



# **Commissioning Consultant Manual**

**Volume 1**

## **Whole Building Commissioning Process and Guidelines v2.0**

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# 1 Introduction

## 1.1 Purpose and Scope

- .1 This document is intended to be used for the following purposes:
  - .1 A reference for consultants providing commissioning services (herein defined as the Commissioning Authority) for new building projects, renovations to existing facilities or re-commissioning of existing systems owned or operated by the City of Edmonton.
  - .2 A resource for the City of Edmonton when reviewing and evaluating the work performed by commissioning firms on City projects. Future editions of this document will contain information on the consultant evaluation process.
- .2 This document is Volume 1 of 2 and is divided into the following sections:
  - Section 1 – Introduction:*

Establishes the scope of the document and gives general contact information.
  - Section 2 – Commissioning Process:*

Describes the information flow on a typical project, standard deliverables expected at each phase and an overview of minimum document standards to be followed.
  - Appendices – Commissioning Guidelines:*

Describes policies and requirements specific to the City of Edmonton that are to be considered when commissioning systems. The contents of this section may not apply to all projects.
- .3 Except where otherwise noted, the technical information contained in this document is to be used as a guide only. The Consultant is expected to follow his or her professional judgment as well as all applicable codes and regulations. Building projects may have specific requirements that supersede some material presented in this document. These requirements will be communicated to the Consultant at the outset of the project or during design as the need arises. When a deviation from these guidelines is either required or requested by the Consultant or Owner, it shall be documented in writing.

## 1.2 Sources

- ASHRAE Guideline 0-2013 – The Commissioning Process
- ASHRAE Standard 202-2013 – Commissioning Process for Buildings and Systems
- Building Commissioning Association – New Construction Building Commissioning Best Practice 2016
- LEED v4
- Canada Standards Association Z320-11 Building Commissioning
- Natural Resources Canada – 1<sup>st</sup> Edition Commissioning Guide for New Buildings

CAN/ULC-S1001-11 - Standard for Integrated Systems Testing of Fire Protection & Life Safety Systems

### 1.3 Definitions

<b>Acceptance</b>	A formal action, taken by a person with appropriate authority to declare that some aspect of the project meets defined requirements, thus permitting subsequent activities to proceed
<b>Automated Fault Detection</b>	A technology that monitors components, equipment and/or systems and recognizes when they are failing, they have failed or when environmental conditions have drifted outside optimal capability range. The technology may potentially optimize operation and/or notify personnel, possibly ensuring timely identification and correction of operating and service issues.
<b>Back-Check</b>	A back-check is a verification that an agreed upon solution to a design comment has been adequately addressed in a subsequent design review.
<b>Basis of Design (BOD)</b>	A document that records the concepts, calculations, decisions, and product selections used to meet the Owner's Project Requirements (OPR) and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process. (Also known as the Design Criteria).
<b>Benchmarks</b>	the comparison of a building's energy usage to other similar buildings and to the building itself.
<b>Code Compliance Review</b>	A review of a document conducted by staff or designated entity of an authority having jurisdiction to determine whether the content of the document complies with regulations, codes, or other standards administered by the jurisdiction.
<b>Commissioning (Cx)</b>	See Commissioning Process
<b>Commissioning Authority (CxA)</b>	An entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the Commissioning Process.
<b>Commissioning (Cx) Issues &amp; Resolutions Log</b>	A 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.

<b>Commissioning Plan (Cx Plan)</b>	A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the Commissioning Process.
<b>Commissioning Process (Cx Process)</b>	A quality focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated and maintained to meet the Owner's Project Requirements (OPR).
<b>Commissioning (Cx) Progress Report</b>	A written document that details activities completed as part of the Commissioning Process and significant findings from those activities, and is continuously updated during the course of a project.
<b>Commissioning Review</b>	A collaborative detailed review of design documents for items pertaining to the following: Owner's Project Requirements (OPR); Basis of Design (BOD); operability and maintainability (O&M) including documentation; functionality; training; energy efficiency, control systems' sequence of operations including building automation system features; commissioning specifications and the ability to functionally test the systems.
<b>Commissioning Specifications</b>	The contract document that details the objective, scope and implementation of the Commissioning Process as developed in the Commissioning Plan.
<b>Commissioning (Cx) Team</b>	A team comprised of the CxA, Owner, A/E, Construction Manager/General Contractor, Contractors, maintenance and operations personnel, and occupants. Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action.
<b>Constructability Review</b>	A review of effective and timely integration of construction knowledge into the conceptual planning, design, construction, and field operation of a project to achieve project objectives efficiently and accurately at the most cost-effective levels to reduce or prevent errors, delays, and cost overruns.
<b>Construction Team</b>	A team comprised of Construction Manager/General Contractor, subcontractors and equipment vendors and suppliers.
<b>Construction Commissioning (Cx) Check Sheet</b>	Project and element specific check sheets that are developed and used during all phases of the Commissioning Process to verify that the Owner's Project Requirements (OPR) are being achieved. This check sheet is used by the Contractor to verify that appropriate components are onsite, ready for

installation, correctly installed, and functional prior to system Functional Performance Tests (FPTs).

<b>Construction Documents</b>	Usually includes the project manual (specifications), plans (drawings), general terms and conditions of the contract and supporting documentation such as change orders and submittals.
<b>Construction Manager (CM)</b>	The Owner's representative managing the construction project. Often the construction manager and the general contractor are the same entity.
<b>Consultant</b>	The design specialist or firm retained to design, provide technical opinions on or advise on the design of the scope of work as requested or required by the Owner. This entity is responsible for the validity of the design or components of the design they are designing or advising on.
<b>Contract Documents</b>	The documents binding on parties involved in the construction of the project (drawings, specifications, change orders, amendments, contracts, Cx Plan, etc).
<b>Contractor</b>	The general contractor's or subcontractor's authorized representative.
<b>Coordination Drawings</b>	Drawings showing the work of all trades to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance or replacement. These drawings graphically illustrate and dimension manufacturers' recommended maintenance clearances.
<b>Current Facility Requirements (CFR)</b>	A written document that details the current functional requirements of an existing facility and the expectations of how it should be used and operated. This includes goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information to meet the requirements of occupants, users, and owners of the facility.
<b>Data Logging</b>	The monitoring and recording of temperature, flow, current, status, pressure, etc. of equipment using stand-alone data recorders.
<b>Deferred Testing</b>	Tests that are performed after substantial completion, due to ambient load or occupancy conditions, not allowing a thorough test during the initial testing period.

<b>Design Checklist</b>	A form developed by the Commissioning Team to verify that elements of the design are in compliance with the Owner's Project Requirements (OPR). Also see Checklists.
<b>Design Narrative</b>	A document for the scope of a design project outlining the issues, solutions and path to achieving of the design solutions including any products or works (function and aesthetics), timing and budget. Design narratives are also used to evaluate the effectiveness of a design after it has been produced and during the design process to keep the project on track and on budget. These may also be called Design Reports.
<b>Design Review (As in Peer Review)</b>	An independent and objective technical review of the design, project or a part thereof, conducted at specified stages of design completion by one or more qualified professionals, for the purpose of enhancing the quality of the design.
<b>Design Team</b>	The professionals (architects, engineers and consultants) responsible for developing the project's design concepts, interim and final drawings, specifications and Basis of Design (BOD).
<b>Facility Guide</b>	A basic building systems description and operating plan with general procedures and confirmed facility operating conditions, set-points, schedules, and operating procedures for use by facility operations to properly operate the facility.
<b>Final Commissioning (Cx) Report</b>	A document that records the activities and results of the Commissioning Process (Cx Process) and is developed from the final Commissioning Plan (Cx Plan) with all of its attached appendices.
<b>Functional Performance Test (FPT)</b>	The testing of the dynamic function and operation of components, equipment and systems using manual (direct observation) and monitoring (data-logging/trending) methods.
<b>Functional Performance Test (FPT) Procedure</b>	A written protocol that defines methods, steps, personnel, and acceptance criteria for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.
<b>Functional Program</b>	A document prepared by the Owner or Architect that describes the facility's space and function requirements.

<b>Manual Test</b>	Testing using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the 'observation').
<b>Monitoring</b>	The recording of parameters (temperature, flow, current, status, pressure, etc.) of equipment operation using data loggers or the trending capabilities of control systems.
<b>Operations and Maintenance (O&amp;M) Manual</b>	A manual to describe key components of each system or piece of equipment and explain how they should be operated and maintained for optimum performance.
<b>Owner</b>	City of Edmonton, and or the Building User Group.
<b>Owner Project Requirements (OPR)</b>	A written document that details the functional requirements of a project and the expectations of how it will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.
<b>Professional Services Agreement (PSA)</b>	The contract the Consultant enters into with the Owner to perform the Work. This document includes the Agreement Form, Description of Work, Payment Terms, General Terms, and Additional Terms (if applicable).
<b>Project Manager (PM)</b>	The contracting and managing authority for the Owner who oversees the design and/or construction of the project. Also may be identified as a Project Officer.
<b>Sampling</b>	Performing observation, review, testing or other verification on only a fraction of the total number of identical or near identical pieces of equipment, drawings, events, etc. Sampling techniques include random statistical sampling and less formal professional judgment methods.
<b>Seasonal Testing</b>	See 'Deferred Testing'.
<b>Sequence of Operations</b>	A narrative describing how the mechanical, electrical, energy management, and control systems are intended to operate during start-up, shut-down, unoccupied, manual, fire, power failure, security lockdowns, and other modes of operation.
<b>Space Story</b>	A brief functional or usage narrative developed by the Design Consultant for each space as a response to the Functional Program which describes the usage intent of the space and identifies which functional needs are being met by the space. This narrative will be used to further develop the Room



Datasheets and should be included within to provide a brief description of what the space can and cannot be used for. This narrative continues throughout the life cycle of the facility and may be used by Operations to briefly describe features of the space such as accessibility and inclusiveness.

**Test Protocol**

A test form that describes exactly how a particular test will be carried out. It includes documentation of such things as required equipment, precautions, detailed procedural steps, and procedures for returning to normal.

**Training Plan**

A written document that details the expectations, schedules, budget and deliverables of commissioning process activities, related to training of project operating and maintenance personnel, users and occupants.

**Warranty Period**

The period of time in which the contractor is responsible for equipment repairs following turnover to the Owner, as defined in the construction contract.

## 1.4 Contact Information

- .1 The latest version of this document may be obtained in electronic format from the Project Manager or by contacting the individual below.

- .2 Input to the progressive updating of this document is invited. Please direct comments to:

CoE Facility Commissioning Support  
% Jill Hoogstraten  
13th Floor, Edmonton Tower  
10111 104 Avenue NW  
Edmonton, AB T5J 0J4  
Tel: 780-718-7266  
Email: bsafacilitycommissioning@edmonton.ca

- .3 All electronic communication and submittals with regards to commissioning activities and deliverables shall be sent directly to the Owner Project Officer and shall carbon copy (cc) the CoE General Commissioning individual as listed above.

## 2 Commissioning Process

### 2.1 Project Communication

#### 2.1.1 General

- .1 The City of Edmonton will assign a Project Manager to be the single point of contact with the City (herein identified as the Owner). At PDDM Checkpoint 3 (CP3) the project will be handed over internally from the Facility Planning and Development (FPD) team to the Facilities Infrastructure Delivery (FID) team. At this time, the Project Manager assigned to the project may change.
- .2 The Commissioning Firm is to appoint one individual to act as the Commissioning Authority (CxA) and be the primary contact and to lead the Commissioning Process (Cx Process). If the commissioning team consists of multiple sub-consultants in multiple firms, all official correspondence and submissions to the Owner should be through the CxA.
- .3 Internal discussions between the CxA and their sub-consultants are to be documented internally. It is the responsibility of the CxA to alert the Owner's Project Manager of any internal discussions that may affect the project scope, budget, schedule, etc.
- .4 Commissioning meeting minutes (see Appendix B for sample) and similar documentation are the responsibility of the CxA and should be distributed to the Owner Project Manager, Design Consultant (including sub-consultants), Owner-identified stakeholders and other parties as necessary.
- .5 Addendums and construction documents such as contemplated change orders, site instructions, and shop drawings are to be distributed to the CxA by the Owner's Project Manager.

## 2.2 Commissioning Deliverables

### 2.2.1 Introduction

- .1 This section outlines typical deliverables at key project milestones. It is understood that all projects are different and the contents of this section may not wholly apply to all projects. For example, a larger project may be phased in such a way that more or less is required from the CxA at each separate phase.
- .2 Specific submissions required are identified herein. In addition to the deliverables identified herein, it is the responsibility of the CxA to prepare any submittals required by external authorities.
- .3 The CxA is responsible for ensuring they are aware of the project deliverables and prepare these submissions on time, with all required information contained therein.
- .4 All submissions will be reviewed by Owner staff or external consultants associated with the project. This may include Project Managers, Architects, Technical Services, Client groups, Building Maintenance, etc. All review comments will be forwarded to the CxA by the Owner's Project Manager.
  - .1 The CxA is to respond to all review comments in writing to the Owner's Project Manager prior to commencing work on the next submission.
  - .2 In some cases, the CxA may be required to re-submit based on the nature of the comments.
- .5 Deliverables submitted to the Owner shall follow naming conventions as outlined in the Commissioning Manual.

### 2.2.2 Design Phase

The CxA shall provide commissioning services as required for Whole Building Commissioning and shall be responsible for carrying out the tasks described within this section.

The Design Phase consists of developing, updating and initializing all project specific documents (mainly the OPR, Cx Plan, and the Cx Issues & Resolutions Log), the completion of the Schematic Design, Design Development, Progress, and Pre-Bid Submission Design Review(s), and creation of the Preliminary Construction Phase Cx Plan and the Preliminary Commissioning Specifications. Commissioning tasks shall be carried out for equipment/systems listed in Appendix A.

For all projects requiring Whole Building Commissioning the Owner expects that all of these tasks will be completed unless any proposed changes to the task list are clearly identified in the CxA's proposal and subsequently agreed to, in writing, by the Owner.

Additionally, all projects shall target LEED® Silver requirements. The CxA shall include in their proposal and estimate all work related to achieving all of the following LEED v4 Energy and Atmosphere (EA) "Prerequisite Fundamental Commissioning and Verification" requirements (total of 6 points):

- Option 1, Path 1: Enhanced Commissioning (3 points)
- Option 1, Path 2: Enhanced and Monitoring Based Commissioning (4 points)
- Option 2: Envelope Commissioning (2 points)

Building Envelope commissioning is not considered to be a component of Whole Building Commissioning as defined within this document. For Building Envelope Commissioning requirements, refer to Commissioning Authority Manual Volume 2. When coordination between the CxA responsible for Whole Building Commissioning and the CxA responsible for Building Envelope commissioning occurs, the expectation of the Owner is that both parties will coordinate and collaborate to ensure a seamless development of common deliverables to both scopes of work and, on occasion, provide support and feedback regarding related documentation.

.1 Owner's Project Requirements (OPR)

The OPR is a compilation of all documentation on the owner's goals, objectives, and expectations for the project. The CxA is responsible for developing the preliminary OPR, revising this document to keep current throughout the project lifecycle and issuing to the Owner at each phase of project. The OPR should include all necessary references to relevant Owner requirement documents and Codes.

.1 The preliminary OPR shall and include the following information:

- .1 Project description (summary including size and scope of project).
- .2 Project schedule and budget.
- .3 Cx Process scope (detailed commissioning process to be included in commissioning plan).
- .4 Project documentation requirements, including format for submittals, training materials, reports, and the Operation and Maintenance (O&M) manual.
- .5 Owner directives.
- .6 Restrictions and limitations.
- .7 User requirements.
- .8 Functional Space Usage Descriptions
  - .1 Including temperature, relative humidity, lighting and ventilation requirements for each space type.
- .9 Occupancy requirements and schedules.
- .10 Environmental and Sustainability Goals
- .11 Training requirements for Owner's personnel.
- .12 Warranty requirements.
- .13 Level of controls integration and desired control interfaces.
- .14 Equipment and system maintainability expectations, including limitations of operating and maintenance personnel.
- .15 Allowable tolerance in facility system operations.
- .16 Community requirements.
- .17 Adaptability for future facility changes and expansion.

- .18 Systems integration requirements, especially across disciplines.
  - .19 Health, hygiene, and indoor environment requirements.
  - .20 Lighting requirements.
  - .21 Acoustical requirements.
  - .22 Seismic requirements.
  - .23 Accessibility requirements.
  - .24 Security requirements.
  - .25 Aesthetics requirements.
  - .26 Constructability requirements.
  - .27 Data and Communication requirements.
  - .28 Applicable codes and standards.
- .2 CxA shall obtain all information required to create an accurate and project specific OPR. The CxA is also responsible for updating the OPR through all phases of the project. Each proposed update must be formally reviewed and approved by the Owner prior to acceptance.
- .1 The Owner will provide the following documents, when available, to aid the CxA in the development of the OPR:
    - .1 Project Initiation,
    - .2 Project Charter,
    - .3 Consultant Manual, Vol 1 and Vol 2,
    - .4 Owner Directives/Mandates (relevant to the project),
    - .5 Functional Program,
    - .6 Preliminary Room Datasheets and/or Space Stories.
- .2 Basis of Design (BOD)
- .1 CxA shall generate the BOD only if the Design Consultant has not provided the record and the document is required per LEED or other regulatory body.
- .3 Commissioning Plan (Cx Plan)
- .1 The CxA is responsible for the developing the Cx Plan, updating and issuing this record to the Owner for review during each phase of the project lifecycle. The Cx Plan shall include, at a minimum, the following information:
    - .1 Overview of the Cx Process developed specifically for the project.
    - .2 Roles and responsibilities for the Cx Team throughout the project.
    - .3 Documentation of general communication channels to be used throughout the project.

- .4 Detailed description of the Cx Process activities and schedule. The following items to be included:
  - .1 Cx Team meetings
  - .2 Management of OPR
  - .3 Design review process
  - .4 Commissioning specifications
- .5 General description of Cx Process activities that will occur during the Construction and Occupancy/Operations Phases.
- .6 Guidelines and format that will be used during the Design Phase to communicate and track critical Cx Process information.
- .7 Project design document verification procedures.
- .8 The framework for procedures to follow whenever Cx Process does not comply with the OPR.
- .9 Quality-based sampling procedures for verification of compliance with the OPR during all project phases.
- .2 Cx Plan to address all items identified in LEED Canada V4 Guidelines for EA prerequisite Fundamental Commissioning and Credit Enhanced Commissioning as well as all non-LEED commissioning items required for Whole Building Commissioning.
  - .1 For monitoring-based commissioning, the Cx Plan shall identify required submeters, acceptable values for tracked points, an action plan for identifying and correcting operational errors and deficiencies, as well as any other LEED requirements associated with this point.
- .4 Cx Issues & Resolutions Log
  - .1 The Cx Issues & Resolutions Log is to record all identified commissioning related issues and the solutions. The CxA is responsible to create and maintain the Cx Issues & Resolution Log for the duration of the project. A copy of the Cx Issue & Resolution log is to be included in the Final Commissioning (Cx) Report and shall include all issues that were closed through the commissioning process, as well as any remaining outstanding issues.
  - .2 The Cx Issues & Resolutions Log shall comply with the guidelines set out by template listed in Appendix B and must include the following:
    - .1 Unique numeric identifier by which the issue may be tracked
    - .2 Short, descriptive title of the issue
    - .3 Date and time of the identification of the issue
    - .4 Test number of the test being performed at the time of the observation, if applicable, for cross-reference
    - .5 Identification of system, equipment, or assembly to which the issue applies
    - .6 Location of the issue

- .7 Description of the observed design, installation, or performance issue, including any information that may be helpful in diagnosing or evaluating the issue
- .8 Recommended corrective action
- .9 Identification of the Cx Team member responsible for resolution of the issue
- .10 Expected date of correction
- .11 Date of completion of resolution
- .12 Description of corrective action taken. Including description of diagnostic steps taken to determine the root cause of the issue and the value of resolving the Cx Process issue for the owner, design team, contractor, or occupant
- .13 Identification of changes to the OPR or BOD that require action (if any)
- .14 Statement that the correction was completed and the system or assembly is ready for retest, if applicable
- .15 Name of the person who resolved the issue
- .5 Design Phase Kickoff Meeting
  - .1 CxA to schedule and chair an initial Kickoff Meeting with the Design Phase Commissioning Team (Cx Team) within fifteen (15) days of appointment to establish the purpose and proposed process for commissioning the design and to review the Design Phase Cx Plan. The Design Phase Kickoff meeting is to include the following:
    - .1 Review of OPR and Cx Plan with the Design Cx Team,
    - .2 Review of the various commissioning activities and schedules,
    - .3 Review of the documentation requirements,
    - .4 Review of communication and reporting procedures,
  - .2 Meeting minutes to be distributed to all Cx Team members within 72 hours of each meeting.
- .6 Design Submission Review
  - .1 Perform commissioning design reviews at Schematic Design, Design Development, Progress Submission and Pre-Bid Submission and provide formal feedback to the design team. The Design Submission Review is to include a review of the Design Narrative and BOD documents for the following:
    - .1 General quality review of the documents, including legibility, consistency, and level of completeness.
    - .2 Coordination between disciplines.
    - .3 Discipline-specific review to address construction coordination and installation concerns, functionality, performance aspects, efficiency, maintainability, cost, indoor air quality, local environmental impacts and adherence to the OPR. Specifically, focusing on the following:

- .1 Access for reading gauges, entering doors and panels, observing and replacing filters, coils, etc.
  - .2 Required isolation valves, dampers, interlocks, piping, etc. to allow for manual overrides, simulating failures, seasons and other testing conditions.
  - .3 Adequacy of Test Ports
  - .4 Sufficient monitoring points in the Building Automation System (BAS), beyond what is required to control the systems, to facilitate performance verification and O&M.
  - .5 Sufficient sub-meters as required to meet LEED monitoring commissioning credit requirements.
  - .6 Adequate trending and reporting features in the BAS
  - .7 Pressure and temperature (P/T) plugs at less critical areas or on smaller equipment where gauges and thermometers would be excessive.
  - .8 Specification of the location and criteria for the VAV duct static pressure sensor and chilled water differential pressure sensor.
  - .9 Adequate balancing valves, flow metering and control stations and control system functions to facilitate and verify reliable test and balance.
  - .10 Uniform inlet connection requirements to VAV terminal boxes
  - .11 HVAC fire and emergency power response matrix that lists all equipment and components (air handlers, dampers, valves, etc.) with their status and action during a fire alarm and under emergency power.
- .4 Integration and functionality of controls systems review for achieving the OPR with a focus on the following:
    - .1 Control logic.
    - .2 Detailed sequences of operations.
    - .3 Integration of dynamic equipment.
  - .5 Clear integration of CxA provided commissioning specifications with the rest of the design package.
  - .6 Verification that the O&M documentation requirements and Training Requirements are incorporated into the Contract Documents.
  - .7 Additional tasks as required to comply with LEED Certification Process.
- .2 The Design Submission Review is to be recorded in the Cx Issues & Resolutions Log.
- .7 Commissioning Meetings
    - .1 Schedule and lead Commissioning Coordination Meetings with the Cx Team, as required but at a minimum of four (4) half-day sessions, to ensure successful coordination of the design phase commissioning activities and development of the OPR. Scheduling of meeting to be coordinated with the Owner Project Manager.



- .2 Prepare and distribute commissioning meetings minutes to all Cx Team members within 72 hours of each meeting.
- .8 Controls and System Integration
  - .1 Coordinate and lead controls integration meetings, as required, between the Consultant, Owner, and CxA to discuss integration issues between equipment, systems and disciplines to ensure that integration responsibilities are clearly described in the specifications. The series of meetings should result in the following outcomes:
    - .1 Verification that the design of the BAS can achieve the control requirements of the OPR and BOD.
    - .2 Verification that the control systems requirements are clearly defined.
    - .3 Verification that the Sequences of Operation are clear and well documented.
- .9 Training Requirements
  - .1 Schedule and lead meetings with Owner Design professionals and Operations & Maintenance personnel to define expectations and training requirements and ensure integration into Contract Documents. Provide meeting minutes of training requirement sessions to all attending members within 72 hours of each meeting.
  - .2 Review consultants training requirements specifications to ensure it complies with Owner's expectations. These specifications should include allowances for the CxA to video record all of the training content.
- .10 Commissioning Specifications
  - .1 Develop full Commissioning Specifications for all commissioned equipment. Coordinate this with the design team and integrate the Commissioning Specifications into the overall project specification bid package. Commissioning Specifications to include:
    - .1 Detailed description of the responsibilities of all parties,
    - .2 Details of the Cx Process
    - .3 Reporting and documentation requirements, including formats
    - .4 Alerts to coordination issues
    - .5 Issue reporting and deficiency resolution
    - .6 Construction Checklist and start-up requirements,
    - .7 Functional Performance Testing (FPT) processes and procedures
    - .8 Specific Functional Test requirements, including testing conditions and acceptance criteria for each piece of equipment being commissioned.
    - .9 Training Requirements
    - .10 Closeout
- .11 Develop draft Construction Commissioning (Cx) Check Sheets

- .1 Refer to Appendix C for sample Construction Cx Check Sheets.
  - .2 Construction Cx Check Sheet sample provided in Appendix C for security systems (C-Cure) shall be used. Proposed alternative formats shall include all content and intention as identified on the provided sample sheets, be submitted for formal review and must be approved in writing by Owner subject matter expert prior to implementation.
  - .3 Additional samples provided in Appendix C represent the minimum required information to be collected and expected level of the vigor for Construction Cx Check Sheets to be developed.
- .12 Develop draft Systems Functional Performance Test (FPT) Procedures
- .13 Commissioning (Cx) Progress Report
- .1 The Design Phase Cx Progress Report is to include the following:
    - .1 Intent
    - .2 Executive Summary
    - .3 Commissioning Overview
    - .4 OPR
    - .5 BOD Report
    - .6 Cx Plan
    - .7 Commissioning Specifications
    - .8 Construction Commissioning (Cx) Check Sheets
    - .9 Release of Use Forms
    - .10 Summary of the Design Review Process
    - .11 Cx Issues & Resolutions Log (to date)
    - .12 Cx Issues & Resolutions Report (since last review)
    - .13 FPT Procedures
- .14 Design Phase Close-out
- .1 Design Phase Commissioning is complete when the final design team Contract Documents are complete.
  - .2 Required Documentation from this Phase includes:
    - .1 Cx Progress Report

### **2.2.3 Construction Bid Phase**

Attend and participate in pre-bid phase meeting to fully explain the commissioning requirements, as specified in the bid documents, and to answer commissioning related questions.

## 2.2.4 Construction Phase

The Construction phase consists of the installation of system equipment. The main focus of this phase is to conduct static inspections of all systems, components and equipment and the completion of the Construction Cx Check Sheets to verify correct installation and successful start-up.

Coordinate and direct the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties. Provide updated timelines, schedules and technical expertise as required.

Generate a commissioning focused schedule itemizing specific commissioning milestones including but not limited to the following: contractor completed static checks, CxA static checks, equipment start-ups, TAB completion, prefunctional dynamic testing completion, CxA TAB check, Functional Performance Testing (FPT) and O&M Training Sessions.

Coordinate the commissioning work with the design team, contractor and construction manager, to ensure that commissioning activities are being incorporated into the contractor's construction schedule.

- .1 Construction Phase Kickoff Meeting
  - .1 CxA to schedule and chair an initial Kickoff Meeting with the Construction Phase Commissioning Team, including subcontractors within fifteen (15) days of appointment to establish the purpose and proposed process for commissioning and to review the Construction Phase Commissioning Plan. The Construction Phase Kickoff meeting is to include the following:
    - .1 Review of Cx Plan with the Construction Cx Team
    - .2 Review of the various commissioning activities and schedules
    - .3 Review of the documentation requirements
    - .4 Review of communication and reporting procedures
  - .2 Construction Meetings
    - .1 Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the Cx Process. Assist in resolving any discrepancies.
  - .3 Commissioning Meetings
    - .1 Plan and conduct Commissioning Progress Meetings, as required, but a minimum of one per month from twenty-four (24) months prior to construction completion, with one (1) every two (2) weeks for last six (6) months.
    - .2 Prepare and distribute commissioning meetings minutes to all Commissioning Team members within 72 hours of each meeting.
  - .4 Site Observations
    - .1 Perform site visits, as necessary but at a minimum monthly, to conduct static Site Observation to observe component and system installations and verify that construction

complies with the Contract Documents and the OPR, and to identify and document and quality issues that may lead to functional issues. Provide feedback on the correct installation and serviceability of the equipment being installed. Site Observations are to be recorded in the Cx Issues & Resolutions Log.

.5 Commissioning Specifications

- .1 Perform the tasks and functions in the specifications assigned to the CxA.

.6 Owner's Project Requirements (OPR)

- .1 Review and update the OPR documentation as required to ensure relevancy and accuracy.

.7 Commissioning Plan (Cx Plan)

- .1 Revise, as necessary, the Cx Plan developed during design, including:

- .1 A detailed overview of the Commissioning Process (Cx Process)
- .2 A list of all systems and assemblies to be verified and tested.
- .3 Roles and responsibilities of all Cx Team members.
- .4 Schedule of Cx Process activities including:

- .1 Pre-Bid Meeting
- .2 Pre-construction meeting
- .3 Cx Team meetings
- .4 Training Sessions
- .5 Shop drawings submittals
- .6 O&M Manual submittal
- .7 Special tests or Inspections
- .8 Tests
- .9 Test periods
- .10 Substantial Completion
- .11 Occupancy
- .12 Seasonal testing
- .13 Initial Cx Process report submittal
- .14 Warranty Review
- .15 Warrant Review shall take place ten (10) months after Substantial Completion (aka: beginning of Warranty Period), or two (2) months prior to end of Warranty Period (if longer than twelve (12) months).
- .16 Lessons Learned meeting
- .17 Final Cx Process Report

- .5 Communication Protocols
- .6 Documentation and reporting requirements and procedures including, but not limited to, the following:
  - .1 Review of submittals
  - .2 Scheduling and holding of meetings
  - .3 Site visit procedures
  - .4 Issues identification, documentation, tracking and resolution
  - .5 Construction-Phase test preparation, implementation and follow-up
  - .6 The responsibilities of each member of the Cx Team
  - .7 Responsibility of costs related to verification and testing, including retesting or verification activities
  - .8 O&M Manual development and review
  - .9 Training program
- .7 Occupancy/operations-Phase test preparation, implementation, and follow-up
- .8 Cx Issues & Resolutions Log
  - .1 Maintain the master issues log started during the Design Phase, separate from the FPT records. Report all issues as they occur directly to the Owner's Representative. Coordinate with Owner and Contractor to facilitate resolution of all issues contained in log.
  - .2 Report all issues as they occur directly to the Owner's Representative. Provide written progress reports including these logs and test results with recommended actions directly to the Owner's representative. Coordinate with Owner and Contractor to facilitate resolution of all issues contained in log.
  - .3 Coordinate any required retesting following corrective action and resolution of issues. All corrective actions taken to resolve recorded issues are to be consistent with the OPR. Where this is not feasible, approval and acceptance from the Owner is required and the OPR is to be updated to reflect the change.
  - .4 Include an explanation of any unresolved issues in the Final Cx Report Executive Summary.
- .9 Submittals and Shop Drawings
  - .1 Review Contractor submittals and shop drawings as applicable to systems being commissioned for compliance with the OPR, the design team Contract Documents and concurrent with the Architectural and Engineering reviews. Document any concerns in a written report.
  - .2 CxA shall provide a list of the submittals and shop drawings requiring CxA review to the Contractor/Owner.

- .3 Review equipment warranties to ensure compliance with the OPR and clearly define the Owner's responsibilities.
- .4 Review coordination drawings and/or records to ensure all trades are making a reasonable effort to coordinate.
- .5 Document any concerns in the Cx Issues & Resolutions Log.
- .10 Addendums, Requests for Information (RFIs) and Contemplated Change Orders (COOs)
  - .1 Review RFIs and COOs for impact on commissioning and the OPR.
- .11 Cx Progress Reports
  - .1 Prepare Cx Progress Reports following each site visit. Cx Progress Reports shall include as a minimum:
    - .1 Any issues or discrepancies found during the execution of the Commissioning Work.
    - .2 An evaluation of the operating condition of the systems at the time of the test completion.
    - .3 Construction Checklist completion verification and summary results from the Cx Issues & Resolutions Log (including descriptions of issues and the measures that were taken to correct them and the uncorrected operational issues that were accepted by the Owner).
    - .4 Test procedures used and raw data obtained.
    - .5 Deferred tests, the prerequisite conditions required, and the estimated schedule for the re-tests.
- .12 Construction Commissioning (Cx) Check Sheets
  - .1 Develop project specific Construction Cx Check Sheets. The check sheets shall be developed to verify that appropriate components are onsite, ready for installation, correctly installed, contractor started-up to verify general operation, adjusted and balanced, and then as a system verified as complete (during system FPT). Manufacturer pre-start and start-up checks to be incorporated into the Construction Cx Check Sheets. Provide Check Sheets to the Contractor within two weeks after product submittal approval. Refer to Appendix C for Sample Construction Cx Check Sheets.
  - .2 Perform the following Prefunctional Check (PC) tasks:
    - .1 Witness and document all specialty equipment vendor start-ups and gather all associated vendor start-up reports.
    - .2 Witness HVAC piping pressure tests and flushing sufficient to be confident that proper procedures were followed. Review documentation and include in the Commissioning Record.
    - .3 Witness ductwork testing and cleaning sufficient to be confident that proper procedures were followed. Review documentation and include in the Commissioning Record.

- .4 Witness major systems startup and document other systems startup by reviewing start-up reports and by selected site observation. Any issues arising from the start-up procedure must be included in the commissioning issues log and monitored until they are closed out.
  - .5 Review and verify air and water systems balancing by field auditing using equipment supplied by the CxA and verifying balancing activities and reviewing completed reports.
  - .6 Document completion of all PCs and accuracy of Construction Cx Check Sheets by reviewing Contractor completed sections of all Construction Cx Check Sheets and verifying with selected site observations. CxA shall complete sections assigned to CxA and ensure all initial portions of the Construction Cx Check Sheets have been submitted and verified prior to commencement of Functional Performance Testing (FPT). Any issues arising from the PCs must be included in the Cx Issues & Resolutions Log and monitored until they are closed out
  - .7 Develop an enhanced start-up and initial systems checkout plan with contractors for selected equipment.
- .13 Controls and System Integration
- The following work to be completed prior to commencing FPT of systems:
- .1 Review and validate Building Automation System (BAS) controls, complete end to end point verification from physical point location to graphical representation.
  - .2 Confirm all sensor calibrations by comparison of onsite physical measurement with points schedule in specification and include in report as a checklist containing the value measured on-site, the value displayed on the BAS graphics, date tested and name of testing person.
  - .3 CxA to provide a check sheet for each input/output point indicating (on graphics) the expected point value, measured point value, acceptable deviation tolerance per the design. Check sheet shall also have a field for Pass/Fail, date tested, name and signature of individual(s) completing the test.
- .14 Functional Performance Tests (FPTs)
- .1 Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures.
  - .2 Before startup, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed functional performance testing procedures
  - .3 Write the FPT procedures to demonstrate the approved sequence of operation for each system. Submit for Owner and Contractor review two (2) months prior to Functional Performance Testing in the field. FPTs to:
    - .1 Operate the system and components through all of the written sequences of operation documented in the specifications and drawings, including start-up, shutdown, unoccupied mode, manual mode, staging, miscellaneous alarms, power

failure, security alarm when impacted and interlocks with other systems or equipment.

- .2 Include an Integrated Systems Test (IST). The IST shall be conducted to confirm that the facility performs as required during specified failure scenarios and shall include Fire Alarm condition, Loss of Normal Power, and return to normal operation and shall include a test of annunciator systems and recovery procedures.
    - .1 If an emergency generator is included within the systems to be commissioned a generator failure or “Black Building” condition shall also be simulated. All battery backup systems shall be fully charged prior to testing.
  - .4 Coordinate, witness, verify and record results of FPTs and ISTs. FPTs and ISTs to be performed by installing Contractor(s). It is the responsibility of the CxA to coordinate retesting as necessary until satisfactory performance, as defined in the specifications and drawings, is achieved.
  - .5 Analyze functional performance trend logs and monitoring data to verify performance.
  - .6 Tests on respective HVAC equipment shall be executed, if possible, during both the heating and cooling season. However, some overwriting of control values to simulate conditions shall be allowed.
  - .7 Tests shall be completed utilizing a BAS workstation. Supplementary control system trend logs, readouts or standalone data loggers can assist in the commissioning documentation process but shall not supersede Functional Performance Testing.
  - .8 One of the deliverables of the FPTs to include a procedure describing the sequence of operation and the date it was tested by the contractor and witnessed by the CxA. There shall be minimum one procedure or check sheet for each sequence of operation.
  - .9 One of the deliverables for the IST is to include a verification letter confirming the ISTs have been completed. See Appendix B for verification letter template.
- .15 Deferred Testing
- .1 Deferred testing is to be completed during the Warranty Phase. CxA to verify and document that deferred tests are performed by the responsible member of the Commissioning Team.
- .16 Record Documents and Operation & Maintenance Information
- .1 Oversee the preparation of the O&M Manuals.
  - .2 Review the Project Record Drawings (As-Built Drawings), and the O&M Manuals for completeness of the documentation from the standpoint of operator training and instruction for startup, shutdown, operation and maintenance information. These documents are to be reviewed prior to the Personnel Training sessions as they form an integral component of the training sessions.
  - .3 Verify that that O&M Manuals comply with the contract documents.
  - .4 The O&M Manual review shall be prepared on the reviewer’s letterhead and must include the date of review.



#### .17 Personnel Training

- .1 Oversee and review the training of the Owner's Operation and Maintenance personnel.
- .2 Coordinate the training sessions into both a dedicated classroom learning session and an on-site, 'at the equipment', training session.
- .3 Review the creation of a classroom "owner's manual" that is to be handed over to the Owner as part of the close-out documentation.
- .4 CxA shall video record all of the training sessions content and provide it to the Owner. The video recording is to include appropriate lighting so that all elements are visible. The recording is to be in high definition and the audio of the presenters is to be sufficiently heard above ambient noise.
- .5 Verify that training was carried out in accordance with the requirements of the construction documents.
- .6 Conduct a review of the commissioned building systems with the Owner's Operations and Maintenance staff after the Contractor training and before the facilities are turned over to the Owner for operation.
- .7 CxA is to provide an executive summary of training content covered in sessions as well as attendance log for each training session to the Owner.

#### .18 Construction Phase Close-out

- .1 Construction Phase Commissioning is complete when all construction and Construction Cx Sheets are complete and accepted by the CxA.

### 2.2.5 Warranty Phase

During the Warranty Phase, the building systems are complete and fully functional. The main focus of the commissioning efforts during the Warranty Phase is to verify that the building is functionally complete.

#### .1 Deferred Testing

- .1 Coordinate and supervise required opposite season or deferred testing and deficiency corrections and provide the final testing documentation for the Final Cx Report and the O&M manuals.

#### .2 Construction Phase Commissioning Follow-up

- .1 Verify that construction Issues have been resolved including retesting, if required.

#### .3 Warranty Phase Commissioning Review Meeting

- .1 Schedule and lead Warranty Phase Commissioning Review Meeting
  - .1 Perform operations review with Owner and Operations.
  - .2 Provide documentation
  - .3 Document any deficiencies in the Cx Issues & Resolutions Log
  - .4 Coordinate retests, as required, and verify items identified as deficient are resolved.

- .4 Lessons Learned Workshop
  - .1 Conduct a “lessons learned” workshop with the Owner and Operators to facilitate improvements to future Owner projects. Workshop to include:
    - .1 A review of the results of commissioning for this project, its successes and failures
    - .2 A review of the functionality of the building
    - .3 A review of the building occupants comfort level
    - .4 Documented suggestions for improvement for inclusion into future project OPR.
  - .5 Required documentation from this Phase includes the Final Commissioning Progress Report which shall contain documentation from all of the phases of the Cx Process.
  - .6 Final Commissioning (Cx) Report
    - .1 The CxA is responsible for the creation of a Final Cx Report which shall include the following:
      - .1 a list of participants and their roles,
      - .2 brief building description
      - .3 overview of commissioning and testing scope
      - .4 general description of testing and verification methods
    - .2 For each piece of commissioned equipment, the report should contain the disposition of the CxA regarding the adequacy of the equipment, documentation, and training, meeting the contract documents in the following areas:
      - .1 Equipment meeting the equipment specifications;
      - .2 Equipment installation;
      - .3 Functional performance and efficiency;
      - .4 Equipment documentation; and,
      - .5 Operator training.
    - .3 Provide a description of each deliverable, including a summary of edits that occurred during the commissioning process.
    - .4 The Final Cx Report shall also include:
      - .1 Commissioning Meeting Minutes
      - .2 Submittal/Shop Drawing evaluation comments
      - .3 Site Observation Reports
      - .4 Control drawings, sequences of control (by Contractor), and a table of all set-points and implications when changing them, schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown, instructions for energy savings operations and descriptions of the energy savings strategies in the facility

- .5 Training Documentation
- .6 Updated OPR
  - .1 Performance metrics, if completed during design
- .7 Updated BOD
- .8 Updated Cx Plan
- .9 Updated Cx Issues & Resolutions Log
- .10 Cx Progress Reports
- .11 Test Schedules
- .12 Completed Construction Cx Check Sheets
- .13 FPT Procedures and Results
- .14 Start-up Reports
- .15 Trend Log Analysis
- .16 Procedures for reporting IAQ concerns by occupants, including the subsequent investigation process and method of reporting back to the occupants;
- .17 Procedures for tracking of outstanding commissioning related issues that arise during the first year of operation.
- .7 Recommendations for re-commissioning frequency by equipment type, energy tracking recommendations and recommended standard trend logs with a brief description of what to look for in them
- .8 All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, Cx Process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented.
- .9 Warranty Phase Close-out
  - .1 Warranty Phase Commissioning is complete when all Warranty Issues are corrected or formally accepted by the Owner.
  - .2 Required Documentation from this Phase includes:
    - .1 Final Cx Report
    - .2 Updated Cx Issues & Resolutions Log
    - .3 Retest forms documenting deferred testing results
    - .4 Lessons Learned Workshop Report

### 2.2.6 Closeout Submittals

- .1 Final documents to be submitted as two (2) hard copies (binder bound in heavyweight fabricord) and one (1) USB Flash drive containing an electronic copy in the form of an unsecured and searchable PDF complete with section bookmarks.

### 2.2.7 Limit of Responsibilities

- .1 The CxA is not responsible for establishing design concept(s), design criteria, compliance with Codes and Standards, design or general construction scheduling, or construction management. The CxA may assist with problem-solving or resolving non-conformances or issues, but ultimately that responsibility resides with the General Contractor and the Design Team. The CxA is not responsible for issuing change orders or other instructions to the field for corrective work.

# **APPENDIX A - SYSTEMS TO BE COMMISSIONED AND SAMPLING RATES (Sample)**

## Systems to be Commissioned and Sampling Rates

The facility systems and sampling rate of systems to be commissioned are as follows:

<b>ACTIVITY DESCRIPTION</b>				<b>SAMPLING RATE</b>
<b>MECHANICAL SYSTEMS</b>				
<b>1.</b>			<b>Heating Ventilation and Air Conditioning (HVAC)</b>	
	1.		Heating Water and Glycol Heating Systems	
		1.	Boilers and Associated Equipment	100%
		2.	Heat Exchangers	100%
		3.	Pumps	100%
		4.	Water Treatment	100%
		5.	Terminal Heating Units	20%
		6.	Fan Coil Units	20%
		7.	Unit Heaters	20%
	2.		Cooling System(s)	100%
	3.		Air Systems	
		1.	Air Handling Units/Make-up Air Units	100%
		2.	Energy/Heat Recovery Units	100%
		3.	Supply and Exhaust Fans, Transfer or circulation fans	100%
		4.	Air Terminal Units	25%
		5.	Air Filtration Units	100%
		6.	Ductwork	20%
		7.	Duct Cleaning	10%
		8.	Fire Dampers	20%
		9.	Smoke Dampers	100%
		10.	Fume Hoods/Exhaust Hoods/Dust Collectors	100%
		11.	Kitchen Exhaust System	100%
		12.	Gas fired furnaces (some c/w DX cooling system)	100%
		13.	Gas-fired infrared tube heaters	100%
		14.	Electric Radiant Heaters	100%
	4.		Humidification System	100%
	5.		Variable Frequency Drives (VFDs)	100%
	6.		Air and Water Balancing	
		1.	Major pieces of equipment (Boilers, Chillers, AHUs, Pumps, Heat Exchangers)	100%
		2.	Terminal Units (Diffusers, VAV Boxes, Fan coils, baseboard convectors, etc)	20%
	7.		HVAC Noise Measurement	
		1.	Animal Holding Areas	100%

<b>ACTIVITY DESCRIPTION</b>			<b>SAMPLING RATE</b>
	2.	Animal Exhibit Areas	100%
	3.	Public Areas (Natatorium Required)	50%
	4.	Staff Areas	50%
<b>2.</b>		<b>Plumbing Systems</b>	
	1.	Domestic Cold Water System	
	1.	Meter	100%
	2.	Backflow Preventers	100%
	3.	Water Softeners	100%
	4.	Disinfection	100%
	2.	Domestic Hot Water and Recirculation System	
	1.	Water Heating Equipment	100%
	2.	Pumps	100%
	3.	Plumbing Fixtures	20%
	4.	Sump Pumps	100%
	5.	Drainage Systems	
	1.	Sanitary Piping	10%
	2.	Storm Piping	10%
	3.	Specialized drainage fixtures for animal holding areas.	100%
	6.	Hose bibs for specialized Zookeeper use	50%
	7.	Commercial kitchen grease trap	100%
	8.	Downspout heat trace	100%
	9.	Irrigation systems	100%
<b>3.</b>		<b>Pool Systems</b>	
	1.	Pool Filtration Pumps	100%
	2.	Pool Filters	100%
	3.	Pool Sanitation Equipment	100%
	4.	Pool Heating Systems	100%
	5.	Pool spray features/waterslides/wave generator	100%
	6.	Ultraviolet Generator	100%
	7.	Pool Chemical Controller	100%
<b>4.</b>		<b>Arena Systems</b>	
	1.	Ice Plant Chillers	100%
	2.	Refrigeration/Brine/Glycol Pumps	100%
	3.	Cooling Tower/Condensers/Fluid Cooler	100%
	4.	Heat Exchangers	100%
	5.	Dehumidifiers	100%
<b>5.</b>		<b>Building Automation Systems (BAS)</b>	
	1.	Sequence of Operation	100%

<b>ACTIVITY DESCRIPTION</b>			<b>SAMPLING RATE</b>
	2.	Entire Gas detection system including all devices	100%
	3.	BAS Interfaces to Other Divisions	100%
	4.	Air Flow Stations	100%
	5.	Every connected physical point and end devices including	
	1.	Temperature/Humidity Sensors	100%
	2.	Pressure Sensors and Controllers	100%
	3.	Occupancy Sensors	100%
	4.	Carbon Dioxide Sensors	100%
	5.	Damper/Valve Actuators	100%
	6.	Meters	100%
<b>6.</b>		<b>Fire Protection Systems</b>	<b>100%</b>
	1.	Fire Extinguishers	100%
<b>7.</b>		<b>Geo Field</b>	
	1.	Confirm glycol percentage and water quality in GHX loop	100%
	2.	Verify thermal transfer coefficient of borehole heat transfer fluid	10%
	3.	Verify borehole depth	10%
	4.	Verify valve actuation and closure in concrete isolation chambers	100%
	5.	Confirm flows and head pressure in GHX loop	100%
<b>8.</b>		<b>Compressed Air Systems</b>	<b>100%</b>
	1.	Air Compressor	100%
	1.	Controls	100%
	2.	Pressure Relief Valve(s)	100%
	2.	Air Receiver	100%
	1.	Pressure Relief Valve(s)	100%
	3.	Air Dryer	100%
	4.	Piping and Accessories	
	1.	Filters	10%
	2.	Pressure Control/Regulator Valves	100%
	3.	Pressure Relief Valves	100%
<b>9.</b>		<b>Vehicle/Bus Wash Systems</b>	<b>100%</b>
<b>ELECTRICAL SYSTEMS</b>			
<b>1.</b>		<b>Power Distribution</b>	
	1.	Main Switch Gear	100%
	2.	Distribution Panel Boards	100%
	3.	Branch Circuit Panelboards	25%
	4.	Transformers	100%
	5.	UPS	100%



<b>ACTIVITY DESCRIPTION</b>				<b>SAMPLING RATE</b>
	6.		Motor Starters	50%
	7.		Variable Frequency Drives	100%
	8.		Receptacles	10%
<b>2.</b>			<b>Lighting</b>	
	1.		Interior Lighting	
		1.	Illumination Levels	20%
		2.	Lighting Controls/Occupancy Sensors/Daylight Sensors	100%
		3.	Interface with BAS	100%
	2.		Exterior Lighting	
		1.	Illumination Levels	50%
		2.	Lighting Controls	100%
		3.	Interface with BAS	100%
	3.		Exit Lights	100%
	4.		Emergency Lighting Battery Units	100%
	5.		Lighting control system	100%
<b>3.</b>			<b>Fire Alarm System</b>	
	1.		Integration with HVAC	100%
	2.		Integration with Elevators	100%
	3.		Connection to Fire Department	100%
<b>4.</b>			<b>Electronic Systems</b>	
	1.		Electronic Access Control	100%
	2.		Intrusion Detection, Security & CCTV	100%
	3.		Telephones	10%
	4.		Data	10%
	5.		Clocks	100%
	6.		Communications systems including testing of all cabling	100%
<b>5.</b>			<b>Integrated System Test (IST)</b>	<b>100%</b>
<b>ARCHITECTURAL SYSTEMS</b>				
<b>1.</b>			<b>Door Hardware</b>	
	1.		Electronic Door Hardware	100%
	2.		Overhead Coiling Doors/Grilles and Sensors	100%
	3.		Security Gates	100%
	4.		Operation of Doors and Hardware	100%

## **APPENDIX B - AVAILABLE TEMPLATES & FORMS**

The following templates and forms are available for reference and use as required. These templates and forms are meant to represent general guidelines and are not meant to be prescriptive or all inclusive and may be modified to suite as appropriate for the application.

The templates and forms can be accessed from the link provided and are subject to continuous improvement development.

#### [Commissioning Related Document Templates and Forms](#)

- Stakeholder Questionnaire
- Owner Project Requirements (OPR)
  - Indoor Environment Quality (IEQ) Table
- Commissioning Plan (Cx Plan)
- Commissioning (Cx) Issues and Resolutions Log
- Commissioning Report (Cx Report)
- Meeting Minutes (Sample)
- Integrated System Test (IST) Verification Letter

## **APPENDIX C - CONSTRUCTION Cx CHECK SHEETS (Samples)**



Owner: City of Edmonton  
 Project No.: CP-00XXXX  
 Date: YYYY-MM-DD

INTEGRATED INFRASTRUCTURE SERVICES  
 Facility Engineering Services - Facility Planning & Design  
**Construction Cx Check Sheet**

Project:	[Name of Project or Institution Detailed Description of Area Affected]			Name of Equipment: [Fan]
System:	System Number:	Location:	Service:	Name of Discipline Responsible: [Mechanical]
Page # of ##	Equipment Tag:	Spare Tag:	Instrument Tag:	Sub-Category:

	<b>TECHNICAL DATA</b>				DATE:	<u>MM/DD/YR</u>
	SPECIFIED	SHOP DRAWINGS	INSTALLED	VERIFIED		
Manufacturer	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>		
Model	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>		
Function	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>		
Type	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>		
RPM	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>		
Air Flow L/S	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>		
Static Pressure (Pa.)	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>		
Motor Manufacturer	<u>--</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>		
Horsepower	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>		
Voltage	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>		
Motor Full Load Amps	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>		
Service Factor	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>		
Motor Efficiency	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>		
Serial No.	<u>--</u>	<u>--</u>	<u>Contractor</u>	<u>Comm. Agent</u>		

<b>STATIC CHECKS</b>		DATE / CHECKED:	<u>MM/DD/YR</u>
Fan Housing	<u>Contractor</u>	Access	<u>Contractor</u>
Bearing Type	<u>Contractor</u>	Air Flow Monitor	<u>Contractor</u>
Local Disconnect	<u>Contractor</u>	Flex Connectors	<u>Contractor</u>
Control From:	<u>Contractor</u>	Belt Alignment	<u>Contractor</u>
Power From:	<u>Contractor</u>	Identification	<u>Contractor</u>
Duct Connections	<u>Contractor</u>		
Damper(s)	<u>Contractor</u>		
Vibration Isolation	<u>Contractor</u>		

\*Items in RED shall be filled in by the appropriate party as indicated. All submissions shall be verified and accepted by the Commissioning Authority (CxA) prior to commencement of any Functional Performance Test (FPT) procedures involving the related equipment.



Owner: City of Edmonton  
 Project No.: CP-00XXXX  
 Date: YYYY-MM-DD

INTEGRATED INFRASTRUCTURE SERVICES  
 Facility Engineering Services - Facility Planning & Design  
**Construction Cx Check Sheet**

Project:	[Name of Project or Institution Detailed Description of Area Affected]			Name of Equipment: [Pump]
System:	System Number:	Location:	Service:	Name of Discipline Responsible: [Mechanical]
Page # of ##	Equipment Tag:	Spare Tag:	Instrument Tag:	Sub-Category:

**TECHNICAL DATA**

DATE: MM/DD/YR

	SPECIFIED	SHOP DRAWINGS	INSTALLED	VERIFIED
Manufacturer	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Model	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Function	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Type	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Medium Pumped	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
RPM	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Capacity L/S	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Discharge Head kPa	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Impellor Size	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Motor Manufacturer	<u>--</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Horsepower	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Voltage	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Motor Full Load Amps	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Service Factor	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Motor Efficiency	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Serial No.	<u>--</u>	<u>--</u>	<u>Contractor</u>	<u>Comm. Agent</u>

**STATIC CHECKS**

DATE CHECKED: MM/DD/YR

Discharge Valve	<u>Contractor</u>	Strainer	<u>Contractor</u>
Suction Valve	<u>Contractor</u>	Flow Meter	<u>Contractor</u>
Check Valve	<u>Contractor</u>	Pressure Gauges	<u>Contractor</u>
Flex Connectors	<u>Contractor</u>	Alignment (Base Mntd)	<u>Contractor</u>
Pump Mounting	<u>Contractor</u>	Unit Disconnect	<u>Contractor</u>
Bypass Filter	<u>Contractor</u>	Power From:	<u>Contractor</u>
Chem. Pot Feeder	<u>Contractor</u>	Pump Arrangement	<u>Contractor</u>
Vibration Isolation	<u>Contractor</u>		

\*Items in **RED** shall be filled in by the appropriate party as indicated. All submissions shall be verified and accepted by the Commissioning Authority (CxA) prior to commencement of any Functional Performance Test (FPT) procedures involving the related equipment



Owner: City of Edmonton  
 Project No.: CP-00XXXX  
 Date: YYYY-MM-DD

INTEGRATED INFRASTRUCTURE SERVICES  
 Facility Engineering Services - Facility Planning & Design  
**Construction Cx Check Sheet**

Owner:	[Name of Project or Institution Detailed Description of Area Affected]			Name of Equipment [CDP]
System:	System Number:	Location:	Service:	Name of Discipline Responsible: [Electrical]
Page # of ##	Equipment Tag:	Spare Tag:	Instrument Tag:	Sub-Category:

**TECHNICAL DATA**

DATE:

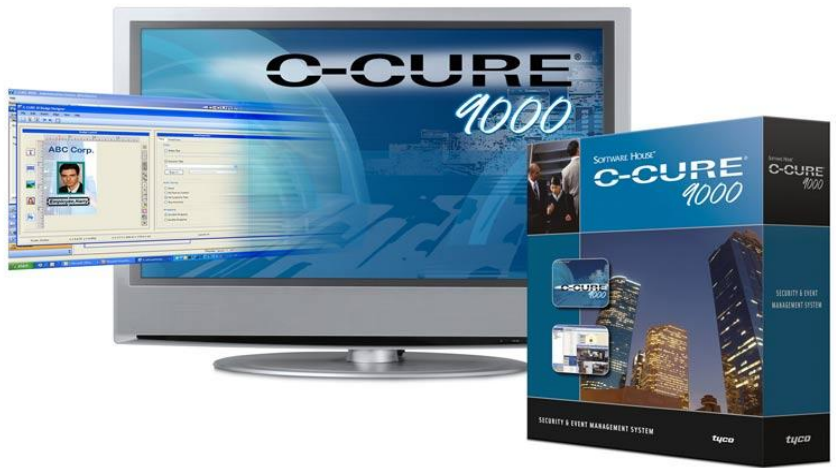
MM/DD/YR

	SPECIFIED	SHOP DRAWINGS	INSTALLED	VERIFIED
Manufacturer	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Model No.	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Phase / Voltage	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Bus Amperage	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Bus Bracing	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Bus Bar Plating	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Enclosure Color	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Door Hardware	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Drip Hood	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Conduit Size	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #1	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #2	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #3	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #4	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #5	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #6	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #7	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #8	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #9	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #10	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #11	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #12	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #13	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #14	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #15	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>
Circuit Breaker #16	<u>Comm. Agent</u>	<u>Comm. Agent</u>	<u>Contractor</u>	<u>Comm. Agent</u>

**STATIC CHECKS**

DATE / CHECKED: MM/DD/YR

All Fillers in Place	<u>Contractor</u>	Directory Complete	<u>Contractor</u>
Breaker Lockouts	<u>Contractor</u>	Interior Clean	<u>Contractor</u>
Conductors Torqued	<u>Contractor</u>	Lamacoid Attached	<u>Contractor</u>
Conductors Labelled	<u>Contractor</u>		



## City Of Edmonton - C-Cure Commissioning Report

<b>Facility Name</b>	
<b>Facility Address</b>	
<b>Site 3 &amp; 3</b>	
<b>Posse Account #</b>	

<b>Panel Type</b>	
<b>Panel MAC Address</b>	
<b>Firmware Version</b>	
<b>Panel IP Address</b>	
<b>Panel SubNet Mask</b>	
<b>Panel Gateway</b>	
<b>Panel Location</b>	
<b>Panel Fed From: Electrical Panel/Circuit Number</b>	

<b>System Integrator</b>	
<b>System Integrator Representative</b>	
<b>Project Manager</b>	
<b>System Representative</b>	
<b>Date Of Testing</b>	
<b>Date Of Acceptance</b>	

Notes:

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# C-Cure Reader Commissioning

Reader Name - Make & Model	Card Control		RDR Wiring		RDR Reads Cards		Arming RDR	
	YES	NO	RS485	Weigand	YES	NO	YES	NO
Eg: COM253_001 (RDR) Main Front Entrance South Office - HID RP40 Multiclass SE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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## C-Cure Reader Commissioning

Reader Name - Make & Model	Card Control		RDR Wiring		RDR Reads Cards		Arming RDR	
	YES	NO	RS485	Wiegand	YES	NO	YES	NO
Eg: COM253_001 (RDR) Main Front Entrance South Office - HID RP40 Multiclass SE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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	<b>Print And Sign:</b>
<b>System Integrator</b>	
<b>System Integrator Representative</b>	
<b>Project Manager</b>	
<b>System Representative</b>	
<b>Date Of Testing</b>	
<b>Date Of Acceptance</b>	

Notes:

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# C-Cure Door Commissioning

Door Name	Door Programmed		Door Triggers Event		Door Functions As Per Programming/Intent?		
	YES	NO	YES	NO	YES	NO	N/A
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# C-Cure Event Commissioning

Event Name	Event Programmed		Event Enabled		Event Goes To Monitoring & Can Be Acknowledged		
	YES	NO	YES	NO	YES	NO	N/A
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