Appendix P-4
Design and Construction Commissioning
Supporting Information

Introduction
Design and Construction Commissioning refers to the process that shall begin in pre-design and conclude after the correction period or after completion of a full year of operation, whichever is later. The Design and Construction Commissioning process is the means to verify and document that the facility systems operate in accordance with their design intent and that the operations staff fully understands the system operational procedures and are prepared to continue operating the system per the design intent. This includes documenting system operational goals and design parameters, specifying verification and testing in the contract documents, confirming the successful completion of the verification process, documenting the system operational procedures and training the operations staff. The Design and Construction Commissioning Process is coordinated by the Commissioning Leader and executed by the Commissioning Team.

The following are narrative descriptions of the activities (rows) in Appendix P-5 Design and Construction Commissioning Matrix.

1. GENERAL

1.01 Design & Construction Commissioning Plan
The Design & Construction Commissioning Plan consists of the following elements:

- Systems Commissioning Plan
  - List of systems to be commissioned
    - Electrical Systems, including Lighting and Daylighting Controls: And other elements related to performance of Guidelines: S.5, E.1, E.2, E.3, I.6, I.9
    - Indoor Air Quality Elements and Systems: And other elements related to performance of Guidelines: I.1, I.2, I.3, I.4, I.5
    - Plumbing Systems: In addition to required flow rate commissioning above as needed to support operational achievement of guidelines: S.7, S.8, S.13 (RECOMMENDED)
    - Interior materials (specification, installation): As needed to support operational achievement of guidelines: I.2, M.1, M.2 (RECOMMENDED)
    - Envelope integrity: In addition to required water infiltration commissioning above as needed to support operational achievement of guidelines: I.3, M.1, M.2 (RECOMMENDED)
    - IEQ: Vibrations/acoustics/noise: In addition to occupant surveys above, perform physical measurements as needed to support operational achievement of guidelines: I.7, I.8 (RECOMMENDED)
    - Plumbing Systems: Flow Rate (RECOMMENDED)
    - Envelope Integrity: Test Building Envelope for Water Infiltration (RECOMMENDED)
  - Design Intent Document for systems to be commissioned
  - Basis of Design for systems to be commissioned
The Design and Construction Commissioning Plan is a living document that grows in detail over time, as systems are specified and design details are refined. The following is a description of how the Commissioning Plan shall evolve over the course of the project.

- **Agency Planning**
  - Brief description of commissioning process for budgeting purposes.

- **Pre-Design/Programming & Pre-Design/Site Selection**
  - Brief description of commissioning process for budgeting purposes.
  - Systems to be commissioned
  - Design Intent Document for those systems
  - Updated Design Intent Document for those systems if work is to be attached to or renovated within an existing building.

- **Schematic Design Phase**
  - Systems Commissioning Plan
    - General list of system types to be commissioned
    - Design Intent Document for those systems
    - Basis of Design Document for those systems
    - Description of commissioning activities
    - List of commissioning team members; by project role, not by name
    - Assignment of roles and responsibilities of each team member
    - Description of commissioning documentation requirements

- **Design Development**
  - Systems Commissioning Plan
    - Detailed list of systems (using design document names/numbers) to be commissioned
    - Updated Design Intent Document for those systems
    - Updated Basis of Design Document for those systems
    - Description of commissioning activities
    - List of commissioning team members; by project role, not by name
    - Assignment of roles and responsibilities of each team member
    - Description of commissioning documentation requirements

- **Construction Documents**
  - Systems Commissioning Plan
    - Updated detailed list of systems (using design document names/numbers) to be commissioned
    - Updated Design Intent Document for those systems
    - Updated Basis of Design Document for those systems
    - Description of commissioning activities
- List of commissioning team members; by project role, not by name
- Assignment of roles and responsibilities of each team member
- Description of commissioning documentation requirements
- List of commissioning activities to be incorporated into the construction schedule, including recommended integration with typical contractor installation, startup, and turnover milestones
- Customized system installation checklists and functional performance test procedures to be completed prior to system acceptance by the owner

- Construction
  - Same as Construction Documents but updated to reflect any system modifications or additions approved during Construction. Sections that may need to be changed include:
    - Updated detailed list of systems (using design document names/numbers) to be commissioned
    - Updated Design Intent Document for those systems
    - Basis of Design for those systems
    - Customized system installation checklists and test procedures to be completed prior to system acceptance by the owner
    - Updated Construction Phase Air Quality Management Plan
    - Updated Correction Period Air Quality Management Plan
    - Updated Construction Waste Management Plan

- Correction Period
  - Same as Construction but updated to reflect any system modifications or additions approved during the time of systems turnover to the owner. This document is intended to represent the final approved and tested condition of the systems being commissioned. Sections that may need to be changed include:
    - Updated Design Intent Document
    - Customized system installation checklists and test procedures to be completed prior to system acceptance by the owner
    - Updated Construction Phase Air Quality Management Plan
    - Updated Correction Period Air Quality Management Plan
    - Updated Construction Waste Management Plan

1.02 Commissioning Reports
Commissioning Reports shall be prepared at the end of each phase of design and construction documenting progress in and compliance with the Commissioning Plan for that phase. Each report should include recommendations for adjustments in the Commissioning Plan for the next phase.

Starting with the Pre-Design Phase and going through the Construction Documents Phase, the Commissioning Reports should include design review comments documenting the Commissioning Team’s evaluation of the ability of the facility, as defined or described at the Phase, to meet the Design Intent Document criteria.

The end-of-Correction Period Commissioning Report shall be the final deliverable of the Design and Construction Commissioning Process. The Report shall state that the Design and Construction Commissioning Plan has been completed and the Design Intent Document criteria have been achieved. If
the owner accepts systems that do not meet the Design Intent Document criteria, the Report shall document which deviations were approved by the owner. The report shall also include, but not be limited to, the following:

- Design Intent Document
- Other System Requirements and Parameters
- Specifics of Equipment and Systems Operation
- Test Procedures
- Testing Record
- O&M Training Record
- Commissioning Team Participants

1.03 Compliance and Outcome Documentation
Submit documentation as required by the MSBG at the end of each phase of the design and construction process using the B3-MSBG Tracking Tool (www.msbgtracking.com).

2. SYSTEMS COMMISSIONING

2.01 Engage Acting Commissioning Team
The Acting Commissioning Team is assembled to facilitate and oversee commissioning activities during the Planning and Pre-Design phases of the project. The Acting Commissioning Team shall include the following members. These team members may or may not be the same people who serve of the Design & Construction Commissioning Team.

- Commissioning Leader
- Facilities Operations Manager (FOM)
- Project Manager
- Guideline Leader

2.02 Review Site Alternatives
Review Site Alternatives for their impact on the ability of the systems being commissioned to achieve their Design Intent criteria.

2.03 Engage Commissioning Team
The Commissioning Team assists in planning, reviewing and coordination of commissioning activities with all disciplines involved in the building project. The Commissioning Team shall include the following members at a minimum. Contractors will not join the team until they are selected through the normal procurement process.

- Commissioning Leader
- Facility Operations Manager (FOM)
- Project Manager
- Designers
- Contractors
- Guideline Leader

The Commissioning Leader facilitates and coordinates the efforts of the commissioning team. For Design and Construction Commissioning, the commissioning leader shall have a distinct role from the design team but may be employed within a firm providing design services.
The Facility Operations Manager is accountable for facility performance during ongoing occupancy and will manage or perform ongoing operations and maintenance following construction. This person is available to participate throughout the design and construction process for continuity into final operation.

2.04 Design Intent Document
The Design Intent Document (DID) shall quantify functional performance expectations and parameters for each system to be commissioned. The DID provides the common understanding that focuses design, construction, and commissioning activities on the desired outcome. The DID shall be written in objective and measurable terms. Quantify parameters such as space temperatures, humidity levels, lighting levels, sound levels, and ventilation rates when applied to the conditioned building spaces.

The DID shall be updated every time the owner accepts an alternate performance criteria—due to owner desires, schedule, or budget. This might occur through normal design evolution, value engineering, change orders, or other supplemental instructions during construction.

During the Correction Period and On-Going Operations, the DID helps the owner/operators understand the original design intent. It also provides the benchmark for maintenance, repair, and replacement decisions.

2.05 Basis of Design
The Basis of Design is a narrative description of how the systems will be designed in order to achieve the design intent acceptance criteria.

2.06 Commissioning Design Review
At least once during each of the Schematic Design, Design Development, and Construction Documents Phases, review the design progress against the goals of the Design Intent Document. Commissioning Design Review comments shall be documented in writing and responses prepared by the appropriate designers.

- Performance Check: Commissioning Team shall review design as documented to verify that it meets the physical outcomes and operational performance defined at that phase. Performance areas include, but are not limited to:
  - Design Intent acceptance criteria for all required or additional pursued guidelines
  - Requirements for specific operational scenarios of the building
  - Regular maintenance, cleaning, and servicing (including ISO 14000 cleaning materials)

- Measurability/Testability Check: Commissioning Team shall review design as documented to verify that it meets criteria for testing and verification of performance for both Design and Construction Commissioning as well as Operations Commissioning monitoring during Ongoing Occupancy. Performance areas include, but are not limited to:
  - Measurements and testing required during all phases of Design and Construction Commissioning.
  - Measurement, monitoring, and control of energy, water, indoor environmental quality during Ongoing Occupancy.

2.7 Coordinate with Operations Commissioning Requirements (Guideline P.5)
Cooperate with the Operations Commissioning Team by incorporating design features required to perform Operations Commissioning. Refer to Guideline P.5 Operations Commissioning for an understanding of what these features might be.
2.8 List of I/O Data Points
Submit a list of input and output (I/O) data points as part of outcome documentation before the end of Design Development. These shall be submitted for all computer-based control systems, e.g., HVAC, lighting controls, etc.

2.9 Measurement & Verification Baseline
The Measurement and Verification Baseline(s) are used to calculate savings as part of the Measurement and Verification Process. See details of Measurement and Verification under Guideline P.5 Operations Commissioning.

2.10 Incorporate Cx Criteria & Scope into Construction Documents
Incorporate a commissioning specification section into Division 1 of the project manual. The commissioning specification shall define and elaborate on the contractor’s responsibilities as defined in the Commissioning Plan. Incorporate the Commissioning Plan into the contract documents by reference in order to communicate the context of the commissioning specification and information regarding other team member responsibilities.

2.11 Review Contractors' Submittals
Review contractor submittals for commissioned equipment and other commissioned design elements.

2.12 Verify Installation
Complete customized system installation checklists, as included in the Commissioning Plan, prior to system acceptance by the owner.

2.13 Verify Functional Performance
Complete customized system functional performance test procedures, as included in the Commissioning Plan, prior to system acceptance by the owner.

2.14 Verify Operations & Maintenance (O&M) Documentation
Verify that the contractor creates and submits Operations & Maintenance manuals for the owner prior to construction completion and system acceptance by the owner.

2.15 Verify Operations & Maintenance (O&M) Training
Verify that the contractor presents Operations & Maintenance training to the owner prior to construction completion and system acceptance by the owner.

2.16 Cohesive O&M Systems Manual
Review Operations and Maintenance Manual, coordinate with the contents of the Commissioning Report, and combine into a cohesive Operations Manual to be delivered to the Owner.

2.17 Deferred Verification
Some of the system functional performance test procedures will not be practical or meaningful to complete prior to the Correction Period. This may be due to construction phasing or climate constraints. Those test procedures shall be completed at an appropriate time during the Correction Period.

2.18 Ten Month O&M Review
At 10 months into the correction period, review building operation with Operations and Maintenance staff, and create a plan for resolution of outstanding commissioning-related issues.
3. CONSTRUCTION AIR QUALITY MANAGEMENT PLAN

3.01 Construction Air Quality Management Plan
The Construction Air Quality Management Plan is part of the Design and Construction Commissioning Plan and shall cover practices to prevent introduction of air quality problems as a result of the construction process.
Meet construction air quality requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction. Requirements include elements for IAQ protection during construction (From CHPS section 01350, 1.6).

Indicate in the bid documents that compliance with the Construction Air Quality Management Plan is required.

3.02 Protect Stored Materials
Protect stored on-site or installed absorptive materials from moisture damage.

3.03 Replace Filtration Media
Replace all filtration media immediately prior to occupancy.

3.04 Temporary Construction Ventilation
Maintain sufficient temporary ventilation of areas where materials are being used that emit VOCs.
Maintain ventilation continuously during installation, and until emissions dissipate after installation. If continuous ventilation is not possible via building's HVAC system(s) then ventilation shall be supplied via open windows and temporary fans, sufficient to provide no less than three air changes per hour.

- Period after installation shall be sufficient to dissipate odors and elevated concentrations of VOCs. Where no specific period is stated in the Specifications, a time period of 72 hours shall be used.
- Ventilate areas directly to outside. Ventilation to other enclosed areas is not acceptable.

3.05 Protect HVAC System
During dust-producing activities (e.g., drywall installation and finishing), turn ventilation system off and protect openings in supply and return HVAC system from dust infiltration. Provide temporary ventilation as required.

Seal ducts during transportation, delivery, and construction to prevent accumulation of construction dust and construction debris inside ducts.

3.06 Offsite Product Preconditioning
All products which have odors and significant VOC emissions shall be preconditioned off-site prior to delivery to the Project site. Allow products to off-gas in a dry, well-ventilated space for 14 calendar days to allow for reasonable dissipation of odors and emissions.

- Condition products without containers and packaging to maximize off-gassing of VOCs
- Condition products in ventilated warehouse or other building. Comply with substitution requirements for consideration of other locations.

3.07 Remove Moisture Damaged Materials
Materials with evidence of moisture damage, including stains, are not acceptable. This includes both stored and installed materials. Immediately remove all such materials from the site and properly dispose.
Take special care to prevent accumulation of moisture on installed materials and within packaging during delivery, storage, and handling to prevent development of molds and mildew on packaging and on products.

- Immediately remove from site and properly dispose of materials showing signs of mold and/or signs of mildew, including materials with moisture stains.
- Replace moldy materials with new, undamaged materials.

3.08 Protect Porous Materials
Where odorous and/or high VOC emitting products are applied on-site, apply prior to installation of porous and fibrous materials. Where this is not possible, protect porous materials with polyethylene vapor retarders.

3.09 Building Flush-out Period
Comply with a pre-occupancy building flush-out as described in LEED NC Version 2.2 which states, "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 an internal temperature of at least 60[degrees]F and relative humidity no higher than 60%." (Source: LEED NC Version 2.2, October 2005, Credit EQ 3.2 First part of Option 1, page 323.) Note: schedule the completion of interior finish materials and occupancy accordingly to accommodate the flush out period.

3.10 Pre-assessment of Existing Building Indoor Air Quality Problems
For New Buildings that are additions, or for Major Renovations, either A) ensure that ventilation flows between new or renovated areas and existing or non-renovated areas are decoupled or B) perform a pre-assessment of indoor air quality problems in the existing non-renovated portion, and the additions or to-be-renovated portions of the building. This pre-assessment should be done in the predesign phase, but no later than the schematic design phase by the design team. For path B, if there are problems in the non-renovated portion of the building that will be carried into the renovated zone by air movement common to the two zones of the building, these must be corrected prior to completion of the entire project. Also for path B, if there are problems in the to-be-renovated portion of the building, these must be corrected prior to completion of the entire project. The types of problems that must be addressed include, but are not limited to: air intakes in the older portion of the building that are now near major outdoor pollution sources, e.g., trucks idling, trash, or garbage areas; cleaning and/or disposal of moldy surfaces or asbestos in the renovated space following code requirements.

3.11 Protect Occupants in Adjacent Building Areas During Construction
Protect occupants in adjacent parts of the building from hazards associated with New Building additions or Major Renovations during construction. (1) Perform a safety risk assessment for potential hazards that may affect occupied zones in areas adjacent to the addition or major renovation. Potential hazards to consider include, but are not limited to: asbestos, mold, and chemicals involved in demolition or new construction in the addition or renovated areas. (2) The new construction zone and the adjacent non-renovated zone shall have either separate HVAC systems or be capped off from the renovated area using metal duct caps during construction. (3) The new construction zone shall be separated from the non-renovated portion of the building using a secure barrier that separates the atmosphere of the non-renovated portion from the renovated portion of the building. Fire resistive barriers that are caulked and taped to the existing structure are considered to be an example of such a barrier. Based on the risk assessment, air flow should be monitored.

4. CORRECTION PERIOD AIR QUALITY MANAGEMENT PLAN
4.01 Correction Period Air Quality Management Plan
The Correction Period Air Quality Management Plan is part of the Design and Construction Commissioning Plan and shall involve periodic indoor air quality testing. Evaluate building air quality three months, six months, and ten months after occupancy with testing that verifies ventilation system is better than or within design guidelines.1

Indicate in the bid documents that compliance with the Correction Period Air Quality Management Plan is required.

4.02 Three Month Building Air Quality Evaluation & Modifications
Three months into the Correction Period measure the key factor that determines ventilation rate for building (major pollutant and/or CO₂) in all building occupied zones. “Occupied zones” shall be, at a minimum, one per air handling system. No single “occupied zone” shall be greater than 5,000 square feet. The testing plan shall take into account high occupancy spaces and the locations of specific pollutant sources and shall not necessarily depend on combined/average return air concentrations at each air handler.

- Record CO₂ concentrations in each zone. If using ventilation strategy B or C, compare to expected value for this zone.
- If using ventilation strategy B or C and CO₂ levels are above expected values, additional ventilation must be provided until concentrations fall below these levels.

4.03 Six Month Building Air Quality Evaluation & Modifications
Six months into the Correction Period repeat the Indoor Air Quality testing performed at three months and make any necessary correction until concentrations fall below action levels.

4.04 Ten Month Building Air Quality Evaluation & Modifications
Ten months into the Correction Period repeat the Indoor Air Quality testing performed at ten months and make any necessary correction until concentrations fall below expected levels.

5. CONSTRUCTION WASTE MANAGEMENT PLAN

5.01 Construction Waste Management Specification

5.02 Construction Waste Management Plan

5.03 Debris Diversion
Divert construction, demolition, and land cleaning debris away from landfills.

5.04 Recycle Packaging
Recycle materials and equipment packaging.

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1 Consider (recommended, not required), monitoring three months, six months, and ten months after occupancy of other pollutants on I.4 guideline list which are not pollutants that determine the ventilation rate. Concentrations should be in guideline range and below action value for each pollutant. Sample pollutant action levels are given in Appendix I-1.
5.05 Hazardous Waste
Reduce and properly handle hazardous waste.

6. CORRECTION PERIOD USER COMFORT & SATISFACTION ASSESSMENT

6.01 Correction Period User Comfort & Satisfaction Assessment Plan
The Correction Period User Comfort & Satisfaction Assessment Plan is part of the Design and Construction Commissioning Plan and shall involve periodic occupant surveys. Assess comfort and satisfaction via occupant surveys three months and ten months after occupancy. A similar survey during the move-in process is recommended.

Issues for assessment include the following areas outlined in the IEQ Guidelines:
- Air Quality (I.4)
- Thermal Comfort (I.5)
- Access to Daylight, Quality of lighting, View space and window access (I.8, I.9, I.10)
- Vibrations, Acoustics and Noise (I.11, I.12)
- Personal Control of IEQ conditions and impacts (I.13)
- Opportunities and encouragement for healthful physical activity (I.14)

6.02 Three Month Occupant Survey
Three months into the Correction Period conduct the first User Comfort & Satisfaction Survey as defined in the Assessment Plan.

6.03 Ten Month Occupant Survey
Ten months into the Correction Period conduct the second User Comfort & Satisfaction Survey as defined in the Assessment Plan.