Commissioning in the Sustainable Environment
Energy & Commissioning Opportunities in LEED v4

Tom Hanlon

CROMWELL ENERGY SERVICES
Agenda

- LEED V4-----Getting Better!!
- LEED Commissioning EAp1 & EA3
- Measurement & Verification EA5
- IAQ   EQ3.1 & EQ3.2
- IAQ Lesson Learned
LEED v4 is not just a faster horse....

...it’s about performance.
Designing High Performance Buildings in LEED v4

BD+C Credit:
Integrated Process
• Synergies & Strategies for energy and water
• Start in Schematic Design & continue thru Design Phase
• Document how analysis informed design, OPR & BOD
Commissioning
LEED V4-Definition

“The process of 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.”

Benefits include:
- better systems performance
- reduced energy use - cost,
- improved occupant comfort- productivity
- systems with longer life - more fully utilized.
Constructing High Performance Bldgs in LEED v4-Fundamental

Expanded Commissioning Scope in LEED v4

“….as they relate to energy, water, indoor environmental quality, and durability”

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Who can be the CxA?

- Experience on 2 similar size/scope projects
- Fundamental: Owner, independent consultant, employee of the design or construction firm not part of the project, or disinterested subcontractor
- Enhanced: Owner, independent consultant, or a disinterested subcontractor
- Reports findings directly to Owner
Commissioning
Fundamental (Construction Phase)

EA Prerequisite pr1:
Fundamental Cx & Verification

Fundamental EAp1. Requirement. Essentially begins with contract award. The “installed, tested and initially operated” component.

Commonly known as Construction Phase Cx:
- Often Duplicates CA
- Seldom adds significant value
Constructing High Performance Bldgs in LEED v4

BD+C EA Credit:
Enhanced Cx & Verification

Option 1
- Path 1: (3 points)
  - Enhanced Cx, similar to LEED 2009
  - Added Seasonal Testing
  - Added Re Cx Plan
- Path 2: (4 points)
  - Path 1 + Measurement & Verification of Energy & Water Systems

Option 2
- Envelope Cx (2 points)
- Don’t have to do Option 1 to earn Option 2
Control System Commissioning
Control System Commissioning

Control System Commissioning (BECx) is a quality-focused process involving evaluation, verification, and documentation that a building’s envelope design, construction, and operation meet defined performance expectations established during project initiation in the Owner’s Project Requirements (OPR).
DDCx BACbone

A collection of tools used to collect, analyze and present data from a building automation system

- Network Discovery Tool
- Collection of drivers (gateways) to bring proprietary systems into BACbone

BACnet
Niagara AX
Johnson Controls
Siemens – Apogee
Trane – Tracer Summit

WHAT DOES BACBONE DO?

- Data Collection
- Algorithmic Diagnostics
- Event Notification and Fault Detection
- Scorecard Reporting
# Controls Commissioning

**Admin Bldg 2-10 Kitchen East**

**Rank: 51 of 51**

**Average Device Score: 33**

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Building Enclosure Commissioning (BECx) is a quality-focused process involving evaluation, verification, and documentation that a building’s envelope design, construction and operation meet defined performance expectations established during project initiation in the Owner’s Project Requirements (OPR).
Building Enclosure Systems

- Exterior Cladding
- Curtain walls and Storefronts
- Windows and Doors
- Sealant, Expansion Joints and Flashings
- Air Barriers
- Roofs
Why BECx?

• BE Function & Performance Expectations
  – Thermal Performance
  – Air/Moisture/Light Control
  – Fire Resistance
  – Acoustical Performance
  – Indoor Comfort
  – Maintainability/Sustainability
  – Economically Viable
Why BECx?

- **Small Percentage But Big Consequences**
  - BE Design Flaws/Construction Defects result in:
    - Uncontrolled air/water intrusion
    - Premature failures/deterioration
    - Biological growth
    - Increased energy costs
    - Costly investigations/repairs
    - Decreased occupant productivity/tenant retention
  - Insert Testing Requirements into Project Requirements
Measurement & Verification (M-V)
EAcr5

BD+C EA Prerequisite:
Bldg Level Energy Metering
• Building level meters for total bldg energy consumption: electric, natural gas, chilled water, steam, fuel oil, propane, etc
• Compile data monthly, manual or automated
• Commit to share for 5 years, Energy Star Portfolio Manager!!

BD+C EA Credit:
Advanced Energy Metering
• Whole building energy sources, plus
• Major users >10% of total load
• Record to remote location
• <1hr intervals, remotely accessible
• Record consumption & demand
Commissioning Services

EA5 Measurement and Verification

Why Pursue M&V?

• LEED point → Energy & Atmosphere Credit 5
• Compliance with EPACT requirements…
• Mitigates the risk the facility won’t achieve the energy savings anticipated.
• Ensures the building is operated in an energy efficient manner to minimize costs.
Commissioning Services

EA5 Measurement and Verification

M&V Process Overview:
• Early involvement in the design process
• Determination of what variables need to be measured and how
• Integration of metering equipment into the design
• Control systems submittal review
• Commissioning of M&V equipment:
  – Collect data for a couple of weeks and ensure accuracy
• Data collection, processing, reports, & investigation
Commissioning Services

EA5 Measurement and Verification

Phase I: M&V Plan Development
- Draft plan consistent with IPMVP Option B. Submit to USGBC for review and approval.
- Plan includes all variables to be measured and metering equipment
- Ensure during the design phase that all metering is consistent with the M&V plan and compatible with the building EMS.

Phase II: M&V Setup & Commissioning
- Ensure that all specified metering equipment, controls, hardware, data collection software programs, and devices necessary to implement the M&V plan are furnished, properly installed or setup and properly calibrated.

Phase III: M&V Execution – 1st Year
- Collect data for 12 months (first full year of operation). Tabulate and summarize the M&V data on quarterly and annual basis. Aggregate and summarize the collected data in a spreadsheet format and provide to the building owner.
- Establish an Energy Star Portfolio Account to share with USGBC!!
Commissioning Services

EQ Credit(s) 3: Construction IAQ Management Plan

Intent:
Reduce indoor air quality problems resulting from the construction/renovation process in order to help sustain the comfort and well-being of construction workers and building occupants.
Indoor Environmental Quality
LEED and the Cx Professional

IEQ Credit 3.1
Construction IAQ Mgmt Plan – During Construction

Requirements:
Develop and implement an Indoor Air Quality (IAQ) Management Plan for construction and pre-occupancy phases

• Meet or exceed SMACNA IAQ Guidelines for Occupied Buildings Under Construction
• Protect stored and absorptive materials from moisture damage
• Use proper filtration media on permanent air handlers used during construction
Indoor Environmental Quality
LEED and the Cx Professional

IEQ Credit 3.1
Construction IAQ Mgmt Plan – During Construction

Major Control Areas:
• HVAC protection from dust & odors
  ✓ Seal duct openings with plastic
  ✓ Use filtration media MERV 8 or better
  ✓ Isolate unducted plenum spaces
• Control exhaust / fumes at the source
• Pathway interruption
  ✓ Use airflow to contain dust & odors
Indoor Environmental Quality
LEED and the Cx Professional

IEQ Credit 3.1
Construction IAQ Mgmt Plan – During Construction

Major Control Areas:
• Housekeeping
  ✓ Protect porous materials from moisture & dirt
  ✓ Use vacuums with high efficiency filters
• Scheduling
  ✓ Sequence construction activities to minimize risk of damage/contamination
Indoor Environmental Quality
LEED and the Cx Professional

IEQ Credit 3.2
Construction IAQ Mgmt Plan – Before Occupancy

Requirements:
Develop and implement an Indoor Air Quality (IAQ) Management Plan after finishes are installed and building is cleaned
  • Flush out building with outdoor air to evacuate airborne contaminants
  • Conduct air quality testing to confirm that contaminants are below acceptable levels
EQ Credit 3.2: Construction IAQ Management Plan

Before Occupancy

REQUIREMENTS:

Develop and implement an Indoor Air Quality (IAQ) Management Plan for the pre-occupancy phase as follows:

Option 1 – Flush-Out

After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total air volume of 14,000 cu.ft. of outdoor air per sq.ft. of floor area while maintaining and internal temperature of at least 60°F and relative humidity no higher than 60%.

OR

If occupancy is desired prior to completion of the flush-out, the space may be occupied following delivery of minimum of 3,500 cu.ft. of outdoor air per sq.ft. of floor area to the space.

Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm/sq.ft. of outside air or the design minimum outside air rate determined in EQ Prereq 1, whichever is greater.
EQ Credit 3.2: Construction IAQ Management Plan

Before Occupancy

REQUIREMENTS (continued):

During each day of the flush-out period, ventilation shall be a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14,000 cu.ft./sq.ft. of outside air has been delivered to the space.

OR

Test

Case Study / ADEQ
ADEQ – Building Occupancy / IAQ 3.2

- Opened Summer 2009
- New 120K sqft combined office & lab facility, located in NLR Industrial Park.
- Building has a 100+ person fte’s. Incorporates state of the art equipment, controls, daylight harvesting, etc.
- Provided Cx, Energy Modeling & LEED Consulting.
- Building certified LEED Gold in 2010, Green Globes 2011
- Mechanical Systems:
  - VAV with HW reheat.
  - Ventilation provided by ERU.
  - Variable Speed Air Cooled Chillers
  - Full Condensing Boilers
  - Complete EMS
- Owner REQUIREMENT!! Meet the EQ 3.2 credit for LEED. “We are in fact the Environmental Quality folks”.
- Decision to pursue the credit was made late in the construction process thus no advanced planning. Issues:
  - The outside air delivery of the ERU’s was not adequate to meet the “Flush-Out requirements.
  - Considered modifications to the Air Handlers to introduce more outside air, not enough cooling capacity.
  - Only option left was to test the building, using the EQ 3.2 option 2 method.
EQ Credit 3.2: Construction IAQ Management Plan

Before Occupancy

REQUIREMENTS (continued):

Option 2 – Air Quality Testing

Conduct baseline IAQ testing, after construction ends and prior to occupancy, using testing protocols consistent with the USEPA Compendium of Methods for the Determination of Air Pollutants in Indoor Air and as additionally detailed in the Reference Guide.

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<td>Formaldehyde</td>
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<tr>
<td>Particulates (PM10)</td>
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<tr>
<td>Total Volatile Organic Compounds (TVOC)</td>
<td>500 micrograms per cubic meter</td>
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<td>* 4-Phenylcyclohexene (4-PCH)</td>
<td>6.5 micrograms per cubic meter</td>
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<tr>
<td>Carbon Monoxide (CO)</td>
<td>9 part per million and no greater than 2 parts per million above outdoor levels</td>
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* This test is only required if carpets and fabrics with styrene butadiene rubber (SBR) latex backing material are installed as part of the base building systems.
EQ Credit 3.2: Construction IAQ Management Plan

Before Occupancy

Requirements (continued):

• For each sampling point where the maximum concentration limits are exceeded conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved.

• Repeat procedure until all requirements have been met.

• When retesting non-complying building areas, take samples from the same locations as in the first test.

The air sample testing shall be conducted as follows:

1) All measurements shall be conducted prior to occupancy, but during normal occupied hours, and with the building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.

2) The building shall have all interior finishes installed, including but not limited to millwork, doors, paint, carpet and acoustic tiles. Non-fixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.

3) The number of sampling locations will vary depending upon the size of the building and number of ventilation systems. For each portion of the building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq.ft., or for each contiguous floor area, whichever is larger, and include areas with the least ventilation and greatest presumed source strength.

4) Air samples shall be collected between 3 feet and 6 feet from the floor to represent the breathing zone of occupants, and over a minimum 4-hour period.
ADEQ – Building Occupancy / IAQ 3.2

• Decision made to test.
• Independent testing provider contracted and scheduled for a weekend.
• Contractor cleans and prepares the building in advance. Stops access to the building 5 days in advance.
• Day of the testing only the test provider and the commissioning technicians on site!!
• Plus, these guys!!
ADEQ – Building Occupancy / IAQ 3.2

RESULTS:
• Test failed, high particulate!!!
• Rescheduled for two weeks later.
• Increased communication, maintained better control of the building.
• Flushed the building continuously in advance.
• Changed filtration 2 days prior to testing.
• Sampled the building the day prior with an independent source.
• Cost $10K added.

• LESSON LEARNED!! Flush when possible.
Summary

• Provide Enhanced & Fundamental when possible!! Why?? Value!!

• Carefully assist in development of the OPR.

• Conduct detailed design reviews, publish to all, be persistent.

• Use enhanced / independent means to verify control system!!!

• Engage and train as early as possible!!

• Understand all the Credits, help implement & complete. Be a team player!!

• Educate, Educate, Educate!!! Be consistent with the Cx message early. Sell it!!
Thanks.....Questions