

SECTION 01 91 13 – BUILDING SYSTEMS COMMISSIONING PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. All HVAC Equipment, HVAC Systems and Lighting Control Systems Commissioning Services for this Project will be contracted directly by the Cocalico School District.
- B. The purpose of this Specification Section is to provide for a completed HVAC and Lighting control system which has been fully commissioned without omissions or overlaps between the installing Prime Contractors and the Commissioning Authority (CA). Installing Prime Contractors are those who perform the installation and start-up of the Equipment and Systems in preparation for the Work to be performed by the Commissioning Agency which is described herein.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, and Division 01 Specifications Sections apply to this Section including:
 - 1. Division 01 Section "Multiple Contract Summary."
 - 2. Division 01 Section "Submittal Procedures."

1.3 DESCRIPTION OF WORK TO BE PERFORMED

- A. HVAC Building Systems and Lighting Control Systems Commissioning is the responsibility of the Commissioning Authority. The Prime Contractors for this Project include the HVAC Contractor and Electrical Contractor, which, along with the BAS Subcontractor, are responsible to provide all required support for equipment and systems start-up and testing as detailed herein and are to complete all portions of their work in a satisfactory manner and make all systems fully operational for the Work to be performed by the Commissioning Authority.
- B. The Commissioning Authority will verify and document the following:
 - 1. Field Installation Verification: This includes verification that all components, equipment, and systems have been installed in accordance with the Project documents (plans and Specifications).
 - 2. Operational Performance Tests: Operational Performance Tests will be conducted to verify and document proper start-up of all components, equipment, and systems.
 - 3. Functional Performance Tests: Functional Performance Tests will be performed to verify and document the interoperability of all components, equipment, and systems.
- C. This Project will be completed in multiple phases and the Commissioning Authority's work must follow the phasing indicated in Division 01 Sections and Phasing Plans, to ensure occupancy requirements are fulfilled for continued use of existing areas that are completed or yet to be completed and for occupancy approvals as renovated areas are brought online.
- D. All on-site activities shall be completed only during time permitted in that phase. Refer to the phasing indicated in Division 01 Sections and Phasing Plans.

1.4 DEFINITIONS

- A. Acceptance Phase Commissioning: Commissioning Tasks which are performed after the construction has been completed and all Site Observations and Pre-Functional Checklists have been completed and accepted. Commissioning activities that are performed during this phase include Functional Performance Tests and Owner training.
- B. Accuracy: Capability of an instrument to indicate the true value of a measured quantity.
- C. Building Automation System Subcontractor (BAS): Vendor or subcontractor responsible for providing the Building Automation System Controls equipment and components and providing all programming of the system.
- D. Calibrate: Act of comparing an instrument of unknown accuracy with a standard of known accuracy to detect, correlate, report, or eliminate by adjustment any variation in the accuracy of the tested instrument.
- E. Commissioning Authority (CA): A NEBB Certified Building Systems Commissioning Firm who administers the Commissioning Plan by managing the members of the Commissioning Team.
- F. Commissioning Plan: Document prepared by the CA that details the scope of work and defines responsibilities and the documentation requirements of the Commissioning Process.
- G. Commissioning Process: Quality focused process for enhancing the delivery of the Project. The process includes verifying and documenting that the building and all of its components, equipment, and systems have been planned, designed, installed, tested, and can be operated in accordance with the Contract Documents.
- H. Commissioning Report: Final document that presents the results of the commissioning process for the Project. The report will include a summary, copy of the fully executed Commissioning Plan, commissioning issues log, Project correspondence, and copies of all completed Pre-Functional Checklists.
- I. Commissioning Team: Individual team members who work in a coordinated effort and are responsible for implementing the commissioning process. This includes but is not necessarily limited to the Commissioning Authority, HVAC Contractor, Electrical Contractor, and BAS Subcontractor.
- J. Construction Phase Commissioning (CPC): Commissioning activities completed during the construction process, after the successful completion of the design phase and prior to the start of the Acceptance Phase Commissioning.
- K. Deferred System Test: Includes any test that cannot be performed during the Acceptance Phase due to ambient conditions or any other condition which prevents the testing from being completed during the normal acceptance testing period.
- L. Deficiency: Condition that adversely affects the operability, maintainability, or functionality of any component, equipment, or system or that does not conform to the Project documents or industry accepted practice.
- M. Design Phase Commissioning (DPC): Commissioning activities performed during the design phase of the Project.
- N. Functionality: A design component or construction process which allows a component or system to be installed or operated in a way which will produce the required outcome required by the Contract Documents

- O. Functional Performance Test (FPT): Performed to prove the functionality of a component or system. Functional Performance Testing is conducted after all Pre-Functional Tests have been performed and accepted.
 - P. Installation Verification: Observations and inspections that are performed to verify that a component, equipment, or system has been installed in accordance with the Contract Documents and industry standards.
 - Q. Issues Log: Formal record of deficiencies and their resolution that have been discovered by the Commissioning Authority during the process of implementing the Commissioning Plan.
 - R. Lighting Controls Subcontractor (LCS): Vendor or subcontractor responsible for providing the Lighting Controls equipment and providing all programming of the system.
 - S. Precision: Precision is the ability of an instrument to produce repeatable readings of the same quantity under the same conditions. The precision of an instrument refers to its ability to produce a tightly grouped set of values around the mean value of the measured quantity.
 - T. Pre-Functional Test (PFT): Inspection and testing that is performed by the installing contractors before functional testing. This includes installation verification and component and system start-up testing.
 - U. Site Observation Reports (SO): Written reports of onsite inspections and observations by the CA. These reports are used to document installation issues which will require correction or further analysis by the Engineer.
 - V. Static Tests: Tests conducted to verify a specified static condition, such as hydrostatic testing of piping systems or leakage testing of duct systems.
 - W. Start-up Tests: Tests conducted to verify that components and systems are ready for automatic operation in accordance with the manufacturer's requirements.
 - X. Systems Manual: Comprehensive document that includes all information required for the Owner's staff to properly operate the systems.
 - Y. Test Procedure: A detailed written procedure that defines methods and expectations for tests conducted on components, equipment, and systems.
 - Z. Verification: Process by which documents, components, equipment, or systems are confirmed to be in compliance with the Contract Documents.
 - AA. Warranty Phase Commissioning: Commissioning activity that is performed after the Project has been completed and accepted by the Owner. Warranty Phase Commissioning includes follow-up verification on system performance, assistance to the Owner in identifying warranty related issues and enforcement of warranty provisions included in the Contract.
- 1.5 DESIGN PHASE ACTIVITIES
- A. The Commissioning Authority will attend and participate in the Pre-Bid meeting to fully explain the commissioning requirements for all trades as contained in the Contract Documents.

PART 2 - CONSTRUCTION PHASE

2.1 CONSTRUCTION PHASE COMMISSIONING

- A. The Commissioning Authority will create all Pre-Functional Checklists which are to be utilized for the Project. The Pre-Functional Checklists will be completed by the installing Prime Contractors, HVAC Contractor (HC), Electrical Contractor (EC), Building Automation System Contractor (BAS), and Lighting Controls Subcontractor (LCS) to verify installation and start-up of all components, equipment, and systems.
- B. During the Construction Phase all components, equipment, and systems are installed and started. During this phase, the Commissioning Authority will coordinate and conduct a kick-off commissioning meeting. This meeting will be conducted to provide detailed information on the completion and submission of the component, equipment, and systems Pre-Functional Checklists and to develop a coordinated systematic plan for the start-up and turnover of the equipment and systems for the start of Acceptance Phase Commissioning activities. Sample Pre-Functional Checklists have been included at the end of this Specification Section. Members of the Commissioning Team who will actively participate in the Construction Phase Commissioning Activities include the Owner or their designated representative, Project Engineer, HVAC Contractor, Electrical Contractor, Building Automation System Subcontractor, , Lighting Controls Subcontractor/vendor and the Commissioning Authority. All members of the Construction Phase Commissioning Team must carefully examine this Specification Section and all other cross-referenced Specification Sections for their individual roles and responsibilities related to commissioning activities.

2.2 CONSTRUCTION PHASE COMMISSIONING ACTIVITIES

- A. The Commissioning Authority is responsible to verify that all Construction Phase and Acceptance Phase Commissioning Activities are fully incorporated into the overall construction schedule.
- B. Submittal and Shop Drawing Review and Approval: The Design Professional will review and provide comments for shop drawing submittals. Commissioning Authority will receive an electronic copy of shop drawing submittals along with the Design Professional's review comments.
- C. The HVAC Contractor, Building Automation System, Electrical Contractor, and Lighting Controls Subcontractor/Vendor are each responsible to provide the CA with a final Clean Set of approved submittals which clearly indicate that any comments made by the Design Professionals have been incorporated into the Final Submittal Data. If a submittal is returned "Approved as Noted," the final Clean Set of submittal data MUST indicate how the noted items have been modified to be in compliance with the applicable Specification Section.
- D. HVAC Contractor's, Electrical Contractor's, and BAS Subcontractor representatives shall attend the initial commissioning meeting and other commissioning meetings scheduled by the Commissioning Authority to facilitate the commissioning process unless such presence is not necessary (as determined by the CA).
- E. HVAC Contractor's, Electrical Contractor's, and BAS Subcontractor shall include all special tools and instruments (specific to a piece of equipment and system) required for testing equipment and systems according to the Contract Documents.

2.3 SITE INSTALLATION INSPECTIONS

- A. The Commissioning Authority shall make routine inspections during the Construction Phase of the Project. A minimum of two inspections per month will be scheduled, or more frequently as required by

the progress of the Work. Inspections will be conducted to verify that the installation of the components, equipment, and systems is in compliance with the Contract Documents and to identify and document any quality issues that may lead to functional performance issues. After the completion of each inspection, the CA will provide a written inspection report. Any deficiencies that are noted will be forwarded to the appropriate member of the Commissioning Team for review and the appropriate corrective action. Any noted deficiencies will also become part of the Commissioning Issues Log until it has been resolved, reviewed, and accepted.

2.4 PRE-FUNCTIONAL CHECKLISTS

- A. As previously noted in Section 2.1, the Commissioning Authority will develop and distribute copies of the Pre-Functional Checklists for all HVAC and Electrical System components, equipment, and systems to the members of the Commissioning Team. The Pre-Functional Checklists shall be used by the installing HVAC Contractor, Electrical Contractor, Building Automation System Subcontractor, and Lighting Controls Subcontractor/Vendor to verify and document installation and start-up of components, equipment, and systems. All work required to be performed by the individual installing Contractors as listed in the Pre-Functional Checklists shall not be considered as complete until documentation of the Work performed has been submitted to and approved by the CA. No Testing, Adjusting, and Balancing work or Acceptance Phase Commissioning work will begin on any equipment or system until the Pre-Functional Checklists have been fully completed, reviewed, and accepted by the CA.

2.5 WORK TO BE PERFORMED PRIOR TO COMMISSIONING

- A. Work to be performed prior to Commissioning: Work performed during this phase of the commissioning process shall include but not be limited to the following:
 - 1. Complete the installation of all components, equipment, and systems including all piping, ductwork, ductwork and piping insulation, wiring, controls, lighting, and lighting controls components per the Contract Documents, including any sub-systems to ensure that they are complete systems and fully functional.
 - 2. Set-up and calibration of all Building Automation Systems control devices, including adjustments to control valves and damper actuators.
 - 3. Set-up and calibration of all Lighting Controls devices, including adjustments to the occupancy sensors, daylight sensors and photoelectric cells.
 - 4. Set-up and programming of Building Automation Systems for accurate response to meet the specified sequence of operations.
 - 5. Set-up and programming of Lighting Controls for accurate response to meet the specified lighting sequence of operations.
 - 6. Final adjustments to vibration isolators and seismic restraints (as applicable).
 - 7. Verify the operation of any Life Safety devices including manual and automatic Fire/Smoke Dampers, as well as emergency power and fire alarm interconnections with the Lighting Controls.
 - 8. Provide start-up of all equipment and systems. Provide factory start-up of equipment and systems as specified. This includes motor rotational checks, any applicable cleaning, filling, or purging of systems and verification of the operation of the control sequences.

2.6 COMMISSIONING ISSUES LOG AND DEFICIENCY RESOLUTION

- A. The Commissioning Authority will report on any deficiencies discovered from the Pre-Functional Checklists. A Commissioning Issues Log will be maintained and distributed to the appropriate Commissioning Team Members for resolution. The CA will work with other members of the Commissioning Team to ensure that any reported deficiencies are completely understood as well as implementing necessary responses or corrective actions that are required for resolution of the stated

deficiencies. It will be the CA's responsibility to manage the Commissioning Issues Log for resolution of any outstanding issues or noted deficiencies. The CA must verify completion of any items noted in the Commissioning Issues Log and report same to the Owner. After corrective actions have been taken, any test necessary to verify conformance with the Contract Documents shall be conducted by the CA.

Deficiencies or incomplete work identified by the Commissioning Authority shall be corrected by the responsible installing contractor and verification performed by the Commissioning Authority for compliance with the Contract Documents prior to the start of Acceptance Phase Commissioning. Any costs associated with any retesting or additional verification by the Commissioning Authority shall be paid by the Contractor whose work was shown by the Commissioning Authority and declared by the Owner to be deficient or incomplete. These costs will be deducted from the Contract of the Contractor whose work is shown by the Commissioning Authority and declared by the Owner to be deficient or incomplete.

2.7 ACCEPTANCE PHASE COMMISSIONING

- A. During Acceptance Phase Commissioning, the building systems shall be completed and made fully functional. The Commissioning Authority is responsible to perform Functional Performance Tests to verify and document that all components, equipment, systems, and sub-systems operate under all specific sequence of operations. During this time, the CA will also be responsible to coordinate any specific or required Owner training.

2.8 ACCEPTANCE PHASE COMMISSIONING ACTIVITIES

- A. Functional Performance Testing: The Commissioning Authority shall operate all components, equipment, systems and controls through their entire sequence of operations as outlined in the Commissioning Plan. All testing performed during Acceptance Phase Commissioning shall be performed directly by the CA and shall include the following:
 - 1. Verification of the location and accessibility of all access panels for components or equipment.
 - 2. Verification of the location, installation, and calibration for all components of the Building Automation System.
 - 3. Verification of the location, installation, and calibration for all components of the Lighting Controls.
 - 4. Verification of the operation of all components of the Building Automation System on a stand-alone basis. This includes all valve and damper actuators.
 - 5. Verification of the physical response of all components of the Building Automation System to setpoint adjustments or other changes.
 - 6. Verification of the physical response of the lighting to the Lighting Controls devices and setpoints.
 - 7. Verification of the operation of any newly installed Fire/Smoke Dampers.
 - 8. Verification of the operation of all HVAC equipment and systems in every specified mode of operation and every control sequence.
 - 9. Verification of the operation of the lighting in every specified mode of operation and every control sequence.
 - 10. Verification of the operation of all HVAC equipment and systems in "Normal Occupied Mode," "Unoccupied Mode," and under emergency conditions.
 - 11. Verification of the operation of the lighting in "Occupied Mode," "Unoccupied Mode," and under emergency and life safety conditions.
 - 12. Verification that occupancy sensors have been located and aimed in accordance with manufacturer recommendations to cover the space.
 - a. If there are greater than seven (7) occupancy sensors, the following tests shall be performed where there is a unique combination of sensor type and space geometry. No less than 10%, but in no case less than one (1) of each unique combination of sensor type and space geometry, shall be verified unless otherwise required by the Code Official. Where 30% or more of the tested devices fail, all occupancy sensors must be tested to

- verify compliance. Where there are seven (7) or fewer occupancy sensors, all sensors must be tested.
- 1) Where there are status indicators, verify correct operation.
 - 2) Verify controlled lights turn off or reduce to the programmed minimum level within the required time.
 - 3) For auto-on sensors, verify the lights turn on to the programmed level.
 - 4) For vacancy (manual-on) sensors, verify the lights only turn on when manually activated.
 - 5) Verify lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.
13. Verification that the time-switch control is programmed with accurate weekday, weekend, and holiday schedules. Document and verify schedules with the Owner.
- a. Verify the correct time and date in the time switch.
 - b. Verify that override limits are set as identified in the Contract Documents, or if not listed, that no override time limit is set beyond two (2) hours.
 - c. Simulate occupied condition. Verify and document the following:
 - 1) All lights can be turned on and off by their respective area control station.
 - 2) The station only operates lighting in the enclosed space in which the switch is located.
 - d. Simulate unoccupied condition. Verify and document the following:
 - 1) All nonexempt lighting, as identified in the locally adopted version of the International Energy Conservation Code (IECC), turns off.
 - 2) Manual override controls allow only the lights in the enclosed space where the override station is located to turn on or remain on until the next scheduled shutoff occurs.
14. Verification that Daylight Responsive Control devices have been properly located, field calibrated, and set for accurate setpoints and threshold light levels.
- a. Daylight controlled lighting loads adjust to light level set points in response to available daylight.
 - b. The locations of calibration adjustment equipment are readily accessible only to authorized personnel.
- B. Deferred Testing: Deferred Testing includes any Functional Performance Test that could not be completed due to seasonal requirements. All Deferred Testing shall be conducted during the Warranty Phase Commissioning and shall be clearly identified by the CA.
- C. Commissioning Issues Log and Deficiency Resolution: The Commissioning Authority will report on any deficiencies discovered from the Pre-Functional Checklists. A Commissioning Issues Log will be maintained and distributed to the appropriate Commissioning Team Members for resolution. The CA will work with the other members of the Commissioning Team to ensure that any reported deficiencies are completely understood, as well as any responses or corrective actions that are required for resolution of the stated deficiency. It will be the CA's responsibility to manage the Commissioning Issues Log for resolution of any outstanding issues or noted deficiencies. The CA must verify completion of any items noted in the Commissioning Issues Log and report same to the Owner. After corrective actions have been taken, any test necessary to verify conformance with the Contract Documents must be conducted by the CA. If issues remain unresolved at the end of the Project, an explanation and clarification of all unresolved issues must be included in the final commissioning report.
- Deficiencies or incomplete work identified by the CA shall be corrected by the responsible installing Contractor and verification performed by the CA for compliance with the Contract Documents prior to the start of Warranty Phase Commissioning at no additional cost to the Owner.
- D. The following equipment and systems shall be tested by the Commissioning Authority to verify that the systems are fully operational and function as described in individual Project Specifications Sections, including integration into the Building Automation System.
1. HVAC Equipment and Systems.
 2. Building Automation System.
 3. Electrical Lighting Systems.

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- E. Graphic User Interface: The Commissioning Authority must verify a usable and accurate graphical user interface for the Building Automation System and Lighting Controls. The Commissioning Authority shall review the Graphic User Interface for accurate readings of the equipment, and actuation of system components. The installing/programming Contractor shall walk the Commissioning Authority through the entire Graphic User Interface proving completeness and compliance with the Project Specifications.

- F. Owner Training: The Owner and/or their designated personnel shall receive thorough training in the operation and maintenance for all components, equipment, and systems for the Project. The Commissioning Authority shall be available to help coordinate and assist in the scheduling of all training activities. The following activities must be included as part of the Owner Training:
 - 1. The CA shall review all training agendas with the trainers.
 - 2. The Design Professionals shall provide and review information with the Owner and their designated staff on all relevant design approaches that have been incorporated into the Project, especially those that are directly related to the operation and maintenance of the facility.
 - 3. The installing Prime Contractors and Subcontractors shall train the Owner and their designated staff on construction materials and techniques that were included in the Project, especially those that are directly related to the operation and maintenance of the facility.
 - 4. Equipment Vendors shall train the Owner and their designated staff in the proper start-up and shut down procedures for all components, equipment, and systems. Training sessions shall include normal operational features and requirements for routine maintenance. Training sessions should be specific in nature and incorporate the exact components, equipment, and systems that have been installed for the Project.

2.9 FINAL COMMISSIONING REPORT

- A. The Commissioning Authority will assemble documentation from all phases of the Commissioning Process into a final Commissioning Report. The final Commissioning Report shall incorporate final record documents for each component, equipment, and system as applicable. The final Commissioning Report shall include the following items:
 - 1. Title Page.
 - 2. Certification Page.
 - 3. Summary.
 - 4. Completed Pre-Functional Checklists and Start-up Reports.
 - 5. Completed Functional Performance Tests.
 - 6. Commissioning Issues Log.
 - 7. Site Observation Reports.
 - 8. Instrument Calibration/Certification Data.
 - 9. Any applicable Project correspondence.

PART 3 - REQUIREMENTS AND WARRANTY

3.1 SYSTEMS TO BE COMMISSIONED

- A. Mechanical systems to be commissioned on this Project include, but are not limited to, the following:
 - 1. All HVAC System controls components including verification that all systems are operating as described in Section 23 09 05, Sequence of Operation – HVAC Controls.
 - 2. Hydronic Piping Systems.
 - 3. Hydronic Pumps.
 - 4. Glycol Feed Systems.

5. Ductwork.
6. Fans.
7. Variable Air Volume Terminal Units (Shut-off type).
8. Boilers.
9. Kitchen Ventilation Systems.
10. Existing Air-Cooled Chiller.
11. Air-Cooled Chiller.
12. Modular Air Handling Units.
13. Packaged Rooftop Units.
14. Packaged Air Handling Units.
15. Packaged Energy Recovery Units.
16. Ductless Split Systems.
17. Fan Coil Units.
18. Unit Ventilators.
19. Hydronic Terminal Heating Units.
20. Variable Frequency Drives.
21. Airflow Measurement Devices.

B. Electrical systems to be commissioned on this Project include, but are not limited to, the following:

1. Lighting Controls components including verification that systems are operating as described in Division 26 Section, Lighting Sequence of Operations.
2. Occupant Sensor Controls:
3. Time-Switch Controls:
4. Daylight Responsive Controls:

3.2 WARRANTY PHASE COMMISSIONING

A. Warranty Phase Commissioning is an effort to ensure that any outstanding warranty issues are resolved, any deferred testing is performed and accepted, and any outstanding construction phase issues are resolved. Any questions, issues, or concerns from the Owner's Operations and Maintenance Staff must be investigated and resolved.

3.3 WARRANTY PHASE COMMISSIONING ACTIVITIES

- A. Deferred Testing: Any Acceptance Phase testing that was deferred shall be performed by the CA during the Warranty Phase.
- B. The HVAC Contractor shall forward one copy of all HVAC related components, equipment, and systems submittal data including all Automatic Temperature Controls drawings and sequence of operations to the Commissioning Authority upon approval by the Design Professionals.
- C. Construction Phase Commissioning Follow-Up: The CA shall work with the Owner to coordinate warranty related issues and any follow-up work to be performed by the installing Contractors. The CA shall be available to the Owner to verify resolution of any warranty issues including additional Functional Performance Testing as required.
- D. Additional Training: The CA must be available to the Owner's Operations and Maintenance Staff to assist with specific questions related to operation or maintenance of components, equipment, or systems and identify any additional training that is required. Additionally, more detailed training sessions may be required for more complex systems such as Building Automation Systems or systems that were not in operation at the time of Substantial Completion.

END OF SECTION 01 91 13