The Life-Cycle of Commissioning for New Construction
A Case Study at NGA Campus East

Owner/Facility Manager:  Dan Kailey and Matt Burkholder
National Geospatial-Intelligence Agency (NGA)

Commissioning Service Provider:  Mike Luffred
Eaton Energy Solutions, Inc. (Eaton)

Design Professional:  Charlie Rowland
RTKL/KlingStubbins, Joint Venture (JV)

Construction Manager:  Mike Lloyd
Clark Balfour Beatty Construction - NCE, A Joint Venture (CBB)
Agenda

- NCE Project Scope
- NCE Commissioning Scope
- Commissioning Process
- Perspectives from
  - Owner
  - Facility Manager
  - Design Professional
  - General Contractor
  - Commissioning Provider
NGA Campus East (NCE) Project Scope

- New headquarters facility for the National Geospatial-Intelligence Agency
- Fort Belvoir North Area
- Located in Springfield, Virginia
- Largest BRAC 2005 building project
  - 2.4 million ft$^2$ - $1.7$ billion
- Largest U.S. Government LEED 2.2 Gold project
- Eaton was Commissioning Authority (CxA) for all phases
  - Design through warranty
  - LEED 2.2 Enhanced Cx
- Also provided third party QA
NGA Campus East (NCE) Project Scope

- Visitor Control Center (VCC)
- Main Office Building (MOB)
- Parking Garage
- Tech Center (TECH)
- Central Utility Plant (CUP)
- Remote Inspection Facility (RIF)
NCE Commissioning Scope

- Commissioning Scope of work
  - Commissioning Authority (CxA) for Campus
    - Main Office Building
    - Central Utility Plant
    - Technology Center
    - Parking Garage
    - Visitor Control Center
    - Remote Inspection Facility
    - Water Feature Pump House
NCE Commissioning Scope

• Cx Scope of work (continued)
  • Implemented ASHRAE Guideline 0-2005 Commissioning
  • In pursuit of LEED 2.2 Credits EA 3.1 (Enhanced Cx)
  • Services Covered
    – Mechanical, Electrical and Plumbing
    – Building Automation & Power Management Systems
    – Building Envelope Systems
    – Life Safety Systems
    – Elevators / Escalators
    – Data / Voice Systems
    – Acoustical
How well have we done?

- Commissioning Definitions
- LEED Requirements
- How the Cx Project Leadership Team (PLT) worked within the project’s governance
  - Phases of Commissioning
  - Use of Metrics and “Macro” Schedule tools to manage expectations of senior leaders not familiar with the “black box” of the Cx process
  - Successes and Challenges
Definition of Commissioning

“The Commissioning Process is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria.”

- ASHRAE Guideline 0-2005

- The process is performed specifically to ensure that the finished facility operates in accordance with the Owner’s Project Requirements (OPR) and the construction documents.

- To be successful the commissioning process must be integrated into all phases and major elements of the project.
LEED for New Construction v 2.2

- Prerequisite – Fundamental Cx required for LEED
  - Review owner’s requirements, develop plan, create final report
  - Verify performance and incorporate Cx into construction documents
  - Counts for Energy and Atmosphere Prerequisite 1
  
- Point Credit – Enhanced Cx
  - Before Construction: Conduct design review, review submittals
  - After Construction: Verify training of O&M staff, review operations after turnover
  - Counts for Energy and Atmosphere Credit 3
Project governance

Program Board

Executive Leadership Team

Stakeholders Represented at each level: USACE, NGA, DPW, Designer, Builder, IT, Security, Deployment, Facility Ops

The Commissioning project leadership team (PLT) was comprised of a cross section of members from several other PLT’s and successfully integrated the Cx process into all major project facilities and elements through the resources provided by the independent third party Commissioning Authority.
Commissioning PLT

National Geospatial-Intelligence Agency
Owner

NGA Design

NGA Operations / Maintenance

MBP Construction Engineering Consultant

US Army Corps of Engineers – Baltimore District Program Manager

Eaton Energy Solutions, Inc. Commissioning Authority

Clark/Balfour Beatty Construction - Joint Venture Construction Manager – Main Campus

RTKL/KlingStubbins - Joint Venture Architect / Engineer

KBI/Gifford Corporation – Joint Venture Construction Manager - RIF

Primary Integration Commissioning Consultant

CBB Quality QA/QC

CBB Main Office Bldg Construction Team

Subcontractors

CBB Parking Garage Construction Team

Subcontractors

CBB Central Utility Plant Construction Team

Subcontractors

CBB Technology Center Construction Team

Subcontractors

CBB Visitor Control Cntr Construction Team

Subcontractors

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Commissioning Process Flow
# Levels of Inspection & Testing

## CONSTRUCTION TESTING

<table>
<thead>
<tr>
<th>Pre Functional Inspections &amp; Tests</th>
<th>CONSTRUCTION TESTING</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Factory Witness Tests - Where called for in Specifications</td>
<td>JV, QC, QA, CxA, NGA, QC, QA</td>
</tr>
<tr>
<td>Level 2a</td>
<td>On-Site Equipment Delivery Inspections</td>
<td>JV, CxA, QA, QC</td>
</tr>
<tr>
<td>Level 2b</td>
<td>Installed Equipment Inspections (PFC)</td>
<td>CxA, QA, QC</td>
</tr>
<tr>
<td>Level 2c</td>
<td>Prior to Energy or Fluid Connection Inspections</td>
<td>CxA, QA, QC</td>
</tr>
<tr>
<td>Level 2d</td>
<td>Manufacturers Factory Start-up and Inspections</td>
<td>CxA, QA, QC</td>
</tr>
<tr>
<td>Level 2e</td>
<td>As required for mechanical systems complete TAB and TAB Verification</td>
<td>JV, CxA, QA, QC</td>
</tr>
</tbody>
</table>

## ACCEPTANCE TESTING

<table>
<thead>
<tr>
<th>Functional Performance Tests</th>
<th>ACCEPTANCE TESTING</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 3</td>
<td>Functional Performance Tests - With Loads</td>
<td>CxA, QA, QC, NGA</td>
</tr>
<tr>
<td>Level 3</td>
<td>Functional Performance Tests - Controls and External Monitoring Inspections</td>
<td>CxA, QA, QC, NGA</td>
</tr>
</tbody>
</table>

## INTEGRATED SYSTEM TESTING

<table>
<thead>
<tr>
<th>Integrated Systems Testing</th>
<th>INTEGRATED SYSTEM TESTING</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 4</td>
<td>Identify reliability constraints that result from normal and adverse operation tests.</td>
<td>All Parties</td>
</tr>
<tr>
<td>Level 4</td>
<td>Prove the Engineer’s design for capacity and failover.</td>
<td>All Parties</td>
</tr>
<tr>
<td>Level 4a</td>
<td>Enhanced testing to verify monitoring and control system accuracy</td>
<td>All Parties</td>
</tr>
</tbody>
</table>
Main Office Building Sequence

Constructed, *Commissioned* & turned over by “Segment”
Metrics and “Macro” Schedule Tools

• Helped manage senior leader expectations of progress for functional (acceptance) testing
• Used during Construction Phase of Cx
• Tracking Mechanisms Evolved
  – Macro schedule included both electrical and mechanical functional testing activities
  – Metrics included deferred testing
  – Cx PLT wrote two simple Cx fact sheets targeted to senior leadership providing updates of the NCE Commissioning Program
Successes & Challenges

Successes

• Complied with LEED v2.2 Cx Credits

• Independent 3rd Party CxA:
  – Helped lead a fully integrated project team to ensure the Cx process was integrated into all major project facilities and elements
  – Enforced compliance of acceptance testing
  – Developed clear metrics for functional and integrated system testing which helped manage expectations of owner
  – Captured lessons learned
  – Was contracted to provide post construction Cx services during warranty period

Challenges

• Phased construction presented several challenges
  – Operations contractor not fully mobilized during first major project turnover
  – Major facilities were not functionally tested under load and permanent power before turnover
  – Final TAB report not yet complete

• CxA was not selected until mid-design phase
• Final Report not yet completed
Owner Perspective – Design & Construction

**Successes**

- Provided valuable experience and lessons learned for application in future construction projects
- Thorough testing of mission-critical power and cooling systems provided a very high level of confidence in their reliability (subsequently proved by unexpected utility power losses – June 2012 Derecho)
- Provided a treasure trove of information for ongoing O&M of the Facility

**Challenges**

- Had to overcome USACE’s concern of managing a third party CxA – not their typical approach
- Speed and complexity of the project created inevitable schedule crunch – commissioning wasn’t on the construction contractor’s schedule in enough detail
- The last 5% of a project takes 95% of the effort – we’re not quite finished yet
Owner Perspective – Operations & Maintenance

**Successes**

- Base operations support contractor attained invaluable training and experience through participation in Cx activities
- Provided opportunity to move into continuous CX

**Challenges**

- How do we take the mountain of data provided from the Construction CX task and translate that into a Continuous CX process?
- The delay in completing CX makes the transition to continuous CX more challenging
Design Professional Perspective

Successes

• Innovative Systems
  – Chilled Beams
  – Dual Temperature Chilled Water System
  – “Pond” Standby Water Storage
  – ETFE Roof System
• False Loading
  – Modified boiler/chiller systems

Challenges

• Phased Turnover
  – Balancing Issues
  – System Turndown Issues
• Late Changes to the Program
General Contractor Perspectives

• Requirements for Successful Commissioning
  – Schedule
    • Early development of construction schedule
    • Must incorporate ALL Cx activities with realistic durations
      – Need to know the scope of the Cx process
      – Must have all the test scripts early
    • Use the schedule to manage the commissioning process
      – Review and update the schedule weekly
General Contractor Perspectives

- Requirements for Successful Commissioning
  - Early Involvement of All Stakeholders
    - Owner, Design Team, Construction Manager, General Contractor, Subcontractors, Commissioning Authority
      - Clearly defined roles and responsibilities
        » Who documents the process
        » Who has authority to make changes
        » Who has authority to sign off on items
      - Accountability between stakeholders
      - Develop relationships with all stakeholders
        » Know each members’ goals and risks
General Contractor Perspectives

• Requirements for Successful Commissioning
  – Subcontractor Management
    • Demand a dedicated commissioning team from appropriate subcontractors
    • Meet regularly with principals of the subcontractors
      – Hold each sub accountable for their responsibilities
      – Listen to their ideas and welcome their input
General Contractor Perspectives

• Requirements for Successful Commissioning
  – Staffing
    • Incorporate appropriate staffing into all budgets and cost proposals
    • Evaluate the requirements for each staff position
      – Select the “Right” person for each position
      – Delicate balance between project management, field supervision, and engineering
General Contractor Perspectives

• Takeaways
  – Commissioning begins prior to proposal submission
  – Early collaboration of all stakeholders
  – Develop a realistic construction schedule that incorporates all commissioning activities
  – Manage the subcontractors and hold them accountable
  – Drive the schedule
Commissioning Provider Perspective

Successes

• Many Potential Show Stoppers Issues were Identified Early
• Warranty Issues Seem Minimal
• Results of Post Construction Occupancy Survey Favorable
• BRAC Mission was Accomplished

Challenges

• Security Requirements
• Multiple Tracking Tools Used
• Scale of Project
• Overcoming Contractors Preconceived Notions of Cx
Wrapping Up

Lessons Learned

• Cx is a defined process that needs to be followed.
• Clearly defined Cx expectations early to all. In particular the definition of DONE.
• Cx is only as effective as the commitment of the owner’s representative.
• UFGS master specs need to be updated to reflect current Cx standards.
• Increase facility management engineering capabilities to address increase in complexity of facilities.
• Partnering works.
• “Quality is a victim of schedule”.

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Questions
References

• ASHRAE Guideline 0-2005 – The Commissioning Process
• USGBC LEED® for New Construction & Major Renovations version 2.2 – October 2005