# Do the Right Thing:

## The Importance of Commissioning, Controls, & TAB in Lab Buildings

Presented by B2Q Associates, Inc.

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*A Woman Business Enterprise (WBE)*

# Learning Objectives

- Understand the role a commissioning agent has in the design, construction, operation, verification, and training of staff in new construction or major renovation.
- Understand the role of the Testing, adjusting, & balancing (TAB) contractor in verifying laboratory safety and optimizing operating costs
- The impact of proper commissioning and TAB on laboratory buildings on the long-term safety, performance, operating costs of lab buildings and the wellbeing of its occupants
- Review of industry standards for TAB and Commissioning and recommended Improvements

# Familiar Story?

- Build a $125 - $200 million lab facility
  - $8-10 million & 2 years on planning & design
  - $5-7 million on “advanced” HVAC controls
  - $150,000 & 4 weeks on commissioning (0.1%)
  - Spend $100,000 & 4 weeks on TAB (0.05%)

# Familiar Story?

## The Good:

- Very good looking building
- Attractive, modern façade and interior
- Nice furniture and surfaces
- Spacious and functional labs & offices

## The Bad:

- Lots of occupant complaints
  - Noise and Comfort issues
  - Annoying controls
- Expensive to operate
  - Excessive energy use & $
  - Costly & consistent maintenance
- Loss of occupants

# Why Cx & TAB of Lab Controls Important?

- The goal of laboratory (or fume hood) ventilation controls is to sufficient and effective ventilation and pressurization.
- Provide a safe and comfortable working environment while keeping operating & maintenance costs at reasonable levels
  - Safety
  - Comfort (temp, RH, noise)
  - Consistency (temp & RH)
  - Reliability / maintainability
  - O&M costs

LAB AIR IS EXPENSIVE

| Project Name | Savings Metric |
|---|---|
| | $/cfm |
| NY College Science Center | $2.82 |
| UMass - LSL | $4.05 |
| UMass - ISB | $4.35 |
| UMass - Elab II | $10.33 |

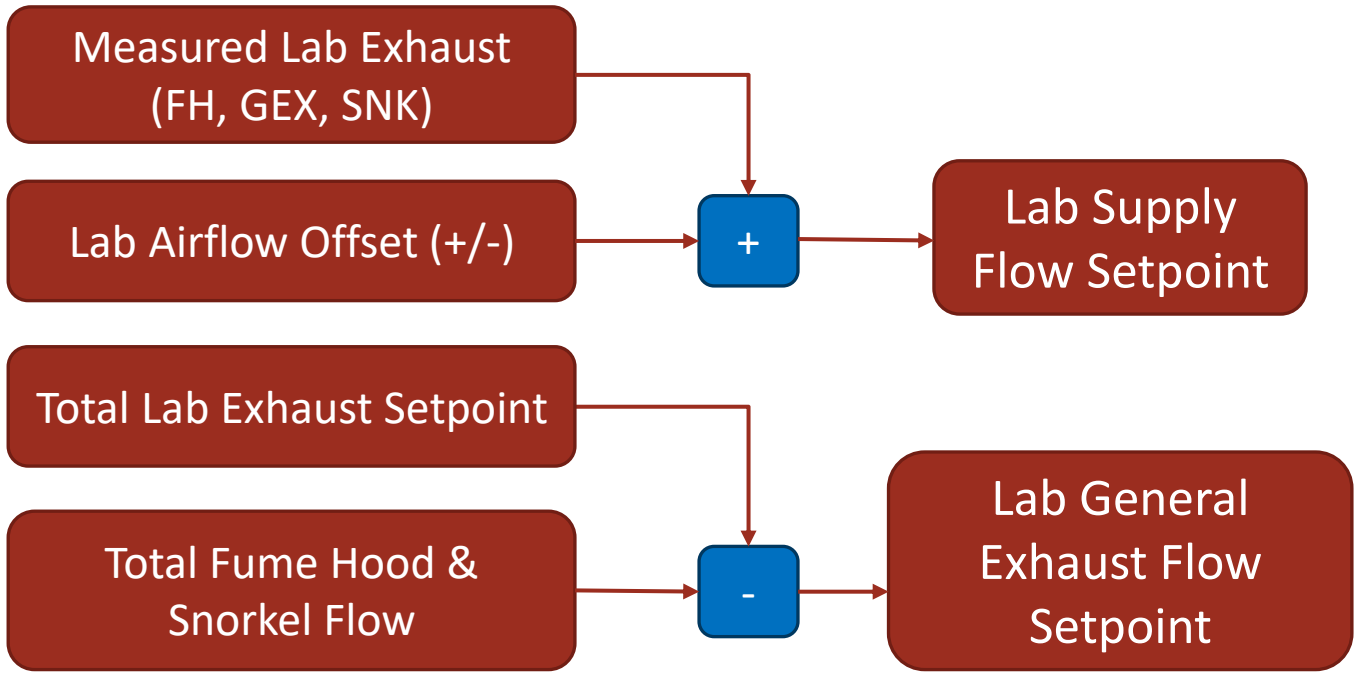
# Commissioning Myths

- Many owners (and others) think commissioning takes place only in the last few weeks/months before occupancy.
- Commissioning is just a bunch of checklists that the Cx Agent has to do at startup
- The Cx Agent is the only one involved in commissioning
- Commissioning is only required for LEED or State req's
- Cx is just to make sure all equipment is functional
- Cx shouldn't cost more than a few tenths of % of budget

# Importance of Commissioning

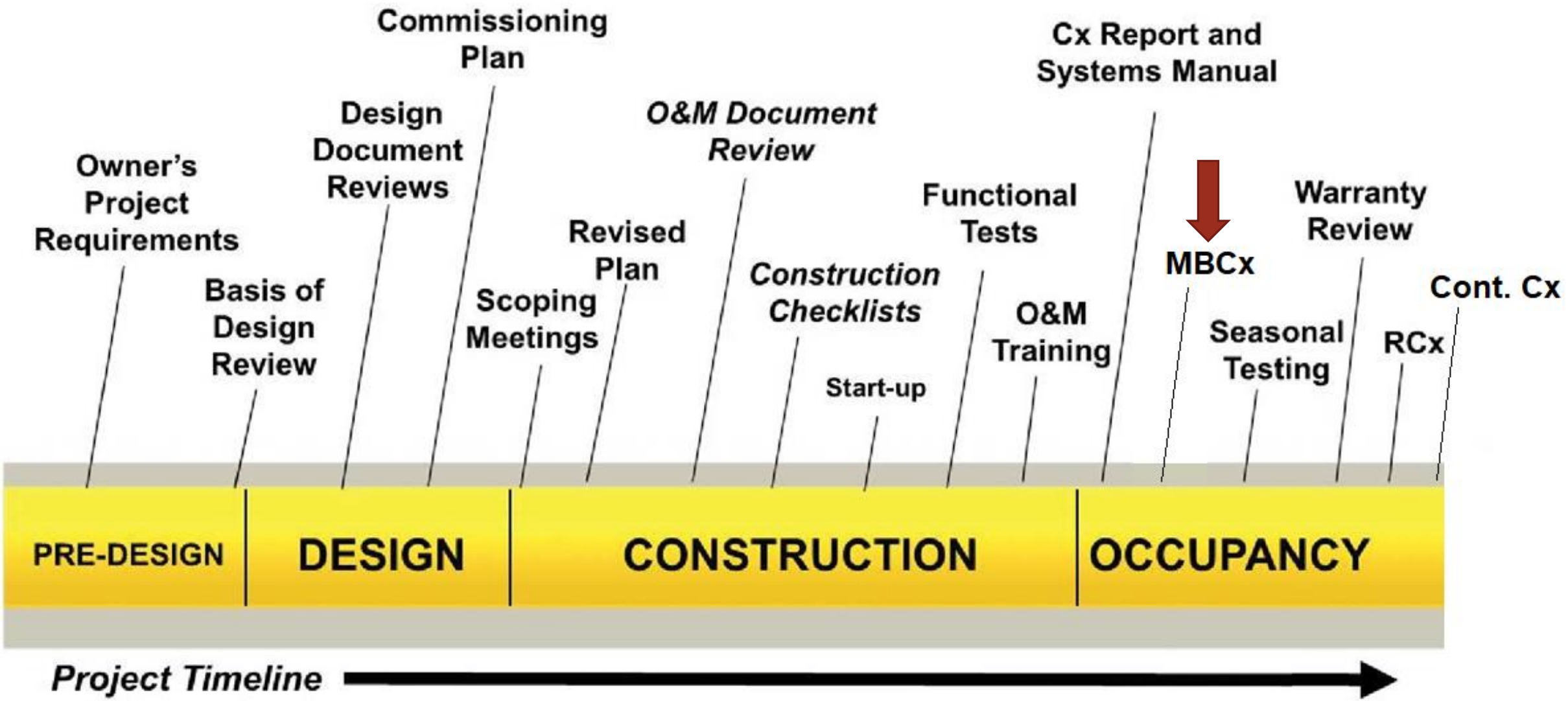
- Commissioning is a continuous process that, when executed properly, helps ensure that equipment and **systems** will meet design intent, contract documents, and updated owner requirements.

- Commissioning not only validates functionality of individual components and systems, but the **interaction** of these



# Typical Cx Process

# Comprehensive Cx Process – More than FPTs!

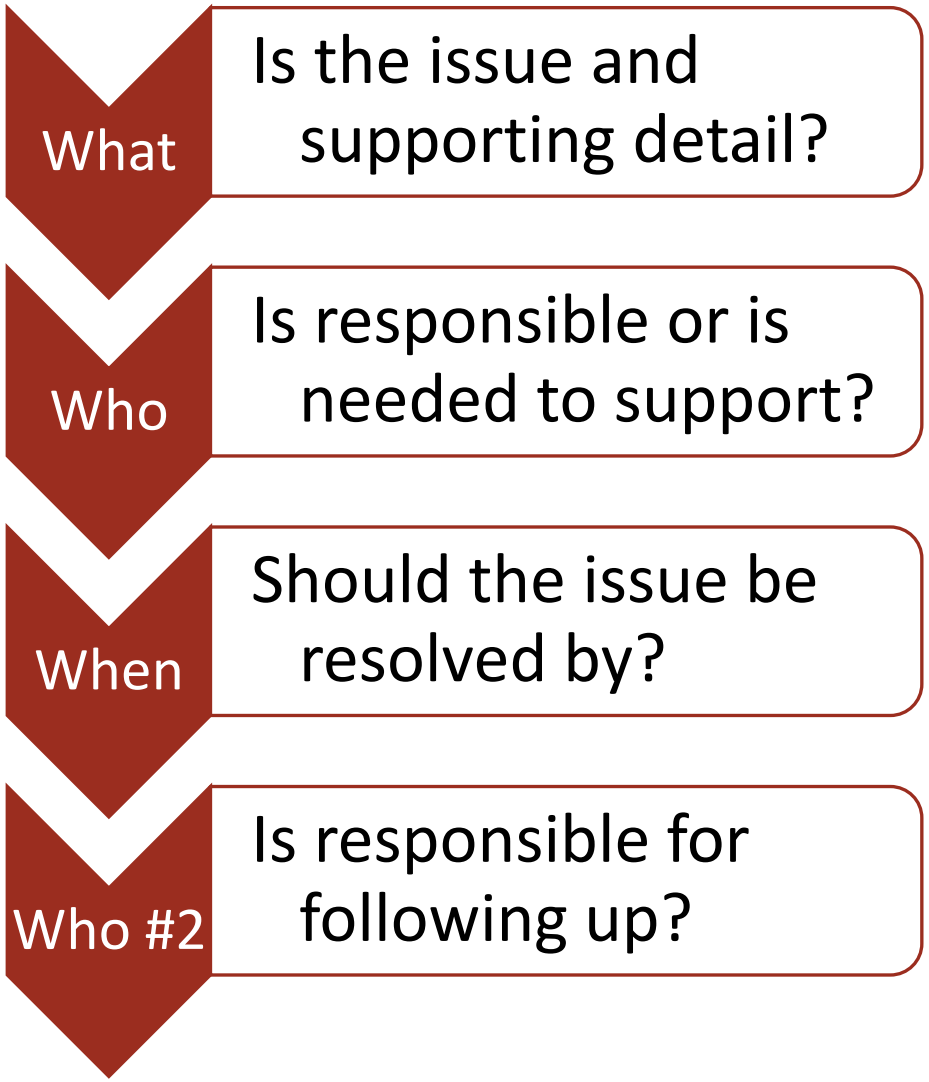


# Keys to Successful Commissioning

- CxA should be involved early & work for the owner directly
- CxA should be involved in development / review of OPR & BoD + controls, HVAC, TAB, & Cx design and specs.
- Solid, comprehensive, & building-specific Cx & TAB specs.
- Cx & TAB should have sufficient time to perform scopes
- CxA should & owner/OPR need to hold D&C team accountable to contract documents
- Comprehensive, multi-faceted O&M training
- Cx process should continue through 1st year of occupancy

# Consistent & Actionable Communication

- What good is an issues log if it doesn't give direction and provide useful information?
- The commissioning agent's communication with the owner, contractors, and design team must be consistent and actionable
- It must be understood that the CxA is not on the project to direct the contractors
  - CxA role is to review, witness, verify, record, and communicate observations continuously with the owner.



# Collaborative Approach – There's a lot of people at the table

- Commissioning needs to be systematically planned and performed with buy-in from all stakeholders
  - The value to the Owner, in terms of building systems efficiency, functionality, and maintainability can be significant.
- A haphazard or non-collaborative approach will most often be a waste of time and money and result in inferior building performance.

# Role of TAB Contractor

## FOREWORD

The purpose of the NEBB *Procedural Standards for Testing Adjusting and Balancing of Environmental Systems* is to establish a uniform and systematic set of criteria for the performance of the testing, adjusting and balancing of environmental or Heating, Ventilating and Air-conditioning (HVAC) systems.

Today's buildings provide highly controlled indoor environments. These conditions could not exist without sophisticated mechanical systems created by a team of skilled professionals. A key member of this team is the NEBB Certified Test, Adjust, and Balance (TAB) Firm.

# Keys for Successful TAB

- Comprehensive & building- & controls-specific TAB spec
- Engineer & CxA should indicate how TAB to be performed
- Proper design & installation – duct layout, device sizing, proper balancing devices & located properly, accessible.
- Allow early / sufficient time for TAB and proper access
- Have the TAB contractor on site / at meetings earlier
- Engr & CxA should engage TAB – **they're knowledgeable!**

# Flow Measurement Accuracy

- Industry standard for VAV flow station setup, calibration, balancing is at design max flow
- BUT….VAVs typically operate in mid- to low-range
- VAV k-factors should be setup across the range of the VAV
  - or somewhere close to typical operating conditions
- If static reset or adjustment, should measure at lower static

# Cx Deficiency Example – Sequence Inconsistencies

- 2 new lab buildings (adjoining buildings): 4 & 2 years old
- Separate design teams but same campus-wide controls contractor.
- Each building had drastically different lab ventilation sequences; only one of them was acceptable.
- Construction drawings for the 2-year old building were lacking in their description of ventilation control; only stated ACH setpoints.
  - No total lab exhaust flow setpoint … difficult to control to occ/unocc ACH
  - Fume hood, snorkel & cabinet airflows not accounted for in room balance
  - Exhaust flow tracked supply flow

# Cx Deficiency Example – Sequence Inconsistencies

- How did this happen?
  - Insufficient OPR / BoD or design standard?
  - Missed in design & submittal reviews?
  - Execution was poor
  - Inexperienced programmer & lack of oversight from controls contractor
  - CxA may not have been actively involved during the design phases
  - CxA may have caught and/or time/scope/funding cut short?

SHOP DRAWING / SUBMITTAL REVIEW

[X] APPROVED AS SUBMITTED [ ] APPROVED AS NOTED

[ ] REVISE AND RESUBMIT [ ] NOT REVIEWED

*Corrections or comments made relating to the submittals/shop drawings during this review do not relieve contractor from compliance with requirements of the drawings and specifications. The engineer is responsible for reviewing this submittal for conformance to design intent of the project and general compliance with contract documents. The contractor is responsible for selecting fabrication processes and techniques of construction, coordinating his work with that of all other trades, and performing his work in a safe and satisfactory manner. The contractor is responsible for all installation details. Contractor is responsible for all costs and performance of substitutions regardless of their approval herein.*

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# TAB Example

| SUPPLY DEVICES | | | |
|---|---|---|---|
| Lab | Device | Average % Error | GEX or Supp |
| S560AB | S560B-SUPP | -29% | SUPP |
| S560CD | S560D-SUPP | -22% | SUPP |
| S570 | SUPP | 10% | SUPP |
| S340 | SUPP | 12% | SUPP |
| S463 | SUPP | 14% | SUPP |
| S330 | SUPP | 22% | SUPP |
| S350A | VAV SUPP | 47% | SUPP |

| EXHAUST DEVICES | | | |
|---|---|---|---|
| Lab | Device | Average % Error | GEX or Supp |
| N350A | GEX | -19% | GEX |
| N260CD | North GEX | -14% | GEX |
| N340AB | Alcove Exhaust | 10% | GEX |
| S461 | GEX | 10% | GEX |
| S320E | GEX | 11% | GEX |
| N340AB | South GEX | 12% | GEX |
| S340 | GEX | 21% | GEX |
| S330 | GEX | 24% | GEX |

| Sample Statistics | |
|---|---|
| Total Devices Sample | 42 |
| Total Above 10% Error | 15 |
| Percent Above 10% Error | **36%** |
| Excess Exhaust | 6 |
| Excess Supply | 5 |
| Under Exhaust | 2 |
| Under Supply | 2 |

- 650 total devices
- At 36% → 234 devices need adj.

- Need to re-TAB
- Safety issues
- Energy waste

# Economics 101

## For a 150,000 ft² lab building → Proper Cx & TAB:

### Energy Savings

- Baseline energy costs = $1,250,000 /year
- Assumed savings w/ Cx & TAB = 20%
- Annual Savings: $250,000
- 10 year savings w/ 2.5% degradation:
  - **$1,700,000**

### Maintenance Savings

- Baseline maintenance= $250,000 /year
- Assumed savings w/ Cx & TAB = 20%
- Annual Savings: $50,000
- 10 year savings: **$500,000**

### Total 10-year Cost Savings:

- $1,700,000 + $500,000 = **$2,300,000**

### Incremental Cost of Cx & TAB

- Base Cx = $225,000 ($1.50 /ft²)
- Proposed Cx = $450,000 ($3.00 /ft²)
- Base TAB = $300,000 ($2.00 /ft2)
- Proposed Cx = $450,000 ($3.00 /ft2)

### Project Payback

- Initial incremental cost: $375,000
- Savings after 2 years = $593,750
- **< 2 year payback**
- Gross benefit 10 year life w/ RCx at 5 yrs
  - $2,300,000 - $375,000 - $500,000
  - **$1,425,000 in savings**

# Final Remarks

- Laboratory airflow control is critical to the health and safety of lab occupants
- Commissioning is a team effort!
- Commissioning starts in pre-design and should involve solid Cx & TAB specs
- Well-performed commissioning and TAB of the building systems are all critical to the ongoing performance, safety, and O&M costs of the building.
- Owner must provide sufficient budget and schedule to allow for comprehensive commissioning, TAB and controls.
- Owner / OPR must hold contractors and designers accountable and ensure punch list and commissioning issues log items are appropriately resolved.

# Questions?

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