Functional Testing: Post-Occupancy

Michael J. Dooley, PE, LEED AP
Northeast Cx Manager
AKF Group
Learning Objectives

Post Occupancy Functional Testing

- Participants will be able to distinguish between multiple mode testing of heating and cooling systems during post occupancy and the impact of acceptance without seasonal post occupancy testing
  - Typical Modes in an approved Sequence of Operations
  - Typical Equipment and Systems Commissioned
  - Typical Acceptance and Turnover Task Sequence
  - Typical seasonal testing expected during the Acceptance and Turnover process

- Participants will be able to update project schedules and maintain clear concise communication of level of effort required to the Commissioning Team during post occupancy performance testing
  - Understanding typical closeout deliverables
  - Identifying the value of seasonal testing and open issues for acceptance
  - Keeping the Design and Construction Teams engaged through final acceptance
  - Critical path scheduling for functional test completion and reporting

- Q & A
The Importance of a Formal Acceptance and Turnover Process

- Verify that the Contractor installed what was purchased by the Owner
- Clearly signals completion of and warranty start dates
- Ensures that the O & M Staff has been properly trained prior to occupancy
- Enables the O & M Staff to experience less of a learning curve
- Reduce the quantity and cost of Day 2 Proposed Change Orders
- Improve the end user transition into the new space
The Importance of a Formal Acceptance and Turnover Process

• Enable the O & M Staff to spend more time performing base duties instead of correcting construction deficiencies
• Project spent 1 to 5 years in Design and Construction but Operations only gets 30 days to get acquainted with the new space during Closeout
• Needed for Green Initiative or Energy Conservation validation
• Performance acceptance testing is a contract requirement for turnover
• Check the reliability and redundancy of the equipment and systems
• Verify that DOH, Environment of Care and other Compliance documents are properly updated
• Good practice to help save money and energy over time
• Establish clear equipment and system responsibilities for all phases of the project
Post Occupancy Functional Testing Planning Depends on Desired Objective

- Plant Operations
- Fire Safety & Security
- Facilities Design & Construction
- Environment of Care
- Contractors
- Other AHJs
- Engineering Operations
- Cx & Testing Team Management
Some Typical Construction Contract Milestones

• Substantial Completion
  Stage or designated portion of a construction project that is sufficiently complete in accordance with a contract for the owner to occupy and/or utilize it for its intended use, without undue interference.

• Partial utilization or conditional acceptance
  The stage of a construction project where the Owner accepts responsibility for the use of completed portions of the new facility well before total project completion

• Beneficial Occupancy
  Stage of construction of a building or facility, before final completion, at which its owner can occupy it for the purpose it was constructed.

• Certificate of Substantial Completion or Final Acceptance
  Document verified by an architect, engineer, or owner of a construction project that the project is substantially complete and is approved for payment by the general contractor on the date of final payment.
Contract Deliverables

How well do the Construction Documents line up expectations for Turnover?

• Project Closeout Checklist
• Contract deliverables
• Payments reflect completion
• Are substantial completion, beneficial use and final acceptance defined?
• Project schedule
• Phasing
• Commissioning specification
• Sequence for Acceptance
• Programming gaps
• Filing and Permitting
• Retainage and leverage
The Acceptance Phase is the Key!

- A formal Acceptance Phase is the most important step in the Construction Process
  - Whether performed by a 3rd party, the House, Owner’s Representative, or GC with A/E/House Witnessing
  - Clear contract expectations for Acceptance, Turnover, and Closeout

- Acceptance Phase
  - Systemic Verification of the installed equipment and systems in accordance with the Plans, Specs, and Approved Submittals
  - Systemic and logical sequence validation that the installed equipment and systems have demonstrated performance in accordance with the Plan, SPEC, and Owner’s Performance Requirements (OPR)

- Turnover Phase
  - O & M Staff and Service Groups have sufficient knowledge, training and documentation to adequately perform the ongoing day-to-day operation and maintenance of the specific equipment and systems
Typical Operation Sequencing

- Summer operation
- Shoulder season operation
- Winter operation
- Occupied schedule
- Unoccupied schedule
Sequence of Operation

- Complete review of the approved SOO
- Approved testing scripts for all mode of operation
- Testing during the season of operation
- Scheduled deferred testing
Typical Building Systems for Turnover

- Typical Energy Systems
- Building Management and Demand Control Energy systems
- Central Chiller Plant
- Central Boiler Plant
- Air Handling/ Ventilation/ Pressurization Systems
- Humidity control systems and monitoring
- Laboratory and Terminal Units
- Domestic Hot Water System
- Sump and Ejector Systems
- Data Centers
- Lighting Systems

- Systems for Compliance
- Power Systems – normal and emergency
- Emergency Generator Plants
- Automatic Transfer Switches
- Fire Alarm and Protection Systems
- Fire Suppression Systems
- Information Technology
- Call System
- Domestic Water Supplier
- Specialty Systems
- Eye Wash and Emergency Shower
- Security System
How do projects flow between business units from Programming to Operations?

• Does the Facility have a Turnover Protocol?
• How do we Closeout a Project?
• Who for the Owner’s Team is responsible for Accepting the M/E/P and FP Equipment and Systems?
• How will we prove the required level of performance is achieved?
• Can we really have a final TAB for Air and Water at this time?
• What internal documents have to get updated for Compliance?
• How do I know the Contractor is 80% complete on that invoice?
• Who’s responsible for updating the Compliance documents?
• Does the end user understand how that thing on the wall works?
• Can the House maintain and test all this stuff or do we need some service agreements?
• When should Operations be involved in the project?
• What happens if I press that red button?
Develop an Acceptance and Turnover Plan

- The Acceptance Plan shall outline the organization, schedule, responsibilities and documentation requirements of the Turnover Process.
- Clearly identify the specified demonstration, testing, training, and quality check-outs to be performed by the Contractor per the contract documents.
- Verify field test reports performed by the sub-contractor and witnessed by the GC, House, or Engineer.
- Validate that the installed systems meet design intent per the plans and specifications through observation, demonstration, or independent measurement and verification.
- The Commissioning or Accepting Authority shall review of the documentation submitted by the Contractor as required by the Specifications for completeness and accuracy. This commissioning review supplements, but does not replace, the Architect/Engineer’s review.
- Review equipment warranties to ensure that the Owner’s responsibilities are clearly defined.
Acceptance and Turnover Phase Steps

- Functional Performance Testing:
  - Write Functional Performance Testing
  - Coordinate Functional Performance Testing
  - Witness and approve Functional Performance Testing
  - Coordinate retesting as necessary
Roadmap to Final Acceptance

INITIAL System Acceptance

- System Performance Verification
- Sequence of Operation Approved
- Equipment Functional Verification
- Vendor Startup Forms
- Vibration Testing/Flushing/Duct Leak Test/Piping Pressure Tests
- Pre-startup Checklist
- Factory Acceptance Tests

Integration System Tests Performed

- Seasonal Testing and Final Tie-In
- Record Submittals/Tests/TAB Received
- Issues Log Items Completed

Final System Acceptance
Documentation after Testing

- Issue/Deficiency Logs: Prepare a formal, ongoing, record of deficiencies, problems, warranty items and concerns and expected resolution raised by members of the Acceptance Team during the Turnover and Closeout Process.
- Document resolution plan to all issues
- Training:
  - Coordinate and oversee the training of Owner’s personnel for equipment and systems in accordance with the specifications.
  - The Contractors will provide training agendas for review, technical documentation and qualified personnel as to conduct the training in accordance with the specifications.
Reporting and Post Acceptance

- Reporting Expectations to the Acceptance Team
  - Provide monthly reports to Operations on Acceptance and Turnover progress.
  - Keep all documentation and log all commissioning related issues and known deficiencies with expected dates of completion by the contractor.
  - Track the status of documentation and testing for each equipment and system
  - Oversee and maintain the development of acceptance documentation.
  - Provide an executive summary of the accuracy and completeness of each MEP/FP Turnover package.

- Post Occupancy/Acceptance
  - Witness seasonal or deferred Functional Performance Testing as prescribed by the Turnover Plan and specifications.
  - Provide a final report following the completion of all contract specified Acceptance Testing. The report is to outline compliance and non-compliance to the construction documents, as well as identify concerns relative to future performance.
Turnover Planning Depends on Resource Needs

- Plant Operations
- Engineering Operations
- Cx & Testing Team Management
- Fire Safety & Security
- Facilities Design & Construction
- Contractors
- Environment of Care
- Other AHJs
Formal Acceptance Meeting

- Sign In Sheet
- Acceptance or Commissioning back up documentation
- Contract deliverable checklist updated
- Change management documentation is in order
- Known and open Issues log, punchlist, and Acceptance deficiencies understood
- O & M Documentation is complete and accurate
- The Contractor provides a Certification of Completeness for each system
- Guarantees have been provided
- Certificates of inspection completed
- Maintenance stock items, spare parts, keying schedule and special tools provided
- Waivers of liens
- Process for hot and cold calls for the following season
- Corrective action process for defects found during the warranty period
- Meeting Minutes by the Owner or Owner’s Accepting Authority with a list of open items attached requesting timelines for correction.
Preparation for Turnover

• O & M Staff has been adequately trained;
• We have a vibration baseline of the equipment;
• We understand the building’s energy use and demand;
• We have proven out the design and operational performance intent;
• The actual control sequences for major systems are clearly documented;
• Equipment nameplate information, maintenance, and potential warranty issues (broken dampers and air handlers, temperature control, dirty coils, sensor calibration, etc.) are clearly outlined;
Preparation for Turnover

- The existing data schedules (set point, economizer cycles, time-of-day, holiday, lighting, etc.) are well documented for reference;
- The most severe control and operational problems;
- A contact list of Installer, Manufacturer and Vendor for each piece of equipment has been provided with copies of the Warranties;
- The location of known deficiencies, major comfort problems or trouble spots in the building are documented; and,
- Current O&M practices are updated as to integrate the new equipment into the ongoing maintenance and compliance documentation effort.
- CMMS updated.
- Service contracts amended.
- Warranty period reviews schedule.
Each project requires an Acceptance and Turnover Plan for Closeout
Clearly identify the roles and responsibilities of each Project Team member

Highlight contract deliverables during scope review and kick off meetings
The EC, O & M, Closeout, and Turnover Processes are linked

Assign a responsible party as the Accepting Authority
Better understanding of which Compliance Documentation are affected and require updates

Reduces the risk of partial acceptance and warranty pit falls
Improves project management, invoicing and change management
Closeout starts at the Project Award to the Design Team
Post Occupancy Scheduling

- Post-Occupancy Performance Testing Game plan:
- Identify the seasonal or deferred performance tests within the Commissioning or Turnover Plan.
- Assign a line item, monetary value, and expected date of completion for each open performance test, so the proper amount of retainage is maintained on the correct existing contracts.
- Openly discuss, document and include the known open issues with the Engineer’s Punchlist, CxA’s issues log, meeting minutes, O & M staff walkthroughs and end user occupancy training.
- Inform the end users on how hot and cold calls or other expected issues will be professionally handled until the systems are fully tested and accepted.
- Schedule to implement performance testing with a coordination meeting, method of procedure for testing, risk assessment for the occupied spaces, and adequate resource representation.
- Implement the Performance Testing with proper notification to all affected parties.
- Maintain a deficiency log of items discovered, repair and retest as required.
- Complete the O&M staff Training.
- Formally accept the completed system.
- Authorize payment for the completed tasks.
- Include the performance test documentation within the Commissioning Report and Turnover Plan.
- Negotiating with the Contractor and End-users prior to Beneficial Use or Occupancy is a critical step to ensure all parties are informed, expectations are matched, and remaining task responsibilities are clearly understood.
• Tracking open schedule items is vital to project close out
• Keeping all informed of the schedule and buy in to completing the schedule is key
• Owner understands implication of schedule and informs occupants of outstanding testing
• Understand what if scenarios
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Questions?
Thank you for your time!
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mdooley@akfgroup.com  www.akfgroup.com
Tel: (507) 208-4488