1. **GENERAL**
   1. **Summary**
      1. Building commissioning is an intensive quality assurance process that spans the entire concept, design, construction, and start-up process – including the first year of operation – helping ensure that the new building’s operation and energy, water, and indoor environmental quality performance meets owner requirements.
      2. The Commissioning Authority will be hired by BCIT from a roster of pre-qualified suppliers. The Commissioning Authority will direct the commissioning of the building systems. Building Systems will include the following systems as applicable and defined in the contract documents:
         1. ALL Contents of Divisions 20 – 28, and all integrated systems within.
         2. Other Divisions as applicable – project-specific needs to be as directed by BCIT.
      3. Commissioning during the design phase is intended to achieve the following specific objectives:
         1. Verify the Owner’s Project Requirements (OPR) and Basis of Design (BOD) are clearly documented and they meet the Owner’s goals and objectives.
         2. Verify commissioning intent for the construction phase is adequately reflected in the contract documents.
      4. Commissioning during the construction phase is intended to achieve the following specific objectives, according to the Contract Documents:
         1. Provide resolution to issues and details not fully developed during design.
         2. Verify and document that applicable equipment and systems are installed according to the contract documents and manufacturer’s recommendations, and that they receive adequate start-up and functional testing by installing contractors.
         3. Verify and document performance of equipment and systems against design intent. Detail where performance is not met and facilitate the Commissioning Team to create resolutions.
         4. Verify that Operations and Maintenance (O&M) handover documentation is complete.
         5. Verify that owner’s operating personnel have adequate time to be familiar with the project, received demonstrations and training, provide comment regarding the handover to the owner and any additional support that maybe required.
   2. **Commissioning Team**
      1. The Commissioning Team shall consist of representatives of each contractor, including project superintendent, installers, suppliers, and specialists deemed appropriate for performing tasks related to the commissioning process. In general, the team will consist of:
         1. Owner’s Representative/Project Manager (PM).
         2. Commissioning Authority (CxA).
         3. Architect and Design Engineers (A/E).
         4. Construction Manager or General Contractor (CM/GC).
         5. Mechanical Contractor (Sub-Contractor).
         6. Electrical Contractor (Sub-Contractor).
         7. Communications Contractor (Sub-Contractor).
         8. Security and Access Control Contractor (Sub-Contractor).
         9. Equipment vendors.
         10. Any other installing contractors or supplier of equipment.
   3. **Related Sections and References**
      1. Section 01 General Requirements.
      2. Section 20 Mechanical – General Requirements.
      3. Section 21 Fire Suppression.
      4. Section 22 Plumbing.
      5. Section 23 Heating, Ventilation, and Air Conditioning (HVAC).
      6. Section 25 Building Management System.
      7. Section 26 Electrical.
      8. Section 27 Communications.
      9. Section 28 Electronic Safety and Security.
      10. ASHRAE Handbook – HVAC Applications.
      11. ASHRAE Guideline 0 – The Commissioning Process.
      12. ASHRAE Guideline 1.1 – HVAC&R Technical Requirements for the Commissioning Process.
      13. ASHRAE Standard 202 – Commissioning Process for Buildings & Systems.
      14. CAN/ULC-S10001-11 – Standard for Integrated System Testing of Fire Protection and Life Safety Systems.
      15. CSA Z320-11 – Building Commissioning.
      16. CSA Z5000-18 Building Commissioning for Energy Using Systems.
      17. IES DG-29-11 – The Commissioning Process Applied to Lighting and Control Systems.
      18. This section includes general requirements for the commissioning process, to supplement other sections in Division 01 and 20 through 28, which specify testing of components, systems, and assemblies, controls and control sequences and demonstration of integrated systems.
      19. This section is intended to compliment the overarching Commissioning Requirements and shall be read in conjunction with the Commissioning Plan.
   4. **Roles and Responsibilities**
      1. Commissioning observation and witnessing of contractor demonstrated pre-functional, and functional testing is the responsibility of the CxA and Design Engineer.
      2. All commissioning team members’ will work together to fulfill their contracted responsibilities and meet the objectives of the contract documents. The CxA shall coordinate the reports to the owner.
      3. The CM/GC, Sub-Contractors and CxA shall have responsibility for implementing the commissioning plan, with leadership, coordination, consultancy and review from the CxA.
      4. The CxA and CM/GC with assistance from trade contractors and vendors are responsible for producing a final commissioning plan, with all required commissioning tests and sequences. The CM/GC shall obtain from the contractors and vendors all commissioning related documentation and submit it to the CxA for incorporation into the final version of the Commissioning plan.
      5. The commissioning team shall attend commissioning meetings, cooperate with the CxA and participate in commissioning coordination and scheduling.
      6. A Quality Assurance/Quality Control (QA/QC) representative for each contractor is to be named to the CM/GC, the responsibilities of this person includes:
         1. Review equipment upon delivery onsite.
         2. Quality of installation work and report on progress.
         3. Review quality of paperwork, ensure timely delivery and collate to deliver to the CM/GC.
         4. Verify that commissioning tasks are complete and systems are functional, prior to turn over to CM/GC.
      7. Documentation required as part of the commissioning plan shall be exchanged between the CxA and the CM/GC but not to be limited to:
         1. Pre-start, and start-up procedures (CM/GC & CxA).
         2. Progress and status reports, including issues noted (CM/GC & CxA).
         3. Minutes from commissioning meetings (CxA).
         4. Commissioning reports (CxA).
         5. As-built records (CM/GC).
         6. Demonstration agenda and materials (CM/GC & CxA).
         7. Operation and Maintenance (O&M) manuals (CM/GC).
         8. Deferred and Seasonal Testing Plan (CxA).
2. **THE COMMISSIONING PROCESS**
   1. **Summary**
      1. This specification section is to be used in conjunction with all other contract documents. The commissioning process does not relieve contractors from the obligations to complete all portions of work in satisfactory and fully operational manner.
      2. Furnish labor and material to accomplish and complete commissioning as specified herein. Complete interim commissioning of systems during initial season operation and follow-up with seasonal testing to complete commissioning and ensure correct operation.
      3. System installation, start-up testing, calibration, functional tests, integrated tests, performance testing, preparation of O&M manuals, demonstration and training, deferred and seasonal testing is the responsibility of the CM/GC, Division 20 through 28 contractors and equipment suppliers/vendors.
      4. The commissioning plan shall include the following tasks and actions:
         1. Documentation of the construction process.
         2. Ensuring the basis of design as well as the design intent is carried out.
         3. Reporting and communicating the project schedule progress.
         4. Installation review with QA/QC verification;
            1. Orientation and integrity checks.
            2. Point to point testing.
            3. Pressure and integrity testing.
            4. Water fill and treatments.
            5. Review of manufacturer’s recommendations.
         5. Equipment start-up procedures:
            1. Using the commissioning schedule, coordinate equipment start-up.
            2. Ensure multiple trades are aware of tasks being performed and their attendance requirement.
         6. Functional tests:
            1. Coordinate trades, tasks and systems, so that dedicated time can be spent with minimal interference of conflicting tasks and trades.
            2. Ensure all equipment is effectively communicating with systems.
         7. Provide on-site demonstrations for the systems specified, with reference to the Demonstrations and Training section.
         8. Seasonal and Deferred Testing.
         9. Confirmation of Performance.
   2. **Commissioning Documentation**
      1. The CM/GC and CxA shall oversee and maintain the development of commissioning documentation, which is required to be converted into a PDF format and delivered to an electronic filing system. The documentation shall be organized by system and sub-system, which shall include, but is not limited to, the following:
         1. Reviewed contractor submittals.
         2. Installation review record.
         3. Equipment start-up procedures.
         4. Functional tests.
         5. Integrated system tests.
         6. Demonstrations and Training record.
         7. Seasonal and deferred testing.
         8. Confirmation of performance.
      2. Any installation, start-up or commissioning reports for equipment or systems, shall be issued to the CM/GC within 14 days of works being carried out by any contractor.
      3. The Commissioning Report compiled by the CxA shall be issued to BCIT as an independent document to the O&M manuals at the time of handover.
3. **EXECUTION**
   1. **Summary**
      1. The CxA and CM/GC has overall responsibility to ensure that QA/QC is upheld by all contractors and that systems are commissioned in a coordinated and complete manner.
      2. Commissioning process / work shall be a team effort to ensure that all equipment and system have been completely and properly installed and function together correctly to meet the design intent. System performance parameters shall be documented for fine tuning of control sequences and operational procedures, coordinate system documentation, equipment start-up, control system calibration, and performance testing.
      3. The CxA shall lead the Commissioning Team to facilitate solutions while implementing the Cx Plan. Where issues are realized, the Commissioning Team shall document, track, discuss and implement resolutions. The Commissioning Team is to present issues with suggested resolutions, the responsibility to accept, direct or create a resolution for implementation is the joint responsibility of relevant Design Team member and CxA and/or Owners Representaive required.
      4. Detailed testing shall be performed on all installed equipment and system to ensure that operation and performance conform to contract documents. All tests shall be performed by the responsible trade contractor, accepted for quality by the CM/GC, evaluated and witnessed by CxA and Design Engineer. After each grade of checklist and test are complete the system will be upgraded to the next test. Once a system(s) has been completed and passed all functional and integration tests it will be ready for acceptance by the CM/GC, with recommendation to begin turn-over process from the construction team to the Owner.
   2. **Meetings**
      1. *Initial Meeting*: The CxA, through the CM/GC, will schedule, plan and conduct an initial commissioning meeting. The contractor and its responsible parties are required to attend. The meeting will review commissioning intent, with relation to the project and align expectations on how the process will be delivered. The meeting shall be held prior to any contractor submittals being gathered and issued to the design team for review.
      2. *Design Intent Meetings*: Prior to any substantial sequence programming, a meetings shall take place and be documented between the engineer of record, CxA, and the hands on programmer(s), to review the following items:
         1. Functional intent.
         2. Sequence of operation.
         3. BACnet/communication points that are available between devices.
         4. System graphical interface.
         5. Alerts, alarms and reporting.
      3. *Commissioning Meetings*. Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution, and planning issues. These meetings will be held at least bi-monthly, becoming more frequent as the project demands, as frequently as once per week.
   3. **Commissioning Plan**
      1. The commissioning plan is intended to be the documented intent of how the commissioning process is to be coordinated, scheduled, documented and implemented.
      2. The CxA will develop a project specific commissioning plan framework and lead the effort to completion. All contractors are to allocate time for their commissioning representative to supply information in a collaborative effort, with agreement to a logical and successful plan execution. The plan shall include, but is not, limited to, the following items:
         1. Detail of project team, organizational chart, with agreed coordination and communication protocol.
         2. Team allocation of responsibilities.
         3. Commissioning stages and milestones.
         4. Project specific listing of systems that are to be commissioned.
         5. Issues Log.
         6. Commissioning Schedule.
         7. Expected commissioning documentation list.
         8. Installation Inspection forms.
         9. Start up plans.
         10. Functional testing procedures and checklists.
         11. Integration testing procedure.
         12. Performance testing procedure.
         13. Training, orientation and demonstration schedule.
         14. Phased handover procedures.
         15. Deferred and seasonal testing plan.
   4. **Submittals**
      1. The contractors are to provide Cx specific information when collecting and issuing a submittal for review. At minimum, submittal package will include:
         1. Manufacturer and model number.
         2. Manufacturer installation and operation manual.
         3. Sequences of operation.
         4. Control drawings, points list and communication protocol.
         5. Performance data.
         6. Manufacturer testing forms, including factory testing where applicable.
      2. The CxA will review submittals related to the commissioned equipment for the consideration of items as follows:
         1. Special requirements for the installation and operation and risk to warranty of the equipment.
         2. Communication protocol, note of points available and points that are of importance for system operation and performance.
         3. Manufacturers start-up requirements and notice periods for site attendance requests.
         4. Testing requirements or procedures.
         5. Any performance characteristics or requirements that may affect operations of equipment when integrated into a system.
         6. Equipment specific start up and testing procedures and forms.
   5. **Installation Check and Start-up: Pre-functional Checks**
      1. *Application*: The following procedures apply to all equipment to be commissioned as outlined in this Section. Some systems that are not comprised so much of actual dynamic machinery, e.g., architectural systems, electrical distribution panels, may have very simplified checks and startup documentation.
      2. *General*: Pre-functional checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full pre-functional checkout. No sampling strategies are used. The pre-functional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.
      3. *Start-up and Initial Checkout Plan*: The CxA shall assist the commissioning team members responsible for startup of any equipment in developing detailed start-up plans for all equipment. The primary role of the CxA in this process is to ensure that the contractor provides written documentation that each of the manufacturer-recommended procedures have been completed. Parties responsible for prefunctional checklists and startup are identified in the commissioning scoping meeting and in the checklist forms (typically contractors, vendors and/or their authorized representative(s).
         1. The CxA obtains manufacturer installation, startup and checkout data, including actual field checkout sheets used by the field technicians from the contractor (through an RFI) or shop drawings.
         2. The CxA copies all pages with important instructional data and procedures from the startup and checkout manuals not covered in manufacturer field checkout sheets and adds a signature line in the column by each procedure.
         3. The copied pages, along with the pre-functional checklist provided by the CxA and the manufacturer field checkout sheets become the “Startup and Checkout Plan”.
         4. For systems that may not have adequate manufacturer startup and checkout procedures, particularly for components being integrated with other equipment, the Sub should provide the added necessary detail and documenting format to the CxA for approval, prior to execution.
         5. The CxA transmits the full Startup Plan to the GC/CM, who designates which trade or contractor is responsible to fill out each line item on the Prefunctional Checklist from the CxA. The GC then transmits the full start-up plan to the Subs for their review and use. (This usually means that the Prefunctional Checklist, alone, will go to more than one Sub, while the full plan will go to the primary installing contractor).
      4. The Subs shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet.
      5. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back charges to the responsible party.
   6. **Execution of Pre-functional Checklists and Start-up**
      1. Four weeks prior to startup, the Subs and vendors schedule startup and checkout with the GC and CxA. The performance of the prefunctional checklists, startup and checkout are directed and executed by the Sub or vendor. When checking off prefunctional checklists, signatures may be required of other Subs for verification of completion of their work.
      2. The Subs and vendors shall execute startup and provide the CxA with a signed and dated copy of the completed start-up and prefunctional tests and checklists. The CxA may review pre-functional checklists in progress, as necessary.

* + 1. The site technician performing the line item task initials and dates on the prefunctional and manufacturer field checkout sheets, as they are completed. Only individuals that have direct knowledge and witnessed that a line item task on the prefunctional checklist was performed shall initial or check that item off. It is not acceptable for supervisors to fill out these forms unless they have directly witnessed the specific task.
  1. **Functional Testing**
     1. This sub-section applies to all commissioning functional testing for all divisions.
     2. The general list of equipment/systems to be commissioned is found in Part 1 of this Section. Specific equipment and modes to be tested are found in relevant equipment sections of the specifications. If specific testing requirements were not included in the bid documents and original specifications, they should be developed for this project for each piece of commissioned equipment.
     3. *Objectives and Scope*: The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing includes validation of completed systems in all modes of operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.
     4. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, low pressure, no flow, equipment failure, etc. shall also be tested. Specific modes required in this project are included in relevant sections of the contract documents.
     5. The CxA shall witness at a minimum, contractor functional testing for each piece of primary equipment, unless there are multiple units, in which case a sampling strategy may be used. In no case will the number of units witnessed be less than four on any one building, nor less than 20% of the total number of identical or very similar units. Sampling strategy is discussed further in this Section.
     6. *Development of Test Procedures*: Before test procedures are written, the CxA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. Using the testing parameters and requirements in contract documents, the CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. CxA obtains clarification, as needed, from contractors and the A/E regarding sequences and operation to develop these tests. Each Sub or vendor responsible to execute a test, shall provide assistance to the CxA in developing the procedures (answering questions about equipment, operation, sequences, etc.). Prior to execution, the CxA shall provide a copy of the primary equipment test procedures to the Subs (via the GC) who shall review the tests for feasibility, safety, equipment and warranty protection. The CxA may submit the tests to the A/E for review, if requested.
     7. The CxA shall review owner-contracted, factory testing or required owner acceptance tests which the CxA is not responsible to oversee, including documentation format, and shall determine what further testing or format changes may be required to comply with the Specifications. Redundancy of testing shall be minimized.
     8. The purpose of any given specific test is to verify and document compliance with the stated criteria of acceptance given on the test form.
     9. *Test Methods*: Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system’s trend log capabilities or by stand-alone dataloggers. The CxA follows the Specifications when given and uses judgement where needed to determine which method is most appropriate. The CxA may substitute specified methods or require an additional method to be executed, other than what was specified, with the approval of the Owner. This may require a change order and adjustment in charge to the Owner. The CxA will determine which method is most appropriate for tests that do not have a method specified.
        1. *Simulated Conditions*: Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
        2. *Overwritten Values*: Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value, or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.
        3. *Simulated Signals*: Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.
        4. *Altering Setpoints*: Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, temporarily change the lockout setpoint to be 2F above the current outside air temperature.
        5. *Indirect Indicators*: Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification is completed during prefunctional testing.
        6. *Setup*: Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The Sub executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test, the Sub shall return all affected building equipment and systems, due to these temporary modifications, to their pre-test condition.
        7. *Sampling*: Not all pieces of identical equipment receive in-depth testing; multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference. It is noted that no sampling by Subs is allowed in prefunctional checklist execution.
           1. A common sampling strategy is the “xx% Sampling—yy% Failure Rule” is defined by the following example:

xx = the percent of the group of identical equipment to be included in each sample.

yy = the percent of the sample that if failing, will require another sample to be tested.

* + - * 1. The example below describes a 20% Sampling—10% Failure Rule, which is applicable to most distributed equipment:

Randomly test at least 20% (xx) of each group of identical equipment. In no case test less than three units in each group. This 20%, or three, constitute the “first sample”.

If 10% (yy) of the units in the first sample fail the functional performance tests, test another 20% of the group (the second sample).

If 10% of the units in the second sample fail, test all remaining units in the whole group.

If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the CxA may stop the testing and require the responsible Sub to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units.

* 1. **Execution of Functional Performance Tests**
     1. *Coordination and Scheduling*: The Subs shall provide sufficient notice to the CxA regarding their completion schedule for the prefunctional checklists and startup of all equipment and systems. The CxA will schedule functional tests through the GC and affected Subs. The CxA shall direct, witness and document the functional testing of all equipment and systems. The Subs shall execute the tests.
        1. In general, functional testing is conducted after prefunctional testing and startup has been satisfactorily completed. For any given system, prior to performing functional testing, the CxA waits until the prefunctional checklist has been submitted with the necessary signatures, confirming that the system is ready for functional testing.
        2. The control system is sufficiently tested by the installing contractor before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interfaces, integration and/or coordinated responses between systems is tested.
     2. *Problem Solving*: The CxA will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the contractors, Subs and A/E.
     3. *Owner Engagement*: The Owner’s facilities operating staff are encouraged to attend and participate in the testing process. The CxA will notify the Owner/PM, who will then notify the facility staff when the commissioning events will occur.
  2. **Documentation, Non-Conformance and Approval of Tests**
     1. *Documentation*: The CxA shall witness and document the results of all functional performance tests using the specific procedural forms developed for that purpose. Prior to testing, these forms are provided to the GC for review and approval and to the Subs for review. The CxA will include completed forms in the Commissioning Report.
     2. *Non-Conformance*: The CxA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the GC/CM on a standard non-compliance form.
     3. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
     4. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the GC/CM.
     5. As tests progress and a deficiency is identified, the CxA discusses the issue with the executing contractor.
     6. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:
        1. The CxA documents the deficiency and the Sub’s response and intentions and they go on to another test or sequence. After the day’s work, the CxA submits the non-compliance reports to the GC/CM for signature, if required. A copy is provided to the Sub and CxA. The Sub corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the CxA.
        2. The CxA reschedules the test (through the GC/CM) and the test is repeated.
     7. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
        1. The deficiency shall be documented on the non-compliance form with the Sub’s response and a copy given to the GC/CM and to the Sub representative assumed to be responsible.
        2. Resolutions are made at the lowest management level possible (preferably between CxA or GC/CM and the Sub). Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the Owner.
     8. The CxA documents the resolution process.
     9. Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA. The CxA reschedules the test and the test is repeated until satisfactory performance is achieved.
     10. *Cost of Retesting*: The cost for the Sub to retest a prefunctional or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the GC/CM.
     11. For a deficiency identified, not related to any prefunctional checklist or start-up fault, the following shall apply:
         1. The CxA and GC/CM will direct the retesting of the equipment once at no “charge” to the contractors for their time. However, the CxA’s and GC/CM’s time for a second retest will be charged to the contractors, who may choose to recover costs from the responsible Sub.
         2. The time for the CxA and GC/CM to direct any retesting required because a specific prefunctional checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be backcharged to the contractor, who may choose to recover costs from the party responsible for executing the faulty prefunctional test.
         3. Refer to the Sampling Section for requirements for testing and retesting identical equipment.
     12. The Contractor shall respond in writing to the CxA and GC/CM at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
     13. The CxA retains the original non-conformance forms until the end of the project.
     14. Any required retesting by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the prime contractor.
     15. *Failure Due to Manufacturer Defect*: If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the GC or PM. In such case, the Contractor shall provide the Owner with the following:
         1. Within one week of notification from the GC or PM, the Contractor or manufacturer’s representative shall examine all other identical units making a record of the findings. The findings shall be provided to the GC or PM within two weeks of the original notice.
         2. Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
         3. The GC or PM will determine whether a replacement of all identical units or a repair is acceptable.
         4. Two examples of the proposed solution will be installed by the Contractor and the GC will be allowed to test the installations for up to one week, upon which the GC or PM will decide whether to accept the solution.
         5. Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.
     16. *Approval*: The CA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CA and by the Owner, if necessary. The CA recommends acceptance of each test to the Owner using a standard form.
  3. **Seasonal and Deferred Testing**
     1. *Unforeseen Deferred Tests*: If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the PM. These tests will be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.
     2. *Seasonal Testing*: During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system’s design) shall be completed as part of this contract. The CxA shall coordinate this activity. Tests will be executed, documented and deficiencies corrected by the appropriate Subs, with facilities staff and the CxA witnessing. Any final adjustments to the O&M manuals and as-builts due to the testing will be made.
  4. **Demonstrations to Owner Personnel**
     1. The CM/GC and contractors shall be responsible providing qualified personnel, coordination, scheduling, documentation and ensuring that “optimum” demonstrations to the Owners facility staff is completed.
     2. The CM/GC shall organize the demonstration to the Owner’s personnel for commissioned equipment and systems. The CxA will be in attendance to aid in facilitation and consider further requirements of BCIT.
     3. Provide, to the Owner and CxA through the CM/GC, a demonstration plan 6 weeks before the planned demonstrations covering the following elements:
        1. Equipment.
        2. Intended audience.
        3. Objectives.
        4. Subject covered (special operation, log in/out, alarms, resets, etc).
        5. Duration of demonstrations on each subject.
        6. Instructor for each subject.
        7. Methods of demonstration (classroom lecture, manufacturer’s quality video, site walk through, actual operational demonstrations, written handouts, etc.).
  5. **Final Commissioning Report**
     1. The Commissioning Report is intended to be a standalone document. The Commissioning Report will be a complete report containing all commissioning related documents from the project.
     2. The Commissioning Report compiled by the CxA shall be issued to BCIT as an independent document to the O&M manuals at the time of handover.
     3. The CxA is responsible to compile, organize and index the project commissioning documents as detailed in this section. The Commissioning Report shall include, but not be limited to:
        1. Basis of Design Review.
        2. The Commissioning Plan.
        3. Commissioning Reports: Startup Records, Pre-Functional Checks and Functional Checks.
        4. Commissioning Meeting Minutes.
        5. Demonstration and Training Record.
  6. **Commissioning Holdback Amounts**
     1. A commissioning Holdback Amount shall be established at the beginning of the project for all disciplines having commissioning scope. Holdback amounts shall be reviewed and approved by the designated payment certifier to ensure adequate funds are allocated for completion of commissioning activities.
     2. In general, payment certification shall not exceed 90% (NINETY PERCENT) of the value of the total construction cost until commissioning has been satisfactory completed and the preliminary commissioning report, project record drawings and preliminary Maintenance Manuals have been submitted and FULLY ACCEPTED in writing by CA and responsible consultants.

\*\*\* END OF **COMMISSIONING** SECTION \*\*\*