



LEED v4 Cx Masterclass

The value of adding commissioning to your project –
and why you shouldn't expect any less!

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Overview LEED & Code Commissioning Requirements

Cx Process throughout all Project Phases and Occupancy

Monitoring Based Commissioning and Synergies with EM

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LEED v4 Cx Masterclass

The value of adding commissioning to your project – and why you shouldn't expect any less!

Experience and research demonstrate that Commissioning on a new construction project has the potential to bring significant value to a project. By hiring a Commissioning Agent just to comply with code or to check the box on a scorecard, owners and project teams miss out on the real potential they have at hand to deliver high quality buildings and systems, with functionalities as designed and expected by the owner.

This class will demystify the varieties of Commissioning requirements and options and instruct on how to apply Commissioning to maximize value to a project. Starting with the process for LEEDv4 BD+C Fundamental and Enhanced Commissioning, the presentation explains the approach and integration during the design, construction and occupancy phases. The presentation then describes the benefits of Monitoring-Based and Building Enclosure Commissioning and how other LEED credits, such as energy modeling, can create synergies with the Commissioning process. The presentation is backed by real-world examples from projects in the United States and Europe and includes recent survey results on the costs and benefits of Commissioning.

Abstract

Oliver Baumann, President

In 2006, German-native Oliver Baumann relocated to the United States to establish Baumann Consulting, successfully growing the business from a one-man operation to a transatlantic firm with a staff of 25 located in three offices across two continents.

Oliver has two decades of experience in design, commissioning, and measurement & verification for high-performance buildings. Building on his previous experiences in Germany, Oliver's expertise covers the entire lifecycle of commercial, institutional and industrial buildings and facilities, from developing innovative energy concepts to the evaluation of building performance and operation.

Oliver is an ASHRAE certified Building Commissioning Professional (BCxP) and is currently teaching Building Performance Verification at The Catholic University in Washington, D.C.



Tony Lyons, Commissioning and Energy Engineer

Tony joined Baumann in 2018 and has experience in commissioning (Cx) of mechanical systems HVAC, controls, fire alarm, fire protection, and building enclosure. His involvement in Cx includes management of the overall process, Cx plan development, design reviews, specification writing, development of FPTs, field inspections and testing, and troubleshooting. He is also involved in O&M training and manual reviews.

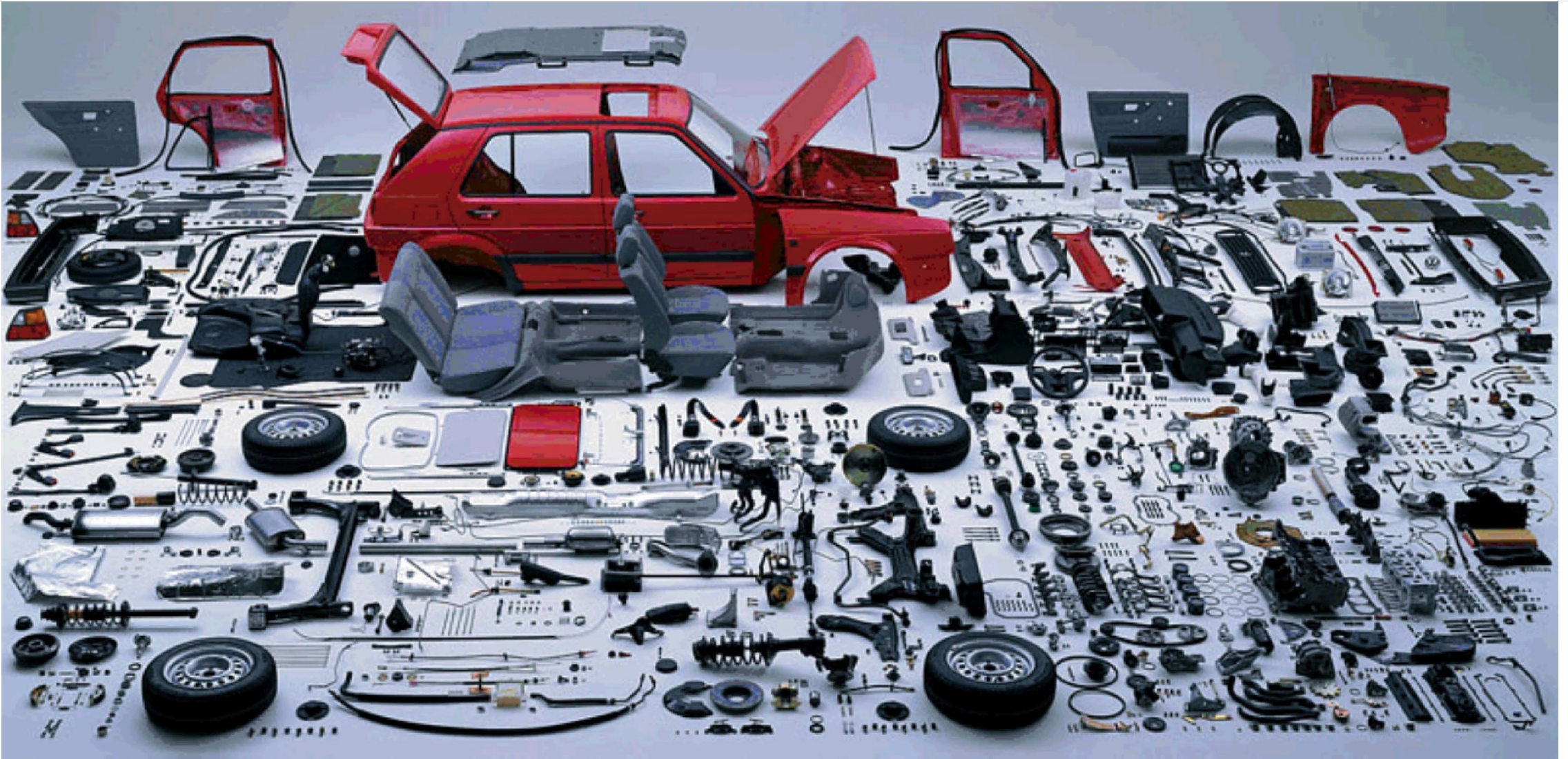
Tony has assisted in or led efforts of over 25 commissioning projects located in the US. Tony's worked in the past as both a general contractor and building engineer, and he carries the lessons he learned into his role as Cx provider.



Presenters

- Understand how to meet the LEED v4 BD+C Fundamental Commissioning and Verification prerequisite to maximize value; improved design, earlier identification and resolution of construction issues, and optimized building operation.
- Understand the approach and value of Option 1, Path 2 – Enhanced and Monitoring-Based Commissioning and Option 2 – Envelope Commissioning in the LEED v4 BD+C Enhanced Commissioning credit.
- Utilize synergies between the LEEDv4 BD+C Fundamental Commissioning and Verification prerequisite and the Enhanced Commissioning credit, along with other LEED v4 BD+C credits, such as Optimize Energy Performance.
- Quantify the costs and benefits of implementing commissioning early in projects.

Learning Objectives



What is Commissioning?

BCxA

Commissioning is a systematic process of assuring that a building performs in accordance with the design intent and the owner's operational needs.

ASHRAE

A quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements.

WBDE – Whole Building Design Guide

Building Commissioning is the professional practice that ensures buildings are delivered according to the Owner's Project Requirements (OPR). Buildings that are properly commissioned typically have fewer change orders, tend to be more energy efficient, and have lower operation and maintenance cost. The documentation of the commissioning process provides the foundation for correctly benchmarking the baseline energy consumption of the facility.

AIA

Commissioning is a proactive process that is safeguarding the design approach and by extension the objectives set out in the OPR. Without a robust commissioning process in place, architects and the design team are often only reacting to situations that arise during construction. The last-minute nature of this kind of situation often does not allow for many choices, and the design and construction team has to develop a solution that may erode the original design approach.

What is Commissioning?

Drivers

- Code Compliance
 - LEED
 - 2012 IgCC – Section 611 / chapter 9
 - 2018 IgCC – Section 10
 - ASHRAE 189.1 / 202
- Sustainability Certification – LEED, Green Globes
- Incentive Programs
- Smoother Process and Turnover (BCxA Survey)
- Owner Awareness (BCxA Survey)

Value

- Better performing buildings and systems
- Lower number of change orders
- Quicker close-out
- Fewer call-backs
- Improved documentation

Why do Commissioning?

ASHRAE

- Standard 202-2018 – Commissioning Process for Buildings and Systems (50 pages)
- Guideline 0-2013 – The Commissioning Process (68 pages)
- Guideline 1.1-2007 – HVAC&R Technical Requirements for The Commissioning Process (146 pages)
- Guideline 1.5-2017 – The Commissioning Process for Smoke Control Systems (32 pages)

BCxA

- 2017 Building Commissioning Handbook, 3rd Edition (348 pages)

GSA

- The Building Commissioning Guide (100 pages) – Apr. 2005

NIBS

- NIBS Guideline 3-2012 – Building Enclosure Commissioning Process BECx (337 pages)

ASTM

- ASTM E2947 Standard Guide for Building Enclosure Commissioning (22 pages)
- ASTM E2813 Standard Practice for Building Enclosure Commissioning (19 pages)

CCC

- California Commissioning Guide: New Buildings (84 pages)

CIBSE

- Commissioning Code M: Commissioning Management (26 pages)

Commissioning Standards & Guidelines

ASHRAE

- BCxP – Building Commissioning Professional
- CPMP –Commissioning Process Management Professional (retired)

BCxA

- ACP – Associate Commissioning Professional
- CCP – Certified Commissioning Professional
- CCF – Certified Commissioning Firm

AEE

- CBCP – Certified Building Commissioning Professional

ACG – AABC Commissioning Group

- CxA – Certified Commissioning Authority

NEBB

- BSC – Building Systems Commissioning Certification

University of Wisconsin-Madison

- QCxP – Qualified Commissioning Process Provider Certificate

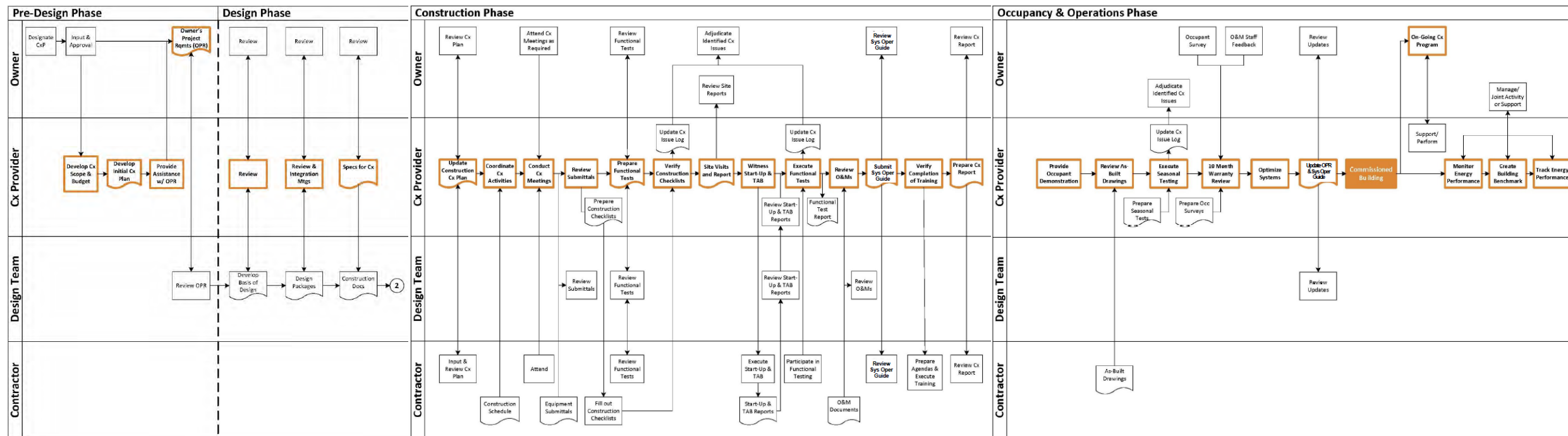
Commissioning Qualifications & Certifications

- BCxA – New Construction Building Commissioning Best Practices (May 2018)
<https://www.bcxa.org/wp-content/uploads/2018/11/BCA-New-Const-Best-Practices-2018-05-14-V2.0.pdf>
- BCxA – Cx Application Tools: Samples and Templates
<https://www.bcxa.org/knowledge-center/best-practices/cx-application-tools/>
- BCxA Position Paper – Building Commissioning Survey: Portfolio Owner Practices and Perceptions (Nov. 2014)
https://www.bcxa.org/wp-content/uploads/2014/12/Portfolio-Owner-Summary_2014.pdf
- BCxA Position Paper – Qualification-based Selection (QBS) Process (Dec. 2014)
<https://www.bcxa.org/wp-content/uploads/2014/12/QBS-Position-Paper.pdf>
- WBDG – Whole Building Design Guide Building Commissioning with References to additional resources, agencies, organizations, publications, etc.
<https://www.wbdg.org/building-commissioning>
- NEBB – Sample Testing Specifications
<http://www.nebb.org/resources/specifications/>
- USACE – Commissioning Requirements
<https://www.usace.army.mil/Missions/Sustainability/Expertise-in-Sustainability/Commissioning/>
- GSA – Commissioning Program
<https://www.gsa.gov/commissioning>

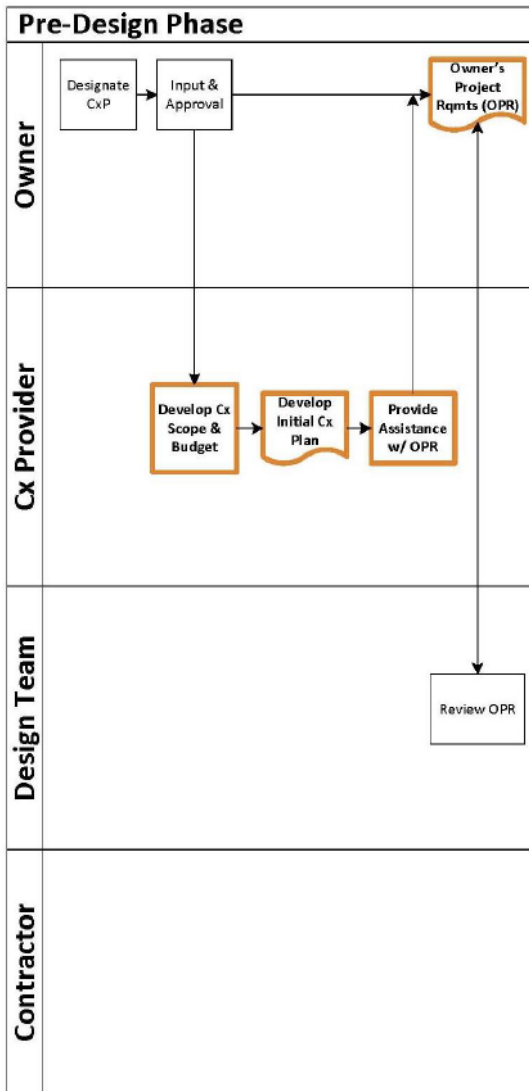
Commissioning – Other valuable Resources

Phase	Tasks	Fundamental Cx (Eap) prerequisite	Enhanced Cx (EAc) 3 pts	Monitoring Based Cx 1 pt	Building Enclosure Cx 2 pts	IGCC 2012	IGCC 2018
Pre-Design	Develop OPR	●	●	●	●		●
	Assemble Cx Team	●	●	●	●	●	●
Design	OPR/BOD Reviews	●	●	●	●		●
	Design Review	●	●	●	●		
	Specifications	●	●	●	●	●	●
Construction	Submittal Reviews		●	●	●		
	Installation & Performance Verification	●	●	●	●	●	●
	Systems Manual		●	●	●	●	●
	Training		●	●	●		
Occupancy	Seasonal Testing / Monitoring-Based Cx			●		●	●
	10-Month Warranty Review		●	●	●		

Overview Commissioning Requirements



Commissioning Process



Objectives

- Identify the Commissioning Team
- Develop the OPR
- Define the initial commissioning scope and budget
- Develop the initial commissioning plan
- Verify that the building program is consistent with the OPR.
- Integrate commissioning into the overall project delivery process and begin building the Commissioning Team.

Pre-Design Phase Commissioning

Phase	Tasks	Value
Pre-Design Phase	Develop OPR	<ul style="list-style-type: none"> Clearly defined expectations, goals, benchmarks and success criteria for the project. Clearly defined commissioning scope, schedule and budget.
	Assemble Cx Team	<ul style="list-style-type: none"> Independent expert and advocate for the Owner to keep track of and verify functionality and performance goals of the project.

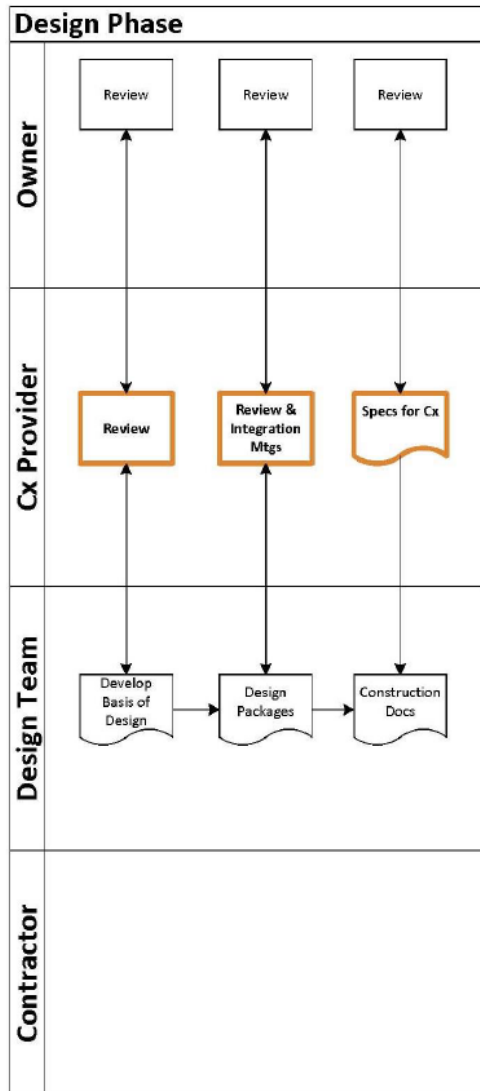
► Commissioning RFP:

- BCA – Request for Commissioning Services Proposal
<https://www.bcx.org/knowledge-center/best-practices/cx-application-tools/>
- LEEDuser – Commissioning RFP Template
<https://leeduser.buildinggreen.com/credit/NC-v4/EAp1> (requires account)
- GSA – RFQ for Commissioning Agent
<https://www.gsa.gov/real-estate/design-construction/commissioning/commissioning-program/appendices/sample-commissioning-services-statement-of-work>

► Commissioning Contract:

- AIA Document C203™–2017 (replaces B211™–2007) – Standard Form of Consultant’s Services: Commissioning
<https://www.aiacontracts.org/contract-documents/155151-standard-form-of-consultants-services-commissioning?tab=library>

Pre-Design Phase Commissioning



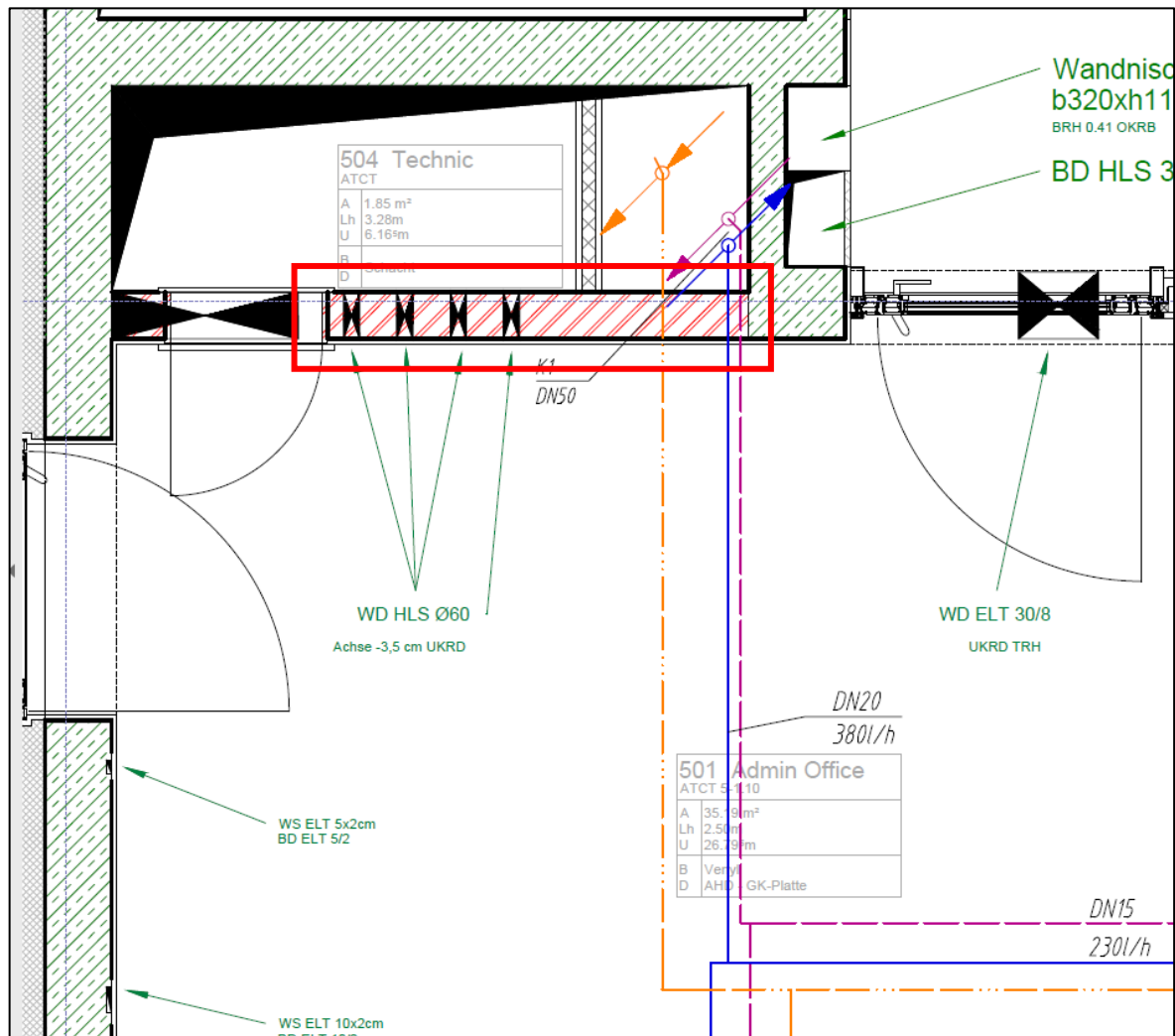
Objectives

- Communicate the commissioning requirements to other project team members.
- Verify, through review, that the design documentation is consistent with the OPR and BOD.
- Ensure that commissioning requirements are included in the construction documents.
- Build Engagement and cooperation among the project team members.
- Review drawings from an operator/occupant lens

Design Phase Commissioning

Phase	Tasks	Value
Design Phase	OPR/BOD Reviews	<ul style="list-style-type: none">• Owner priorities and foundational design basis carry through to project completion.• Provides a basis for all reviews, checks, and testing.
	Design Review	<ul style="list-style-type: none">• An extra pair of eyes catches errors, preventing change orders later• A review based on the OPRs keeps priorities from getting lost• Suggestions are generated for optimization, higher efficiency, better maintainability, etc.
	Specifications	<ul style="list-style-type: none">• Generates clearer requirements on what the contractor must demonstrate, reducing headaches later on, when stress is high.

Design Phase Commissioning



The Cx Design Review revealed that the water piping layout was not coordinated with the location of the wall penetrations. There is no guarantee that the contractor will know whether the penetrations or the piping show the correct location. This can lead to unnecessary penetrations, additional piping installed, and incorrect system installation.

➔ Expect your Cx Engineer to point out coordination issues between disciplines.

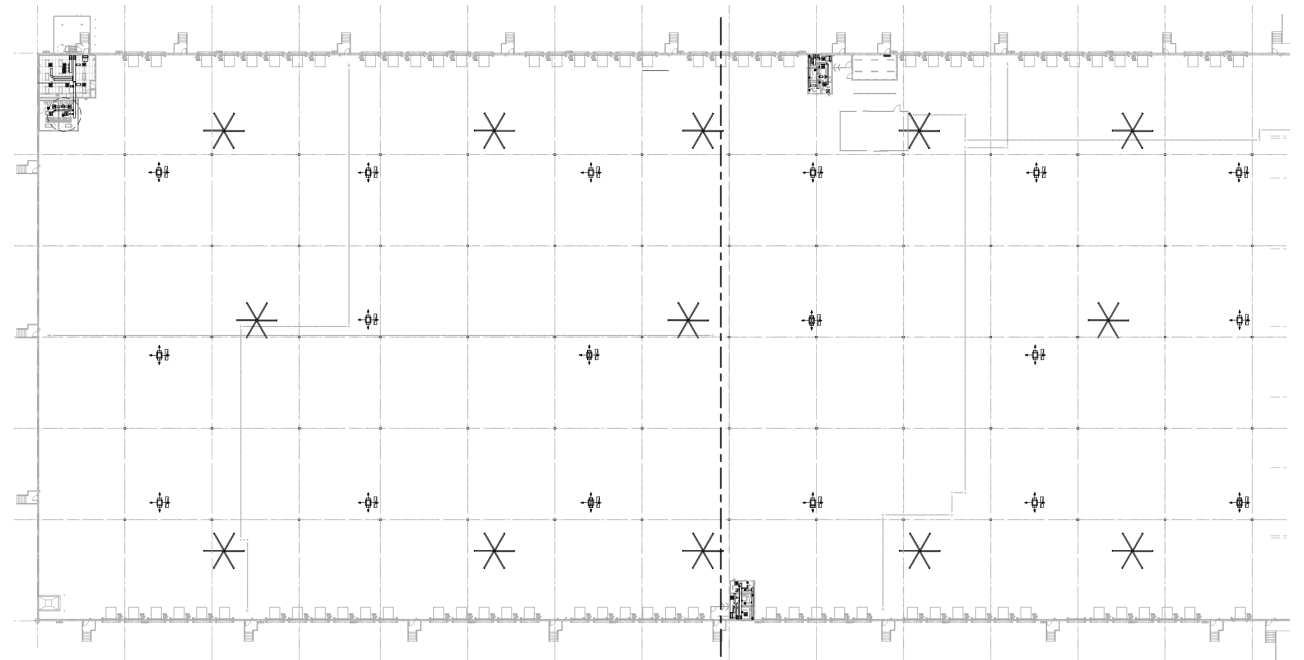
Construction Phase Commissioning

HVLS FANS

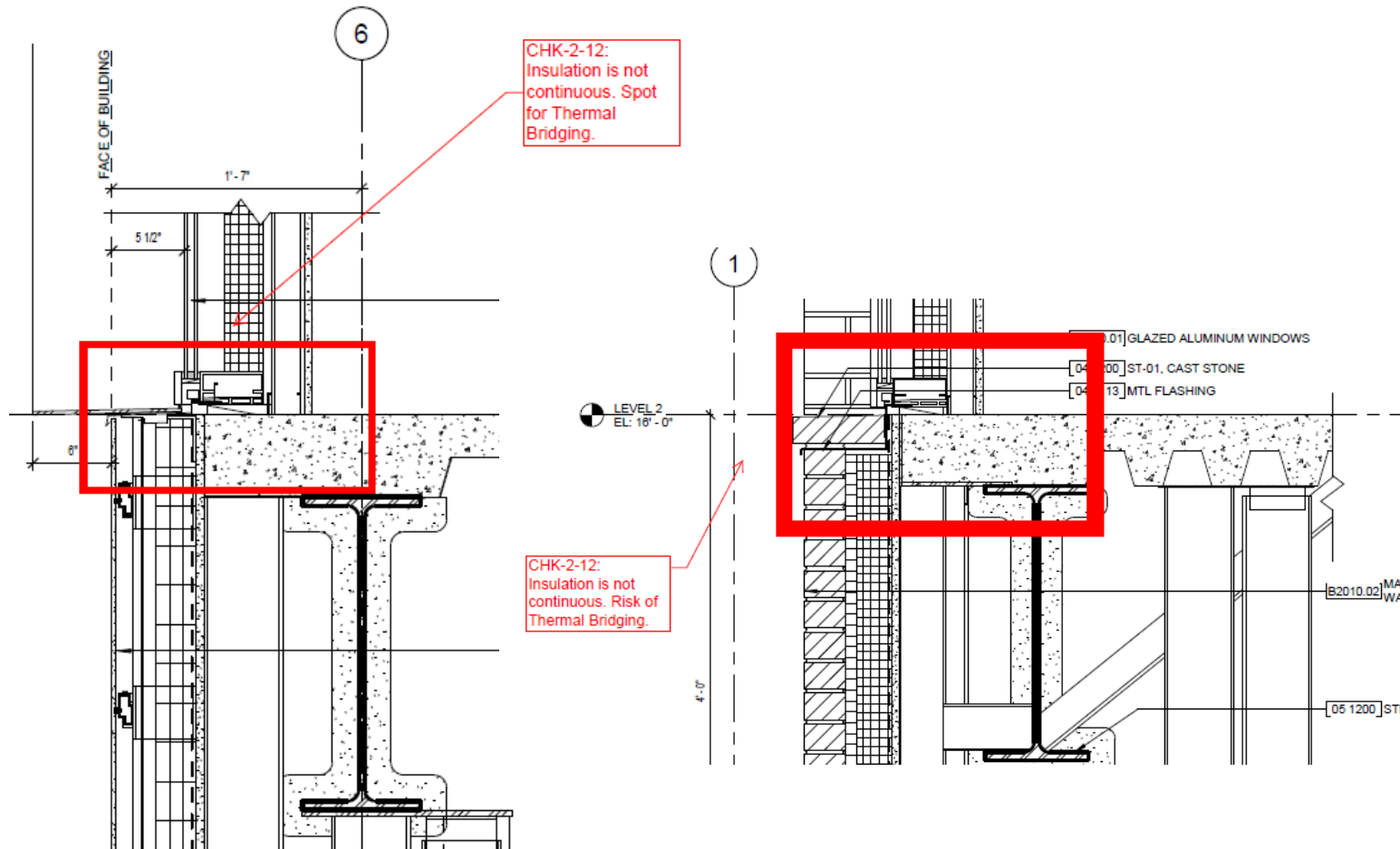
TAG	SERIES	MANUFACTURER	DUTY	DIAMTER (FT)
HVLS-A1-A18	POWERFOIL D	BAF	DESTRATIFICATION	24

Sometimes mechanical schedules are not updated as the equipment on the drawings get updated

➔ If the information isn't clear or is contradictory, the Cx Engineer isn't the only one who will be confused – their questions benefit the entire team.



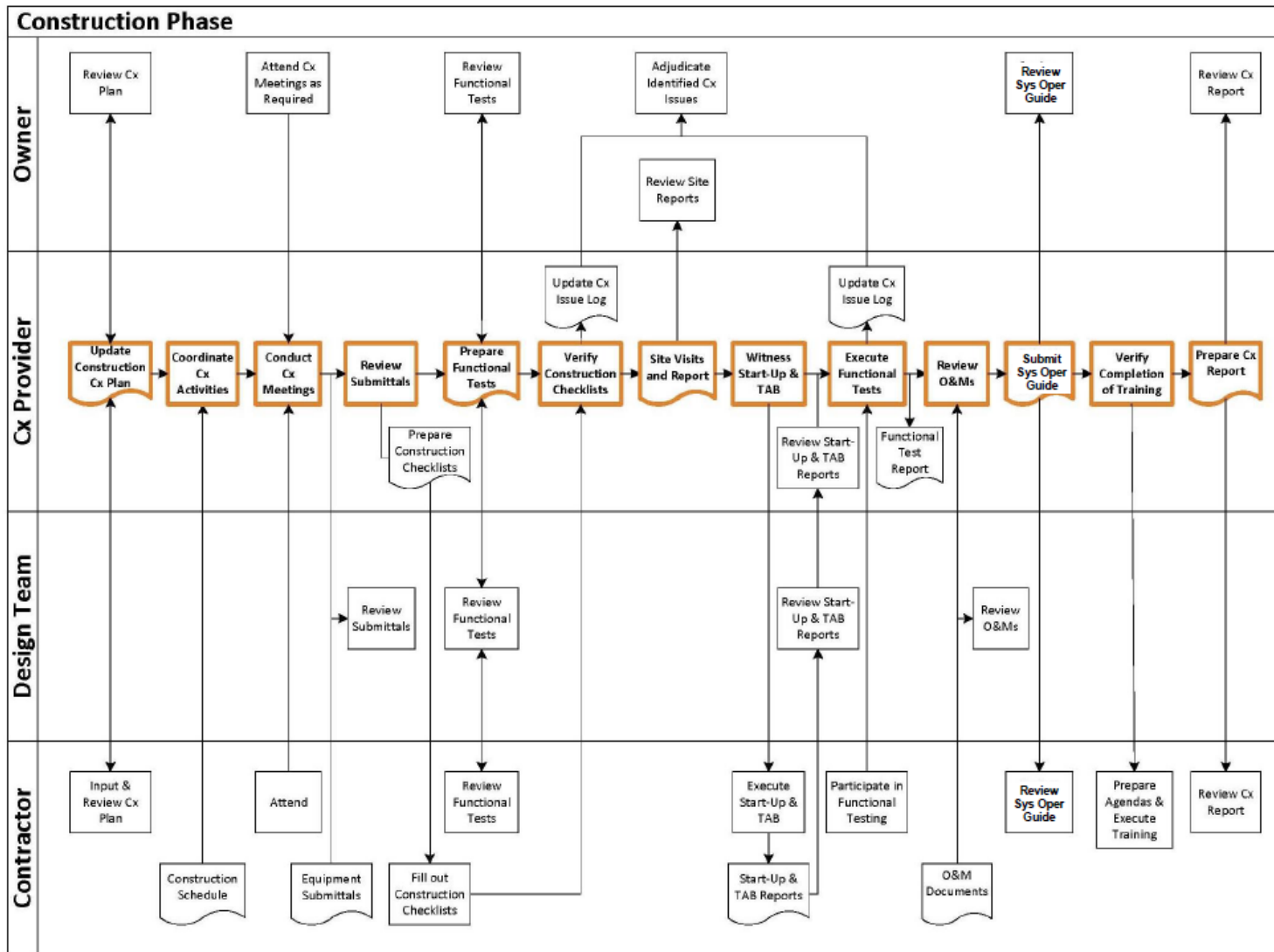
Construction Phase Commissioning



During the 50% DD design review for an office building in Chicago, we were able to point out thermal bridges at the transition from a masonry façade to a window facade due to the lack of continuous insulation. We shared our concerns with the architect and discussed possible solutions that will be considered in the further design development.

➔ Expect your Cx Engineer to help find solutions.

Design Phase Commissioning



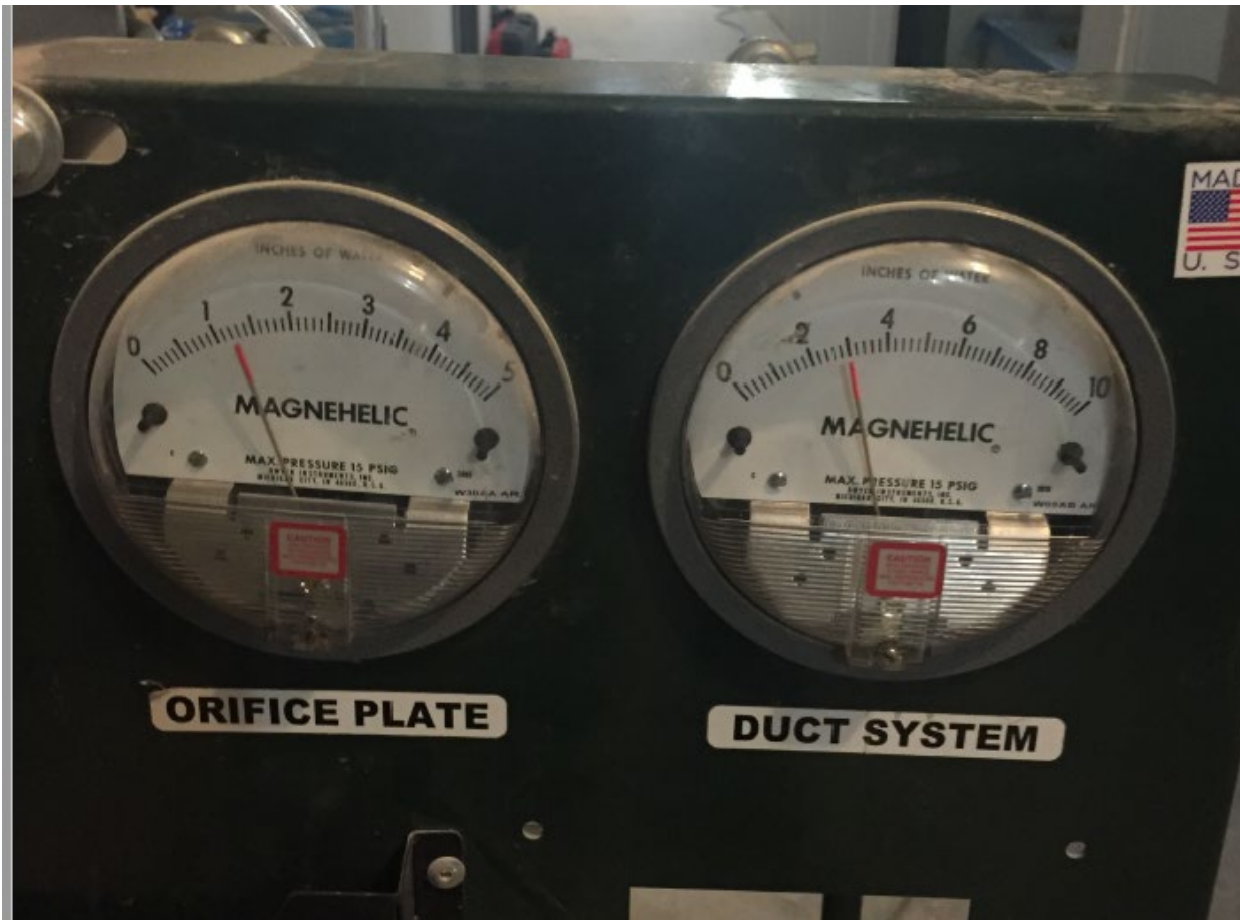
Objectives

- The Cx Plan, OPR, and BOD are updated.
- Cx team members understand their roles and responsibilities for the construction phase commissioning activities.
- Equipment, systems, and assemblies are properly installed, maintainable, and functioning properly as required to meet the OPR.
- The O&M personnel are provided with complete and proper systems operating documentation.
- The O&M personnel, and occupants as needed, are properly trained. Training materials and documentation compiled to facilitate repeating training and training new staff in the future.

Construction Phase Commissioning

Phase	Tasks	Value
Construction Phase	Submittal Reviews	<ul style="list-style-type: none"> • An extra pair of eyes catches errors, preventing change orders later. • Checks not only if it is the right equipment, but if all the necessary information is given.
	Installation & Performance Verification	<ul style="list-style-type: none"> • Issues caught earlier, before walls and ceiling are closed. • More thorough supervision than typical contract administration • General perspective on integrated systems prevents issues from falling through the cracks • Improves construction planning, which reduces delays • Tests function, not just installation
	Systems Manual	<ul style="list-style-type: none"> • Operator receives needed information, reducing calls to the construction team • Systems work better, because the information is accessible
	Training	<ul style="list-style-type: none"> • Operator receives needed information, reducing calls to the construction team • Better documentation of training takes place, for better reference

Construction Phase Commissioning



As part of commissioning for a mission critical facility in Washington, DC, Baumann witnessed and reviewed pressure testing of the facility's ductwork prior to close in. During our first testing observation, we noted that the tester was not following proper test procedures and that readings presented to the contractor to show passage were not interpreted correctly. Baumann provided feedback to the general contractor regarding proper test procedures. The subcontractor corrected their methods, identified additional sealing requirements, and passed re-testing.

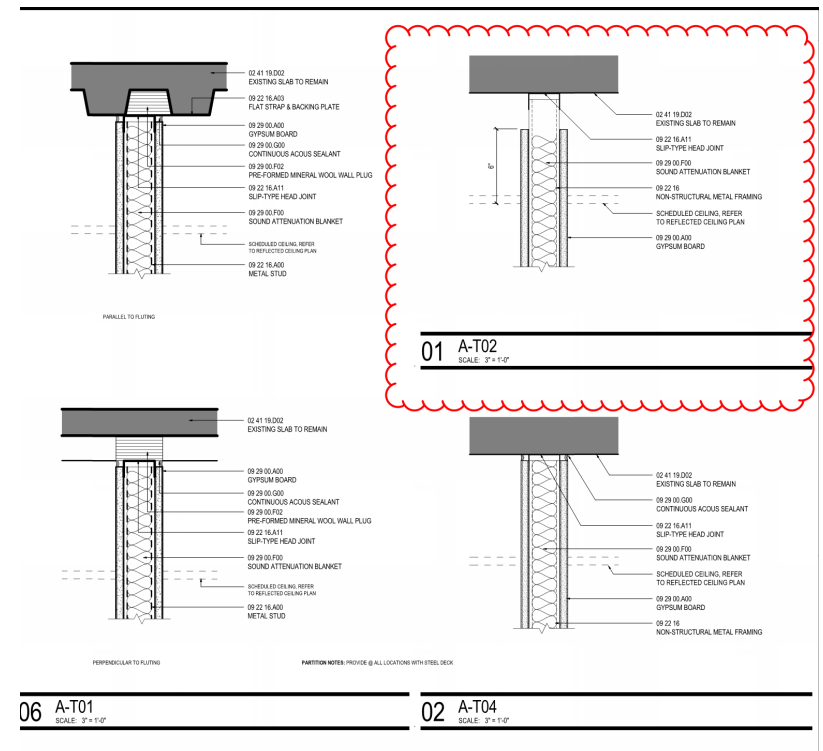
➔ Expect your Cx Engineer to check on contractor testing procedures.

Construction Phase Commissioning

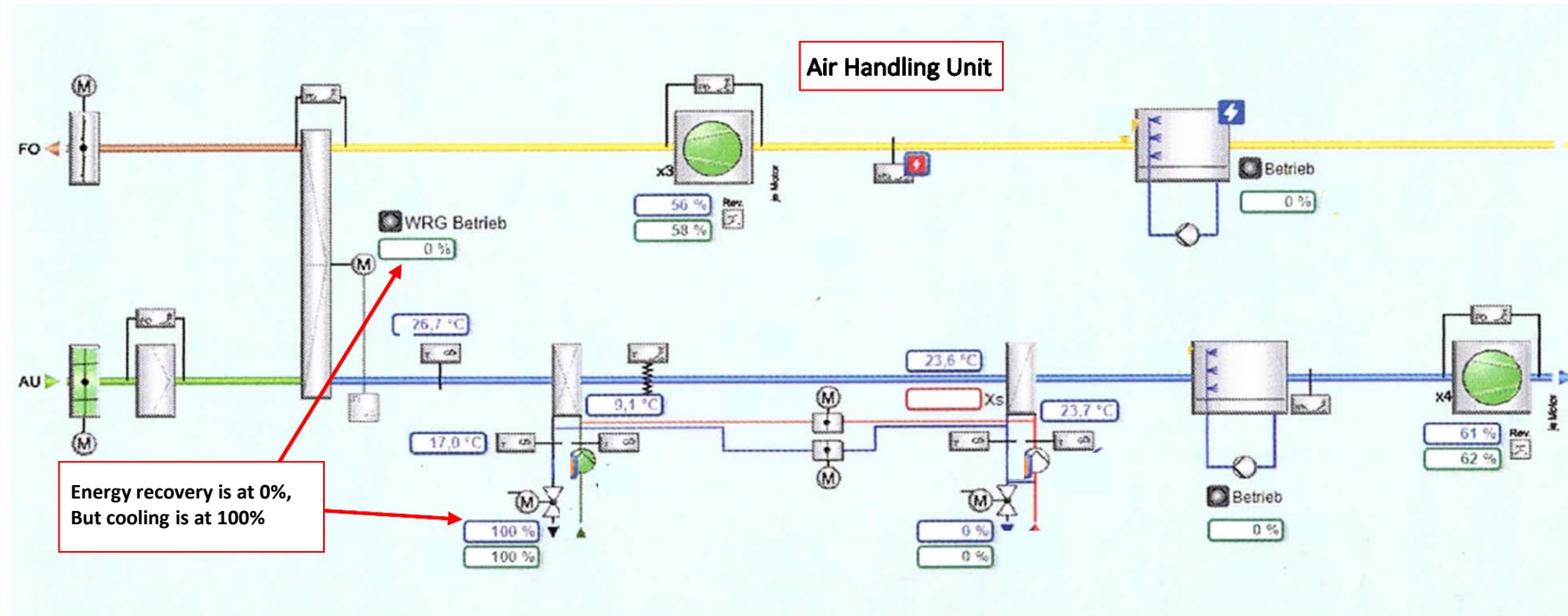
This fit-out project installed new offices with a plenum return above a drop-ceiling. During a pre-close-in site visit, Baumann noticed that the drywall above ceiling was built full height instead of with a gap for return air



➔ Expect your Cx Engineer to look for potential issues anywhere, not just with the system being tested at the moment.



Construction Phase Commissioning



→ Cx testing should check all aspects of a system, from installation to the final, actual operation.

While testing air handling unit operation according to the sequence of operations, we discovered that the energy recovery wheel was functioning, but only during heating operation, and not in cooling operation. At the time of testing (a hot, 80°F July day), all of the supply air cooling was being carried out by the chilled water (valve full-open at 100%), without any help from the energy recovery wheel. What ended up being a small programming fix, for an issue which otherwise would likely never have been caught, will save significant cooling energy, utility cost and greenhouse gas emissions.

Construction Phase Commissioning



Our client asked us to test the supply and return air systems before the final building handover. Due to the construction of the supply air diffusers it was not possible to measure the volume flow. With the help of a fog machine we were able to verify the air flow in the room. We identified five office spaces which received low or nearly no air volume flow. The on-site engineer was able to quickly adjust the required airflows based on our structured Cx-Report.

➔ Expect your Cx Agent to find solutions to get things done, not work around them.



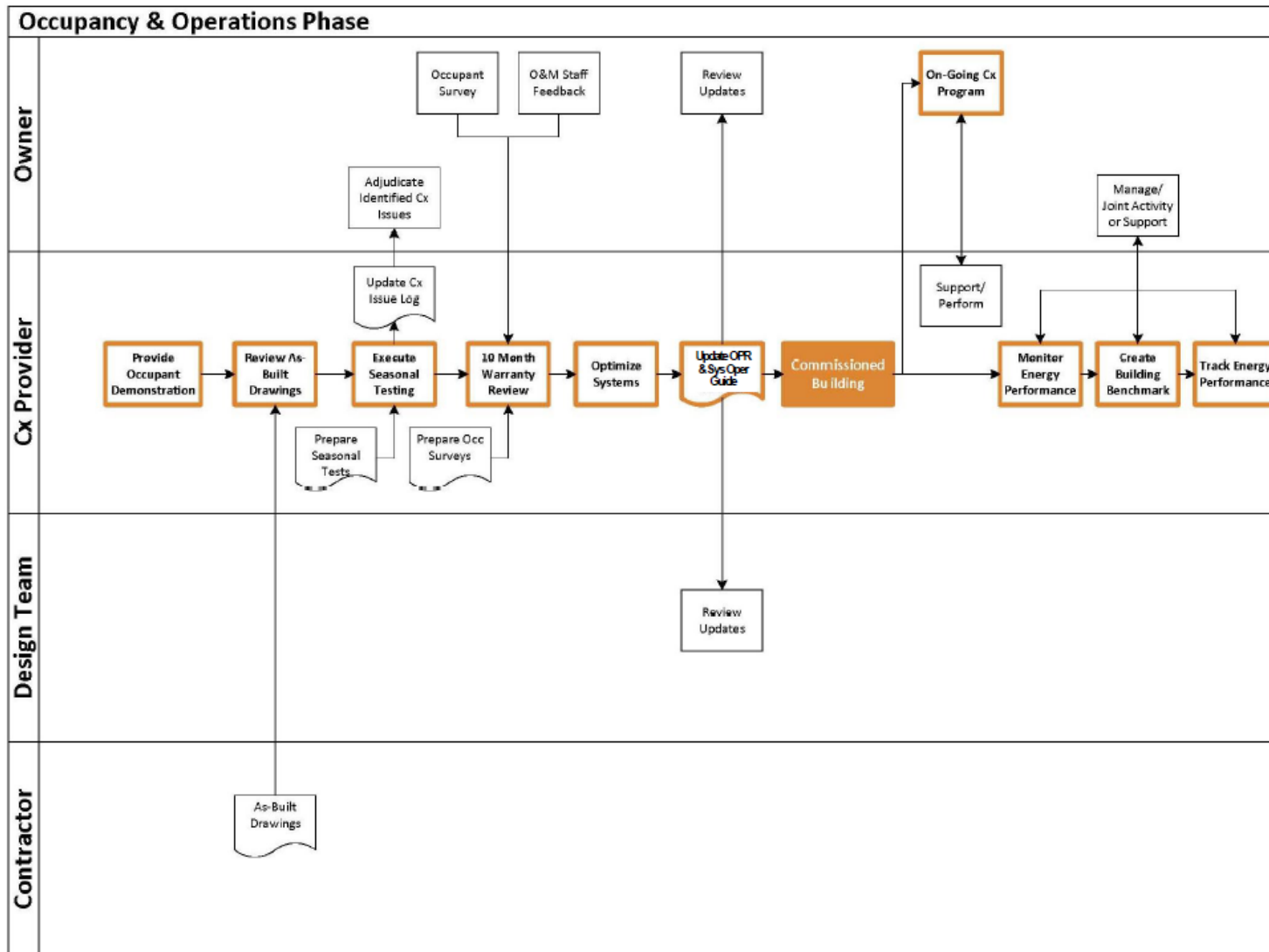
Construction Phase Commissioning



During a commissioning walkthrough of a high-rise commercial building in Virginia, Baumann was doing an installation walkthrough of the chiller plant. Upon inspection of the installed pipes, Baumann noticed there were no chainfalls on any of the valves over 6' above the ground – a significant maintenance and safety concern that had gone unnoticed.

➔ Expect your Cx Agent to look for more than correct operation – maintenance and safety are just as important.

Construction Phase Commissioning



Objectives

- Facilitate the continued engagement of the Cx team and verify the completion of outstanding Cx issues.
- Complete any seasonal and deferred functional testing and O&M staff training and occupant orientation.
- Complete systems and commissioning documentation.
- Evaluate project success.
- Optimize building performance.
- Develop and begin implementation of an Ongoing Cx plan.
- Survey occupants, formally check in with operations staff and assess issues.
- Benchmark energy performance; evaluate and track performance over time.

Occupancy & Operations Phase Commissioning

Phase	Tasks	Value
Occupancy Phase	Seasonal Testing / Monitoring-Based Cx	<ul style="list-style-type: none"> • System actually operates, and is operated, as intended • Optimization potential is revealed • Bugs are caught during warranty, with the contractor present, rather than later
	10-Month Warranty Review	<ul style="list-style-type: none"> • Priceless feedback from the operator and the occupants • Issues are caught during warranty, with the contractor present, rather than later

Occupancy & Operations Phase Commissioning



While carrying out a site inspection in the months after a new construction turn-over, mechanical spaces were found to be dirty and used as storage spaces. When this happens, the equipment and accessories can more easily be damaged, as was this damper-actuator, which had evidently been used as a step. A non-functioning outdoor air damper here would prevent economizer control (negating energy savings) as well as proper unit start-up and shut-off.

→ A Cx Agent's presence after turnover helps building systems to maintain as-intended use.

Occupancy & Operations Phase Commissioning



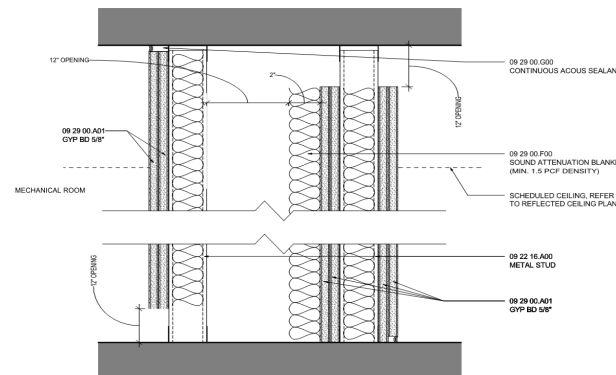
dP across Mechanical Room Door @ 53% VFD.jpg



dP across Mechanical Room Door @ Max VFD.jpg

During warranty phase Cx, an owner complained of insufficient cooling. We found out the building engineer adjusted the fan VFD max because the unit was making an extremely loud noise when it ran per design. We found that the RA opening in the wall was too narrow to allow for quiet airflow.

We measured air speed across the opening before and after the Z-Wall was opened and found the noise levels and pressures to be reduced and acceptable to the owner



➔ Expect your Cx Agent to track the problem to the source.

Occupancy & Operations Phase Commissioning



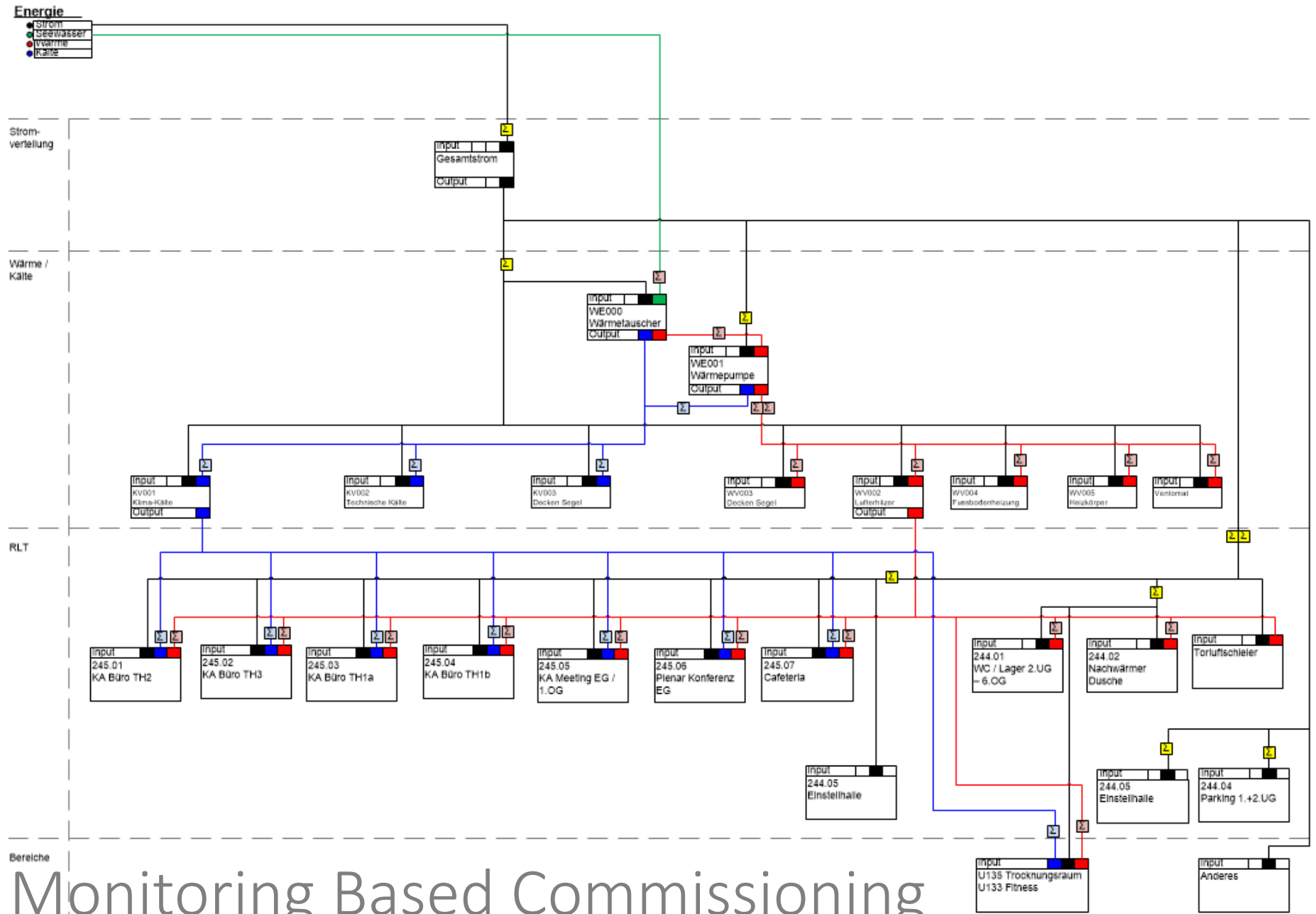
Through the warranty phase interview and site-walk process for a DC office building, Baumann learned that the facility engineers were overriding the controls system to maintain building comfort. After hand-over, the system sequence of operations had been modified under the guidance of the design engineer to increase overall air flow volume to the facility. The upgraded system led to system lock-outs. In response, the building engineers disabled the new sequence and were operating the system manually. Based on this finding the design engineer, controls contractor, and building engineer worked together to reestablish full automatic control of the building's mechanical systems.

➔ Expect your Cx Agent to take the initiative in communicating with all team members and bringing them together.

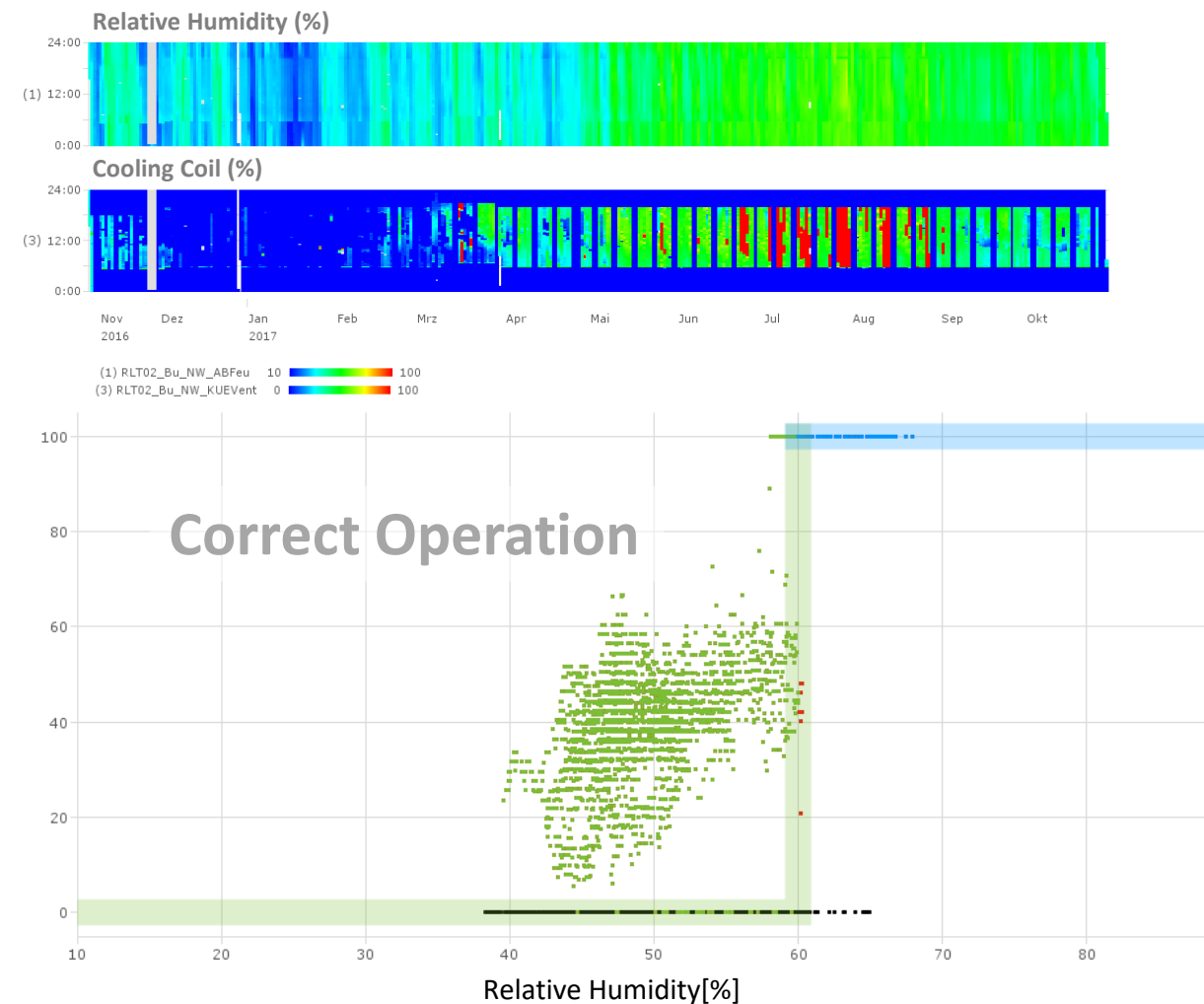
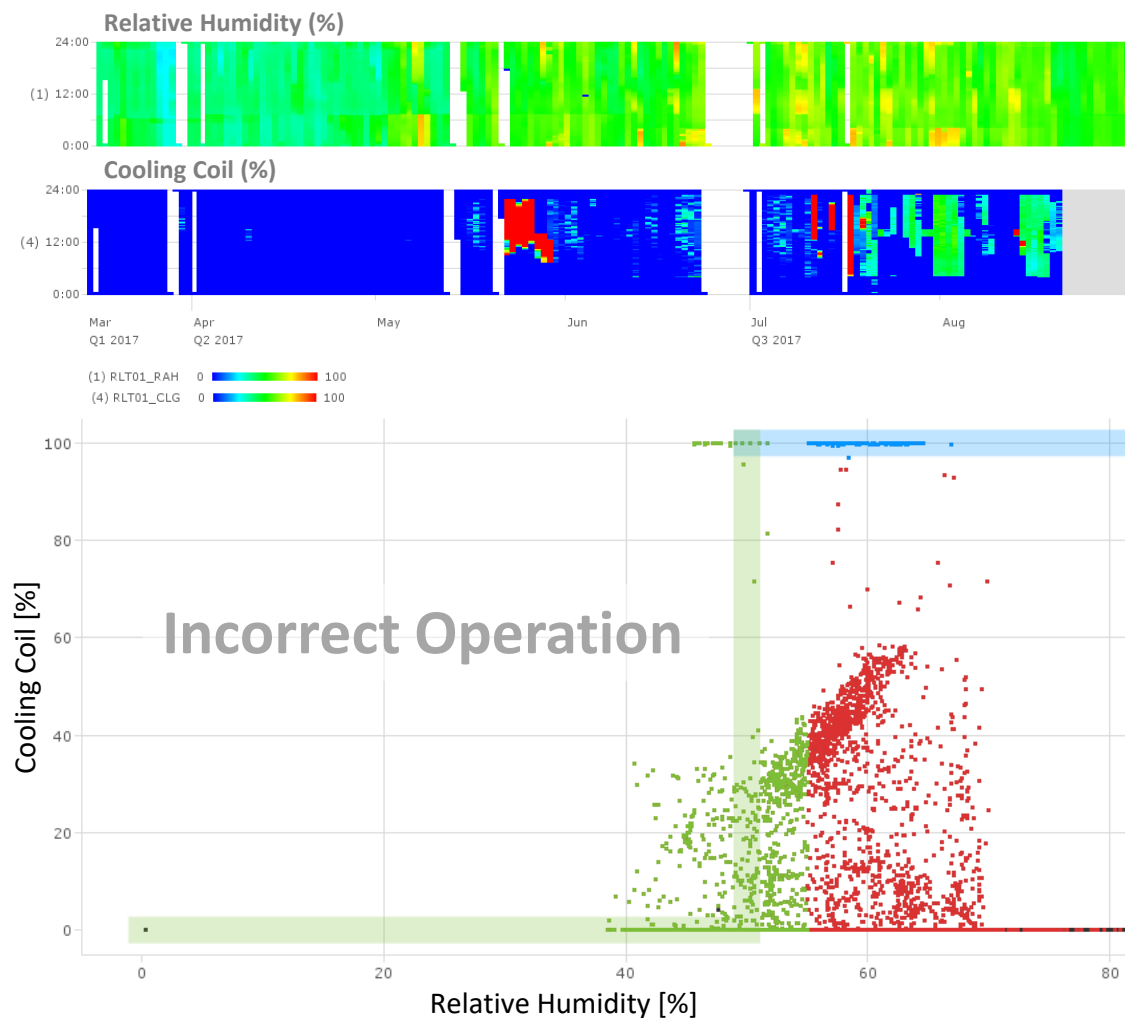
Occupancy & Operations Phase Commissioning

Phase	Tasks	Monitoring-Based Cx: 1 pt	Value
Design	OPR/BOD Reviews	●	<ul style="list-style-type: none"> • Metering requirements in the OPR provide a basis for what matters during operation. • Metering concept review during the design phase prevents last minute add-ons • Clear metering specification prevents issues with data recording and export, which takes place at a stressful time in the project • MBCx Reports enable benchmarking, optimization, and trouble shooting. • Performance tracking can continue beyond the Cx scope.
	Design Review	●	
	Specifications	●	
Construction	Submittal Reviews	●	
	Installation & Performance Verification	●	
	Systems Manual	●	
	Training	●	
Occupancy	Seasonal Testing / Monitoring-Based Cx	●	
	10-Month Warranty Review	●	

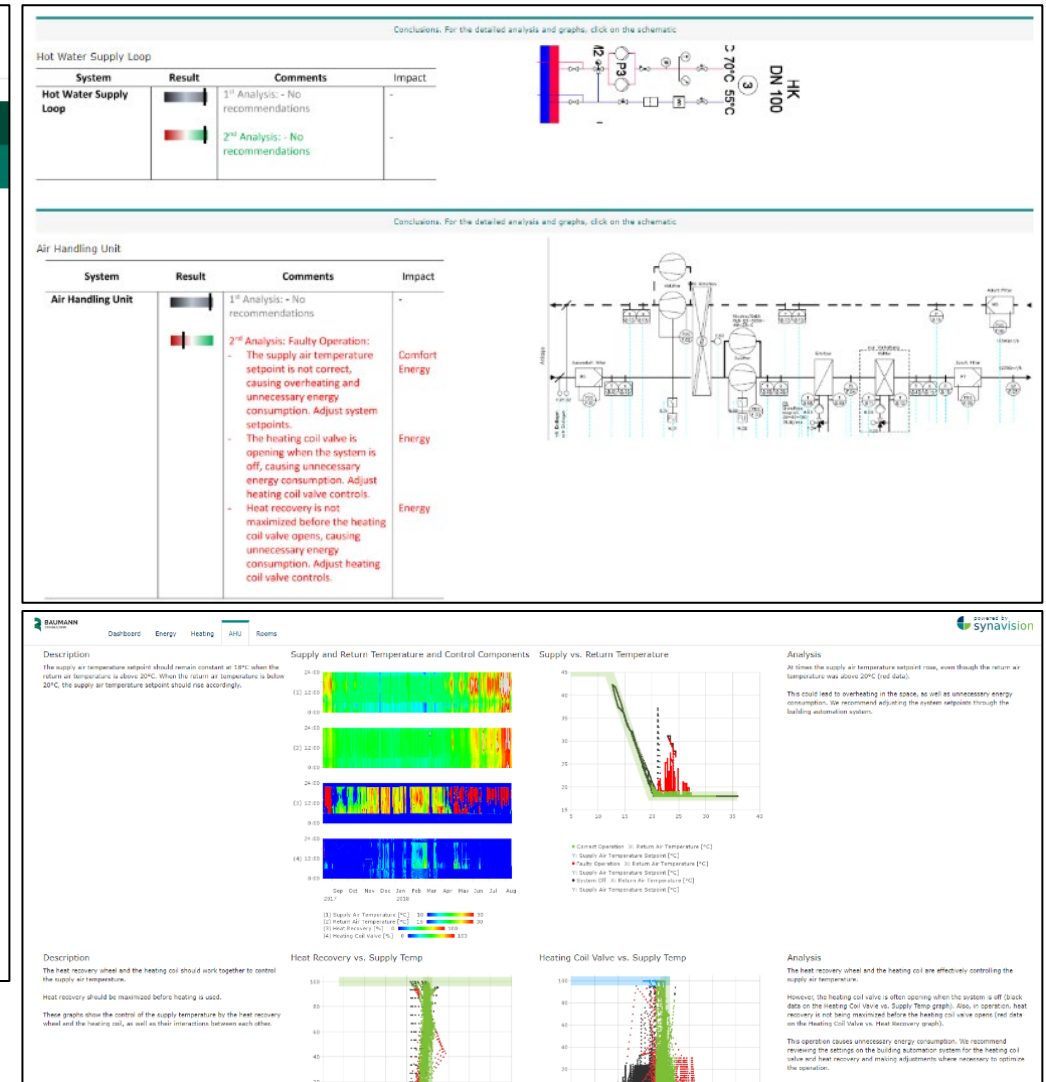
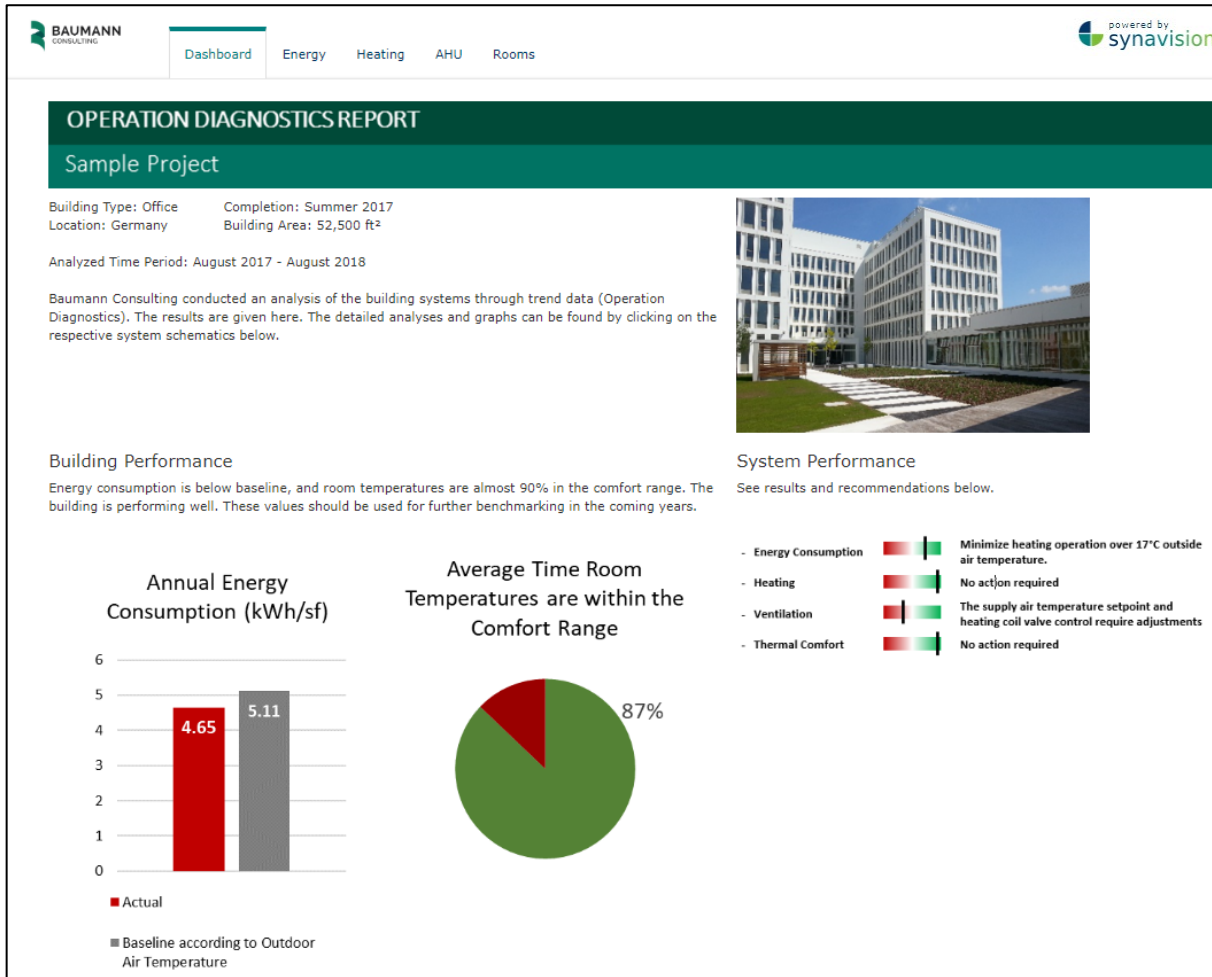
Monitoring Based Commissioning



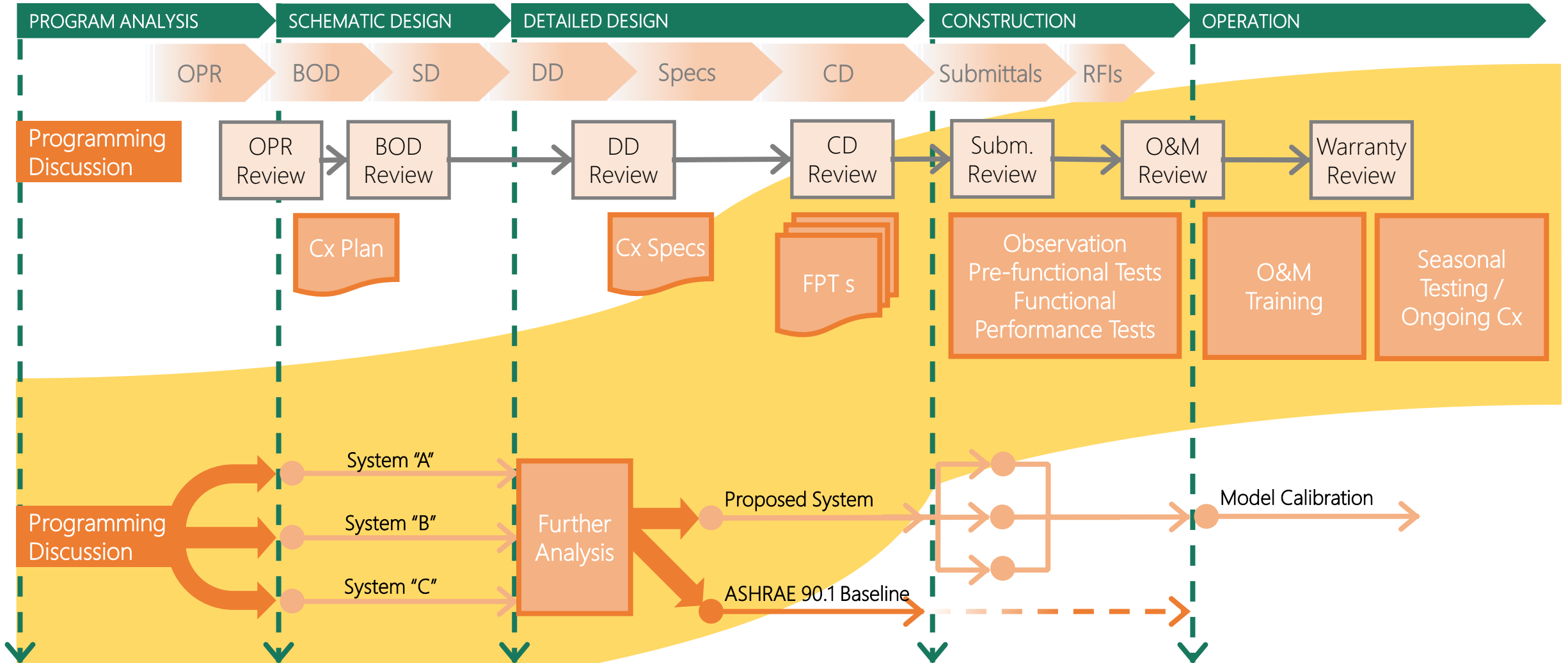
Monitoring Based Commissioning



Monitoring Based Commissioning



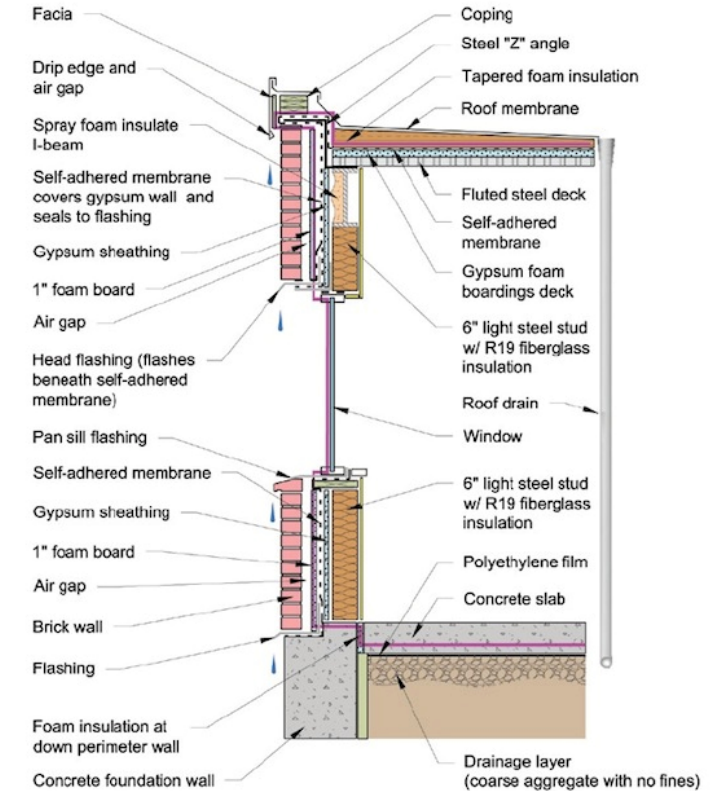
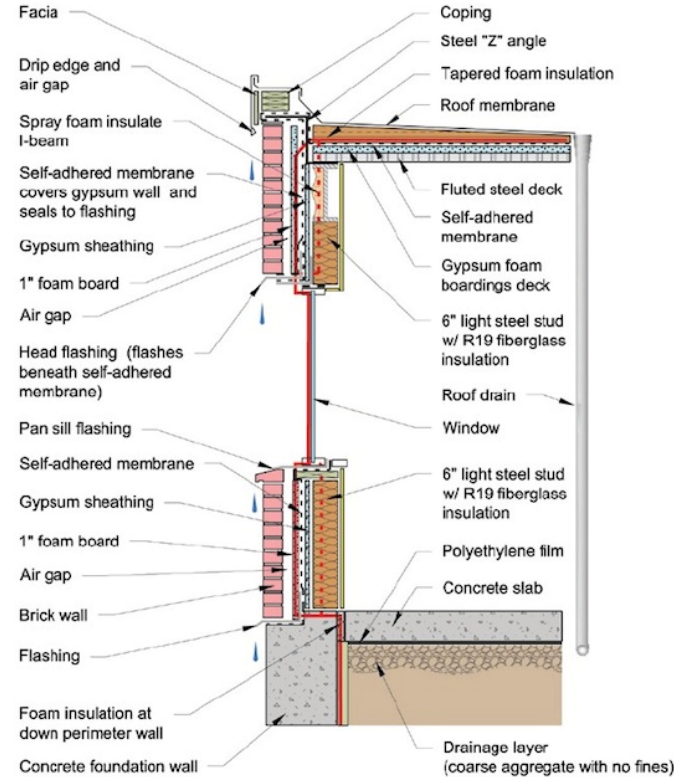
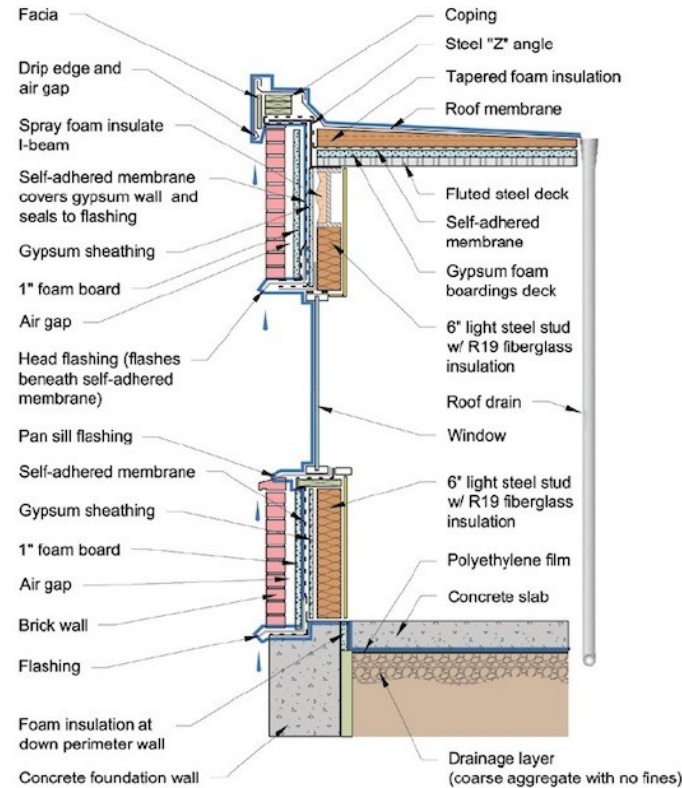
Monitoring Based Commissioning



Process Synergies and Interrelation

Phase	Tasks	Building Enclosure Cx: 2 pts	Value
Design	OPR/BOD Reviews	●	<ul style="list-style-type: none"> Air / Water tightness and thermal performance of the building enclosure make arguably the greatest impact on building performance and durability.
	Design Review	●	
	Specifications	●	
Construction	Submittal Reviews	●	
	Installation & Performance Verification	●	
	Systems Manual	●	
	Training	●	
Occupancy	Seasonal Testing / Monitoring-Based Cx	⊙	
	10-Month Warranty Review	⊙	

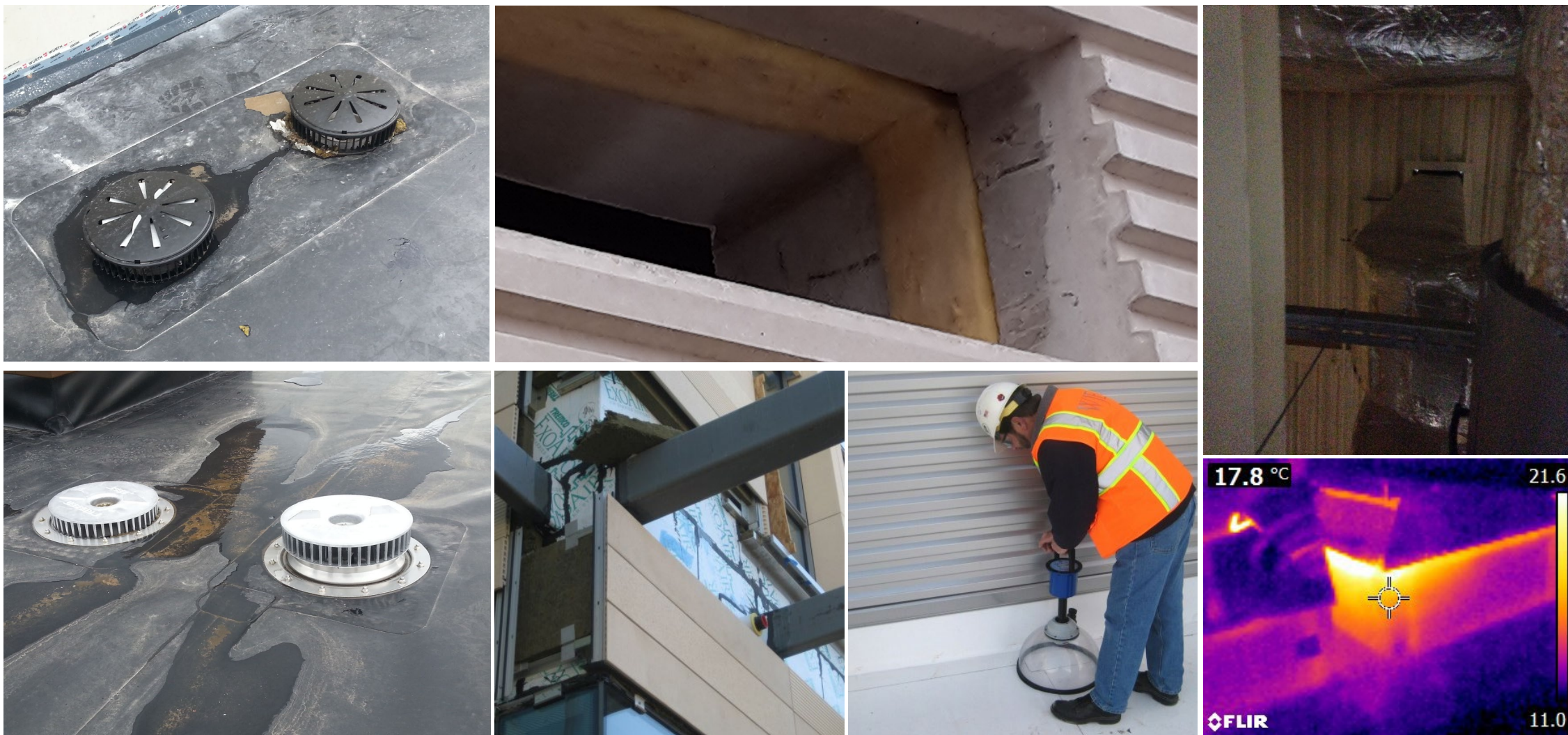
Building Enclosure Commissioning



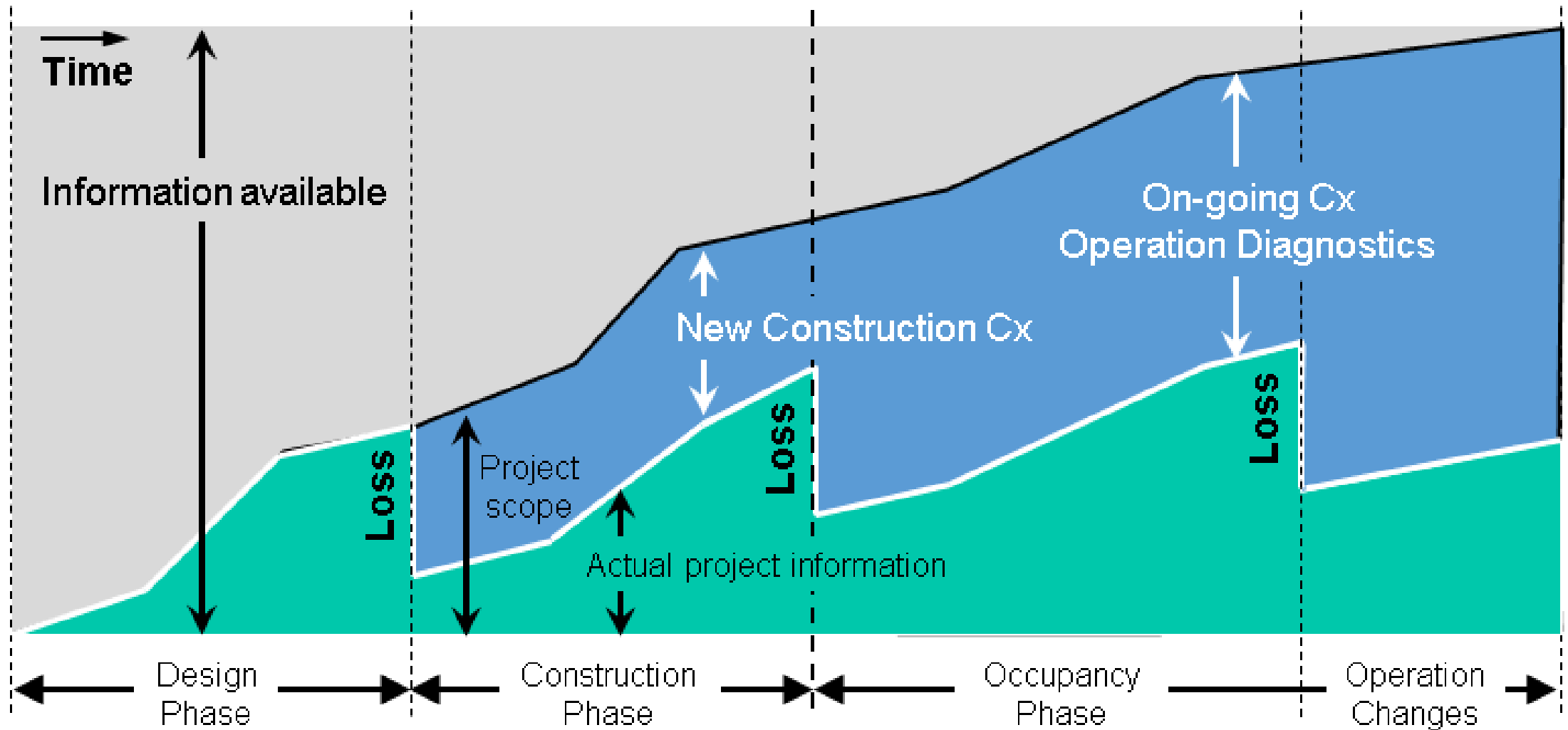
Building Enclosure Commissioning – Keeping the Outside Out

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13	✓	✗	NA	ADD ISSUE	ADD FILE	NOTE	08 44 13 Glazed Aluminum Curtain Walls 1.5.E.2 - Field Testing - ASTM E 1105 Water Spray Test Plan
14	✓	✗	NA	ADD ISSUE	ADD FILE	NOTE	08 44 13 Glazed Aluminum Curtain Walls 1.5.E.2 - Field Testing- ASTM E 1105 Water Spray Testing (One per wall type, 6 total)
15	✓	✗	NA	ADD ISSUE	ADD FILE	NOTE	08 44 13 Glazed Aluminum Curtain Walls 2.1.B - ASTM E 283 Air Leakage Test Plan
16	✓	✗	NA	ADD ISSUE	ADD FILE	NOTE	08 44 13 Glazed Aluminum Curtain Walls 2.1.B - ASTM E 283 Air Leakage Testing
17	✓	✗	NA	ADD ISSUE	ADD FILE	NOTE	08 44 13 Glazed Aluminum Curtain Walls 2.1.C - ASTM E 331 Water Penetration Test Plan
18	✓	✗	NA	ADD ISSUE	ADD FILE	NOTE	08 44 13 Glazed Aluminum Curtain Walls 2.1.C - ASTM E 331 Water Penetration Testing
19	✓	✗	NA	ADD ISSUE	ADD FILE	NOTE	08 80 00 Glazing 1.5.H/I.1 - Preconstruction Bow and Warp Test Plan
20	✓	✗	NA	ADD ISSUE	ADD FILE	NOTE	08 80 00 Glazing 1.5.H/I.1 - Preconstruction Bow and Warp Testing
21	✓	✗	NA	ADD ISSUE	ADD FILE	NOTE	08 80 00 Glazing 1.5.H/I.2 - Roll Ripple Distortion Test Plan
22	✓	✗	NA	ADD ISSUE	ADD FILE	NOTE	08 80 00 Glazing 1.5.H/I.2 - Roll Ripple Distortion Testing
23	✓	✗	NA	ADD ISSUE	ADD FILE	NOTE	08 80 00 Glazing 1.5/I.4 - Insulation Glass Unit Testing – butterfly, desiccant, bow/warp and air space Test Plan
24	✓	✗	NA	ADD ISSUE	ADD FILE	NOTE	08 80 00 Glazing 1.5/I.4 - Insulation Glass Unit Testing – butterfly, desiccant, bow/warp and air space Test

Building Enclosure Commissioning – Owner’s Risk/QA

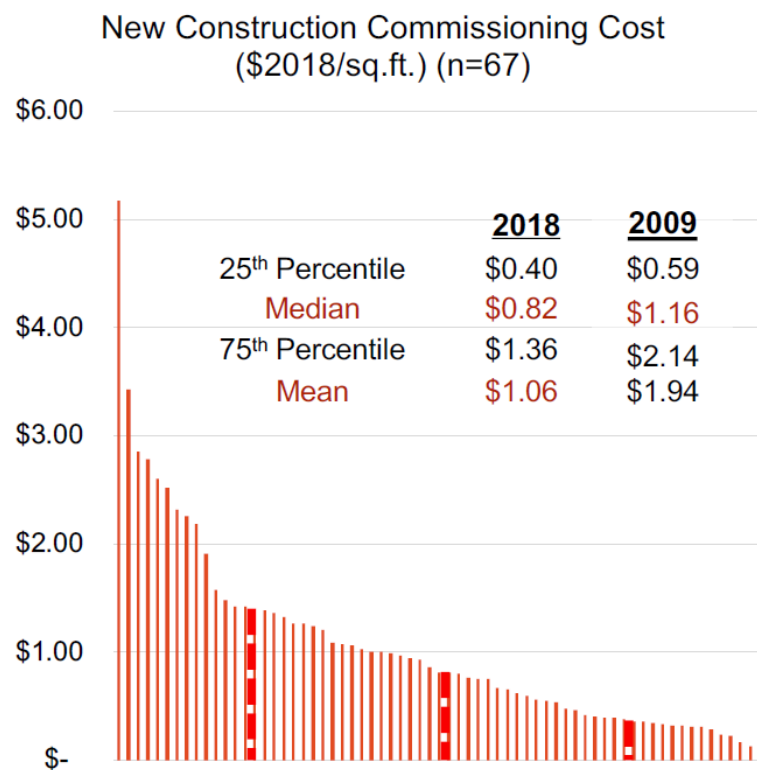


Building Enclosure Commissioning

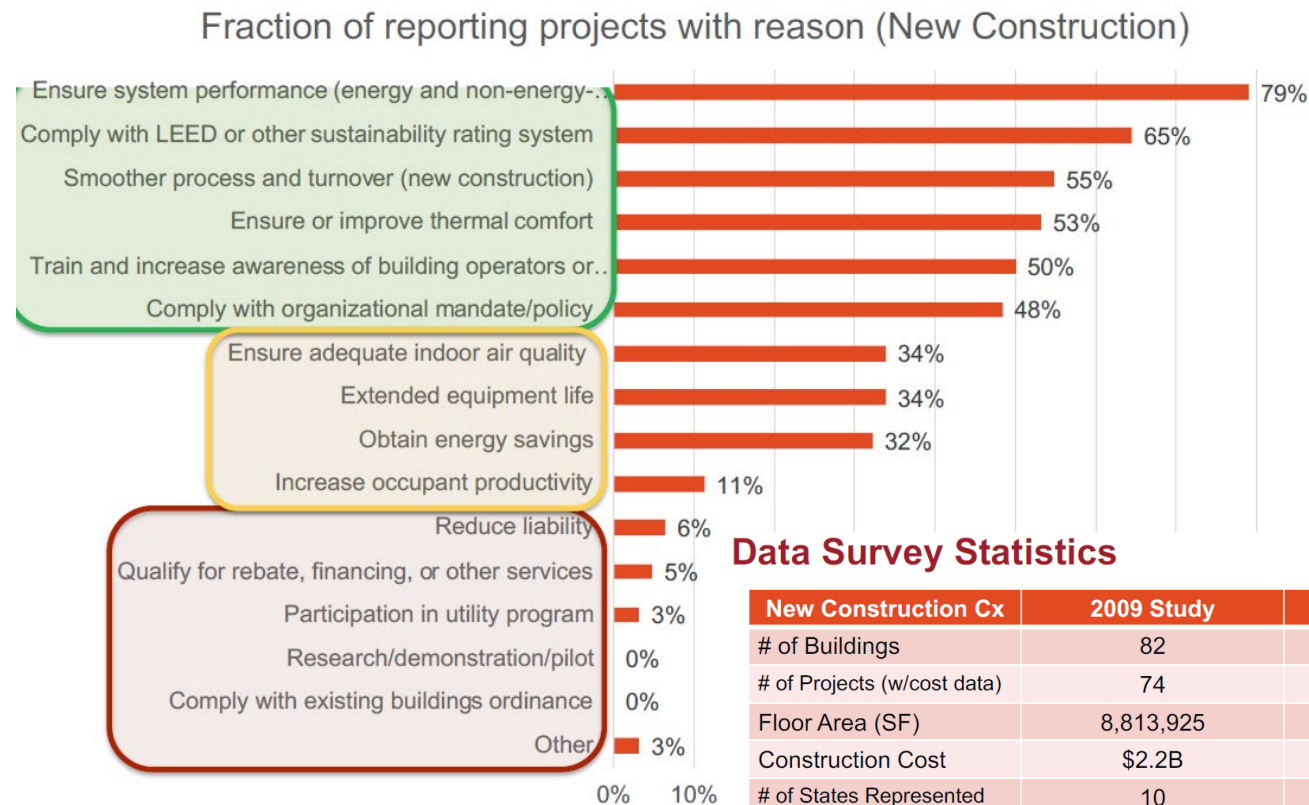


The Value of Commissioning

#1–NCCx Cost per Square Foot



#2 – Reasons for Implementing NCCx



Data Survey Statistics

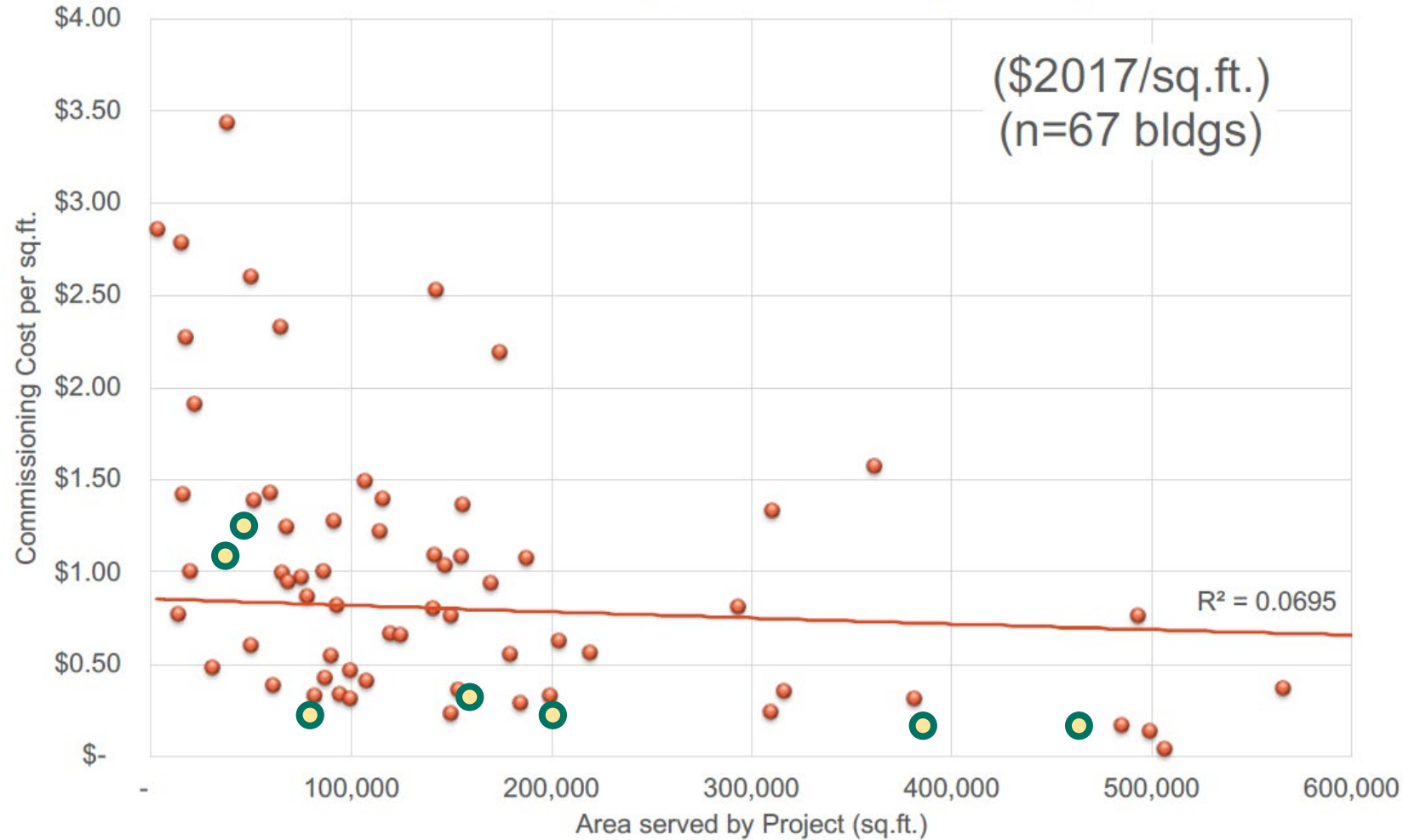
New Construction Cx	2009 Study	2018 Study
# of Buildings	82	101
# of Projects (w/cost data)	74	67
Floor Area (SF)	8,813,925	22,217,059
Construction Cost	\$2.2B	\$10.1B
# of States Represented	10	18

Existing Building Cx	2009 Study	2018 Study
# of Buildings (total)	562	738
# of Projects (w/energy savings data)	300	604
Floor Area (SF)	90,410,884	274,159,847
# of States Represented	21	18

The Value of Commissioning

Source: Tom Poeling, BCxA President-Elect, Eliot Crowe, program Director LBNL

#1–NCCx Cost vs. Project Size (2017)



The Value of Commissioning

Source: Tom Poeling, BCxA President-Elect, Eliot Crowe, program Director LBNL

Pamela Sams, AIA, Technical Director at the Washington, D.C. office of Gensler

“Commissioning is a proactive process that is safeguarding the design approach and by extension the objectives set out in the OPR. **Without a robust commissioning process in place, architects and the design team are often only reacting to situations that arise during construction. The last-minute nature of this kind of situation often does not allow for many choices, and the design and construction team has to develop a solution that may erode the original design approach.**

The landscape of our profession has changed. Performance-based designs are becoming the norm, and this is a positive development. The commissioning industry is growing rapidly and award-winning designs are no longer confined to innovative forms; the industry is shifting toward buildings that perform beautifully. The design profession as a whole will benefit from integrating commissioning into the design and construction process because **it will push the industry to adopt a whole building approach** and move the profession toward carefully crafted buildings. **If the commissioning process is tacked on or poorly coordinated, the value of commissioning is watered down and it becomes an administrative exercise that does not deliver on its potential to aid in delivering a facility that is performing as designed.**

Commissioning strengthens design; Cx is a way of ensuring that we deliver improved products that are better maintained and used in a manner consistent with the owner’s goals.”

The Value of Commissioning

Source: Why architects should lead the commissioning process, by Pamela Sams, AIA, March 29, 2016

General

- Bring on the CxA EARLY!
- Increase integration of the CxA in the project process, if even just present in more key meetings
- The Cx process is scalable, both for tasks included, and depth within the tasks (i.e. # of meetings, site visits)
- The CxA can handle the detailed coordination, but needs the owner's backing
- Use Synergies with other LEED credits

Take-Aways

Provide a clear Cx Scope

- Look up sample scope descriptions
- “LEED compliant” isn’t clear enough
- Be clear who carries out vs. supports commissioning activities
- What to look for in a Commissioning Proposal:
 - Sampling rates
 - Systems included
 - Number and timing of meetings
 - Number and timing of site visits
 - List of deliverables

Take-Aways

OPR / BOD Review

- Make sure there is an OPR.
- Bring on the CxA early to obtain input before design gets too far – 1st meeting!

Design Review

- Bring on the CxA early.
- Contract multiple CxA design reviews.
- Look for suggestions on overall system design / approach to OPR fulfillment.
- Make sure design team is aware of the CxA design reviews and coordinates accordingly.

Specifications

- Have information ready for the CxA: desired sampling rates, training, manuals.
- Who will the operator be? What will they need?

Submittal Reviews

- Make sure design team is aware of CxA submittal reviews and coordinates accordingly.
- Ensure a clear submittal review process is in place.

Installation & Performance Verification

- Enable CxA presence at initial meetings to establish presence.
- Be ready to back up CxA when construction team is not delivering.
- Help ensure top-down engagement of the construction team.
- Look for issues communicated from CxA. Also, that designers are in the loop to provide technical direction.
- Include SOO coordination meeting and/or BMS mock-up in the specifications.
- Touch base with CxA when delays / time constraints occur, to learn how the testing plan needs to be adjusted.

Take-Aways

Systems Manual

- Involve the operator whenever possible. This maximizes relevant information.
- Provide clear requirements on the delivery of documentation.

Training

- Involve the operator in the PLANNING of the training.
- Provide clear requirements on the documentation / recording.

Seasonal Testing / Monitoring-Based Cx

- Manage expectations of the contractors regarding presence.
- Involve the right people: owner, operator, contractor, designer, CxA
- Follow up with the contractor on issues resolution.

10-Month Warranty Review

- Manage expectations of the contractors regarding presence.
- Involve the right people: owner, operator, contractor, designer, CxA
- Follow up with the contractor on issues resolution

Take-Aways

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