BC HOUSING

Building Commissioning Guidelines

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BRITISH COLUMBIA

BC HOUSING

Contents

LEGEND:

Blue font text: Revised provision to BC Housing Commissioning Guidelines (January 2025) through Technical Bulletin No. 4 - 2025. These revisions are for clarification on the requirements that are already adopted in the former version of the Commissioning Guidelines.

1 Glossary of Terms

Term	Definition
Basis of Design (BOD)	A stand-alone document, produced by the design team. It records the concepts, analysis, decisions, and system/product selections used to meet the Owner's Project Requirements (OPR) and to satisfy applicable regulatory requirements, standards, and guidelines. The document lists individual items that support the design process and must include narrative descriptions of building systems. The Commissioning Provider (CxP) reviews the BOD against the OPR and reports back to the Owner.
Commissioning (Cx) Plan	A document that outlines and specifies the commissioning processes, roles and responsibilities, resources required, schedule and sequence, and commissioning documentation. This includes all pre-functional, functional and integration testing plans that are to be executed for the project for new or renovated building projects and systems.
Commissioning Provider (CxP)	The entity identified by the Owner or BC Housing who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process. This is an independent third-party entity working under a separate contract directly with the Owner or BC Housing. The CxP provides the Owner with an unbiased, objective view of the systems: installation, documentation, operation, performance and witnessing of tasks and tests.
Contractor's Commissioning Agent (CxAg)	Individuals, each having authority to act and report on behalf of the entity they represent, explicitly organized to implement the commissioning tasks required within their respective contracts (such as mechanical, electrical, etc.). They aid in the overall commissioning (Cx) process through coordinated actions, within the Cx Team.
Functional Testing	Testing of a given system or piece of equipment to verify that it is functioning to its design intent. This includes testing the specified sequences of operation and functionality in all modes of operation, including unoccupied mode, shutdown, and failure scenarios. It also includes verifying that user and operator interfaces, trending, alarms, and so on have been properly configured to support ongoing operation and maintenance.

Issues Log	Formal and ongoing record of problems or concerns and their resolution that have been raised by members of the commissioning team during the course of the commissioning process.
Owner's Project Requirements (OPR)	A stand-alone document that details the functional requirements of the building systems installed as part of the project. The OPR document is critical to the commissioning process because it forms the foundation for the design, construction, occupancy, and operation of the facility, and it is the standard that will be used for verification. The Owner creates the OPR at the conceptual design stage, and the document may evolve as decisions are made to reflect the current project requirements of the Owner.
Operations and Maintenance (O&M) Manual	A required set of documents that provides information on the operation and maintenance of the building. It includes a list of systems; operating instructions; maintenance and lubrication instructions; installation, operation, and maintenance information; and so on.
Pre-functional Testing	Includes both static and start-up checks performed at the individual equipment level. Must be completed by the contractor before proceeding with the subsequent functional testing phase. Pre-functional checklists provided by the CxP are completed by the contractors, and augment the contractors' other documentation, such as pre-functional testing checklists, manufacturer's equipment start-up checklist/reports, contractor's QA/QC reports, control's end-to-end checkout reports, and testing and balancing reports.
Static Verification	Inspections performed prior to equipment activation, to ensure that the equipment or system is correctly installed and ready for initial operation. Static verifications include reviewing equipment installations against the design documents and pre-start-up inspection procedures from the associated equipment installation manuals and/or industry best practice inspection procedures. The CxP will perform independent static verifications in addition to those completed and documented by the contractor as part of the pre-functional checklists.
Start-up Representative	Individual in charge of starting up a given piece of equipment, often to meet warranty requirements. Typically this is the manufacturer's representative.

Integrated System Testing (IST)	CAN/ULC-S1001, "Integrated Systems Testing (IST) of Fire Protection and Life Safety Systems," provides the methodology for verifying and documenting that interconnections between building systems satisfy the design as intended by the BC Building Code and Fire Code. It is performed to ensure that the fire protection and life safety systems and their components (i.e., fire alarm systems, sprinklers, standpipes, smoke control, ventilation, pressurization, door hold-open devices, elevator recalls, smoke and fire shutters and dampers, emergency power, emergency lighting, fire pumps, generators, etc.), including their interconnections with other building systems, are functioning according to the intent of their design.
Integrated Testing Plan	A written project specific document, prepared by the Integrated Testing Coordinator, outlining the required tests and necessary functional results to conduct Integrated Fire Protection and Life Safety Systems Testing.
Integrated Testing Coordinator	The person, firm, corporation, or organization responsible for the development and implementation of the Integrated Testing Plan. Where a firm, corporation, or organization is responsible for Integrated Fire Protection and Life Safety Systems Testing, a representative of that firm, corporation, or organization shall be designated as the Integrated Testing Coordinator.

2 Introduction

This updated set of commissioning guidelines encompasses both new development and renovation/capital improvement projects financed or funded by BC Housing. This guideline document explains the commissioning needs of such projects, in accordance with the type and complexity of each project.

Commissioning is an integrated set of activities intended to ensure that a project meets both the Owner's Project Requirements (OPR) and the operational needs. The Owner's goals and objectives should drive the project team. The value of commissioning lies in its power to verify and document that all building systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's goals and objectives.

Historically, the term "commissioning" has referred to how only the heating, ventilation, and air conditioning (HVAC) systems of a building were tested and balanced according to established standards prior to acceptance by the building Owner/Operator. Today's use of commissioning recognizes the integrated nature of all building systems' performance, which impacts sustainability; improves occupant comfort, productivity, and indoor air quality; and reduces maintenance and operating expenses.

This guide provides an overall framework for building commissioning for different types of BC Housing projects. Systems to be commissioned and commissioning activities—from project planning to post-occupancy—will differ depending on the type of building. This guide covers the roles and responsibilities of each project participant.

The commissioning process is the Owner/Operator's way of making sure that the systems are installed properly, are calibrated as planned, and perform according to project requirements. This guide aims to streamline the commissioning process and enable the Owner/Operator to improve building handover and operation.

While recognizing that every project is unique and that required activities will vary, this guide provides the minimum requirements of commissioning for BC Housing projects. The requirements depend on the project size and best practices based on industry guidance. The level and depth of commissioning required for the project will be determined by the size and complexity of the project itself and by the needs defined in the OPR.

The consultant team will determine the rezoning and building commissioning bylaw requirements before establishing the commissioning activities for the project. Regardless of whether a third-party Commissioning Provider (CxP) is hired by the Owner or BC Housing, the consultant team will ensure that the contract documents are in accordance with the OPR, Basis of Design (BOD), the BC Housing Design Guidelines and Construction Standards, other project-specific

requirements, the building code, and the bylaws and other requirements of authorities having jurisdiction. The team will also ensure that the commissioning requirements, the process to be used for all building systems, and the integration of the systems are outlined in the contract documents. The general contractor is ultimately responsible for ensuring that all building systems and integration of the systems are operating and functioning as specified in the contract documents.

There are four options (see **Article 5.1.2, Third-Party Commissioning Provider Scope and Responsibilities**) for implementing the third-party independent commissioning process initiated by the Owner/BC Housing. The Owner/BC Housing is responsible for choosing one of the four options based on the local rezoning bylaws, project classification, and size/complexity of the building.

The primary audiences for this guide are the Owner/Operator of the building, its non-profit society, the development team (including consultants), the construction manager/contractor, and the Commissioning Provider. The secondary audiences for this guide are the many stake-holders in the commissioning process, including the balance of the project team and other funding partners of the project.

3 General Information

The aim of the commissioning process is to confirm that the building systems are functioning and operating in accordance with the OPR, BOD, and contract documents. Full commissioning requires the systematic review of activities during all project phases, including design, construction, verification and testing, and post-occupancy.

All building systems are integrated; therefore, a defect in one or more of the components can result in suboptimal operation and performance in other components. A properly executed commissioning process clearly expresses the OPR and provides a variety of benefits, including the following:

- Fewer change orders and system deficiencies during construction;
- Better quality control during construction and after construction;
- Improved planning and coordination;
- Smoother handover of project from construction team to Owner/Operator;
- Reduced energy consumption during building operation;
- Improved occupant comfort, productivity and indoor air quality;
- Improved systems and equipment function and extended life cycle; and
- Better building documentation and improved building operation and maintenance (O&M).

Typically in BC Housing projects, the average cost of building commissioning has been within 0.1%–0.3% of the project's gross capital budget. The cost is at the lower end for high-rise buildings with single-use occupancy and standardized units. The O&M costs for the life cycle of a building can be up to 80% of the total project cost. However, spending less than 0.3% upfront on commissioning can lead to significant savings, reducing the total O&M costs over the course of the building's life. If re-commissioning is completed every 3-5 years, the savings in total O&M costs can increase even more.

BC Housing therefore requires the engagement of a third-party independent CxP to perform the commissioning activities on both new construction and major renovation/capital improvement projects. Not all smaller projects will require a third-party independent CxP hired by the Owner, but buildings with multi-unit housing or mixed-use facilities, large buildings, and buildings with complex mechanical or electrical systems require a formal Cx process led by an independent CxP. Whatever the building type, commissioning is a quality-assurance-based process that provides a clear set of benefits to the Owner/Operator. Re-commissioning 3-5 years after completing a new building is also recommended to maintain operational savings and ensure that the building operates at its optimum level.

4 Project Classification

BC Housing undertakes projects that can be classed as either new developments, renovation/capital improvements, or conversion. There are three sub-categories under these parent categories: 7 storeys and higher, 3-6 storeys, and 1-2 storeys. These can be further sub-divided according to a range of attributes, such as construction methods (wood frame, concrete, modular, or pre-manufactured), parking type (underground or surface), building form (transition/second stage housing, emergency shelter, licensed group home, townhouses, low- to medium-density apartment, or high-density housing), and housing client types (homeless, families, seniors, etc.). Some buildings may not fit into this classification, but the complexity of systems should be considered. For the purposes of commissioning or quality assurance activities, new build, renovation/capital improvement, or conversion projects should be primarily classified as follows:

.1 7 STOREYS AND HIGHER

- Typically non-combustible concrete or structural steel frame building
- Underground parking
- Mainly medium- to high-density housing

An independent CxP hired by the Owner/BC Housing performs the commissioning process for these buildings. Refer to Article 5.1.2, Third-Party Commissioning Provider Scope And Responsibilities.

Marguerite Ford Apartment.
147 units – 11 storeys with 1-level underground parking

.2 3-6 STOREYS

- Generally wood frame building or in some cases with concrete podium
- Surface or underground parking
- Mainly medium-density housing
- Pre-fabricated or modular construction systems can also be considered

An independent CxP hired by the Owner/BC Housing performs the commissioning process for these buildings. Refer to Article 5.1.2, Third-Party Commissioning Provider Scope and Responsibilities.

Alewem – 1580 Vernon Dr., Vancouver, 98 units – 3-storey wood frame modular

.3 1-2 STOREYS

- Wood frame or modular construction methods, generally Part 9 buildings
- Surface parking
- Mainly low-density housing

Lions Valley View Estates. 32 units – 2-storey wood frame with surface parking

Hart Heaven. 30 units senior housing – 1-storey wood frame modular construction

For 1-2 storey projects, the system-specific commissioning is to be carried out by an independent agency contracted by the project's mechanical contractor, per the contract documents. Refer to Article 5.1.2., Third-Party Commissioning Provider Scope and Responsibilities.

5 Commissioning Requirements

.1 PROJECT COMMISSIONING ACTIVITIES AND RESPONSIBILITIES

.1 Consultant and Contractor Commissioning Responsibilities

The design and construction team is responsible for ensuring that all building systems function and operate properly and that integration of the systems is achieved as required by the contract documents, regardless of whether a third-party commissioning process is initiated by the Owner or BC Housing. The contractor is ultimately responsible for delivering a fully commissioned building. The contractor must submit all test reports to the consultant (and CxP if applicable) and include them in the O&M manuals. Refer to the BC Housing Design Guidelines and Construction Standards, Section 4, Division 017800 - Closeout Submittals.

.1 Mechanical, HVAC, and Plumbing Systems

.1 The commissioning of the mechanical, HVAC, and plumbing systems is the responsibility of the mechanical contractor. At a minimum, the mechanical contractor is required to hire an independent testing and balancing (TAB) agency to meet contract requirements, regardless of project size.

.2 The mechanical consultant is responsible for ensuring that all commissioning items and related tests (those outlined below, plus any additional tests) are incorporated in the contract documents. They are also responsible for tracking, reviewing, and reporting on the status of all contractor test reports required for Schedule C-B, contract documents, and/or approval of final contractor progress draws. The mechanical consultant is to review and update the list of tests based on the complexity of the building and as needed to meet the local codes and regulations of the authority having jurisdiction.

The mechanical consultant is responsible for the following in the commissioning process:

- Produce and update a project BOD document for their design discipline;
- Attend selected commissioning meetings where input is required;
- Coordinate field inspections with the CxP to facilitate consultant involvement in key functional testing activities, as needed;
- Provide responses to Cx issue log items requiring input from the consultant;
- Distribute the monthly mechanical field review report to the CxP; and
- Assign appropriate holdback amounts against contractor's deficiencies and outstanding issues.

Driver House. 10612 17 St., Dawson Creek – mechanical room

.3 At a minimum, the mechanical contractor and/or their suppliers, sub-trades, or CxAg must perform the following tests and submit the completed reports at or before substantial completion of the project:

- Backflow inspection test;
- Water main chlorination test;
- Piping pressure test;
- Hydronic system flushing and chemical treatment/glycol test;
- Manufacturer start-up of equipment where required (i.e., boiler, chiller, split AC/heat pumps, variable frequency drives, etc.);
- Fire damper drop test;
- Megger test of heat tracing;
- Parkade gas detector test and calibration;
- Sprinkler system verification and sign-off;
- Start-up checks for all pumps, fans, and other motor-driven equipment;
- Testing, adjusting, and balancing report by a third-party TAB agency;
- Integrated automation (BAS/DDC system) point-to-point checkout report; and
- Report on temperature limit stops for all fixtures, ensuring set temperature is regulated when no central thermostatic mixing valve in domestic hot water (DHW) system.

.4 These tests and any other related tests required by the contract documents are typically the prerequisites for handover and for performing functional testing of the mechanical systems.

Rose Harbour. In-floor radiant heating

.5 The Owner/BC Housing will retain a third-party CxP to complete the commissioning process in Options 1, 2, and 3, as outlined in **Article 5.1.2. Third-Party Commissioning Provider Scope and Responsibilities.** The CxP will oversee and witness the contractor's (or their CxAg's) pre-functional testing; perform functional tests of 100% of the systems; witness CAN/ULC-S1001: Integrated Systems Testing of Fire Protection and Life Safety Systems; coordinate the Owner's demonstration; review O&M documentation; and perform seasonal testing and warranty reviews. In Option 4, the mechanical contractor is required to complete the entire mechanical commissioning process for the project. The mechanical consultant must specify if an independent mechanical CxAg is required to carry out all the commissioning tasks, or if the contractor plus a third-party TAB agency would suffice (depending on the complexity of the project). Refer to the Cx deliverables in Option 4.

.6 Depending on the complexity of the project and at the design consultant's discretion, if the commissioning activities outlined in the above paragraph (i.e., pre-functional and functional testing, witnessing CAN/ULC-S1001: Integrated Systems Testing of Fire Protection and Life Safety Systems; Owner's demonstration, O&M, seasonal testing, and

warranty reviews) are to be performed and completed by the mechanical contractor's third-party independent commissioning agency for Options 1, 2, and 3, and no CxP is required for the project, the consultant must obtain prior approval from the Owner and BC Housing no later than the design development stage. In such event, the Owner/BC Housing may engage a third-party CxP to oversee the process only.

For better quality assurance of the mechanical design, BC Housing will also engage an independent mechanical peer review (MPR) consultant to ensure that the proposed mechanical design meets all requirements of the BC Housing Design Guidelines and Construction Standards, the BC Building Code (or the City of Vancouver/local building bylaws), and all applicable CSA, ASHRAE, ASPE, and NFPA standards. The MPR is typically a one-time process conducted at the 50% construction document stage (must be before the building permit submission) so that any potential design issues can be addressed before the project moves to the next design stage. This independent MPR process should simplify the mechanical design and ensure that the commissioning at construction will be effective, with less design issues at later stages. When an MPR is conducted, the CxP will be given a copy of the MPR report.

.2 Electrical Systems Commissioning

.1 The installation and commissioning of the electrical systems is the responsibility of the electrical contractor.

.2 The electrical consultant is responsible for ensuring that all commissioning items and related tests (outlined below, plus any additional tests) are incorporated in the contract documents. The consultant will also review the final testing reports and ensure that they are complete. These reports are part of the O&M manual at the project handover stage. The electrical consultant is to review and update the list of tests based on the complexity of the building and as needed to meet the local codes and regulations of the authority having jurisdiction.

.3 At a minimum, the contractor must perform the following tests and submit the completed reports at or before substantial completion of the project for the consultant review:

- Insulation resistance testing of feeders, transformers, bus bars, etc.;
- Voltage and current readings of motor-driven equipment (i.e., fans, pumps, refrigeration equipment, compressors) and transformers, all operating at or near full load;
- Operational test to prove the proper operation of controls and interlocks;
- Ground testing;
- Phase load balance;
- Lighting control systems;
- Protective device coordination and fault studies;
- Infrared scan for major feeder termination;
- Building distribution system;

Fernie Family Housing. In-suite ERV

- Low voltage switchgear and motor controls (600 volts and below);
- Power factor readings;
- Intrusion detection and access control testing;
- Generator and transfer switch start-up report;
- UPS start-up report; and
- Fire alarm verification per CAN/ULC 537.

The contractor will prepare a summary checklist for the Owner/BC Housing ensuring all the above-listed tests are complete.

.3 Building Envelope

.1 The commissioning of the building envelope systems is the responsibility of the general contractor.

.2 The architect (and/or building envelope consultant) is responsible for overseeing envelope commissioning. Separate envelope commissioning may be required based on bylaws or funding partners (the health authority, non-profit society, CMHC, etc.) or other third-party certification requirements (e.g., if pursuing Leadership in Energy and Environmental Design [LEED v4] Enhanced Commissioning Option 2).

.3 All buildings will meet or exceed the whole building performance targets identified in the BC Housing Design Guidelines and Construction Standards, Section 2 - Energy and Environmental Design. These targets will be verified through mandatory building and energy modelling according to the BC Energy Step Code. Energy modelling will be performed in all types of BC Housing projects and the results submitted to the architect at the schematic design, building permit, and as-built stages.

Grandview Terrace. Building envelope upgrade

.4 The architect is to ensure the following:

- The envelope-related energy efficiency measures (i.e., insulation values, window-to-wall ratios, glazing characteristics including overall U-value, performance rating and solar heat gain coefficient, shading, and window operability) are included in the plans and specifications. Coordination with the energy modeller is required to identify options for envelope insulation values, building orientation, shading, and any other variables that can affect load and are most effectively evaluated during the early stage of design.
- The contractor submits the airtightness testing at substantial completion. Continuity of the air barrier and insulation layer must be clearly illustrated on drawings and details, with special attention paid to typical air leakage and thermal bridge pathways, such as the interface between design elements, including parapets, balconies, window edges, walls, and foundations. Refer to the BC Housing Design Guidelines and Construction Standards, Section 2, Energy and Environmental Design.

- The windows must be carefully integrated into the entire envelope system. The architect will ensure that the air barrier and insulation continuity is maintained at the window/wall interface and that thermal bridging is minimized.
- The contractor will perform the pre-installation laboratory tests (as required) and field testing for fenestration products as outlined in the BC Housing Design Guidelines and Construction Standards, Section 4, Division 08 50 00 – Windows, Side Hinged and Sliding Glass Doors. The architect ensures the testing reports meet the contract documents and are submitted to the Owner at substantial completion of the project.
- The contractor will submit an as-built energy modelling report that includes actual airtightness testing results. Refer to the BC Housing Design Guidelines and Construction Standards, Section 4, Division 01 78 00 – Closeout Submittals.
- The contractor will submit the final roofing inspection report and Roofing Contractors Association of BC (RCABC) guarantee certificate.

The contractor will prepare a summary checklist for the Owner/BC Housing ensuring all the above-listed tests are complete.

.4 Architectural Systems

.1 The general contractor is responsible for commissioning architectural systems, with a focus on systems that may be integrated into life safety systems, such as fire shutters, door hardware, operable louvres, and other systems required by the contract documents.

.2 The architect will ensure that these items are included in the contract documents and will collect and review related test results/reports at substantial completion of the project.

.5 Elevator

.1 The commissioning of the elevator systems is the responsibility of the general contractor.

.2 The architect will ensure that the elevator commissioning requirements are included in the contract documents and meet the building code requirements. The architect will collect and review all the testing results at or before substantial completion of the project.

.6 Integrated Systems Testing

Inclusion Homes. 4872 Ontario Ave., 4897 Ontario Ave., Powell River. Integration system testing

.1 The architect (as the coordinating registered professional) is responsible for; developing the project specific test protocol and procedures, accumulating and submitting the necessary documentation, coordinating shop drawings and field reviews as well as attend and witness the CAN/ULC-S1001: Integrated Systems Testing of Fire Protection and Life Safety Systems to confirm that the as-built systems function as intended by design.

.2 The general contractor is responsible for coordinating the required trades, performing and documenting integrated systems testing to meet the requirements of CAN/ULC-S1001: *Integrated Systems Testing of Fire Protection and Life Safety Systems*. Time is to be allocated in the construction schedule for these tests, and the general contractor is to ensure that the key sub-trades are part of this testing.

.3 Prerequisites for integrated systems testing are individual verification reports such as a fire alarm verification report, sprinkler sign-off, elevator sign-off, fire/smoke/life safety fan balancing reports, and others.

.4 The intent is not to replicate the tests of each device, but to test the operation of the life safety systems as a whole. Examples include but are not limited to the following:

- Fan shutdown on duct smoke detector;
- Activation of fans (stair pressurization, vestibule pressurization, smoke evacuation) on fire alarm;
- Successful integration of sprinkler devices, pre-action systems, and so on;
- Proper operation of door hold-open devices, mag locks, fire shutters, and so on;
- Elevator recall to home and alternate home floors; and
- Operation of life safety systems on loss of power or on generator power.

.5 The general contractor (or the general contractor's qualified Integrated Testing Coordinator) is responsible for developing the Integrated Testing Plan at the time the mechanical equipment installation begins on site. The general contractor shall distribute the final Integrated Testing Plan to the Certified Registered Professional / architect and the owner's hired CxP prior to functional testing for review.

.6 After performing and documenting the Integrated Systems Testing the general contractor will distribute the test results/report to the Certified Registered Professional/ architect and the owner's hired CxP for review.

.7 Each Registered Professional of Record (RPR) and the Owner's hired CxP shall review the IST test results/report to ensure compliance with CAN/ULC-S1001. Should any deficiencies arise, the Consultant/ Architect will be responsible to coordinate with the General Contractor to resolve the outstanding deficiencies and schedule a re-test for resolving the deficiency.

.8 The architect will ensure that these requirements are included in the contract documents under Division 01 91 00 - Building Commissioning and that related test results/reports are collected at substantial completion of the project for their Letters of Assurance (Schedules A, B, C-A and C-B).

.9 Regardless of the level (Option 1-3) of third-party commissioning hired by the Owner/ BC Housing required for the project, the CxP will be required to witness these tests, be provided a copy of the test results and collect supporting documents on behalf of the owner. The CxP will document the deficiencies in the Issues Log and ensure they are resolved before project completion. Refer to Article 5.1.2, Third-Party Commissioning Provider Scope and Responsibilities.

.2 Third-Party Commissioning Provider Scope and Responsibilities

.1 The architect (including their consultants and project team) will consult local rezoning bylaws, building commissioning bylaws, and the funding partner's commissioning requirements before establishing the commissioning activities and requirements to be

conducted by a third-party CxP hired by the Owner/BC Housing. Projects are required to exceed the minimum mandatory commissioning requirements of rezoning and municipal bylaws where BC Housing requirements are more stringent. If rezoning and/or the funding partner's commissioning requirements are not as stringent, then at minimum choose one of the four options listed below, as appropriate for the project.

.2 Depending on local rezoning bylaws, project classification, and the size/complexity of the building, there are four options for implementing the commissioning process in BC Housing projects. The four options described here are for an independent third-party Commissioning Provider hired by the Owner/BC Housing or the contractor. This should not replace the responsibilities of consultants, the contractor, subcontractors, or third-party agencies outlined in Article 5.1.1, Consultant and Contractor Commissioning Responsibilities.

.3 The project team is responsible for choosing one of the following four options based on the project complexity:

- **Option 1:** Independent Enhanced Commissioning, if required by rezoning or funding partners (hired by Owner)
- **Option 2:** Independent Commissioning, 7 storeys or higher or high-complexity project (hired by Owner)
- **Option 3:** Independent Mechanical Commissioning, 3-6 storeys or medium-complexity project (hired by Owner)
- **Option 4:** Independent Mechanical Commissioning, 1-2 storeys or low-complexity project (hired by mechanical contractor)

Each of these options is described in the following sections.

.4 The commissioning activities in different phases for all options are to follow the approach outlined in Section 5.2, Commissioning Process Phases.

.1 Option 1: Independent Enhanced Commissioning, if Required by Rezoning or Funding Partners (Hired by Owner)

Where the project is required to achieve third-party certification or where enhanced commissioning (as outlined in LEED v4) is required by local rezoning bylaws or by funding partners, the commissioning process will follow the requirements of Enhanced System Commissioning or any other requirements by the municipalities that is more stringent than BC Housing requirements, depending on building type (the options outlined above).

Before the design development phase is complete or per rezoning requirements, the Owner will retain the CxP, who will review the design requirements/concepts and oversee/implement the enhanced commissioning process for the mechanical, electrical, and building envelope components (if required), as they relate to functionality, energy performance, and durability.

The commissioning process will depend on the rezoning or funding partner's requirements and may follow ASHRAE Guideline 0 *The Commissioning Process*, ASHRAE Guideline 1.1 *HVAC&R Technical Requirements for The Commissioning Process*, or an alternative commissioning standard required by municipalities, such as:

- ASHRAE Standard 202 *The Commissioning Process for Buildings and Systems*;
- CSA Z320 *Building Commissioning*;
- CSA Z8001 *Commissioning Standard of Health Care Facilities*; or
- CSA Z5000 *Building Commissioning for Energy Using Systems*.

Regardless of the activities outlined in the enhanced commissioning to meet rezoning requirements, the CxP hired under Option 1 must perform, at a minimum, sample checks of 25% of the contractor's pre-functional testing/equipment start-up, functional testing of 100% of the mechanical systems and controls and witness the CAN/ULC-S1001:Integrated Systems Testing of Fire Protection and Life Safety. The mechanical consultant will clearly state who is performing these tests in the contract documents under Division 23 08 00 - Commissioning of Mechanical Systems and that a contractor-hired independent TAB agency (at a minimum, if there is no CxAg) is required for completing the TAB. The roles and responsibilities for the CxAg, TAB agent, and CxP will be clearly specified. The Cx scope and activities in each stage will be outlined in the OPR document early in the project, in commissioning specifications, and in contract documents prior to tendering.

.A Required Commissioning Activities

REQUIRED COMMISSIONING ACTIVITIES: OPTION 1 Independent Enhanced Commissioning
1. Assist Owner to develop Owner's Project Requirements (OPR)
2. Review Basis of Design (BOD)
3. Develop and implement a Cx plan, pre-functional checklists, and system test procedures
4. Confirm that necessary Cx requirements/activities (including system test procedures, contractor's commissioning responsibility, training, etc.) are in the construction documents
5. Perform regular field reviews and prepare/update issue log throughout construction
6. Perform and document static verification and witness manufacturer's start-up, as required
7. Perform and document functional performance testing
8. Witness CAN/ULC-S1001: Integrated Systems Testing of Fire Protection and Life Safety Systems on behalf of the Owner.
9. Review O&M manual, and summarize equipment warranties and maintenance schedule
10. Coordinate training for Operator
11. Provide final Cx report
12. Provide 5-month seasonal testing walkthrough
13. Provide 10-month warranty walkthrough

.B Systems to Be Commissioned

.1 Which systems are to be commissioned is determined according to rezoning or funding partner's requirements. At a minimum, however, the project must meet BC Housing's commissioning scope based on the options indicated above (depending on building type).

.2 The CxP will be required to participate in and witness the testing for CAN/ULC-S1001 *Integrated Systems Testing of Fire Protection and Life Safety Systems.* Integrated Systems Testing is to be performed and documented by the general contractor and coordinated and reviewed by the architect.

.C Commissioning Management

.1 The CxP is to lead the commissioning process and chair commissioning meetings with the Owner, consultant, general contractor, and sub-trades, per rezoning or funding partner's requirements. At a minimum, the CxP must follow BC Housing commissioning guidelines for the number and frequency of meetings based on the options indicated above (depending on building type).

.2 Option 2: Independent Commissioning, 7 Storeys or Higher or High-Complexity Project (Hired by Owner)

For projects where there is no rezoning or funding partner commissioning requirement, if the building is 7 storeys or higher or it is deemed to have increased complexity (e.g., mixed use, separate mechanical and electrical systems for different user groups, high energy performance buildings with renewable systems, etc.), an independent CxP will be hired by the Owner/BC Housing.

The CxP's involvement will begin at the design development stage, and at no later than the 50% construction document stage. The scope will be in line with Fundamental Commissioning (as outlined in LEED v4), with a few exceptions—notably, which systems are to be commissioned and increased involvement in the post-occupancy phase of the project.

Depending on the complexity of the project or if recommended by the consultant, the requirement for an independent CxAg hired by the mechanical contractor can be included in the mechanical specifications under Division 23 08 00 - Commissioning of Mechanical Systems for Option 2. Prior consultation with BC Housing and the Owner is required. Refer to **Article 5.1.1, Consultant and Contractor Commissioning Responsibilities,** under Mechanical, HVAC, and Plumbing Systems.

The CxP must complete, at a minimum, on-site checks of 25% of the contractor's pre-functional testing/equipment start-up and perform functional tests of 100% of the systems when these sample pre-functional checks are complete, as well as, witness the CAN/ULC-S1001:Integrated Systems Testing of Fire Protection and Life Safety. The construction contract documents will clearly state who will perform these tests.

.A Required Commissioning Activities:

REQUIRED COMMISSIONING ACTIVITIES: OPTION 2 Independent Commissioning (Hired by Owner)
1. Assist Owner to develop Owner's Project Requirements (OPR)
2. Review Basis of Design (BOD)
3. Develop and implement a Cx plan, pre-functional checklists, and system test procedures
4. Confirm that necessary Cx requirements/activities (including system test procedures, contractor's commissioning responsibility, training, etc.) are in the construction documents
5. Perform regular field reviews and prepare/update issue log throughout construction
6. Perform and document static verification and witness manufacturer's start-up, as required
7. Perform and document functional performance testing
8. Witness CAN/ULC-S1001: Integrated Systems Testing of Fire Protection and Life Safety Systems on behalf of the Owner.
9. Review O&M manual, and summarize equipment warranties and maintenance schedule
10. Coordinate training for Operator
11. Provide final Cx report
12. Provide 5-month seasonal testing and mid-warranty walkthrough
13. Provide 10-month warranty walkthrough

.B Systems to Be Commissioned

.1 The CxP is to be involved in the commissioning of the following systems in this option:

- HVAC&R and their tie-in to life safety systems;
- Domestic water systems;
- Building automation/control systems;
- Electrical systems as they relate to life safety (fire alarms, emergency generators, emergency lighting) and electrical sub-metering and associated data collection and reporting systems; and
- On-site renewable energy systems (if applicable).

.2 The CxP will be required to participate in and witness the testing for CAN/ULC-S1001 *Integrated Systems Testing of Fire Protection and Life Safety Systems*. Integrated systems testing is to be performed and documented by the general contractor and coordinated and reviewed by the architect.

The CxP is to witness the functionality of ancillary device integration with fire alarms, such as elevator homing functions, mechanical equipment start-up/ shutdown, smoke control and smoke venting equipment including fans and dampers, door hold-open devices, electro-magnetic locks, fire pumps, generators, and so on.

Alder Gardens.
36 units – 4-storey wood frame apartment with 1-level underground parking. Solar domestic hot water heating

Maitland Street Village. Port Alberni –
46 units, 4-storey apartment.
Fan coil unit

.C Commissioning Management

The CxP is to lead the commissioning process and chair commissioning meetings with the Owner, consultant, general contractor, and sub-trades. As a guideline, the following is likely to be required during design and the final 4-6 months of construction:

- 2-3 meetings at the design stage;
- Meetings every other week for 3-4 months of construction;
- Weekly meetings for the final 1-2 months of construction; and
- On-site walkthroughs at the 5- and 10-month marks for seasonal testing and warranty reviews.

.3 Option 3: Independent Mechanical Commissioning, 3-6 Storeys or Medium-Complexity Project (Hired by Owner)

For projects where there is no rezoning or funding partner commissioning requirement, if the building is 3-6 storeys or it is deemed to have reduced complexity, an independent mechanical CxP will be hired by the Owner or BC Housing.

If more value is found in Option 2 than Option 3, Option 2 can be chosen depending on the complexity of the building, subject to the Owner's discretion.

The CxP must complete, at a minimum, on-site checks of 25% of the contractor's pre-functional testing/equipment start-up and perform functional tests of 100% of the systems when these sample pre-functional checks are complete, as well as, witness the CAN/ULC-S1001:Integrated Systems Testing of Fire Protection and Life Safety. The construction contract documents will clearly state who will perform these tests.

The mechanical CxP's involvement will begin during construction. The CxP will create a Cx plan outlining the scope of commissioning activities during the construction phase, along with responsibilities, schedules, and procedures. The CxP will distribute the plan to the Owner and the commissioning team before the commissioning process starts at the site.

.A Required Commissioning Activities:

REQUIRED COMMISSIONING ACTIVITIES: OPTION 3 Independent Mechanical Commissioning (Hired by Owner)
1. Develop Cx plan and implement, pre-functional checklists, and system test procedures
2. Perform regular field reviews and prepare/update issue log throughout construction
3. Perform and document static verification and witness equipment start-up, as required
4. Perform and document functional performance testing
5. Witness CAN/ULC-S1001: Integrated Systems Testing of Fire Protection and Life Safety Systems on behalf of the Owner.
6. Review O&M manual, and summarize equipment warranties and maintenance schedule
7. Coordinate training for Operator
8. Provide final Cx report
9. Provide 5-month seasonal testing and mid-warranty walkthrough
10. Provide 10-month warranty walkthrough

.B Systems to Be Commissioned

.1 The CxP is to be involved in the commissioning of the following systems:

- HVAC&R and their tie-in to life safety systems;
- Domestic water systems;

- Building automation/control systems; and
- On-site mechanical renewable energy systems (if applicable).

.2 The CxP will be required to participate in meeting CAN/ULC-S1001 *Integrated Systems Testing of Fire Protection and Life Safety Systems*. Integrated systems testing is to be performed and documented by the general contractor and coordinated and reviewed by the architect.

Ruth and Naomi's Mission Family Centre. Electrical overload

.C Commissioning Management:

.1 The CxP is to lead the mechanical commissioning process and chair commissioning meetings with the Owner, consultant, general contractor, and sub-trades. As a guideline, the following is likely to be required during the final 4 months of construction:

- 8-12 meetings during construction or as directed by the Owner/BC Housing; and
- On-site walkthroughs at the 5- and 10-month marks for seasonal testing and warranty reviews.

.4 Option 4: Independent Mechanical Commissioning, 1-2 Storeys or Low-Complexity Project (Hired by Mechanical Contractor)

For projects where there is no rezoning or funding partner commissioning requirement, if the building is 1-2 storeys and it is deemed to have reduced complexity, the mechanical contractor is required to hire an independent mechanical commissioning agency to complete the Cx process.

The mechanical consultant will decide if an independent CxAg is necessary for the project. At a minimum, the contractor will retain an independent TAB agency and submit a commissioning report to BC Housing with all test results and static, start-up, and functional test documentation for the project. The commissioning report must be submitted prior to substantial completion of the project. In addition, the contractor will submit a summary checklist of completed tests for all other building systems as outlined in the minimum testing requirements in Section 5: Commissioning Requirements to the Owner/BC Housing.

These responsibilities need to be clearly outlined in the construction specifications prepared by the mechanical consultant.

The commissioning process starts during the construction phase.

Eden Gardens.
130 bed licensed care – 2-storey wood frame

.A Required Commissioning Activities:

Contractor to complete activities outlined in Option 4 checklists provided by BC Housing.

REQUIRED COMMISSIONING ACTIVITIES: OPTION 4 Independent Mechanical Commissioning (Hired by Mechanical Contractor)
1. Perform and document static verification and start-up
2. Perform and document functional performance testing
3. Complete O&M documentation
4. Coordinate training for Operator
5. Provide Cx report and summary of completed Cx tests

.B Systems to Be Commissioned

.1 The mechanical contractor (or their CxAg) is to be involved in the commissioning of the following systems:

- HVAC&R and their tie-in to life safety systems;
- Domestic water systems;
- Building automation/control systems; and
- On-site mechanical renewable energy systems (if applicable).

.C Commissioning Management

.1 The contractor (or their CxAg) is to lead the mechanical commissioning process, and chair commissioning meetings with the consultants, general contractor, and sub-trades. Owner representatives will be provided with meeting minutes and may attend at their discretion.

.2 COMMISSIONING PROCESS PHASES

This section outlines the different phases of the commissioning process, as applicable to each of Options 1-4. There are five distinct commissioning phases; each consists of a series of actions and activities performed by the project team, and they align with the project development phases.

.1 Pre-Design or Conceptual Design Phase (Options 1 and 2)

For Options 1 and 2, the commissioning process typically starts at the pre-design stage of the project. The CxP is hired at this preliminary stage to plan and set up the requirements and activities. From the outset, the CxP needs to understand the process, documents, responsibilities, and activities to be completed. At this stage, the CxP undertakes the following activities:

- Assist the Owner to develop the OPR;

- Create commissioning scope and requirements for commissioning team; and
- Create the initial commissioning plan with draft templates related to reports.

.2 Design Phase (Options 1 and 2)

During the design phase, the designer provides project systems details in the form of specifications, documents, and drawings. If the CxP was not hired at the pre-design phase for Option 1 and 2, then they must be hired at the beginning of this phase (and at no later than the 50% construction document stage).

This phase typically starts before the detailing of the design commences. The following activities are completed during this phase:

- Design team produces Basis of Design reports;
- CxP reviews Basis of Design against the OPR; and
- CxP ensures that the appropriate Cx and training requirements have been included in the project specifications for tendering.

.3 Construction Phase (All Options)

The commissioning process plays an important part in the construction phase. When construction work begins, the general contractor should be fully committed to the requirements and delivery of the documents, process, testing, and final submissions required by the contract documents. The CxP (hired by the Owner) or the contractor's hired CxAg (or their agent) must be engaged at the beginning of construction for Options 3 and 4. The following commissioning steps are performed in this phase:

a. Step 1: Static Verification

The contractor checks that a specific piece of equipment or system is ready for starting and documents their check using the pre-functional checklists from the commissioning plan.

The CxP ensures that all tests and certificates have been completed and that all equipment has been verified by the mechanical contractor and is ready to operate, including all wiring and controls. The CxP issues commissioning tracking checklists for the team to assess progress.

The CxP also performs static inspections as part of field reviews before contractor or manufacturer start-up of equipment. The CxP circulates a commissioning issue log to the team summarizing any items of concern.

The issue log is discussed and monitored throughout the Cx process.

1005 Station Street, Vancouver. 80 units – 6-storey building. Mechanical room

b. Step 2: Witness Equipment Start-Up

The CxP witnesses start-up and checkout operation, calibration, testing, and adjusting of all equipment and systems performed by the contractor or manufacturer and certifies the operations as complete. This includes all air and water balancing performed by an independent TAB agency hired by the contractor. At a minimum, checks of 25% of mechanical equipment and pre-functional tests are to be completed by the CxP after the contractor competes full pre-functional testing/equipment start-up. All deficiencies are recorded and reviewed with the commissioning team (consisting of the mechanical consultant, general contractor, mechanical contractor, contractor's mechanical CxAg, if any, control contractor, contractors' suppliers, and the CxP), and are corrected and verified before proceeding.

c. Step 3: Functional Performance Testing

The CxP creates functional testing checklists, performs functional tests of 100% of the systems, and submits all test certificates and the Commissioning Completion Certificate when beginning the verification process. The CxP draws up a schedule for the verification inspection by the consultant. The schedule lists all equipment and systems and the estimated time required for verifying the operation of each item. This phase includes reviewing the project record drawings for accuracy and completeness, reviewing the O&M manuals, summarizing equipment warranty and maintenance schedules, and submitting all testing/start-up reports and certificates/approvals from the authorities having jurisdiction. Any deficiencies are listed in the issue log, and the project consultant compiles those in the deficiency list (with an associated amount of holdback). When all required documents and certificates are complete, and all equipment and systems are in full and satisfactory operation, the consultant may declare substantial completion. At the end of this step, all issues documented in the issue log have been resolved.

.4 Handover Stage (All Options)

After functional testing is complete, the CxP reviews the O&M manuals and prepares a warranty summary list and maintenance schedule for BC Housing. The CxP prepares a schedule for the demonstration and instructional process and a training agenda. The agenda is coordinated with the contractor and reviewed by the commissioning team and the Owner prior to implementation. The operation and maintenance requirements of all equipment and systems are demonstrated and explained in detail to the Owner's operating personnel.

The controls contractor provides a separate demonstration/training for controls and sequences of operation. On completion of the demonstration and instructional process, the CxP obtains a signed statement of satisfaction from the building Owner and/or their operating personnel. The CxP issues the final Cx report to BC Housing at project completion, with a placeholder in the appendix section for seasonal testing at 5 months and a warranty review at 10 months.

.5 Post Occupancy Stage (All Options)

The CxP completes substantial performance follow-up and verification of systems operation during a minimum of two separate site visits, scheduled for approximately 5 and 10 months after the date of substantial completion. These visits consist of general troubleshooting, seasonal testing, and verification of the operation and maintenance of all equipment and

systems. These site visits are over and above normal troubleshooting and warranty call-backs, which may require the CxP to coordinate with the contractor and consultant team. After completing the site inspection and reviewing the Operator's issue log, the CxP submits a detailed report to the consultant and the Owner outlining their findings, including any problems encountered with the operation and maintenance of equipment and systems, and any required repair work or correctional action. When all issues are resolved, the CxP provides the updated appendix in the final Cx report to the Owner and Cx team.

.3 COMMISSIONING FOR BUILDING RENEWALS AND RETROFIT PROJECTS

Depending on the size, scope, type, and complexity of the building renewal and retrofit project, the project team will choose the appropriate commissioning option (as described in the preceding sections).

The systems to be commissioned and the applicable commissioning option will depend on the scope of the project and how the new and existing building systems are integrated with new, retrofitted, or modified systems. For example, the scope of an HVAC upgrade in a capital improvements project will require not only the commissioning of HVAC and control systems, but also their tie-in to life safety systems.

For a mechanical system upgrade, questions to ask include whether the retrofit scope includes centralized or decentralized systems, plumbing, fire suppression, or HVAC upgrades. That is, is it an entire system retrofit or is it only major equipment such as the heat pump, boiler, AHU, and so on? A deep energy retrofit program may require significant modernization of existing equipment.

In addition to mechanical systems, a retrofit may include upgrades of other building systems, such as electrical, the building envelope, elevators, control systems, and so on. For example, the scope of a major electrical retrofit could include the following projects:

- The addition of or major modifications to photovoltaic systems;
- The addition of or major modifications to an electrical sub-metering system;
- The addition of or major modifications to emergency generator or emergency lighting systems; and
- Replacement of or major modifications to fire alarm systems or a significant number of ancillary device integrations with the fire alarm system.

.1 Independent Mechanical Commissioning for Building Renewals and Retrofit Projects

Given the vast array of possible renewal project scopes for mechanical systems, these guidelines cannot provide prescriptive requirements for which commissioning option is to be followed for hiring an independent CxP. However, the following provides some general recommendations about which option may be most applicable. The Owner must consult with BC Housing to review project-specific details and determine which option to follow.

Brookland Court. 78 units – 7-storey senior development. Building envelope retrofit

Option 3: Independent Mechanical Commissioning, Medium-Complexity Retrofit Project (Hired by Owner)

Option 3 is for major renovations or retrofits including new or upgraded DHW production and recirculation systems, central hydronic or chilled water systems, air-to-water heat pump systems, air handling systems with variable air volume (VAV) terminal units, or a large quantity of distributed mechanical equipment. Other major retrofits include:

- Projects with the addition of solar hot water heating;
- Building automation system upgrades or replacements; and
- Upgrade/installation of central ventilation systems.

If Option 3 is selected, the CxP will be required to participate in and witness the testing for CAN/ULC-S1001 Integrated Systems Testing of Fire Protection and Life Safety Systems. The CxP is to witness the correct functionality of any integration between the fire alarm and ancillary devices, such as the mechanical systems, elevators, lighting, door access controls, and so on, that were added or modified as part of the renewal or retrofit project. Integrated systems testing is to be performed and documented by the general contractor and coordinated and reviewed by the consultant involved in the project.

Option 4: Independent Mechanical Commissioning, Lower-Complexity Retrofit Project (Hired by Mechanical Contractor)

Renovations or retrofits including or impacting multiple pieces of distributed mechanical equipment or multiple central air handling systems will follow commissioning Option 4, and the contractor (or their CxAg) will complete the full commissioning.

.2 Commissioning for Other Building Systems in Renewals and Retrofit Projects

For projects with other systems upgrades, the contractor will complete the minimum testing requirements outlined in Article 5.1.1, Consultant and Contractor Commissioning Responsibilities, as necessary. For example, for major electrical upgrades, the consultant must include the contractor's testing requirements in the specifications, and the contractor is to complete all testing and submissions required by the contract documents and these guidelines

Maitland Street Village. Port Alberni – 46 units. Rooftop units

6 Re-commissioning

Alexander Street. 139 units – 7 storeys. Mechanical re-commissioning

Successful commissioning should result in a building that meets the performance targets in the OPR and the design intent. However, over time the building or systems will require maintenance to maintain optimum performance. The commissioning processes should be repeated, which is known as re-commissioning. Re-commissioning identifies and addresses system inefficiencies that can cause the building's Owner/Operator to incur high operating and maintenance costs, as well as premature replacement costs.

Re-commissioning is normally done every 3-5 years depending on ongoing commissioning rigour, or whenever the building experiences a significant change. Another essential aspect of the re-commissioning process is providing training to Operator maintenance personnel and service contractors.

The Owner is to determine the system(s) to be included in the re-commissioning process, and define whether the focus is on improving building comfort, operation and maintenance, energy savings, or other.

REQUIRED COMMISSIONING ACTIVITIES: Independent Re-Commissioning (Hired by Owner)
1. Develop a re-commissioning plan
2. Develop/update Owner's operating requirements
3. Create a diagnostic monitoring and functional testing plan
4. Develop a master list of findings that includes details on the findings, recommendation, and listing of benefit (with quantification of savings and costs if required by Owner)
5. Provide an assessment report
6. Lead/participate in implementation (if required by Owner; otherwise, this is led by Owner)
7. Provide a handover report, based on the assessment report
8. Update building documentation
9. Hold follow-up meetings with Owner to review re-commissioned systems and ensure persistence

.1 COMMISSIONING MANAGEMENT:

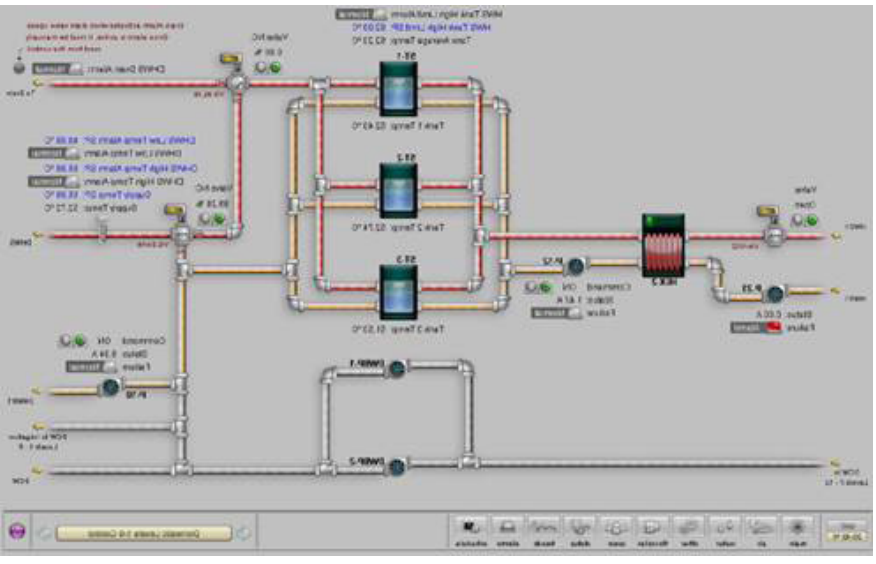
Several factors affect how re-commissioning may be executed, including the condition of the building; the size, complexity, scope, and budget of the project; and the availability of resources and expertise. A well-planned and executed re-commissioning project generally occurs in four phases: planning, assessment, implementation, and handover.

.1 Planning: To develop a re-commissioning plan, the consultant or Re-commissioning Provider (RCxP) conducts an on-site visit and talks with O&M personnel. They review current operating conditions, existing as-built documents, any other related documents, and the operational issue log. After gaining a clear understanding of project goals, the consultant or RCxP identifies the re-commissioning requirements and opportunities for operational improvements in the building.

.2 Assessment: The consultant or RCxP assesses how building systems are currently operated and maintained to identify issues and potential improvements, and they select the most cost-effective improvements for implementation. The consultant will produce an assessment report for the Owner, describing the specific findings and identifying potential costs and savings. The report will outline the re-commissioning processes and procedures, provide a schedule of activities, identify the re-commissioning team members and their roles, and create a budget for this scope. These findings identify not only the payback period, but also the associated non-energy benefits such as increased comfort, system reliability, and so on.

.3 Implementation: In this phase, the selected re-commissioning measures and recommendations (i.e., scope, schedule, budget, cost/benefit analysis, etc.) from the assessment report are approved by the Owner/Operator and implemented. Implementation can be carried out by the consultant, RCxP, Owner, maintenance personnel, and individual contractor and their sub-trades. Depending on the overall project scope and budget, the RCxP's scope is to be defined in this stage to include oversight of re-commissioning work.

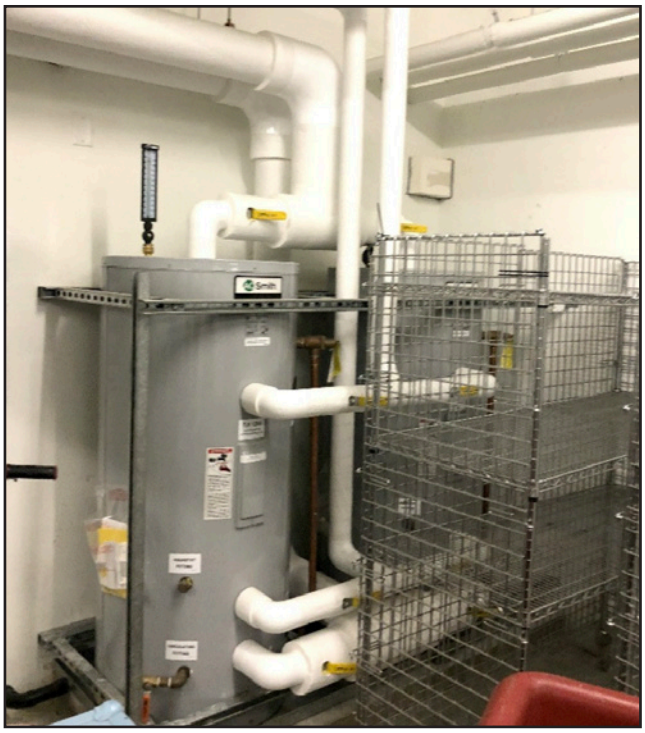
.4 Handover: After a successful re-commissioning, the consultant or RCxP produces a final report documenting the process and its findings, conducts O&M personnel training, and holds a project handover meeting with the Owner/Operator.



First Place.
129 units – 11 storeys.
Mechanical re-commissioning – control systems

Alexander Street.
139 units – 7 storeys. Solar system re-commissioning

1249 Howe St.
Air-to-water heat pump chiller. ATHP-1 – Airstack ASP 060X-H (2 modules)



1249 Howe St.
Two pre-heating storage tanks added upstream of high zone DHW tanks

1249 Howe St.
Water-to-water heat pump WHP-1

7 Retro-Commissioning

Retro-commissioning works and activities are usually completed on a building that has been "handed over" but that did not have its equipment, systems, and services fully commissioned, either during the initial construction or since then. Retro-commissioning in BC Housing projects is ideal for:

- Existing buildings that are facing commissioning issues and buildings that were never properly commissioned at the start; or
- Existing buildings that have longer lifespans and whose overall performance can be improved, especially in areas that affect energy efficiency, the carbon footprint, thermal comfort, and operation and maintenance.

Retro-commissioning evaluates all the systems of a building and determines the best sequence for the operation. This includes simple fixes, such as recalibrating a thermostat, and, if needed, more extensive renovations, which may involve more of a re-engineering effort.

The required activities, commissioning management, and CxP involvement is the same as for re-commissioning, outlined in the previous section.

8 Guidelines and Standards Referenced

Guidelines and/or standards for further information and guidance:

1. ASHRAE Guideline 0 *The Commissioning Process*
2. ASHRAE Standard 202 *The Commissioning Process for Buildings and Systems*
3. CSA Z320 *Building Commissioning Standard*
4. CAN/ULC-S1001 *Integrated Systems Testing of Fire Protection and Life Safety Systems*
5. CanmetENERGY Recommissioning Guide for Building Owners and Managers
6. The Building Commissioning Association (BCxA)
7. BC Housing Design Guidelines and Construction Standards, latest version

Depending on the project region or partner organization, other requirements may need to be fulfilled, such as:

- City of Vancouver – Green Buildings Policy for Rezoning – Process and Requirements
- CSA Z8001, if a health authority is a funding partner

Appendix A: Commissioning Reports Requirements and Templates

The following lists provide an overview of the key items that should be included in each document template.

.1 OWNER'S PROJECT REQUIREMENTS (OPR)

The OPR provides an explanation of the ideas, concepts, and criteria that are considered to be very important to the Owner, coming out of the programming and conceptual design phases. These items are desired to be tracked throughout design and construction. The OPR does not list items that are already required by code or authorities having jurisdiction. This is a live document and is updated throughout the project.

The OPR is developed by the Owner, in consultation with the project development team. The CxP (if hired) will assist the Owner at the conceptual or schematic design phase for Options 1 and 2. The following items must be included in the OPR at a minimum:

OWNER'S PROJECT REQUIREMENTS		
A. Project General Information		
A. Project Name and Location		
B. Client Type		
C. Building Type (number of storeys)		
D. Total Number of Units and Unit Mix	**Total:**	**Unit Mix:**
E. Type of Construction (wood frame, concrete, modular, etc.)		
F. Site Conditions (any site limitations or constraints)		
1. Site related issues (site due diligence reports)		
2. Municipal permits		
3. Neighbourhood concerns		
D. Project Budget		
E. Project Schedule		
F. Project Team	**Project Owner:**	**Funding Partners:**
	Design Team:	**Construction Team (if hired)**
G. Other		

B. BC Housing Involvement		
A. BC Housing Consultants' Involvement	**Cost Consultant:**	**Project Technical Consultant:**
	Commissioning Provider:	**Mechanical Peer Review:**
B. BC Housing Plan Review Milestones (i.e., Schematic, DD, 50% CD, 98% CD)		
C. Form of Construction Contract		
D. Other		

C. Design Objectives and Building Performance		
PERFORMANCE CRITERIA	**DESCRIPTION**	**RESPONSIBLE PARTY/ STATUS OF INPUT**
A. Compliance with BC Housing Design Guidelines and Construction Standards		
B. Compliance with Other BC Housing Design Guidelines (such as Shelter Guidelines, etc.)		
C. Accessibility and Adaptability (% of units)		
D. Energy Performance and Sustainability		
1. Minimum energy performance target (Step Code Target)		
2. Minimum construction waste management target		
3. Minimum GHG reduction		
4. Energy efficient products and incentives		
5. Metering and reporting		
6. Water efficiency		
7. Any sustainability certifications (i.e., passive house, etc.)		
E. Mechanical Systems Overview		
1. Fire suppression		
2. Plumbing		
3. HVAC and controls (including minimum ventilation requirements, thermal comfort inside units, desired temp/ventilation parameters, i.e., 20°C +/- 1°C for heating, ventilation per ASHRAE 62.1 or defined L/S per m^2 if exceeding standard)		
4. Resiliency and climate adaptation (i.e., overheating, etc.)		
5. Redundancy in equipment design		
6. Regional availability, system reliability and service requirements		

F. Electrical Systems Overview		
1. Fire alarm system		
2. Access control (building entry, individual suites, and common areas)		
3. Requirements in audio/visual devices		
4. Data and communication systems		
5. Regional availability, system reliability, and service requirements		
G. Building Envelope Systems		
1. Thermal bridging and airtightness		
2. Fenestration product performance		
3. Passive strategies		
4. RCABC warranty		
5. Regional availability, system reliability, and service requirements		
H. Elevator		
1. Regional availability, system reliability, and service requirements		
I. Other Building Systems (i.e., generator, UPS etc.)		
J. Tenant's Individual Control within Units		
K. Building Safety and Security		
1. 24/7 facility reliability, if any		
2. Enhanced fire alarm systems (smoke detector and smoke alarm in each unit)		
3. Enhanced camera locations		
L. Acoustic Consideration		
M. Quality Assurance and Compliance		
1. Third-party energy modelling		
2. Airtightness testing		
3. Other third-party quality requirements per BC Housing Design Guidelines (such as RCABC warranty, fenestration testing, etc.)		
4. Owner/BC Housing hired third-party CxP		
5. Warranty requirements		
6. O&M, maintenance schedule, maintenance and renewal plan		
7. Training/Owner's demonstration		

N. Maintenance Requirements (i.e. any requirements for access panels, any desired equipment such as direct drive to reduce belt maintenance, other)		
O. Other		

D. Project Commissioning Activities		
COMMISSIONING ACTIVITIES	**DESCRIPTION**	**RESPONSIBLE PARTY/ STATUS OF INPUT**
A. Level of Rigour Desired for BC Housing CxP as Outlined in This Document Based on Options (Option 1 , 2 , 3, or 4)		
B. Systems to Be Commissioned (i.e., mechanical, electrical, elevator, building envelope, other architectural systems, integrated system testing, other)		
C. Design Teams' Responsibility		
D. Contractor's Responsibility		
E. Any Independent CxAg under Contractor to Be Considered		
F. BC Housing's Independent CxP Involvement		

.2 BASIS OF DESIGN (BOD)

The BOD is narrative and technical documentation prepared by the design team along with design submissions to explain how the OPR is met by the proposed design and how the commissioning activities will be applied in the project. This document also describes what systems are to be commissioned and the roles of the contractor and the Owner-hired third-party CxP.

The BOD will be submitted by the design team at no later than the schematic design phase. In some cases, the OPR may need to be updated to comply with the BOD if the design team identifies approaches that better satisfy the Owner's needs.

The following items are to be included in the BOD at a minimum:

- Project description and overview of systems;
- How OPR are being met;
- Systems to be commissioned;
- Third-party commissioning activities;
- Contractor's responsibility and Owner-hired CxP's involvement;
- Statement of building operational modes;
- Primary design assumptions:
  - Style of building use;

  - Redundancy;
  - Diversity;
  - Occupancy;
  - Climatic design considerations;
  - Space environmental conditions;
- Performance criteria and BC Housing Design Guidelines and Construction Standards;
- Governing codes and standards; and
- Narrative description.

The CxP will review the BOD and assist the design team in creating Cx specifications for construction documents.

.3 COMMISSIONING PLAN (Cx PLAN)

The commissioning plan establishes the framework for how commissioning will be implemented and managed on a project. This includes a discussion of the commissioning process, schedule, team and team member responsibilities, communication structures, and a general description of the systems to be commissioned.

The preliminary version of the plan will be developed by the CxP at the pre-design phase for commissioning Options 1 and 2 and finalized at the start of construction. During the design phase, the Cx plan is updated and incorporated into the construction contract documents. It should be considered a live document and updated on an ongoing basis to reflect changes to the BOD.

In Option 3, where the CxP is retained at the start of construction, the Cx plan will be created based on the Issued-for-Construction (IFC) document and commissioning scope of the project, and distributed to the commissioning team. The Cx checklists and detailed project schedule may need to be developed later; they can be addressed in appendices to the main Cx plan. If any information was missing in the original Cx plan, the CxP will update these appendices when information becomes available.

The following items must be included in the Cx plan at a minimum:

COMMISSIONING PLAN (Cx PLAN)	
Description	**Purpose/Detail Outlines/General Summary**
General Project Information	Project description, location, client type, number of units, building type (number of storeys), type of construction (wood frame, concrete, modular, etc.), summary of functional spaces, and overall building service life expectancy
Design Objectives and Performance Targets	Compliance with the BC Housing Design Guidelines and Construction Standards, energy and sustainability performance targets, and design objectives

Building Systems Overview	Overview of the major systems (i.e., mechanical, electrical, building envelope, elevator where applicable) and building integration system
Commissioning Scope and Option	Building type and BC Housing commissioning requirements, option chosen, systems to be commissioned, commissioning scope, design teams' responsibility, contractor's responsibility per contract documents, and Owner-hired third-party commissioner's activities for the project
Team Contacts	Team's contacts, and their roles and responsibilities (refer to Appendix B)
Communication Plan and Protocols	Methods of communications and coordination throughout the project
Commissioning Process and Phases	Summary of commissioning processes and activities, OPR and BOD review, static verifications and start-up checks by the contractor and Owner-hired CxP (Options 1, 2, and 3), submission requirements, verifying and reviewing system performance process, issue resolution process, training process, 1-year warranty review process, etc.
Appendix: Commissioning Documentation	Pre-functional checklists and system test procedures, documentation of static verification, functional performance test procedures and checklists, verifying and reviewing system performance document/issue log, Owner's training, letter confirming O&M review completion, summary document of equipment warranties and maintenance schedule, deficiency reports, final Cx report, 1-year warranty review report, etc.
Appendix: Commissioning Schedule	Specific sequences of events and relative time frames, dates, and durations for commissioning, overall project completion date, and 1-year warranty milestone

.4 COMMISSIONING REPORT

.1 Commissioning Report (Cx Report)

The commissioning report will include information on how all of the above (OPR, BOD, Cx plan) transpired, in addition to including the issue log, commissioning document checklist,

submittals, a general description of testing and verification methods, O&M manuals, M&R plans, and warranty information.

The Cx report is typically issued as a draft, and captures any issues on installation, pre-functional testing, and functional testing. A final report is issued after all seasonal testing and warranty reviews are complete.

The following items must be included in the Cx report at a minimum:

COMMISSIONING REPORT (Cx REPORT)	
Description	**Purpose/Detail Outlines/General Summary**
Participants	Primary commissioning participants: Owner's representatives, design team, construction team, and CxP

Summary of Commissioning Process and Overview	Scope of commissioning, commissioning systems overview (including all equipment), commissioning process, static verifications and start-up checks by the contractor and Owner-hired CxP (Options 1, 2, and 3), submission requirements, verifying and reviewing system performance process, process of evaluation (inspection, testing, deficiencies and defects, and resolutions), training, O&M, and 5-month and 1-year warranty review process
Design Review Log and Submittal Lists	Design and construction phase submittals according to commissioning scope and construction contract documents, receipt status, and outstanding items
List of Systems Commissioned	Systems commissioned, equipment-specific summaries (installation, performance, testing reports, issue summary)
Installation Checklists	List of equipment installation and start-up tests
Functional Performance Checklists	Pre-functional checklists completion status and functional testing checklists
Issue Logs	All issues in a tabular format itemized by equipment and overall functional performance, highlighting unresolved issues and outstanding actions
Description of Estimated Schedule and Deferred Testing	Specific sequences of events and relative time frames, dates, and durations for testing and deferred testing, and commissioning completion date including seasonal testing and 1-year warranty milestone
Owner's Training	Compiled equipment and system training list, parties involved in training, any video demonstration required by the construction contract documents or by the Owner, estimated training dates and seasonal testing schedule, and Owner's sign-off
Final Cx Report	Estimated date of submission
Appendix: Cx Plan	

For further reference and templates, refer to the Building Commissioning Association (BCxA) for sample templates and BC Housing Design Guidelines and Construction Standards, Section 4, Division 1 - 01 78 00 – Closeout Submittals.

.2 Commissioning Meeting Minutes

Commissioning meeting minutes should be prepared regularly to document progress of the work on commissioned building systems. These minutes will address issues arising on the site, on the mechanical field report, or from installation, pre-functional testing, functional testing, or integration. Issue logs are to be discussed with the design and construction team and performance expectations should be clarified.

The following items are to be included in the commissioning meeting minutes at a minimum:

- Attendance;
- Topic of discussion;
- Summary description of discussed topic;
- Ongoing updates to discussed topic (until closed out and deleted from future minutes);
- Responsible parties or action items for each discussed topic;
- New business/topic; and
- Indication of next meeting time and date.

.5 COMMISSIONING PROVIDER ISSUES LOG

Issue logs are a formal and ongoing record of problems or concerns and their resolution that have been raised by members of the commissioning team during the commissioning process. Issue logs should be included in all commissioning meeting minutes. Issue logs address comments from the pre-design stage (if using Option 1 or 2), the CxP's site inspection, the consultant's field inspection reports, the contractor's testing, workmanship and deficiencies meetings, contract documents, submittal, O&M, and training.

The CxP will create the issue log at the beginning of construction to facilitate the documentation, tracking, and resolution of commissioning-related issues and will maintain the document until all issues are resolved. This document will be distributed to the commissioning team as issues occur and discussed at Cx meetings. The CxP ensures the team responds to and rectifies all issues as soon as possible, and that no issues (critical to moderate) remain at project completion.

Any outstanding issues from the issue log should be addressed as deficiencies and included as part of a whole building deficiency list with an associated amount of holdback. The contractor must agree on completion dates for these items. The Owner is to confirm that the architect and consultants responsible for compiling the deficiency list have the final Cx issue log.

Issues logs typically contain the following, at a minimum:

ISSUES LOG									
Issue Number	**Observation Date**	**Detailed Observations and Cause/Comments (list equipment tag and zone)**	**Responsible Party** **1. Main** **2. Other Coordination**	**Status of the Issue**	**Recommendation with Time Frame to Resolve the Issue**	**Response or Action Taken by Contractor, Design Team, CxP, or Owner**	**Final Review by CxP**	**Issue Resolved Date**	**Additional Comments**

.6 PRE-FUNCTIONAL AND FUNCTIONAL CHECKLISTS

Please refer to the BCxA template for more detailed pre-functional and functional checklists.

.1 Pre-functional Checklists

A pre-functional checklist is a list of items to inspect. These are elementary component tests conducted to verify proper installation of equipment. Pre-functional checks are primarily static inspections and procedures to prepare the equipment or system for initial operation. Pre-functional checklists augment and are combined with the manufacturer's equipment start-up checklist.

The CxP creates these checklists with the responsible parties and distributes them to the contractor. Draft pre-functional checklists are to be provided with the Cx plan at the design stage and updated as required during the early construction phase, prior to the start of on-site commissioning activities. Most checklists contain items for several sub-trades. The contractor will ensure that checklist items by their sub-trades are completed and checked off.

At a minimum, pre-functional checklists should include the following items:

- Make/model of equipment;
- Equipment installed matches shop drawings;
- Installation is per the shop drawings or installation and operation manual;
- Equipment is clean and no visible damage;
- Piping, valving, ducting, wiring, and controls are complete;
- Freedom of rotation (if applicable);
- Start-up completed by manufacturer's representative (if applicable), and start-up report received;
- Overloads and protective devices set;
- Other safeties operational;
- Motor rotation checked;
- Voltage and amperage checked by electrician; and
- Noise and vibration below acceptable limit

The CxP has the flexibility to customize the checklist. A sample is included below. For Options 1, 2, and 3, the CxP will complete a sample of 25% of the pre-functional tests/equipment start-up. In Option 4, the contractor or their hired CxAg will complete 100% of the pre-functional tests/ equipment start-up.

SAMPLE PRE-FUNCTIONAL CHECKLISTS			
ITEM	**CH-1**	**CH-2**	**COMMENTS**
INSTALLATION CHECKS			
Make	ABC		
Model	DEFG		
Correct unit installed	✓	✓	
Mounting/support system/vibration isolation	✓	✓	
Seismic restraints	✓	✓	
Maintenance clearance and access panels	✓	✓	
Heat exchanger	✓	✓	
Local valving/piping correct	✓	✓	*unit was originally piped wrong, fixed
Chemical cleaning and treatment complete	✓	✓	
Insulation/lagging	✓	✓	
Refrigerant relief valve	n/a	n/a	
Temperature and pressure gauges	✓	✓	
Flow switches–safety interlocks	int	int	
Temperature sensors–safety interlocks	int	int	
Control / diagnostic / programmable module	✓	✓	
DDC interfaces with specified points, i.e., chilled water setpoint and demand limiter analogue inputs, and % load, run status, and alarm outputs	✓	✓	
Electrical wiring complete	✓	✓	
Overload protection (sized correctly)	✓	✓	
Disconnect switch	✓	✓	
Control system–end-to-end checks complete	✓	✓*	*not communicating

OPERATIONAL CHECKS			
Start-up by manufacturer's rep.	✓	✓	
Start condenser water system	✓	✓	
Start chilled water system to create load	✓	✓	
Start hydronic system to create load	✓ blending buffer tanks to create load	✓ blending buffer tanks to create load	
Modulation through specified range	✓ 4 compressors observed	✓ 4 compressors observed	
Safety interlocks	flow switch checked	flow switch checked	
Installation Checks by:			Date:
Operational Checks by:			Date:

.2 Commissioning Tracking Checklist

The CxP should review the manufacturer's start-up documentation and perform their own independent checks.

The CxP will compile an equipment tracking checklist for the various pieces of equipment that have been outlined in the manufacturer's recommended start-up procedures or report.

A sample commissioning tracking checklist is below:

SAMPLE COMMISSIONING TRACKING CHECKLIST													
Tag / Name	**Equipment Service**	**Installed**	**Piping Complete**	**Duct / Vent Complete**	**Electrical Complete**	**Controls Complete (End-to-End)**	**System Clean Hydronic / Water**	**System Clean Ventilation**	**Pre-functional Checks Complete**	**TAB**	**Start-up Document-ation Type**	**Start-up Document-ation Received**	**Functional Testing**
Name of Responsible Parties													
Contractor						**Control Trades**		**Contractors**	**Sub-trades / Contractor / Third-party CxAg**	**Third-Party Agency**			
AHU-1	Main Ventilation	yes	no	no	no	no	no	no	no	no	MFG Start-up Report	no	no
EF-1	Bathroom Exhaust	yes	n/a	no	no	no	yes	no	yes	yes	VFD Start-up Report		no
P-1	Domestic Hot Water	yes	yes	n/a	no	no	yes	no	yes	yes	Start-up Reports		yes
P-2	Hydronic Heating Water	yes	yes	n/a	no	no	yes	no	yes	yes	VFD Start-up Report		no
DHWT-1	Domestic Hot Water	yes	yes	yes	yes	yes	yes	yes	yes	n/a	None	n/a	n/a
BFP-1	Domestic Backflow Preventer	yes	yes	n/a	n/a	n/a	yes	n/a	yes	n/a	Backflow Inspection Repor	yes	n/a
AC-1	Electrical Room Cooling Fan Coil	yes	yes	yes	yes	yes	n/a	yes	yes	yes	Start-up Reports	yes	yes
CU-1	Electrical Room Cooling Condense	yes	yes	n/a	yes	yes	n/a	yes	yes	n/a	Start-up Reports	yes	yes
HP-1	Heat Pump in Office	yes	yes	yes	yes	yes	yes	yes	yes	yes	None	n/a	yes

.3 Functional Checklist

Functional performance tests are performed after pre-functional checks, start-up, TAB, and control system's end-to-end checkouts are completed, and the associated documentation is submitted to the CxP. The functional checklist is created by the CxP with the responsible party and distributed to the contractor. A sample functional checklist should be included in the Cx plan.

For all BC Housing projects, the Owner-hired CxP will perform functional tests for 100% of the systems under Options 1, 2, and 3. Under Option 4, the contractor or their hired mechanical CxAg will perform 100% of these tests, and the mechanical consultant will include the requirements in the specifications.

All testing records, diagnostic monitoring results, identified deficiencies, and recommendations for functional performance testing will be documented in the Cx reports and issue logs and distributed to the commissioning team for any further action to be taken to resolve the issue.

The CxP can customize this checklist, but at minimum it must include the following:

- Confirmation that pre-functional checks have been completed;
- For each system/equipment, its:
  - Associated equipment (if applicable);
  - Test procedure that aligns with the sequence of operation (i.e., pumps lead/lag, flow rate controls, boiler staging, etc.);
  - Sequence of operations per final approved control sequence
  - Indication of pass or fail for each line item on the sequence of operation (if failed, indication of whether there is a need to retest during seasonal testing); and
  - Test notes (i.e., temperatures observed, issues encountered and rectified, and supplemental information such as graphic screen shots or trends).

.4 Integrated Systems Testing

Integrated systems test procedures are to be developed by the team. A full understanding of how the systems operate under fire alarm and life safety scenarios is required. It is recommended that a table summarizing the integration among systems be developed as a guide that can be used for witnessing and documenting integrated systems tests.

The contractor will perform and document the integrated system testing, and the CxP hired by the Owner will witness the testing procedure.

The table below shows a sample for testing the integration among systems:

SAMPLE INTEGRATED SYSTEMS TESTING							
	Fire Alarm	**BMS**	**Smoke Control**	**HVAC**	**Lighting**	**Elevators**	**Generator**
Fire Alarm Stage 1:	Local alarm, audible and strobes	Monitors fire alarm / trouble, shuts down AHU-1 to 4 on fire alarm	Pressurization fans ___ start	Duct smoke shut down of MUA-x		Primary recall: ___ Secondary recall: __	Fire alarm has battery backup, also on EM power
Fire Alarm Stage 2:	Activated after _x_ minutes of stage 1. Otherwise activated by key switch.						
Wet Sprinkler	Monitors flow / tamper switches						Panel on EM power
Dry Sprinkler	Monitors alarm / trouble						Compressor on EM power
BMS	Monitors fire alarm / trouble, shuts down AHU-1 to 4 on fire alarm				BMS Control of corridor / exterior lighting		On standby power
Smoke Control	Pressurization fans ___ start						Pressurization fans on EM power
HVAC							Loads XYZ on standby power
Lighting		BMS Control of corridor / exterior lighting					Emergency lighting on EM power
Elevators	Primary recall: ___ Secondary recall: ___						
Door Holders, Mag Locks	Release						Panel on EM power
Access Control							Panel on EM power
Intrusion Detection					Corridor/ exterior lighting commanded to FULL ON upon intrusion detection		Panel on EM power
Fire Shutters	Zone ABC fire shutter drops on local smoke detector						Panel on EM power

.7 TRAINING REQUIREMENTS

The design team ensures that the needs of the Owner (based on their capacity, function, level of expertise, and daily operational requirements) captured in the OPR are in harmony with the equipment and system design and addressed early in the development process. The CxP will consult with the O&M staff and the design team/architect to determine the areas where training will be most valuable and the training rigour desired for each piece of equipment. At a minimum, a complete demonstration and training of all mechanical and electrical equipment and systems and bed bug room operation (if one exists) must be included in the contract documents.

The CxP will develop an overall training plan and is responsible for coordinating and approving the content and adequacy of the training of O&M staff for commissioned systems. TThe CxP will create the training agendas; communicate the desired rigour to the contractor, their sub-trades, and vendors who have training responsibilities; and ensure the Owner/Operator's needs are met and questions are answered. Depending on the contract documents, the contractor or Owner/Operator may need a video recording of these training sessions.

The contractor is responsible for coordinating and scheduling the training, and ultimately for ensuring that training is completed on all equipment (and all other building systems) per the specifications and to the Owner's satisfaction. The appropriate trade or manufacturer's representative will provide the instructions for each major piece of equipment. The representative must be expert in their knowledge of the equipment and familiar with the installations for the project, including equipment locations and access requirements. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training for a piece of equipment (e.g., for a chiller, the chiller vendor provides training on the chiller and on board controls, and the mechanical contractor's start-up technician or the controls contractor provides training on the chilled water system).

A separate training session will be completed on building controls. The controls contractor will also attend sessions other than the controls training, as specified, to discuss the interaction of the controls system with the equipment.

The training agenda will cover the following elements:

SAMPLE TRAINING AGENDA								
Systems	**Date and Time**	**Duration**	**Intended Participants** **1. Mandatory (M)** **2. Optional (O)**	**Detailed Instruction**	**Modes of Operation** **1. Start Up** **2. Shut-Down** **3. Fire/Smoke Alarm** **4. Power Failure** **5. Any Others**	**Any Health and Safety Issues**	**Maintenance Schedule**	**Any Spare Parts**
1. Mechanical								
Air Handling Units								
Boilers								
Pumps and VFDs								
Split System AC units								
Other								
2. Plumbing								
Grey Water System (piping, valves, pumps, water treatment)								
Domestic Water System (booster pumps)								
Domestic Water Heating System (heaters, circulation pumps, mixing valves)								
Other								
3. Life Safety Systems								
Fire Alarm								
Fire Suppression								
Elevators								

SAMPLE TRAINING AGENDA								
Systems	**Date and Time**	**Duration**	**Intended Participants** **1. Mandatory (M)** **2. Optional (O)**	**Detailed Instruction**	**Modes of Operation** **1. Start Up** **2. Shut-Down** **3. Fire/Smoke Alarm** **4. Power Failure** **5. Any Others**	**Any Health and Safety Issues**	**Maintenance Schedule**	**Any Spare Parts**
Other								
4. Electrical								
Electrical Distribution								
Emergency Generator								
Transfer Switches								
Lighting Controls								
Digital Metering Systems								
Other								
5. Other Systems								

The training process will include the following:

.1 The training sessions will follow the outline in the table of contents of the O&M manuals. Whenever possible, they will use the installation, operation, and maintenance instructions in the O&M manuals and the latest drawing package for reference.

.2 The training sessions will emphasize safe and proper operating requirements, preventive maintenance, special tools needed, and spare parts inventory suggestions (as outlined in the O&M manual). The hands-on training will include start-up; operation in all modes possible, including manual, shutdown, and any emergency procedures; seasonal changeover, as applicable; and preventive maintenance for all pieces of equipment.

.3 The mechanical contractor will fully explain and demonstrate the operation, function, and overrides of any local packaged controls not controlled by the central control system.

.4 Discussion of relevant health and safety issues and concerns.

.5 Discussion of warranties and guarantees.

.6 Common troubleshooting and maintenance issues, problems and solutions.

.7 Local equipment suppliers of parts, subcontractors, and reputable and qualified service companies.

.8 Discussion of any peculiarities of equipment installation or operation.

.9 Training will occur after functional testing and piping and equipment labelling are complete, unless approved otherwise by the Owner/BC Housing.

.8 HANDOVER DOCUMENTATION

.1 Maintenance Schedule

The maintenance schedule and warranty summary should be created and reviewed by the CxP before the training sessions. The CxP will include a maintenance schedule and warranty summary in the final Cx report.

The following is a sample:

SAMPLE MAINTENANCE SCHEDULE

Equipment	Tags	Belt / Drive Info	Filter Info	Maintenance Schedule		Warranty Summary
				Quarterly	Yearly	
Pumps	P-1 to 10	n/a	Sidestream filter model ABC	Check strainers, inline filters, chemical levels	Check mechanical seals, lubrication	5-year pump impeller warranty through mfg. ABC
Parkade Fans	PEF-1 to 5	4L310-820006	n/a	Check belt tension, lubrication, clean grille	Check belt tension, lubrication	1-year warranty in defects in material and workmanship through mfg ABC
Parkade Fans	PEF-5,6	Direct Drive	n/a	n/a	Check for clean grille	1-year warranty for defects in material through mfg. ABC
Fan Coil Units	FC-1 to 10	Direct Drive	MERV-13 20x20	Filter change	Inspect coils	2-year warranty in defects in material and workmanship through mfg ABC
Other						

.2 Operational Issues Log

At project handover, the CxP will provide the operational issue log template to the Owner/Operator to log any issues during operation. At the 5-month and 10-month warranty walkthrough, the CxP will review with operational staff the current building operation, as well as any

outstanding issues in the operational issue log related to the original and seasonal commissioning.

Operational issue logs are completed by the building Owner/Operator or their operational staff and are provided to the CxP for review.

Any suggestions for system improvements and changes to the O&M manuals must be made during these reviews by the CxP. The CxP also identifies areas that may come under warranty or under the original construction contract.

The following is a sample:

SAMPLE OPERATIONAL ISSUES LOG

Issue Number	Observ-ation Date	Description of Issue or Cause	Status of the Issue	Priority (low, medium, high)	Response or Action Taken by Owner's Maintenance or Contractor	Any Recommend-ations from Design Team or CxP	Final Resolution (reviewed by CxP and design team within warranty period)	Issue Resolved Date	Additional Comments

Appendix B: Commissioning Responsibility and Process

The following table has been adapted from CSA Z320 *Building Commissioning*. It shows commissioning activities that should be undertaken for each project phase, along with a status and participant label for each specific commissioning activity.

The status (L, P, A) indicates the responsibility that a participant has for a particular commissioning activity. The participants are listed below.

Status
(L) = Leads
(P) = Participates
(A) = Approves

Participant
Own = Building Owner/BC Housing, building O&M staff, or another role.
BCH = BC Housing
CxP = Commissioning Provider
Des = Designer
Con = Contractor
Man = Manufacturer
CxAg= Contractor's commissioning agency

PROJECT DEVELOPMENT PHASES	COMMISSIONING PROCESS		
	Options 1 and 2: 7 storeys and higher	Option3: 3-6 storeys	Option4: 1-2 storeys
Conceptual/Schematic Design Phase			
Develop and document Owner's Project Requirements (OPR)			
• Define owner's project requirement (OPR)	(L) BCH/Own (P) Des	(L) BCH/Own (P) Des	(L) BCH/Own (P) Des
• Review OPR or create a new one, if it does not exist	(L) CxP, if no OPR yet (P) CxP, Des, if OPR exists	(P) Des	(L) Des
Select an Owner-hired Commissioning Provider (CxP)	(L) BCH/Own	n/a	n/a
Form a commissioning team	(L) CxP (P) BCH/Own, Des, Con, Man	n/a	n/a
Develop and implement a commissioning plan			
• Develop the commissioning responsibilities into project scope and schedule	(L) CxP, Des (P) BCH/Own, Con, Man	(L) Des (P) BCH/Own, Con, Man	(L) Des (P) BCH/Own, Con, Man

PROJECT DEVELOPMENT PHASES	COMMISSIONING PROCESS		
	Options 1 and 2: 7 storeys and higher	Option3: 3-6 storeys	Option4: 1-2 storeys
Review Basis of Design (BOD)			
• Develop and review BOD	(L) Des (P) CxP, Con, Man	(L) Des (P) Con, Man	(L) Des
Acceptance	(A) BCH/Own	(A) BCH/Own	(A) BCH/Own
Design Development/Construction Document Phase			
Hold design phase commissioning kickoff meeting	(L) CxP (P) BCH/Own, Des, Con, Man	n/a	n/a
Confirm commissioning requirements/activities in the construction documents		n/a	
• Verify OPR and BOD for completeness and clarity	(L) CxP, Des	(L) Des	(L) Des
Develop construction checklist and system test procedures		n/a	
• Plan/prepare verification checklists and testing procedures	(L) CxP (P) Des, Con, Man,	n/a	n/a
• Define requirements for O&M manuals, maintenance schedule, or closeout documentations	(L) Des (P) BCH/Own, CxP, Con	(L) Des	(L) Des
• Develop commissioning specifications; design consultant to incorporate into construction specifications list min. testing requirements, and include operational training requirements	(L) CxP (P) Des (A) BCH/Own	(L) Des	(L) Des
• Prepare commissioning plan draft for inclusion in tender documents	(L) CxP	n/a	n/a
• Acceptance	(A) BCH/Own	(A) BCH/Own	(A) BCH/Own
Construction			
		** For Option 3: where CxP is hired before or at the beginning of construction**	
Review commissioning activities in the current construction documents			
• Perform commissioning-focused reviews of drawings and specs of IFT/IFC		(L) CxP (P) BCH/Own	
Develop commissioning plan, including construction checklists (and the activities listed under this, similar to above)		(L) CxP (P) Des, Con, Man, BCH/Own	

PROJECT DEVELOPMENT PHASES	COMMISSIONING PROCESS		
	Options 1 and 2: 7 storeys and higher	**Option3: 3-6 storeys**	**Option4: 1-2 storeys**
Hold construction commissioning phase kickoff and progress meetings	(L) CxP (P) BCH/Own, Des, Con, Man	(L) CxP (P) BCH/Own, Des, Con, Man	(L) CxAg, if hired (P) Con, Des
Perform and document static verification and start-up			
• Perform and document static verification	(L) CxP/Con/ CxAg (P) CxP/Con/CxAg, Man	(L) CxP/Con/ CxAg (P) CxP/Con/CxAg, Man	(L) Con/CxAg, Man
• Witness start-up	(L) Con (P) CxP, BCH/Own, Con, Man	(L) Con (P) CxP, BCH/Own, Man	(L) Con/CxAg, Man
Perform and document functional performance testing of 100% of the systems	(L) CxP (P) BCH/Own, Con, Man	(L) CxP (P) BCH/Own, Con, Man	(L) Con/CxAg, Man
Perform and document integrated systems testing of fire protection and life safety systems	(L) Con (P) CxP, Des	(L) Con (P) CxP, Des	(L) Con (P) Des
Prepare issue logs and coordinate to resolve all issues resulting from all tests	(L) CxP (P) Des, Con, Man	(L) CxP (P) Des, Con, Man	(L) Con/CxAg, Man (P) Des
Review O&M manuals	(L) Des (P) BCH/Own, CxP, Con	(L) Des (P) BCH/Own, CxP, Con	(L) Des (P) BCH/Own, Con
Coordinate training	(L) CxP (P) BCH/Own, Des, Con, Man	(L) CxP (P) BCH/Own, Des, Con, Man	(L)CxAg/Con (P) BCH/Own, Des, Con, Man
Acceptance	(L) BCH/Own	(L) BCH/Own	(L) BCH/Own
Occupancy and Operations			
Resolve all outstanding issues at completion	(L) CxP, Con, Man (P) BCH/Own, Des	(L) CxP, Con, Man (P) BCH/Own, Des	(L) Con/CxAg (P) BCH/Own, Des, Con, Man
Coordinate to complete the seasonal/deferred testing and resolve issues resulting from seasonal/ deferred testing	(L) CxP (P) BCH/Own, Des, Con, Man	(L) CxP (P) BCH/Own, Des, Con, Man	(L) Con/CxAg, Man (P) Des
Complete final commissioning report	(L) CxP, Con, Man (P) BCH/Own, Des, Con	(L) CxP, Con, Man (P) BCH/Own, Des, Con	(L) CxAg, Con (P) BCH/Own, Des, Con
Acceptance	(A) BCH/Own	(A) BCH/Own	(A) BCH/Own
Warranty walkthrough	(L) Des, CxP, Con, Man (P) BCH/Own	(L) Des, CxP, Con, Man (P) BCH/Own	(L) Des, Con, Man (P) BCH/Own