SM1-1</td>
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<td>Outdoor Air Temp Sensor</td>
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<td>PM-T</td>
<td>LP-NVR611-000C</td>
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<td>Mechanical Room Temp Sensor</td>
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<td>Immersion Temperature Sensor</td>
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<tr>
<td>E-T</td>
<td>TE-630DW-101</td>
<td>8</td>
<td>Immersion Sensor Well</td>
</tr>
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</table>

Sequence of Operation

LOOP PUMPS:
The loop pumps will alternate operation weekly. If the lead pump fails, the secondary pump will operate and an alarm will be generated by the DDC control system.

Day mode: The primary loop pump will operate when any unit calls for heating or cooling.

Night mode: The primary pump will operate when any unit calls for heating or cooling.

LOOP TEMPERATURE CONTROL: As the system supply water temperature (SYS-SW-T) rises above set point of 80°F (adj.), the cooling tower circulating pump (P-4) will be enabled and shuts off at 75°F. As the system supply water temperature (SYS-SW-T) continues to rise above 90°F, the cooling tower (CT-1) and shuts off at 85°F. Once enabled, the cooling tower will be controlled by package controls.

BOILER:
As the system supply water temperature (SYS-SW-T) falls below set point of 60°F (adj.), the boiler (BLR-C) and boiler pump (P3-C) will be enabled. The boiler will be controlled by package controls. The boiler (BLR-C) and boiler pump (P3-C) will shut off at 70°F.
Cx Construction Review

[Image of a construction review with labels 'Supply temp' and 'Return temp']
Controls Integration Meetings

Part 1 – Hold the meeting after submittal review by design engineer and Cx and before re-submittal.

Part 2 – As second part of the meeting invite all trades that touch the BAS such as plumbing, electrical, FA, etc.
Controls Integration Meetings

During the early construction phase
• Design team
• Controls contractor
• Electrical contractor
• Fire alarm contractor
• TAB contractor

It often takes more than one meeting to coordinate all of these details.
Controls Integration Meetings

Part 3 – Hold a separate meeting with the controls tech who will be doing the programming prior to him starting. This planning meeting assures that all the accumulated information gets transferred to him.

Part 4 – Have them submit the controls graphics 3 months prior to substantial completion. Try to foster facilities staff participation in this controls integration meeting.
Controls Integration Meetings - Graphics
Controls Integration Meetings - Graphics
Controls Integration Meetings - Graphics
TAB and Controls Testing with Cx

- Room pressurization control testing
TAB and Controls Work Review by Cx

- Options for verifying the TAB work
  - Hire a 2nd TAB firm to re-read 10% of the readings
  - Witness like other contractor tests
  - I don’t recommend repeating the tests yourself
- Verification should include a check of the TAB-reported airflows against airflow readings as shown through the BAS.
TAB and Controls Review Work by Cx

- Check Critical BAS documentation:
  - Terminal/branch airflow readings:
    - TAB report of which branch damper is 100% open. (NEBB requirement)
    - Settings of terminal damper positions for critical room pressure readings.
  - AHU total airflow readings:
    - Damper positions, duct pressure readings, etc.
    - Documentation of most critical boxes for static pressure verification.
    - Operation details of other AHU components or return fans that may affect results.
  - Pump flow:
    - Balance valve and control valve settings/positions.
    - Documentation of critical valves and zones for differential pressure setting verification
    - Hydronic flow meter reading verification.
Summary –
Leveraging TAB and BAS for a Successful Cx Project

• Design Review – Specs and drawings for TAB and BAS
• Construction Phase – Submittals for TAB and BAS
• Write final Cx Plan to match
• Pre-TAB planning
• Construction Review
• Controls Integration Meetings
• TAB, BAS and Cx testing together
Questions?

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