

APPENDIX "A"

PRELIMINARY COMMISSIONING PLAN



Maritech Commissioning Works Ltd.

PRELIMINARY COMMISSIONING PLAN

**New Food Service Building
Cook Chill Production
Westmorland Institution
Dorchester, N. B.**

**(Project No. R.061828.001)
(Maritech Project No. 15-13-020)**

Date: October 25, 2013

Prepared By:

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1. Overview

Abbreviations and Definitions

The following are common abbreviations used in this document.

A/E	Consultants	MC	Mechanical Contractor
CA	Commissioning Agent	Mfr	Manufacturer
CC	Controls Contractor	PC	Pre-functional Checklist
EC	Electrical Contractor	PM	Project Manager
FT	Functional Performance Test	Subs	Subcontractors to General
GC	General Contractor	TAB	Test and Balance Contractor

Commissioned Systems

Commissioning and training of the following systems will be verified in this project.

HVAC Systems:

- Air and water testing and balancing (TAB)
- Steam Boilers
- Heating Boilers
- Air Handling Units
- Energy Recovery Ventilator
- Exhaust Fans
- Domestic Water Heaters
- Heat Exchanger
- Cabinet Unit Heaters and Baseboards
- Door Air Curtain
- Pumps
- HVAC Zones
- Heating Loops
- Energy Management and Control System (EMCS)

Electrical Systems:

- Interior and Exterior Lighting and Lighting Controls
- Main Service Entrance Board
- Panelboards
- Emergency lighting
- Feeders
- Exit signs
- Wiring Devices

Life Safety:

- Fire alarm
- Fire suppression system
- Security Access and Alarm System

2. General Building Information

Project: New Food Services Building, Cook Chill Production

Location: Westmorland Institution, Dorchester, N.B.

3. Construction/Commissioning Team

Team Member	Company & Contact Names	Telephone, Fax, E-Mail
Owner	Correctional Service Canada Westmorland Institution Dorchester, New Brunswick Contact Person	Tel: (XXX) XXX-XXX Fax: (XXX) XXX-XXX E-mail: XXX@XXX.XXX
Project Manager	Public Works and Government Services Canada Moncton, New Brunswick Nathalie Sears	Tel: (506) 851-2344 Fax: (506) 851-6500 E-mail: nathalie.sears@pwgsc-tpsgc.gc.ca
Architect	DFS Inc. Saint John, New Brunswick Gaye Kapkin	Tel: (506) 634-8377 ext. 448 Fax: (506) 632-1741 E-mail: kapkin@dfsarch.com
Commissioning Agent	Maritech Commissioning Works Moncton, New Brunswick Garth Nason, CET, CEM	Tel: (506) 857-8880 Fax: (506) 859-8393 E-mail: gnason@mcw.com
General Contractor	TBD	Tel: Fax: E-mail:
Structural Engineering	Eastern Designers & Company Ltd. Fredericton, New Brunswick Contact Person	Tel: (506) 452-8480 Fax: (506) 452-1510 E-mail: XXX@XXX.XXX
Mechanical Engineering	CBCL Limited Saint John, New Brunswick Matthew Peachman, P. Eng.	Tel: (506) 633-6650 Fax: (506) 633-6659 E-mail: mpeachman@cbcl.ca
Electrical Engineering	CBCL Limited Saint John, New Brunswick Matthew Peachman, P. Eng.	Tel: (506) 633-6650 Fax: (506) 633-6659 E-mail: mpeachman@cbcl.ca
Mechanical Contractor Plumbing & Heating Contractor	TBD	Tel: Fax: E-mail:
Ventilation Contractor Project Supervisor	TBD	Tel: Fax: E-mail:
Electrical Contractor Project Supervisor	TBD	Tel: Fax: E-mail:
TAB Contractor Project Supervisor	TBD	Tel: Fax: E-mail:
Controls Contractor Project Supervisor	TBD	Tel: Fax: E-mail:

4. Roles and Responsibilities

Team Members

The members of the Commissioning Team consist of the CA, PM, assigned members from the GC, A/E, user representative, MC, EC, TAB representative, CC, any other installing subcontractors or suppliers of equipment.

General Management Plan

In general, the CA coordinates the commissioning activities and reports to the PM, and A/E as well as the Owner's Representative. The CA's responsibilities, along with all other Contractors' commissioning responsibilities, will be detailed in the specifications. All members' work together to fulfill their management protocols section below.

General Descriptions of Roles

General descriptions of the commissioning roles are as follows:

CA:

- Develops the Commissioning Plan
- Coordinates the Commissioning Process
- Oversees and documents Performance Tests
- Approves Test Plans and Signs-off on performance
- Verifies that the systems are performing in accordance with Contract Documents
- Develops General Training Plan and coordinates training
- Develops the Functional Test Forms for incorporation in the Contract Documents

GC:

- Facilitates the Commissioning Process
- Ensures that Subs perform their responsibilities
- Integrates Commissioning into the Construction Process and Schedule
- Coordinates Training

Subs:

- Demonstrate proper system performance and perform the actual testing as designated by the Commissioning Team.

A/E:

- Performs construction assistance prior to O & M Manuals and assist in resolving problems
- Reviews the functional testing and performance testing

PM:

- Facilitates and supports the Commissioning process
- Gives final approval of the Commissioning work

Mfr:

- The Equipment Manufacturers and Vendors provide documentation to facilitate the Commissioning work and perform contracted startup
- Provide training as requested by the GC and CA.

4. Roles and Responsibilities – (Cont'd)

Summary

The *Commissioning Plan* provides direction for the development of the site-specific commissioning specifications by the design team. During the construction phase, the plan provides direction for the commissioning tasks during construction. The plan focuses on providing support for the specifications and provides forms for the application of the commissioning process.

The **fundamental objectives** of the Commissioning Process are:

- .1 To create a procedure to verify and provide documentation that the performance of the facility and its systems meet the Owner's requirements;
- .2 To enhance communication by documenting data and decisions throughout all phases of the project; and
- .3 To validate and report that building system performance meets the design intent and Owner's requirement.

During the Construction phase; the facility is constructed, utility services established and systems and equipment installed, functionally tested and operated. At this time system verification or pre-functional testing can be carried out. The Commissioning Plan is modified to reflect changes made to systems and equipment.

During the *acceptance phase*; functional testing is conducted to verify that performance of the systems meet the objectives defined in the design intent. Building system O & M documentation is reviewed and approved and maintenance staff is trained on O & M procedures.

Commissioning Process, Final Commissioning

Commissioning Scope Meeting

A Commissioning Meeting is planned and conducted by the CA. In attendance are the respective representatives of the GC, CA, PM, A/E, user representative and the Mechanical, Electrical, Controls and Tab Subs. The following items will be discussed at the meeting; reporting lines, flow of documents, project schedule and a primary contacts / contact information for each company represented. The *Commissioning Plan* is reviewed, process questions are addressed and the work product list discussed. Also covered is the general list of each party's responsibilities, which is responsible to develop the startup for each piece of equipment. The outcome of the meeting is, increased understanding by all parties of the commissioning process and their respective responsibilities. The meeting provides the additional information needed by the CA to finalize the *Commissioning Plan*. Following the meeting; the commissioning schedule will be developed for review by the PM and GC.

Prior to this meeting, the CA is given by the GC, all drawings and specifications and the construction schedule by trade. The CA keeps notes from the meeting and distributes them to each team member.

4. Roles and Responsibilities – (Cont'd)

Site Observation

The CA will make periodic visits to the site as necessary to witness equipment and system installations and carry out any information gathering required. Any additional witnessing required will be carried out by the CM or Site Engineer.

Commissioning Coordination Meetings / Construction Meetings

The CA attends selected planning and job-site meetings in order to remain informed on construction progress and to update parties involved in commissioning. The CA obtains and reports as required, information regarding substitutions, Change Orders and any Site Instructions that may affect commissioning equipment, systems or the commissioning schedule. The CA will review Construction Meeting Minutes and Change Orders.

Later during construction, the CA through the GC will schedule Commissioning Coordination meetings between the various commissioning team members.

Sequential Priorities

The following sequential priorities are followed:

1. Equipment is not “temporarily” started (for heating or cooling), until pre-start checklist items and all Manufacturers’ pre-start procedures are completed and moisture, dust and other environmental and building integrity issues have been addressed.
2. Functional testing is not begun until pre-functional and start-up and TAB is completed, for a given system.
3. The controls system and equipment it controls are not functionally tested until all points have been calibrated and pre-functional testing completed.

Project Schedule

Initial Commissioning Schedule Summary – **TENTATIVE**

Task/Activity	Est. Start Date	Est. End Date
Initial scoping meeting and final plan	February 1, 2014	October 31, 2014
Submittals obtained and reviewed	February 1, 2014	October 31, 2014
Begin construction site visits/inspections	April 1, 2014	October 31, 2014
Prefunctional forms developed and distributed	April 1, 2014	October 31, 2014
Startup and initial checkout plans	April 1, 2014	October 31, 2014
Startup and initial checkout executed	April 1, 2014	October 31, 2014
TAB	September 1, 2014	October 31, 2014
Water	September 1, 2014	October 31, 2014
Air	September 1, 2014	October 31, 2014
Functional performance tests	October 1, 2014	October 31, 2014
O&M documentation review and verification	November 1, 2014	November 30, 2014
Training and training verification	November 1, 2014	November 30, 2014
Final commissioning report	November 1, 2014	November 30, 2014

5. Deliverables

.1 Initial Submittals and Documentation

Standard Submittals

The CA provides the GC with all applicable documentation requirements for commissioning equipment. This information is to be coordinated appropriately with his subs. This data request typically coincides with the normal A/E submittal process. At minimum, this equipment data includes installation and start-up procedures, O & M data and performance data and control drawings. The CA reviews submissions relative to commissioning issues expressed in the contract documents, not for General Contract compliance, which is the A/E's responsibility.

Special Submittals, Notifications and Clarifications

The A/E notifies the CA of any new design intent or operating parameter changes, added control strategies and Sequences of Operation or other Change Orders that may affect commissioned systems. As the phases of the TAB are completed, the draft TAB report is provided to the CA with full explanations of approach, methods, results, data table legends, etc. The final TAB report is provided to the CA upon completion.

These submittals to the CA do not constitute compliance for submittals for the O & M Manuals. The CA receives system sequence and performance criteria from the A/E and from the GC.

Pre-functional Checklists, Tests and Startup

Pre-functional checklists are important to ensure that the equipment and systems are hooked up and operational and that functional performance testing may proceed without unnecessary delays. Each piece of equipment receives full pre-functional checkout by the Contractor. No sampling strategies are used. In general, the pre-functional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

Pre-functional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., oil levels OK, fan belt tension, labels affixed, gauges in place, sensor calibration, etc.). However, some pre-functional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three-phase pump motor of a chiller system). The word pre-functional refers to before functional testing. Pre-functional checklists augment and are combined with the Manufacturer's start-up checklist.

Contractors typically already perform some, if not many of the pre-functional checklist items the commissioning authority will recommend. However, few Contractors document in writing the execution of these checklist items. This process requires that the procedures be documented in writing by the installing technician. The CA or Resident Engineer does not necessarily witness all of the pre-functional checks, except for testing of larger or more critical pieces of equipment.

5. Deliverables – (Cont'd)

.1 Initial Submittals and Documentation – (Cont'd)

Execution of Checklists and Startup

Four weeks prior to startup, the Subs and Vendors schedule start-up and initial checkout with the GC, PM and CA. The start-up and initial checkout are directed and executed by the Sub or Vendor. Reports are to be submitted to the CA.

To document the process of start-up and checkout, the site technician performing the line item task and checks off items on the pre-functional and Manufacturer field checkout sheets as they are completed. Only individuals having direct knowledge of a line item being completed shall check or initial the forms.

Deficiencies and Non-Conformance

The Subs clearly list any outstanding items of the initial start-up and pre-functional procedures that were not completed successfully at the bottom of the procedure form or on an attached sheet. The procedure form and deficiencies are provided to the CA within two days of test completion. The CA works with the GC, Subs and Vendors to correct and retest deficiencies or uncompleted items. The installing Subs or Vendors correct all areas that are deficient or incomplete according to the checklists and tests.

.2 Development of Functional Test and Verification Procedures

Overview

Functional testing is the dynamic testing of systems (rather than just components) under full operation. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all of the Control System's Sequences of Operation and components are verified. The A/E and CA develop the Functional Test Procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing Contractor or Vendor.

Scope of Testing

The specifications "Testing Requirements" may provide specific Functional Testing Scope for each piece of Commissioned equipment. A detailed description of the functional and pre-functional testing procedures and process is found in the Specifications. Specific testing requirements will be included in the bid documents and original specifications, further testing will be developed as required for the project and for each piece of commissioned equipment.

5. Deliverables – (Cont'd)

.2 Development of Functional Test and Verification Procedures – (Cont'd)

Development Process

Before test procedures are written, the CA obtains all requested documentation and a current list of Change Orders affecting equipment or systems, including an updated points list, Control Sequences and Operation to develop these tests. Prior to execution, the CA provides a copy of the primary equipment tests to the installing Sub (via the GC/PM) who reviews the tests for Feasibility, Safety, Warranty and Equipment Protection. Blank copies of the procedures are input into the O & M Manuals for later use by Operations Staff.

Functional Testing and Verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. The CA follows the Specifications when given and uses judgement where needed to determine which method is most appropriate. According to the Specifications, not all pieces of identical equipment receive in-depth testing. The CA reviews Owner-contracted, factory or required Owner acceptance tests and determines what further testing may be required. Redundancy is minimized.

.3 Execution of Functional Testing Procedures

Overview and Process

The CA schedules functional tests through the PM, A/E, GC and affected Subs. For any given system, prior to performing functional testing, the CA waits until the pre-functional checklist has been submitted with the necessary signatures, confirming that the system is ready for functional testing. The CA or Site Engineer oversees witnesses and documents the functional testing of all equipment and systems according to the requirement of the Plan.

The Sub-contractors execute the tests. The control system is tested before it is used to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems and finally to interlocks and connections between systems.

Deficiencies and Re-testing

The CA documents the results of the test. Corrections of minor deficiencies identified are made during the tests at his discretion. The CA or Site Engineer schedules re-testing through the GC. Decisions regarding deficiencies and corrections are made between PM, CA, A/E or GC and the Sub. For areas in dispute, final authority resides with the A/E and PM. The CA recommends acceptance of each test.

Facility Staff Participation

The Owner's facilities operating staff are recommended to attend and participate in the testing process. The CA will notify the PM who will then notify the Facility Staff when the commissioning events will occur.

5. Deliverables – (Cont'd)

.3 Execution of Functional Testing Procedures – (Cont'd)

Sampling Strategy

Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy.

The following table provides a tentative list of the equipment and how the Commissioning Authority will witness functional testing of equipment. **Please note, this is an example only and will be modified in the Final Commissioning Plan).**

<u>Equipment or System</u>	<u>Fraction to be Observed by CA or Site Engineer</u>
Water side TAB Work	20%
Air side TAB Work	20%
Steam Boilers	100%
Heating Boilers	100%
Air Handling Units	100%
Energy Recovery Ventilators	100%
Exhaust Fans	100%
DHW Heating System	100%
Heat Exchanger	100%
Cabinet Heaters and Baseboards	50%
Door Air Curtain	100%
Pumps	100%
HVAC Zones	50%
Heating Loops	100%
Building Automation System	per mechanical functional tests.
Lighting Controls/Lighting Levels	50%
Panelboards	100%
Main Service Entrance Board	100%
Feeders	100%
Wiring Devices	20%
Emergency Lighting	100%
Exit Signs/Exterior Lighting	100%
Fire Alarm System	100%
Fire Suppression System	100%
Security Access and Alarm System	100%

In all cases including functional testing based on a percentage of the total items of equipment (sampling rate), the equipment to be tested will be listed in the particular functional test. In the case of multiple and identical items of equipment, the sampling percentage will be as outlined in the commissioning plan section 5.3 execution of test procedure, sampling strategy.

A failure of more than 10% of the selected equipment in the functional test shall be considered a failure of the particular test item. In this case, the equipment failure shall be corrected and retested and an additional number of items of equipment shall be tested. This shall continue until the particular functional test is successful i.e. less than 10% failure.

5. Deliverables – (Cont'd)

.4 O & M Manuals, Training Records and Commissioning Report

Standard O & M Manuals

The CA receives from A/E for review the O & M Manuals for systems that were commissioned. The CA recommends approval of these sections of the O & M Manuals to the A/E. The CA also reviews each equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated.

Training and Orientation of Owner Personnel

Owner training and orientation on equipment systems is the responsibility of the GC. The CA will review and approve training outlines as well as oversee and document the training. The owner will provide a list of participants and a location for the training if possible.

The GC will coordinate all training activities in accordance with this document and the specifications. Specification 01 91 41 provides detailed instructions and information for all parties involved in the training process. The GC will provide the CA with a training schedule and outline. The schedule is to include training location, equipment to be covered, material to be covered and a timeline for each session. Information on the instructor shall also be provided including qualifications.

The CA will review the training schedule/outline and approve or make recommendations as necessary. The CA will also consult with the owner and develop a list of participants which will be provided to the GC. The training material will be incorporated into the final commissioning report by the CA.

The owner shall work in conjunction with the CA to review and approve the training schedule and outline. The owner will also provide to the CA a list of participants for the training and make them available for training. A location for training will also be provided by the owner, if possible.

The instructor for each piece of equipment shall be factory trained and fully knowledgeable on the operation and maintenance of the equipment.

Special Training and Orientation

For the following checked items, the CA and A/E would complete orientation and training according to the specifications:

✓ Re-commissioning

The Commissioning Agent will provide instruction on the use of blank Functional Test Forms for periodic re-commissioning of equipment and systems per the specification.

 Architect

The Architect will provide a general overview of the Facility, its use, special features, tenant and public considerations, etc.

5. Deliverables – (Cont'd)

.4 O & M Manuals, Training Records and Commissioning Report – (Cont'd)

Special Training and Orientation – (Cont'd)

✓ Mechanical Design Engineer

The Mechanical Designer will provide an overview of the major systems and equipment in the facility. It will include for each system: the design intent, why the system was chosen, an overview of its operation and interactions with other systems, any special areas to be aware of, issues regarding future expansion and remodeling, etc. They will verify the total system as constructed meets the project specific requirements, i.e.: energy consumption, serviceability, system longevity, etc.

✓ Electrical Design Engineer

The Electrical Designer will provide an overview of the major electrical systems and equipment in the facility. They will particularly include the lighting control systems, fire alarm, security and emergency power focusing on the design intent, why the system was chosen, an overview of its operation and interactions with other systems, any special areas to be aware of, issues regarding future expansion and remodeling, etc. They will verify the total system as constructed meets the project specific requirements, i.e.: energy consumption, serviceability, system longevity, etc.

Summary Report

A Final Summary Report by the CA will be provided to the PM. The Report shall include an Executive Summary, List of Participants and Roles, Brief Building Description provided by the A/E, overview of Commissioning and Testing Scope and a General Description of testing and verification methods. All outstanding non-compliance items shall be specifically listed. The functional performance and efficiency section for each piece of equipment shall include a brief description of the verification method used (manual testing, BMS trend logs, data loggers, etc.) and includes observations and conclusions from the testing.

6. Testing Equipment

- .1 All standard testing equipment required to perform start-up and installation verification and required functional performance testing shall be provided by the division Contractor for the equipment being tested.
- .2 Special test equipment, tools or instruments required by the Contract documents shall be provided for commissioning and shall be left on site.
- .3 All testing equipment shall have had a certified calibration, traceable to a national standard, performed within the past year. If not otherwise noted, temperature sensors and digital thermometers shall have an accuracy of $\pm 0.1^{\circ}\text{F}$, pressure sensors shall have an accuracy of $\pm 1.0\%$ for each range available on the instrument (not the full range of the meter). All equipment shall be re-calibrated when dropped or damaged.

APPENDIX A

MECHANICAL STATIC CHECK FORMS

INDEX/COVER SHEET

PAGE #

MSC-1	Steam Boiler Static Check Form
MSC-2	Heating Boiler Static Check Form
MSC-3	Air Handling Unit Static Check Form
MSC-4	Energy Recovery Static Check Form
MSC-5	Exhaust Fans Static Check Form
MSC-6	Domestic Water Heater Static Check Form
MSC-7	Heat Exchanger Static Check Form
MSC-8	Cabinet Unit Heaters and Baseboards Static Check Form
MSC-9	Door Air Curtain Static Check Form
MSC-10	Pumps Static Check Form
MSC-11	HVAC Zones Static Check Form
MSC-12	Heating Loops Static Check Form
MSC-13	EMCS Static Check Form
MSC-14	Fire Suppression Static Check Form

NOTE: **Mechanical Static Check Forms will be developed based on Reviewed Shop Drawings.
Final equipment list to be determined.**

APPENDIX B

MECHANICAL START-UP FORMS

INDEX/COVER SHEET

PAGE #

MSU-1	Steam Boiler Start-Up Form
MSU-2	Heating Boiler Start-Up Form
MSU-3	Air Handling Unit Start-Up Form
MSU-4	Energy Recovery Start-Up Form
MSU-5	Exhaust Fans Start-Up Form
MSU-6	Domestic Water Heater Start-Up Form
MSU-7	Heat Exchanger Start-Up Form
MSU-8	Cabinet Unit Heaters and Baseboards Start-Up Form
MSU-9	Door Air Curtain Start-Up Form
MSU-10	Pumps Static Start-Up Form
MSU-11	HVAC Zones Start-Up Form
MSU-12	Heating Loops Start-Up Form
MSU-13	EMCS Start-Up Form
MSU-14	Fire Suppression Start-Up Form

NOTE: **Mechanical Start-Up forms will be provided by Equipment Manufacturer or developed by Commissioning Agent.**
 Final equipment list to be determined.

APPENDIX C

MECHANICAL FUNCTIONAL TESTS FORMS

INDEX/COVER SHEET

PAGE #

MFT-1	TAB Functional Test
MFT-2	Steam Boiler Functional Tests
MFT-3	Heating Boiler Functional Tests
MFT-4	Air Handling Unit Functional Tests
MFT-5	Energy Recovery Ventilator Functional Tests
MFT-6	Exhaust Fans Functional Tests
MFT-7	Domestic Water Heater Functional Test
MFT-8	Heat Exchanger Functional Tests
MFT-9	Cabinet Unit Heaters and Baseboards Functional Tests
MFT-10	Door Air Curtain Functional Test
MFT-11	Pumps & Heating Loops Functional Test
MFT-12	HVAC Zones Functional Test
MFT-13	EMCS Functional Test
MFT-14	Fire Suppression System Functional Test

NOTE: **Mechanical Functional Test Forms will be developed based on Reviewed Shop Drawings and Sequence of Operations.
Final systems and equipment list to be determined.**

APPENDIX D

ELECTRICAL STATIC CHECK FORMS

INDEX/COVER SHEET

PAGE #

ESC-1	Power Cables Static Check Form
ESC-2	Load Break Switches Static Check Form
ESC-3	Main Service Entrance Board Static Check Form
ESC-4	Feeders Static Check Form
ESC-5	Panelboards Static Check Form
ESC-6	Wiring Devices Static Check Form
ESC-7	Lighting and Controls Static Check Form
ESC-8	Unit Equipment for Emergency Lighting Static Check Form
ESC-9	Exit Signs Static Check Form
ESC-10	Exterior Lighting Controls Static Check Form
ESC-11	Fire Alarm System Static Check Form
ESC-12	Security Access and Alarm System Static Check Form

NOTE: **Electrical Static Check Forms will be developed based on Reviewed Shop Drawings.
Final equipment list to be determined.**

APPENDIX E

ELECTRICAL FUNCTIONAL TEST FORMS

INDEX/COVER SHEET

PAGE #

EFT-1	Power Cables Functional Test Form
EFT-2	Load Break Switches Functional Test Form
EFT-3	Main Service Entrance Board Functional Test Form
EFT-4	Feeders Functional Test Form
EFT-5	Panelboards Functional Test Form
EFT-6	Wiring Devices Functional Test Form
EFT-7	Lighting and Controls Functional Test Form
EFT-8	Unit Equipment for Emergency Lighting Functional Test Form
EFT-9	Exit Signs Functional Test Form
EFT-10	Exterior Lighting Controls Functional Test Form
EFT-11	Fire Alarm System Functional Test Form
EFT-12	Security Access and Alarm System Functional Test Form

NOTE: **Electrical Functional Test Forms will be developed based on Reviewed Shop Drawings.
Final equipment list to be determined.**

APPENDIX F

MECHANICAL AND ELECTRICAL VERIFICATION OF COMMISSIONING OUTLINE

Two way radios will be required for this work.

Estimated time duration indicated for each functional test is based on the following:

- Commissioning having been completed prior to verification of commissioning by means of the functional tests
- The time/resource allowances provided are offered as a guideline only and actual allowance for time and resources carried in the tender by contractors involved will be held to be their own interpretation of contract requirements with respect to verification of commissioning.

Mechanical

1. MFT-1 TAB Functional Test, estimated time, 4 hours.

Prerequisites as follows:

- Mechanical/Electrical services complete
- TAB complete and reports verified
- Tab agent present
- EMCS tech available and on site within 30 min
- HVAC trade available and on site within 30 min
- Plumbing/heating trade available and on site within 30 min.

2. MFT-2 Steam Boiler Functional Test, estimated time, 4 hours.

Prerequisites as follows:

- Mechanical/Electrical services complete,
- TAB complete and reports verified.
- EMCS tech present
- Plumbing/Heating, Gas trade present.

3. MFT-3 Heating Boiler Functional Test, estimated time, 4 hours.

Prerequisites as follows:

- Mechanical/Electrical services complete
- TAB complete and reports verified.
- EMCS tech present
- Plumbing/Heating, Gas trade present.

4. MFT-4 Air Handling Units, estimated time, 8 hours.

Prerequisites as follows:

- Mechanical/Electrical services complete
- TAB complete and startup report verified.
- Factory rep, EMCS tech present
- HVAC trade present
- Electrical trade available and on site within 30 min
- Plumbing/heating trade available and on site within 30 min

Mechanical – (Cont'd)

5. MFT-5 Energy Recovery Ventilator Functional Test, estimated time, 4 hours.
Prerequisites as follows:
 - Mechanical/Electrical services complete
 - TAB complete and startup report verified.
 - Factory rep, EMCS tech present
 - HVAC trade present
 - Electrical trade available and on site within 30 min
 - Plumbing/heating trade available and on site within 30 min
6. MFT-6 Exhaust Fans Functional Test, estimated time 4 hours
Prerequisites as follows:
 - Mechanical/Electrical services complete
 - TAB complete and reports verified.
 - EMCS tech present
 - Electrical trade available and on site within 30 min.
 - HVAC trade present.
7. MFT-7 Domestic Water Heater Functional Test, estimated time, 2 hours.
Prerequisites as follows:
 - Mechanical/Electrical services complete, startup report verified.
 - Hydronic TAB completed.
 - Boiler start-up complete.
 - Plumbing trade, Gas Trade, EMCS Tech present.
 - Electrical trade available on site within 30 min.
8. MFT-8 Heat Exchanger Functional Test, estimated time, 2 hours.
Prerequisites as follows:
 - Mechanical/Electrical services complete
 - TAB complete and startup report verified.
 - Factory rep, EMCS tech present
 - Electrical trade available and on site within 30 min
 - Plumbing/heating trade available and on site within 30 min
9. MFT-9 Cabinet Unit Heaters and Baseboards Functional Test, estimated time, 8 hours.
Prerequisites as follows:
 - Mechanical/Electrical services complete
 - TAB complete and startup report verified.
 - EMCS tech present
 - Electrical trade available and on site within 30 min
 - Plumbing/heating trade available and on site within 30 min
10. MFT-10 Door Air Curtain Functional Test, estimated time, 2 hours.
Prerequisites as follows:
 - Mechanical/Electrical services complete
 - EMCS tech present
 - HVAC trade present
 - Electrical trade available and on site within 30 min
 - Plumbing/heating trade available and on site within 30 min

Mechanical – (Cont'd)

11. MFT-11 Pumps and Heating Loops Functional Test, estimated time, 8 hours.

Prerequisites as follows:

- Mechanical/Electrical services complete
- TAB complete and startup report verified.
- EMCS tech present
- Electrical trade available and on site within 30 min
- Plumbing/heating trade available and on site within 30 min

12. MFT-12 HVAC Zones Functional Test, estimated time, 8 hours.

Prerequisites as follows:

- Mechanical/Electrical services complete
- TAB complete and reports verified.
- EMCS tech present
- HVAC trade available and on site within 30 min
- Plumbing trade available and on site within 30 min

13. MFT-13 EMCS Functional Test, estimated time, 2 hours.

Prerequisites as follows:

- Mechanical/Electrical services complete
- EMCS tech present

14. MFT-14 Fire Suppression System Functional Test, estimated time, 8 hours

Prerequisites as follows:

- Testing is to be done in accordance with NFPA 13 Installation of Sprinkler Systems, Chapter 24
- Systems Acceptance
- Building water supply, fire protection system fully operational.
- Copies of completed Contractors Material and Test Certificate for Above Ground Piping and
- Contractors Material and Test Certificate for Below Ground Piping provided to Commissioning
- Agent (CA).
- Sprinkler trade present.
- Fire alarm contractor present at testing of devices connected to fire alarm system.

END OF MECHANICAL SECTION

Electrical

1. EFT-1 Power Cables Functional Test, estimated time 2 hours
Prerequisites as follows:
 - Connection check
 - Megger test
 - High pot test
2. EFT-2 Load Break Switches Functional Test, estimated time 2 hours
Prerequisites as follows:
 - Check mechanical operation
 - Megger (Insulation Integrity) test
3. EFT-3 Main Service Entrance Functional Test, estimated time 4 hours
Prerequisites as follows:
 - Adjustments and calibrations carried out, field verification report by manufacturer provided to commissioning agent.
 - Testing of primary and branch feeders and torque of lug bolts to be done before the seb is energized. Otherwise it will have to be shut down for this work.
 - Entrance board loaded to design capacity.
 - EMCS Tech available by telephone and on site within 30 min to manipulate the mechanical systems as required.
 - Electrical trade present.
4. EFT-4 Feeders Functional Test, estimated time 2 hours
Prerequisites as follows:
 - Electrical trade present.
 - Testing of feeders and torque of lugbolts to be done before the panels are energized.
5. EFT-5 Panelboards Functional Test, estimated time 2 hours
Prerequisites as follows:
 - Testing of branches circuits and torque of lugbolts to be done before the panels are energized.
 - Panels loaded to maximum capacity.
 - EMCS Tech available by telephone and on site within 30 min to manipulate the mechanical systems as required.
6. EFT-6 Wiring Devices Functional Test, estimated time 4 hours
Prerequisites as follows:
 - Electrical trade present.
 - Electrical services complete.
7. EFT-7 Lighting and Controls Functional Test, estimated time 4 hours
Prerequisites as follows:
 - Lighting fixtures must be installed c/w controls and operational, involves testing at night.
 - Light meter as specified.
 - Trained rep available.

Electrical – (Cont'd)

8. EFT-8 Unit Equipment for Emergency Lighting Functional Test, estimated time 1 hour
Prerequisites as follows:
 - To be coordinated with verification of emergency power supply.
 - Electrical trade complete.
9. EFT-9 Exit Signs Functional Test, estimated time 1 hour
Prerequisites as follows:
 - Electrical trade present.
 - Electrical services complete.
10. EFT-10 Exterior Lighting Controls Functional Test, estimated time 1 hour
Prerequisites as follows:
 - Lighting fixtures must be installed c/w controls and operational, involves testing at daylight and dusk.
 - Electrical trade present.
 - Manufacturer rep when required.
11. EFT-11 Fire Alarm Systems Functional Test, estimated time 4 hours
Prerequisites as follows:
 - Electrical services present.
 - Electrical trained tech complete.
 - Fire alarm trade present.
 - EMCS tech available by telephone and on site within 30 min to manipulate the mechanical systems as required.
12. EFT-12 Security Alarm and Access System Functional Test, estimated time 4 hours
Prerequisites as follows:
 - Electrical services present.
 - Electrical trained tech complete.
 - Electrical trade present.
 - EMCS tech available by telephone and on site within 30 min to manipulate the mechanical systems as required.

END OF ELECTRICAL SECTION

-- END OF APPENDIX F --

APPENDIX G

TRAINING PLAN

Training shall be provided in accordance with the following requirements which are specified in Section 01 91 01 General Commissioning Requirements:

1. Instruct personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction. Review contents of manual in detail to explain all aspects of operation and maintenance.
2. No training will take place without the contractor submitting the following information to the Project Manager two (2) weeks in advance:
 - The qualifications of the instructors.
 - The written agenda for the training session(s).
 - The training manuals, tools and O&M Manuals for review.
3. As a minimum, the training sessions shall cover the following information as applicable:
 - .1 Introduction.
 - .2 Description of the system with factory personnel being involved at appropriate times.
 - .3 Instructions on start-up procedures including seasonal procedures, system check-lists and emergency procedures.
 - .4 A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
 - .5 Instruction on system shutdowns, including checklists.
 - .6 Instructions on all aspects of system maintenance, including routine servicing, lubrication, overhaul and factory servicing.
 - .7 Discussion of relevant health and safety issues and concerns.
 - .8 Common troubleshooting problems and solutions.
 - .9 Information concerning the warranties and their use and the location of all guarantees.
 - .10 A description of spare parts in stock and their service.
 - .11 A description of normal tools required for servicing the systems/equipment.
 - .12 Service contacts/protocols.
4. The energy management and control system training does not include demonstration of system sequences as these will have been demonstrated to the Owner's designate(s) during the various functional tests. **Use of a room with overhead or table mount projector and screen in concert with laptop computer containing control software, graphics, sequences etc specific to this project is considered a prerequisite for most effective demonstration and presentation of the material specified herein.**

MECHANICAL

Day 1

- 8:30 – 10:00 am Mechanical Design Engineer
- Overview of the major systems and equipment, interactions with other systems, any special areas to be aware of, issues regarding future expansion, system longevity, etc.
- 10:30am – 12:00pm Plumbing as follows:
- Explanation of equipment, arrangement and operation of the system, location of principle control valves, turnover and explanation of valve chart, identification of location of principle devices above ceiling
 - Backflow preventers esp requirement for periodic retesting as required by CSA B64, Canadian Plumbing Code
 - Trap priming system
 - Sanitary drainage, waste and venting pipe routing including location of cleanouts
 - Oil interceptor operation and maintenance
 - Cold, recirculation and hot water distribution piping and routing
 - Domestic water heating system
 - Domestic water heaters including maintenance/spare parts, operating characteristics/pressures etc, periodic cleaning –**manufacturer's rep mandatory**
 - Thermostatic mixing valves, recirculation subsystem, makeup water system
 - Service contacts/protocol
 - Pumps incl controls, maintenance, spare parts, normal operating range
- 1:00pm – 3:00pm Heating as follows:
- Explanation of equipment, arrangement and operation of the system, location of principle control valves, turnover and explanation of valve chart, identification of location of principle devices above ceiling
 - AHU's and perimeter heating loop operation and maintenance
 - Steam and Hot Water Boiler operation and maintenance
 - Hot water distribution system, pumps ,water temperature scheduling system, expansion compensation
 - Makeup water system
 - Glycol charging system
 - Service contacts/protocol

MECHANICAL (Con't)

Day 2

8:30 am – 10:30am Ventilation as follows:

- General arrangement and operation of the systems, identification of location of principle devices above ceiling
- Location of, function and resetting of fire dampers
- Air Heating Units including normal operating temperatures, pressures, filter change etc - **manufacturer's rep mandatory**
- Static pressure control, variable speed drives - **manufacturer's rep mandatory**
- Interpretation of control module parameters, servicing requirements, panel settings, manual capacity output adjustment
- Heating/cooling coil
- Maintenance requirements, spare part requirements, operating characteristics, periodic filter changes including location of spare filters supplied under this contract, belt replacements
- Exhaust systems
- CO₂ sensors, maintenance requirements, calibration requirements
- VAV Box operation, maintenance and operating ranges
- Service contacts/protocol

10:30am – 12:00pm Energy management and control system (EMCS) as follows:

- Explanation of equipment, arrangement and operation of the control system front end including remote access modem
- Explanation of equipment, arrangement and operation of the components: actuators, valves, VFD's, sensors, relays, junction boxes, fire alarm signal wires, front end computer, EMCS boards, available memory with regard to future expansion, communication wires, transformers and fuses
- Capabilities and purpose of the operators workstation software including security measures, requirements for access
- Identification of location of principle devices above ceiling
- Explanation of software, password protection, remote access modem, web interface, effects of electrical service interruption, restart after.
- Graphic annunciation of systems, setpoints, modifying setpoints
- Various functions available including:
 - Scheduling including optimum start. Review schedule with trainees.
 - Alarming
 - Logging of historical data, procedure to set up a trend log, procedure to review and print out data
 - Graphic annunciation of system performance , setpoints, modifying setpoints
- Operation of energy and flow measuring instrumentation and procedure for accessing this information.
- Energy consumption tracking
- Demand limiting
- Energy Meter

MECHANICAL (Con't)

- 1:00 pm –2:30 pm Automatic Sprinkler Fire Suppression System as follows:
- Explanation of equipment, arrangement and operation of the system, location of principle control valves, turnover and explanation of valve chart,
 - Explanation of equipment, reset procedures, periodic testing requirements for backflow preventers per CSA B64
 - distribution piping and routing
 - identification of location of principle devices above ceiling
 - Demonstration of panel operation including reset procedures.
 - Maintenance requirements, spare parts, periodic testing requirements per NFPA 25
 - Service contact / emergency protocol , reset procedures

ELECTRICAL

1. Training topic: Electrical systems
Estimated time: 1 hour
Instructor: Electrical consulting engineer
Electrical systems training outline:
 - Overview of the major systems and equipment
 - Interactions between systems, any special areas to be aware of
 - Issues regarding future expansion, system longevity, etc.
2. Training topic: Lighting systems
Estimated time: 1 hour
Instructor: Electrical trade, Manufacturer's rep
Lighting systems training outline:
 - Switching methods, occupancy and daylight compensating controls
 - Exterior lighting, Electrical trade to provide instructions on the operation of devices controlled by any internal controls supplied with the system, keypad menu, password, panel settings, manual capacity output adjustment, servicing requirements etc.
 - Maintenance requirements, service contracts/protocol
 - Exit and Emergency Lighting - Fixtures
3. Training topic: Main service entrance board/ Power distribution
Estimated time: 2 hours
Instructor: Electrical trade
Main service entrance board training outline:
 - Review operating ranges, maintenance requirements and testing requirements
 - Main service entrance board
 - Power distribution
 - Motor and Controls
 - UPS
 - Service contracts/protocol

-- END OF APPENDIX G --

