

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 This Section specifies mechanical system testing, adjusting, and balancing requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.2 DEFINITIONS

- .1 "Agency" – means agency to perform testing, adjusting, and balancing work.
- .2 "TAB" – means testing, adjusting, and balancing to determine and confirm quantitative performance of equipment and systems and to regulate specified fluid flow rate and air patterns at terminal equipment, e.g., reduce fan speed, throttling, etc.
- .3 "hydronic systems" – includes heating water, chilled water, glycol-water solution, condenser water, and any similar system.
- .4 "air systems" – includes outside air, supply air, return air, exhaust air, and relief air systems.
- .5 "flow rate tolerance" – means allowable percentage variation, minus to plus, of actual flow rate values in Contract Documents.
- .6 "report forms" – means test data sheets arranged for collecting test data in logical order for submission and review, and these forms, when reviewed and accepted, should also form permanent record to be used as basis for required future testing, adjusting, and balancing.
- .7 "terminal" – means point where controlled fluid enters or leaves the distribution system, and these are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- .8 "main" – means duct or pipe containing system's major or entire fluid flow.
- .9 "submain" – means duct or pipe containing part of the systems' capacity and serving 2 or more branch mains.
- .10 "branch main" – means duct or pipe servicing 2 or more terminals.
- .11 "branch" – means duct or pipe serving a single terminal.

1.3 SUBMITTALS

- .1 Within 30 days of work commencing at site, submit name and qualifications of proposed testing and balancing agency in accordance with requirements of article entitled Quality Assurance below.
- .2 Submit sample test forms, if other than those standard forms prepared by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB), are proposed for use.
- .3 Submit a [TAB plan](#) by Agency to indicate Agency's evaluation of mechanical drawings with respect to service routing and location or lack of balancing devices. Include set of drawings used and marked-up by Agency to prepare report.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit a report by Agency after each site visit made by Agency during construction phase of this Project.
- .2 Submit a draft report, as specified in Part 3 of this Section.
- .3 Submit a final report, as specified in Part 3 of this Section.
- .4 Submit a testing and balancing warranty as specified in Part 3 of this Section.
- .5 Submit reports listing observations and results of post construction site visits as specified in Part 3 of this Section.

1.5 QUALITY ASSURANCE

- .1 Employ services of an independent testing, adjusting, and balancing agency meeting qualifications specified below, to be single source of responsibility to test, adjust, and balance building mechanical systems to produce design objectives. Agency is to have successfully completed testing, adjusting, and balancing of mechanical systems for a minimum of 5 projects similar to this Project within past 3 years, and is to be certified as an independent agency in required categories by one of following:
 - .1 AABC – Associated Air Balance Council;
 - .2 NEBB – National Environmental Balancing Bureau.
- .2 NBCTA certification in lieu of the above noted organizations is not permitted.
- .3 Testing, adjusting, and balancing of complete mechanical systems is to be performed over entire operating range of each system in accordance with one of following publications:
 - .1 National Standards for a Total System Balance published by Associated Air Balance Council;
 - .2 Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems published by National Environmental Balancing Bureau;
 - .3 Chapter 37, Testing, Adjusting, and Balancing of ASHRAE Handbook HVAC Applications.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 SCOPE OF WORK

- .1 Perform total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of fluid quantities of mechanical systems as required to meet design specifications and comfort conditions, and recording and reporting results.
- .2 Mechanical systems to be tested, adjusted, and balanced include:
 - .1 TAB of domestic water systems (all piping extended from Municipal main) is to include:
 - .1 domestic hot water recirculation piping;
 - .2 tempered water piping flows.
 - .2 TAB of fuel oil system is to include supply and return oil flows as applicable, and is to be in accordance with requirements of CAN/CSA B139.

- .3 TAB of heating systems is to include piping and equipment fluid temperatures, flows and control, and if TAB is not done during heating season, a follow-up site visit during heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .4 TAB of cooling systems is also to include piping and equipment fluid temperatures, flows and control, and if TAB is not done during cooling season, a follow-up site visit during cooling season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .5 TAB of air handling systems is to include equipment and ductwork air temperatures, capacities, and flows.

3.2 TESTING, ADJUSTING, AND BALANCING

- .1 Conform to following:
 - .1 as soon as possible after award of Contract, Agency is to carefully examine a set of mechanical drawings with respect to routing of services and location of balancing devices, and is to issue a report listing results of the evaluation;
 - .2 set of drawings examined by Agency is to be returned with evaluation report, with red line mark-ups to indicate locations for duct system test plugs, and required revision work such as relocation of balancing devices and locations for additional devices;
 - .3 after review of mechanical work drawings and specification, Agency is to visit site at frequent, regular intervals during construction of mechanical systems, to observe routing of services, locations of testing and balancing devices, workmanship, and anything else that will affect testing, adjusting, and balancing;
 - .4 after each site visit, Agency is to report results of site visit indicating date and time of visit, and detailed recommendations for any corrective work required to ensure proper adjusting and balancing;
 - .5 testing, adjusting, and balancing is not to begin until:
 - .1 building construction work is substantially complete and doors have been installed;
 - .2 mechanical systems are complete in all respects, and have been checked, started, adjusted, and then successfully performance tested.
 - .6 mechanical systems to be tested, adjusted and balanced are to be maintained in full, normal operation during each day of testing, adjusting, and balancing;
 - .7 obtain copies of reviewed shop drawings of applicable mechanical plant equipment and terminals, and temperature control diagrams and sequences;
 - .8 Agency is to walk each system from system "head end" equipment to terminal units to determine variations of installation from design, and system installation trades will accompany Agency;
 - .9 Agency is to check valves and dampers for correct and locked position, and temperature control systems for completeness of installation before starting equipment;
 - .10 wherever possible, Agency is to lock balancing devices in place at proper setting, and permanently mark settings on devices;
 - .11 Agency is to leak test ductwork as specified in Section entitled HVAC Air Distribution in accordance with requirements of SMACNA "HVAC Air Duct Leak Test Manual", coordinate work with work of aforementioned Sections, provide detailed sketch(es) to Sheet Metal

- Contractor and Consultant identifying ductwork not in accordance with acceptable leakage values specified in aforementioned Sections, and retest corrected ductwork;
- .12 Agency is to balance systems with due regard to objectionable noise which is to be a factor when adjusting fan speeds and performing terminal work such as adjusting air quantities, and should objectionable noise occur at design conditions, Agency is to immediately report problem and submit data, including sound readings, to permit an accurate assessment of noise problem to be made;
 - .13 Agency is to check supply air handling system mixing plenums for stratification, and where variation of mixed air temperature across coils is found to be in excess of $\pm 5\%$ of design requirements, Agency is to report problem and issue a detail sketch of plenum baffle(s) required to eliminate stratification;
 - .14 Agency is to perform testing, adjusting, and balancing to within $\pm 5\%$ of design values, and make and record measurements which are within $\pm 2\%$ of actual values;
 - .15 for air handling systems equipped with air filters, test and balance systems with simulated 50% loaded (dirty) filters by providing a false pressure drop;
 - .16 test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 2.8°C (5°F) wet bulb temperature of maximum summer design condition, and within 5.5°C (10°C) dry bulb temperature of minimum winter design condition, and take final temperature readings during seasonal operation.
- .2 Prepare reports as indicated below.
- .1 Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on AABC or NEBB forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in same manner specified for final reports and submit for review.
 - .2 Upon verification and approval of draft reports, prepare final reports organized and formatted as specified below. Use units of measurement (SI or Imperial) as used on Project Documents.
 - .3 Report forms are to be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Report forms complete with schematic systems diagrams and other data are to be consolidated in electronic format as a PDF. PDF file to be indexed and organized into sections, as it applies to the project, as follows:
 - .1 General Information and Summary;
 - .2 Air Systems;
 - .3 Hydronic Systems;
 - .4 Temperature Control Systems;
 - .5 Special Systems.
 - .4 Agency is to provide following minimum information, forms, and data in report:
 - .1 inside cover sheet to identify Agency, Contractor, and Project, including addresses, and contact names and telephone numbers and a listing of instrumentation used for procedures along with proof of calibration;

- .2 remainder of report is to contain appropriate forms containing as a minimum, information indicated on standard AABC or NEBB report forms prepared for each respective item and system;
- .3 Agency is to include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying equipment, terminals, and accessories;
- .4 Agency is to include report sheets indicating building comfort test readings for all rooms.
- .3 After final testing and balancing report has been submitted, Agency is to visit site with Contractor and Consultant to spot check results indicated on balancing report. Agency is to supply labour, ladders, and instruments to complete spot checks. If results of spot checks do not, on a consistent basis, agree with final report, spot check procedures will stop and Agency is to then rebalance systems involved, resubmit final report, and again perform spot checks with Contractor and Consultant.
- .4 When final report has been accepted, Contractor is to submit to Owner, in name of Owner, a certificate equal to AABC National Guaranty Certification or a NEBB Quality Assurance Program Bond, and in addition, Contractor is to submit a written extended warranty from Agency covering one full heating season and one full cooling season, during which time any balancing problems which occur, with exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by Agency and reported on to Owner, and if it is determined that problems are a result of improper testing, adjusting, and balancing, they are to be immediately corrected without additional cost to Owner.
- .5 After acceptance of final report, Agency is to perform post testing and balancing site visits in accordance with following requirements:
 - .1 post testing and balancing site visits are to be made:
 - .1 once during first month of building operation;
 - .2 once during third month of building operation;
 - .3 once between fourth and tenth months in a season opposite to first and third month visit.
 - .2 during each return visit and accompanied by Owner's representative, Agency is to spot rebalance terminal units as required to suit building occupants and eliminate complaints;
 - .3 Agency is to schedule each visit with Contractor and Owner, and inform Consultant;
 - .4 after each follow-up site visit, Agency is to issue to Contractor and Consultant a report indicating any corrective work performed during visit, abnormal conditions and complaints encountered, and recommended corrective action.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 This Section specifies commissioning requirements that are common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. When requirements of this Section contradict requirements of Division 00 or Division 01, conditions of Division 00 or Division 01 to take precedence.

1.2 REFERENCES

- .1 Refer to commissioning requirements specified in Division 01.

1.3 COMMISSIONING AGENT INVOLVEMENT VERSUS WARRANTY OBLIGATIONS

- .1 Involvement of Commissioning Agent performing duties as described in this Section is not in any way to void or alter any Contractual warranty obligations.

1.4 SUBMITTALS

- .1 Submit to Commissioning Agent, at same time as submittal to the Consultant, one copy of each shop drawing or product data sheet associated with equipment or systems to be commissioned.
- .2 Submit for review, a Commissioning Plan with schedule, commissioning procedures for commissioning events, and a copy of Commissioning Agent's commissioning data sheets for equipment/systems to be commissioned.
- .3 Submit a list of commissioning instruments and for each instrument, indicate purpose of instrument and include a recent calibration certificate.
- .4 Submit equipment and system manufacturer's start-up and test report sheets for review a minimum of 1 month prior to equipment and system start-up procedures.

1.5 CLOSEOUT SUBMITTALS

- .1 After start-up and successful pre-functional performance testing and submittal of completed forms, submit, for each system or subsystem, a letter confirming pre-functional performance testing has been successfully completed and system or subsystem is ready for functional performance testing and commissioning process to commence.

1.6 DEFINITIONS

- .1 Commissioning: process of demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, all as further described below.
- .2 Commissioning Agent: commissioning authority who will supervise commissioning process, and who will recommend final acceptance of commissioned mechanical work.
- .3 Start-Up and Adjusting: process of equipment manufacturer's/supplier's technical personnel, with Contractor, starting and operating equipment and systems, making any required adjustments, documenting process, and submitting manufacturer's/supplier's start-up reports to confirm equipment has been properly installed and is operational as intended.

- .4 Pre-Functional Performance Testing: testing, adjusting and operating of components, equipment, systems and/or subsystems, by Contractor, after start-up but before functional performance testing, to confirm components, equipment, systems and/or subsystems operate in accordance with requirements of Contract Documents, including modes and sequences of control and monitoring, interlocks, and responses to emergency conditions, and including submittal of pre-functional performance testing documentation sheets.
- .5 Functional Performance Testing: a repeat of successful pre-functional performance testing by Contractor, in presence of Commissioning Agent and the Consultant with completed Commissioning Agent's commissioning documentation sheets to document, validate and verify equipment, systems and subsystems are complete in all respects, function correctly, and are ready for acceptance.
- .6 Commissioning Documentation Sheets: prepared sheets for pre-functional performance testing and for functional performance testing supplied by Commissioning Agent for each piece of equipment/system to be commissioned, each sheet or set of sheets complete with Project name and number, date of commissioning, equipment/system involved, equipment/system name and model number, equipment tag in accordance with drawings, and, for each commissioning procedure listed, a column giving expected data in accordance with Contract Documents, a column to fill in observed data during commissioning, and space for signatures of Contractor and Commissioning Agent.
- .7 Systems Operating Manual: a manual prepared by Commissioning Agent to present an overview of building mechanical systems and equipment to be used by building maintenance personnel to assist them in daily operation of systems.
- .8 Validate: to confirm by examination and witnessing tests correctness of equipment and system operation.

1.7 QUALITY ASSURANCE

- .1 Commissioning work is to be in accordance with requirements of following:
 - .1 CSA Z320, Building Commissioning Standard and Check Sheets;
 - .2 ASHRAE Guideline 0, The Commissioning Process;
 - .3 ASHRAE Guideline 1.1, The HVAC Commissioning Process;
 - .4 ASHRAE Guideline 1.5, Commissioning Smoke Control Systems;
 - .5 Owner designated Commissioning [Provident](#).

1.8 COMMISSIONING OBJECTIVES

- .1 Objectives of commissioning process:
 - .1 to support quality management by means of monitoring and checking installation;
 - .2 to verify equipment/system performance by means of commissioning of completed installation;
 - .3 to move completed equipment/systems from "static completion" state to "dynamic" operating state so as to transfer a complete and properly operating installation from Contractor to Owner.

1.9 TESTING EQUIPMENT

- .1 Supply instruments and test equipment required to conduct start-up, testing and commissioning procedures.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 COMMISSIONING

- .1 Commission work in accordance with requirements of this Section and as required by Commissioning Agent.
- .2 Prerequisites to successful completion of [functional performance testing](#):
 - .1 submittal of signed start-up and test reports;
 - .2 completion of system testing, adjusting and balancing (TAB), and acceptance of TAB reports;
 - .3 permanent electrical and control connections of equipment;
 - .4 successful completion and documentation of pre-functional performance testing;
 - .5 submittal of letters to the Consultant certifying systems and subsystems have been started, tested, adjusted, successfully pre-functional performance tested, are ready for functional performance testing, and are in accordance with requirements of Contract Documents. [BAS is fully programmed, graphics completed, and in AUTO.](#)

3.2 PHASING OF COMMISSIONING

- .1 If Project will be constructed in phases, phase commissioning accordingly to suit progress and phases of Work.

3.3 DEFICIENCIES LISTED DURING COMMISSIONING

- .1 Correct deficiencies listed by the Consultant and Commissioning Agent during commissioning process within 15 calendar days of notification unless agreed otherwise with the Consultant, and when deficiencies have been corrected, notify the Consultant and Commissioning Agent immediately.

3.4 SYSTEMS TO BE COMMISSIONED

- .1 Mechanical systems to be commissioned include, but are not to be limited to, systems described below. Specific commissioning procedures are to be as directed by Commissioning Agent.
- .2 Commissioning of drainage systems includes:
 - .1 commissioning of drainage pumps and controls by means of tests recommended by manufacturer to confirm proper operation and performance;
 - .2 commissioning of equipment such as interceptors and backflow preventers.
- .3 Commissioning of fire protection systems will be considered complete upon preparation and submittal by Contractor of completion certificates required by applicable NFPA Standards, demonstration of proper system operation to local Fire Chief and any other authorities, including

Owner's insurance underwriter as required, and coordination and cooperation with fire alarm system commissioning procedures, in particular smoke control systems and other such fan system control sequences.

- .4 Commissioning of water systems (all piping extended from Municipal main) includes:
 - .1 commissioning of pumps and controls;
 - .2 commissioning of water heaters;
 - .3 commissioning of piping specialties such as backflow preventers, mixing valves, and similar components;
 - .4 commissioning of trap seal primer units, including adjustment of water flows and confirmation of water flow at each connected trap;
 - .5 commissioning of plumbing fixtures.
- .5 Commissioning of compressed air system includes "head end" compressor equipment, pressure reducing equipment, and outlets.
- .6 Commissioning of natural gas system includes pressure regulating equipment. Perform commissioning in accordance with requirements of CAN/CSA B149.1, and any supplemental requirements of governing authorities.
- .7 Commissioning of propane gas system includes pressure regulating equipment. Perform commissioning in accordance with requirements of CAN/CSA B149.2, and any supplemental requirements of governing authorities.
- .8 Perform commissioning of fuel oil system in accordance with requirements of CAN/CSA B139.
- .9 Commissioning of heating systems includes piping, piping specialties, equipment, and control, as well as checking and validating temperature and flow documentation contained in TAB reports. If TAB is not done during heating season, a follow-up site visit during heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .10 Commissioning of cooling systems includes piping, piping specialties, equipment, and control, as well as checking and validating temperature and flow documentation contained in TAB reports. If TAB is not done during cooling season, a follow-up site visit during cooling season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .11 Commissioning of HVAC chemical treatment systems includes feed and monitoring equipment, and testing of system fluids to confirm proper concentration of chemical.
- .12 Commissioning of air handling systems includes equipment, ductwork, ductwork specialties, controls, interlocks, and checking and validating air capacities and flows in accordance with TAB reports.
- .13 Control work commissioning includes confirmation of proper operation of individual control components, and overall operation of controls in conjunction with operation of connected building systems, including heating season/cooling season testing requirements specified above.
- .14 Commissioning of BAS includes confirmation of proper operation of components, input/output points, hardware and software, and demonstration of system performing required procedures.
- .15 Commissioning of special usage room controls includes confirmation of proper operation of individual components, and proper operation of overall control system, all in accordance with governing Codes and Standards.

- .16 Commissioning of noise and vibration control equipment includes noise and vibration measurements to confirm proper operation of equipment.

3.5 COMMISSIONING PROCESS

- .1 Perform commissioning process in stages and include, but not be limited to, following:
 - .1 Stage 1: Commissioning of equipment/systems as listed in this Section, which is a prerequisite to an application for Substantial Performance of the Work and includes supervising and validating results of functional performance testing, and submittal of reviewed Systems Operating Manual.
 - .2 Stage 2: Commissioning work performed 12 months after issue of a Certificate of Substantial Performance and which includes supervision of Contractor's "fine tuning" of equipment/systems through seasonal occupancy, and any other such work to achieve optimal comfort and performance conditions.
 - .3 Stage 3: Successful completion of satisfactory equipment/system operation during 1st month after issue of a Certificate of Total Performance of the Work.
 - .4 Stage 4: Successful completion of satisfactory equipment/system operation during 3rd month after issue of a Certificate of Total Performance of the Work.
 - .5 Stage 5: Successful seasonal [testing](#) of building.

3.6 RESPONSIBILITIES OF CONTRACTOR

- .1 During construction phase, Contractor is to:
 - .1 prepare and submit an installation schedule which includes a time schedule for each activity with lead and lag time allowed and indicated, shop drawing and working detail drawing submissions, and major equipment factory testing and delivery dates;
 - .2 prepare and submit a commissioning schedule which is to include a time schedule coordinated with installation schedule referred to above and Commissioning Agent, and allowances for additional time for re-tests as may be required, and update schedule on a monthly basis as required;
 - .3 when requested by Commissioning Agent, arrange site commissioning meetings with Owner, the Consultant, and applicable subcontractors present, to be chaired by Commissioning Agent who will also prepare and distribute meeting minutes;
 - .4 promptly correct reported deficient work, and report when corrective work is complete;
 - .5 where required by Codes and/or Specification, retain equipment manufacturers/suppliers or independent 3rd parties to certify correct installation of equipment/systems;
 - .6 under supervision of equipment manufacturers/suppliers, start-up and adjust equipment to design requirements, and submit start-up sheets which include equipment data such as manufacturer and model number, serial number where applicable, and performance parameters, all signed by equipment manufacturer/supplier and Contractor;
 - .7 complete Commissioning Agent's commissioning data sheets for multiple items of smaller equipment such as air terminal boxes, fan coil units, backflow preventers, etc., submit sheets to Commissioning Agent, accompany Commissioning Agent for an on-site check of 30% of data sheet information for each type of equipment, and perform any corrective action required as a result of site checks;

- .8 perform system testing, adjusting and balancing and, when complete, issue a copy of final report to Commissioning Agent for review and a site check of results, and perform any corrective work required as a result of site checks by Commissioning Agent;
 - .9 in accordance with updated commissioning schedule and actual progress at site, certify in writing to the Consultant and Commissioning Agent that equipment and/or systems are complete, have been checked, started and adjusted, successfully pre-functional performance tested and documented, and are ready for functional performance testing and commissioning procedures, giving the Consultant and Commissioning Agent a minimum of 5 working days' notice;
 - .10 perform system and subsystem functional performance testing under supervision of Commissioning Agent, and submit to the Consultant and Commissioning Agent, completed and signed functional performance testing and commissioning data sheets (issued by Commissioning Agent) and also signed by Commissioning Agent.
- .2 During post construction phase, Contractor is to:
- .1 optimize system operation in accordance with building occupant's needs and comments using System Operation Manual prepared by Commissioning Agent as reference;
 - .2 complete commissioning procedures, activities, and performance verification procedures that were delayed or not concluded during construction phase;
 - .3 accompanied by Commissioning Agent, complete system checks and "fine tuning" with signed documentation as follows:
 - .1 once during 1st month of building operation;
 - .2 once during 3rd month of building operation;
 - .3 once between 4th and 10th months in a season opposite to 1st and 3rd month visits.
 - .4 correct deficiencies revealed by system checks described above, and, where required, involve equipment manufacturers/suppliers during corrective actions, and report completion of corrective work;
 - .5 3 months after Substantial Completion conduct a question and answer session(s) at building with Owner's operating and maintenance personnel, with duration of session(s) dictated by number of questions and concerns that have to be addressed.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Commissioning of all building electrical systems and component including:
 - .1 Testing and adjustment.
 - .2 Demonstration and training.
 - .3 Instructions of all procedures for Owner's personnel.
 - .4 Updating as-built data.
 - .5 Co-ordination of Operation and Maintenance material.
- .2 Provide labour and material to conduct the commissioning process as outlined in this specification section, including the hiring of an Independent Testing Contractor (ITC) as detailed below.
- .3 Provisions of this section shall apply to all sections of Division 26, Division 27, Division 28, and sections related to electrical utilities in Division 33.

1.2 RELATED REQUIREMENTS

- .1 Testing and commissioning are called for throughout the individual specifications. This does not relieve this trade from providing all testing and commissioning necessary to ensure that systems and equipment operate as required and that they interface with other systems and equipment as required.
- .2 Section 26 08 50 – Commissioning of Lighting: additional commissioning requirements for commissioning of lighting and lighting controls.

1.3 COMMISSIONING PROCESS ALLOCATION

- .1 The commissioning process shall be allocated a value equal to 5 per cent of the contract. The Electrical Contractor may draw from this allocation as the commissioning process is completed.
- .2 The Electrical Contractor shall submit all test and verification forms. The Consultant will use these forms to calculate percentage complete.
- .3 The Electrical Contractor may claim up to 3 per cent of the contract from this allocation leading up to performance testing. The remaining 2 per cent shall not be paid out until the performance testing, O&M manuals, and training have been completed satisfactorily.

1.4 DEFINITIONS

- .1 Cx – Commissioning.
- .2 Commissioning Provider (CxP)
 - .1 The Commissioning [Provider](#) (CxP), also referred to as the Commissioning Consultant, shall be hired by The Owner.
 - .2 The CxP responsibilities shall include:
 - .1 preparing the commissioning plan.
 - .2 co-ordinating with the contractor to schedule tests.
 - .3 preparing a test form manual.

- .4 witnessing selected tests.
- .5 receiving all test forms.
- .6 co-ordinating the contractors training.
- .7 chair the commissioning meetings.
- .3 The Electrical Contractor shall co-operate with the CxP.
- .4 The Electrical Contractor shall provide assistance to the CxP and have personnel available during the performance testing procedure. Each electrical system shall be tested in the operational mode.

1.5 SUBMITTALS

- .1 Conform to Section 01 33 00 for requirements for shop drawings and record drawings.
- .2 A commissioning document shall be prepared by the CxP prior to conducting these activities for use by the Commissioning Team.
- .3 The electrical sub-contractor shall be responsible for ensuring all activities are properly documented in this manual and co-ordinated through the General Contractor.
- .4 As-built drawings and data books must be available two weeks prior to commissioning for review and use by the consultant and Commissioning Team prior to the start of the commissioning activities.

1.6 CLOSEOUT SUBMITTALS

- .1 Attendance records for all training sessions.
- .2 Testing reports for system load balance measurements, infra-red test and harmonics tests.

1.7 QUALITY ASSURANCE

- .1 Provide qualified trades persons, certified testing agencies, factory trained and approved by the Commissioning Team Leader.
- .2 Submit the names of all personnel to be used during the Commissioning activities.

1.8 WARRANTY

- .1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by the Owner.
- .2 The Electrical Contractor shall fill out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
- .3 Refer to Division 01 and Section 26 05 00 for the requirements during the warranty period.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- .1 The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests specified. The Contractor shall advise the Consultant of instrumentation to be used and the dates the instruments were calibrated.

PART 3 - EXECUTION

3.1 THE COMMISSIONING PROCESS

- .1 The purpose of the commissioning process is to fully test all building systems including architectural, mechanical, and electrical components and operating procedures by challenging these systems to realistic operation conditions.
- .2 The commissioning process consists of:
 - .1 Shop Drawings and Record Drawings.
 - .2 Installation inspection and equipment verification.
 - .3 Independent testing contractor.
 - .4 Testing of equipment and systems.
 - .5 Commissioning meetings.
 - .6 Operating and maintenance manuals.
 - .7 Operating training.
 - .8 Commissioning Agent testing.
 - .9 Systems Demonstration and turnover.
 - .10 Testing forms.
 - .11 Warranties.

3.2 PREPARATION

- .1 Provide test instruments required for all activities as defined in the commissioning documents.
- .2 Verify all systems are in compliance with the requirements of the commissioning documents prior to the pre-commissioning check out operation.
- .3 Confirm all scheduled activities have identified personnel available.
- .4 Where systems or equipment do not operate as required, make the necessary corrections or modifications, re-test and re-commission.

3.3 SYSTEM DESCRIPTION

- .1 Perform all start-up operations, control adjustment, trouble shooting, servicing and maintenance of each item of equipment as defined in the commissioning documentation.
- .2 Owner will provide list of personnel to receive instructions and will co-ordinate their attendance at agreed upon times.
- .3 Prepare and insert additional data in the operations and maintenance manuals and update as-built drawings when need for additional data becomes apparent during the commissioning exercise.
- .4 Where instruction is specified in the commissioning manual, instruct personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction.
- .5 Conduct presentation on Owner's premises. Owner will provide space.

3.4 COMMISSIONING

- .1 Commission the components of the electrical system using the NETA Acceptance Testing Specifications.
- .2 Refer to the project commissioning plan prepared by the [CxP](#).
- .3 Commissioning activities for the electrical systems must have available up to date as-built drawing information and accurate Operations and Maintenance Manuals. These documents shall be a major part of this activity.
- .4 Contractor shall be responsible to update all documentation with information and any changes duly noted during the Commissioning exercise.
- .5 Contractor shall arrange for all outside suppliers, equipment manufacturers, test agencies and others as identified in the commissioning sections of this specification. The cost associated with this requirement shall be included as part of the tender price.

3.5 FINAL REPORT

- .1 This trade shall assemble all testing data and commissioning reports and submit them to the General Contractor for submission to the Owner.
- .2 Each form shall bear signature of recorder, and that of supervisor of reporting organizer.

3.6 SCHEDULE OF ACTIVITIES

- .1 Commissioning activities shall be conducted based on pre-established schedule with all members of the commissioning team.
- .2 In addition, there will be two meetings held through the contract duration to introduce the parties of the commissioning team, establish the schedules and deadlines for the various activities and review the Commissioning Manual.
- .3 Adhering to the established schedule is very important as the co-ordination and scheduling of the participants will be difficult to alter once this is established. Close co-ordination of this schedule is important.
- .4 In the event project cannot be commissioned in the allotted time slot, the contractor shall pay for all costs associated with assembling the Commissioning Team at a later date. If the contractor has not performed his duties to reach commissioning stage as outlined earlier, he will incur all expenses of other trades and the Commissioning Team due to his non-compliance.

3.7 INSTALLATION INSPECTION AND EQUIPMENT VERIFICATION

- .1 The Electrical Contractor shall co-ordinate with the Electrical Consultant who will inspect the electrical installation.
- .2 The Electrical Contractor shall complete the equipment verification forms for each piece of equipment. The forms shall be included in the operating and maintenance manual. The equipment data shall include:
 - .1 Manufacturers name, address, and telephone number.
 - .2 Distributors name, address, and telephone number.
 - .3 Make, model number and serial number.
 - .4 Voltage and current ratings.

3.8 INDEPENDENT TESTING CONTRACTOR

- .1 The Independent Testing Contractor (ITC) shall be hired by the contractor and shall issue reports to the Electrical Consultant.
- .2 The ITC shall conduct load balancing measurements to verify load balancing performed in accordance with Section 26 05 00.

3.9 TESTING OF EQUIPMENT AND SYSTEMS

- .1 The Electrical Contractor shall be responsible for all tests detailed in this Section, and those tests required by a manufacturer as part of their installation requirements.
- .2 The Electrical Contractor shall schedule all tests which shall be witnessed by the Electrical Consultant or the Commissioning Consultant. The contractor shall complete and sign the testing forms.
- .3 The Electrical Contractor shall conduct tests on the following equipment as a minimum. Refer to the individual specification sections for test procedures.
 - .1 Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
 - .2 Section 26 05 73.16 – Coordination Studies.
 - .3 Section 26 24 13 – Switchboards.
 - .4 Section 26 24 16 – Panelboards.
 - .5 Section 26 24 19 – Motor Control Centres.
 - .6 Section 27 51 16 – Public Address Systems.
 - .7 Section 28 10 00 – Access Control.
 - .8 Section 28 46 13 – Fire-Alarm Systems.
- .4 When all testing has been completed and all mechanical and electrical systems are operational the contractor shall conduct system load balance measurements, infra-red test and harmonics tests.

3.10 COMMISSIONING MEETINGS AND REPORTING

- .1 The Electrical Contractor shall include the schedule for all tests in the construction schedule.
- .2 The Commissioning meetings shall occur during the regular construction meetings. The testing schedules and the results of all tests shall be reviewed.
- .3 All testing forms and reports associated with the electrical systems shall be directed to the Electrical Consultant, with copies to the Consultant, Commissioning Consultant, and the Owner.
- .4 The forms and reports to be issued shall include:
 - .1 Shop drawings, issued and accepted.
 - .2 Equipment verification forms.
 - .3 Testing forms.
 - .4 Reports resulting from tests.
 - .5 Testing schedule.
 - .6 Minutes of commissioning meetings.
 - .7 Manufacturers' Certificates.

3.11 OPERATING AND MAINTENANCE MANUAL

- .1 Conform to the specification section for the requirements of the O&M manuals.

3.12 CLOSEOUT ACTIVITIES

- .1 Conform to section for requirements for instructions to the Building Owner for each system and equipment.
- .2 The training shall be provided by qualified technicians or electricians and shall be conducted in a classroom and at the equipment or system.
- .3 The training sessions shall be scheduled, co-ordinated and video recorded by the Commissioning Consultant.
- .4 Each training session shall be structured to cover:
 - .1 The operating and maintenance manual.
 - .2 Operating procedures.
 - .3 Maintenance procedures.
 - .4 Troubleshooting procedures.
 - .5 Spare parts.
- .5 Submit a course outline to the Electrical Consultant before training commences. Provide course documentation for up to eight people.
- .6 The training session shall be scheduled and co-ordinated by the Commissioning Consultant. [Contractor](#) shall video tape the sessions.
- .7 Training shall be provided for the following systems:
 - .1 Electrical Systems including distribution and lighting: 8 hour minimum
 - .2 Section 27 51 16 – Public Address Systems: 1 hour minimum
 - .3 Section 28 10 00 – Access Control: 1 hour minimum
 - .4 Section 28 46 13 – Fire-Alarm Systems: 2 hours minimum
- .8 The Electrical Contractor shall conduct a walkthrough of the installation. During the walkthrough the Electrical Contractor shall:
 - .1 Identify equipment.
 - .2 Identify electrical panels.
 - .3 Identify starters and disconnects.
 - .4 Review the electrical power distribution.
 - .5 Review the light power distribution.
 - .6 Review the switchgear.
 - .7 Review the general maintenance procedures.

3.13 THE ELECTRICAL SYSTEM DEMONSTRATION AND TURNOVER

- .1 The system demonstration and turnover to The Owner shall occur when:
 - .1 The installation is complete.

- .2 The acceptance test conducted by the Electrical Consultant has been completed successfully.
- .3 Training has been completed.
- .4 Equipment Operating and Maintenance Manuals have been accepted.
- .5 System operating manuals have been accepted.
- .6 Shop-drawings have been updated.
- .7 As-built drawings have been completed.
- .8 The commissioning process has been completed successfully and system operation accepted by the Electrical Consultant and Commissioning Consultant.
- .2 The systems demonstration shall be conducted by the Electrical Contractor and manufacturers. The demonstration shall cover a physical demonstration of equipment installation and operation.

3.14 TESTING FORMS

- .1 The Electrical Contractor and manufacturers shall fill out the forms listed in this section or provide other forms. The forms must be approved by the Electrical Consultant and the Owner before they are used.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Provide commissioning of fire alarm and interconnected systems to verify that installations are in accordance with project requirements, and to ensure proper system operation.

1.2 RELATED REQUIREMENTS

- .1 Section 01 91 13 – General Commissioning Requirements.
- .1 Section 01 91 26.13 – Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.3 REFERENCES

- .1 CAN/ULC-S1001-11 – Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.4 SUBMITTALS

- .1 Commissioning plan.

1.5 CLOSEOUT SUBMITTALS

- .1 Final commissioning and functional test report.

1.6 QUALIFICATIONS

- .1 Commissioning Organizations:
 - .1 Certified member of Electrical Contractors Association of Ontario (ECAO) or Canadian Fire Alarm Association (CFAA).

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 SITE TESTS AND INSPECTIONS

- .1 Perform [testing](#) of integrated systems in accordance with CAN/ULC-S1001.
- .2 Follow manufacturer's recommendations for testing.
- .3 Inspect wiring connections to all devices comprising the system.
- .4 Verify supervision of wiring at every device connection to a supervised circuit.
- .5 Test operation of every device on a system to verify its function.
- .6 Examine equipment for any apparent damage or tampering that may interfere with its intended operation.
- .7 Test equipment with capabilities for field adjustment to establish that it functions as intended under the conditions prevailing at its point of installation.

- .8 Examine devices for evidence of damage or obstructions which may interfere with their operating mechanisms.
- .9 Test automatic devices by simulating an operating condition.
- .10 Wiring:
 - .1 Inspect every device and test to demonstrate that disconnection of the device from the circuit or malfunction of the equipment or wiring activates the required supervisory signals. Inspection shall include verification that:
 - .1 Supervisory signals operate in response to open circuits, short circuits, ground faults and disconnection of plug-in components;
 - .2 Terminations of conductors entering and leaving equipment have been made;
 - .3 Circuit polarities are in accordance with the system design, where applicable.
 - .2 In addition, test to establish that the power supplied to any device is within its recommended operating range and that the required voltage levels are maintained and that the fusing is correct.
- .11 Initiating Devices - Manual:
 - .1 Inspect manual alarm stations in consideration of the following:
 - .1 The device shall be mounted with sufficient clearance to facilitate ease of access and proper operation;
 - .2 Operate each manual alarm station, toggle switch and key switch to verify proper functions.
- .12 Automatic heat detectors:
 - .1 Use a heat source reproducible in its intensity, as recommended by the manufacturer of the device, to initiate an alarm.
 - .2 Test equipment - Heat lamp or Air heater. DO NOT USE AN OPEN FLAME HEAT SOURCE.
 - .3 Apply heat source as to not damage or operate fusible disc parts.
- .13 Automatic heat detectors - non-resettable:
 - .1 Test by simulating its electrical operation by jumpering the wiring points (creating a short) adjacent to its operating mechanism.
- .14 Automatic smoke detectors - area type:
 - .1 Test by introducing smoke into its detecting chamber. This may consist of actual smoke from burning materials or artificially generated smoke aerosol spray as recommended by the manufacturer. The sensitivity should be noted and adjusted if necessary.
- .15 Automatic smoke detectors:
 - .1 Examine the air sampling arrangements of the detectors under actual conditions of balanced air circulation by conducting a check of the field sensitivity and a check of the air velocity in accordance with the manufacturers' recommendations.
 - .2 Test gas to be used similar to Automatic Smoke Detector.
- .16 Alarm signals - audible:
 - .1 Test on main power supply and standby power supply with the maximum expected load on the system.

- .2 The audible signalling appliances shall function as intended and shall be audible throughout the building over the background noise present.
- .3 Decibel recordings in each area covering 100 sq. metres shall be taken.
- .4 The level of sound should usually be 15 dB above ambient noise level.
- .17 Alarm signals - visual:
 - .1 The visual signal appliances shall function as intended and shall be clearly visible.
- .18 Fire suppression supervision:
 - .1 Coordinate with the requirements of Section 21 12 00, and Section 21 13 00.
 - .2 Sprinkler and standpipe trade to activate each sprinkler and standpipe supervisory and alarm device by operating valves and producing flows as required in conjunction with fire alarm technician to observe activation of flow switches, pressure switches, supervised valves, etc.
- .19 Annunciators, printers, and workstations:
 - .1 Inspect and operate to establish that their operation in conjunction with the control equipment and other system components, is as intended. The equipment shall be inspected to ensure:
 - .1 The zone of each alarm initiating device is properly indicated;
 - .2 The legend is clearly visible;
 - .3 Adequate voltage under local conditions is present;
 - .4 Wiring connections have been made in a workmanlike manner.
 - .5 Proper care must be taken to establish that each item is complete and satisfactory.
- .20 Standby power supplies - batteries:
 - .1 Examine batteries for possible damage and consideration of the following:
 - .1 The charging system functions as intended;
 - .2 The installation has not resulted in the bypassing of a fuse or a similar protective device;
 - .3 The installation protects the batteries from accidental or mechanical damage.
 - .4 The batteries must be able to operate the fire alarm system with the charger input disconnected for one rated load cycle.
- .21 Control equipment and transponders:
 - .1 Test to establish that they function as intended. The following examinations and tests shall be performed:
 - .1 A visual and physical inspection of all cables, plug interconnections, plug-in circuit components, lamps, sockets and controls to establish that their mechanical and electrical connections and mounting are as required for intended function and, where applicable, to confirm electrical supervision;
 - .2 Verification that all field wiring is terminated in a workman-like manner;
 - .3 All lamps and indicators shall be tested for operation and intended function;
 - .4 All keypad functions shall be tested for operation and intended function;

- .5 All control unit functions shall be operated to verify appropriate response including all software routines and programme functions are simulated;
- .6 Simulation of open circuits, short circuits and ground faults on all relevant internal circuits in order to confirm the appropriate supervisory response;
- .2 Commissioning Report:
 - .1 Provide in accordance with requirements of Section 01 91 13, supplemented as specified herein.
 - .2 Report to include relevant information of the system including:
 - .3 Each system part described.
 - .4 How the system is operated.
 - .5 What functions the system performs.
 - .6 Requirements for tests and service.
 - .7 Itemization of all devices connected on the system, their general location.
 - .8 The date of the performed tests.
 - .9 All pertinent details of the report sheets requested.
- .3 Verification:
 - .1 The Commissioning Report to be submitted to the Commissioning Manager upon completion of commissioning and will be subject to verification by the Commissioning Manager.

3.2 SIMULATIONS OF INTERCONNECTED SYSTEMS

- .1 Provide simulations of all interconnected systems in accordance with CAN/ULC-S1001.

END OF SECTION