

Appendix A

Commissioning Plan

COMMISSIONING PLAN

**Project No.: R.079951.001
BIO Energy Centre Upgrade
Bedford Institute of Oceanography, Dartmouth, NS**

Issued for Tender

Prepared by: SNC Lavalin Inc.

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TABLE OF CONTENTS

1.	INTRODUCTION	1
1.1	Commissioning Plan Objectives	1
2.	COMMISSIONING TEAM ROLES AND RESPONSIBILITIES.....	1
2.1	The Commissioning Authority (CA).....	1
2.2	Department Representative	2
2.3	Departmental Representative Technical Authority.....	3
2.4	Design Team Consultants.....	3
2.5	Operations Team	4
2.6	General Contractor	4
3.	COMMISSIONING PROCESS, ROLES AND RESPONSIBILITIES	6
4.	COMMISSIONING STATIC VERIFICATION FORMS	7
5.	SHOP DRAWINGS	7
6.	SYSTEMS START-UP VERIFICATION	7
6.1	Coordination.....	7
6.2	Forms.....	7
6.3	Signatures.....	7
6.4	Non-conformance:	8
6.5	Mechanical Systems:	8
6.6	Electrical Systems:.....	8
7.	SYSTEM DYNAMIC FUNCTIONAL PERFORMANCE TESTS.....	8
7.1	Objectives	8
7.2	Mechanical Systems	9
7.3	Mechanical Systems Dynamic Functional Performance Tests	9
7.4	Electrical Systems Dynamic Functional Performance Tests.....	9
8.	TRAINING.....	10
9.	FINAL ACCEPTANCE	12
10.	O&M MANUALS AND AS-BUILT DRAWINGS.....	12
11.	POST CONSTRUCTION – SEASONAL COMMISSIONING.....	12
Appendices:		
Appendix 1: Sample Training Plan		
Appendix 2: Detailed List of Building System Requiring Commissioning		
Appendix 3: Detailed Start-up Inspection and Functional Verification Forms.-To Follow		

**BIO Energy Center Upgrade
Bedford Institute of Oceanography, Dartmouth, NS**

THE PURPOSE OF THIS DOCUMENT IS TO:

1. INTRODUCE THE CONCEPT AND APPROACH TO THE COMMISSIONING OF THIS PROJECT.
2. DEFINE THE ROLE AND RESPONSIBILITIES FOR ALL THE PARTICIPANTS INVOLVED.
3. LIST AND DETAIL THE COMMISSIONING ACTIVITIES AND TEST;
AND
4. ESTABLISH A TENTATIVE SCHEDULE OF COMMISSIONING ACTIVITIES

1. INTRODUCTION

1. Commissioning is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Commissioning is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved.
2. Use this Commissioning Plan as master planning document for Commissioning. The Plan:
 1. outlines the organization, scheduling, allocation of resources, documentation, pertaining to implementation of Commissioning;
 2. communicates the responsibilities of team members involved in Commissioning Scheduling, documentation requirements, and verification procedures;
 3. sets out deliverables relating to O&M, process and administration of Commissioning;
 4. describes a process of verification of how built works meet design requirements;
 5. produces a completely functional system in accordance with the contract documents prior to issuance of Certificate of Occupancy;
 6. is a management tool that sets out scope, standards, roles and responsibilities, expectations, deliverables, and provides:
 1. overview of Commissioning;
 2. general description of elements that make up the Commissioning Plan; and
 3. process and methodology for successful Commissioning.

1.1 Commissioning Plan Objectives

1. To bring all building systems from the static completion to a state of dynamic operation;
2. Achieving, verifying and documenting the performance of the building systems to ensure that they meet the design documentation and the Owner's performance requirements;
3. To confirm the installations meet the system performance requirement.
4. To ensure that the completed facility meets user and stated requirements.

2. COMMISSIONING TEAM ROLES AND RESPONSIBILITIES

2.1 The Commissioning Authority (CA)

1. Is an authorized representative designated by the Departmental Representative.
2. Leads and ensures that the Commissioning activities are carried out in accordance with the Commissioning Plan.
3. Reports to the Departmental Representative Project Manager (PM) / Departmental Representative and ensures that the constructed systems perform in accordance with the performance and contractual requirements.
4. Co-ordinates the Design Consultant's involvement and solicits their co-operation in carrying out the Commissioning Plan to the extent that the consultant will provide a written

statement affirming that the building systems are operating in accordance with the performance requirements.

5. Is responsible for:
 1. Assembling the Commissioning Team at the first commissioning meeting and coordinating their activities in carrying out the Commissioning Plan.
 2. Chairing the commissioning meetings and distributing minutes.
 3. Participating in :
 1. The development of the Commissioning Plan Implementation Schedule; and hence, the co-ordination of this plan with the Contractor and the Departmental Representative.
 2. The preparation of the supplementary Equipment Verification Forms.
 3. The preparation of the supplementary Performance Test Procedures.
 4. The provision of information to the PM on all Commissioning activities.
 5. The co-ordination of the operation and maintenance manual set up.
 4. Reviewing:
 1. Construction and manufacturers' mechanical / electrical / misc. shop drawings after the consultant's review.
 2. Commissioning procedures in the contract documents, prior to execution of tests.
 3. Operating/maintenance data prepared by the contractors, as indicated in the Contract Documents.
 4. Project schedules with PM and Departmental Representative.
 5. Balancing reports.
 5. Witnessing/Verifying:
 1. Testing/balancing measurements and procedures. The Contractor shall submit, in writing, the air and water balancing procedures
 2. All tests specified in the contract documents. The CA shall initial all these documents at time of testing.
 6. Training:
 1. The CA in conjunction with the Departmental Representative shall co-ordinate the training of all appropriate building operators and maintenance staff.
 7. Seasonal Commissioning:
 1. The CA shall co-ordinate with the Departmental Representative as to scheduling of the required personnel.
 8. Commissioning Reports
 9. The CA shall advise the PM and the Departmental Representative on coordination of activities during the plan execution.
 10. Issues the final commissioning certificate after successful completion of seasonal commissioning

2.2 Department Representative

1. Ensures that the commissioning activities are carried out in accordance with contract documents.
2. Works with the Departmental Representative Project Manager, the CA and the General Contractor to resolve technical difficulties which may arise during the process.

3. Ensures non-conformance issues are resolved with the CA in both design and execution.
4. Works with the Operations team to ensure that the appropriate building operators and maintenance staff receive the specified training and are familiar with the system.
5. Ensures that all shop drawings, labour and materials necessary to implement commissioning, are supplied by the contractor.
6. Informs all parties of the test scheduling of mechanical and electrical installations, including site services.
7. Informs all parties of the project schedule with the co-operation of the Contractor and the CA

2.3 Departmental Representative Technical Authority

1. Ensures that the systems are installed as per the performance requirements of the project in conjunction with the CA.
2. Attends the commissioning meetings, as required by PM.
3. Attends commissioning activities, as required by PM.
4. Reviews and comments on technical problems relating to the design.

2.4 Design Team Consultants

1. Attends commissioning activities to certify that the systems meet the performance requirements.
2. Reviews all CA reports and issues any site instructions required.
3. Provides a complete and comprehensive description of system performance.
4. Co-operates with the CA by providing a written statement affirming that the building systems are operating in accordance with the performance specification.
5. Provides the Schematic Flow Diagrams required for commissioning and shall co-ordinate this activity with the CA.
6. Provides a complete Sequence of Operation for each system indicating all operating parameters, set points and schedules.
7. Provides a complete I/O Summary, which will be used as the main document in the Function and Final Performance Test.
8. Provides evaluations of each system's performance as per the design intent for inclusion in the Final Commissioning Report.
9. Provides a list of equipment to be commissioned along with the performance expected to be achieved for the project. The CA shall coordinate these requirements.

10. Forwards a copy of all shop drawings to the CA, through the Departmental Representative, after review by the Contractor and Design Consultant.

2.5 Operations Team

1. Participates in the commissioning process to receive an early introduction to the facilities systems and to provide operator feedback.
2. Identifies the prime areas of interest for the training of the building operators and maintenance staff.
3. The building operators and maintenance staff are invited to witness the start-up and testing activities and may provide comments, for future reference, on the operation and maintenance of the various systems, components and procedures.
4. The Operations representative is invited to attend the commissioning meetings.
5. Co-ordinates with the Departmental Representative and CA ensuring that all appropriate staff receive the appropriate training.
6. Provides assistance during the seasonal (deferred) commissioning.

2.6 General Contractor

1. Co-operate fully with the CA in carrying out the Commissioning Plan. At the completion of Commissioning, they shall provide a written statement affirming that the building's systems are operating properly in accordance with the design intent of the specifications and construction drawings.
2. Ensure that all necessary labour and materials are supplied for the implementation of Commissioning.
3. The General Contractor shall appoint a Contractor's Commissioning Coordinator (CCC). The CCC shall provide coordination for the delivery and fulfilment of all roles and responsibilities of the General Contractor's scope as detailed in the Commissioning Plan.
4. Submit Supplementary Equipment Verification Forms and Performance Test Procedures to the CA for review and inclusion in the Cx Plan.
5. Prepare:
 1. A comprehensive commissioning schedule, co-ordinating the activities with the Sub Contractors, Departmental Representative and CA.
 2. All testing procedures for all systems
 3. Schematics and flow diagrams necessary for Commissioning.
 4. The supply of all labour and materials required to perform seasonal commissioning as required by the CA.
 5. The Commissioning forms, as provided by the CA.
6. Prepare Commissioning Binder:
 1. The following documents shall be included in the Commissioning Binder.
 1. Commissioning Plan

2. Commissioning Schedule
3. Commissioning Meeting Minutes
4. Warranties
5. Architectural Systems Testing/Verification Reports
6. Mechanical Systems Testing/Verification Reports
7. Electrical Systems Testing/Verification Reports
8. Training and Orientation Documents
9. Seasonal
10. Final Balancing Reports
11. Commissioning Site Reports
12. Issues Log
13. Final Commissioning Plan and Report

3. COMMISSIONING PROCESS, ROLES AND RESPONSIBILITIES

1. The Commissioning Process and roles/responsibilities of all participants are as follows:

Commissioning Roles and Responsibilities Matrix									
LEGEND									
A=Accountable	P=Participates	Dept Rep PM	Dept Rep Representat Authority	Operations Team	Dept Rep	Design Team Consultants	Cx Authority (CA)	General Contractor	Sub Trades
J=Joint Effort	N=Notify								
S=Sign-off	V=Verify								
PROJECT INCEPTION STAGE									
Develop Owner's Project Requirements	A	P	P						
PRE-DESIGN PHASE									
Review Owners Project Requirements and Documentation	A	P	P			P			
Develop Statement of Construction Requirement (SOCR)	A	J				P			
Develop preliminary Commissioning (Cx) Scope	A	P	P						
Establish budget for all Cx work and integrate costs for into project budget.	A/J	J							
Identify Commissioning Authority (CA)	A/J	J							
Engage Commissioning Authority (CA)	A/S	N			N	N	N		
Provide standard Cx specification and data sheets	P	A			N	P	P		
Review Cx scope with design team and CA	P	A			P	P	P		
DESIGN STAGE									
Prepare Cx spec and supporting documentation	S				P	P	A		
Review Design Drawings and Specifications	A	P			N	P	P		
Perform Project Constructability Reviews	A				J	J	J		
Incorporate changes to design documents from design reviews	N				P	A	P		
Incorporate Cx Spec into construction package	A				P	P			
Create Cx Plan					N		A		
CONSTRUCTION STAGE									
	Dept Rep PM	Dept Rep Tech Authority	Dept Rep Construc. Eng Personnel (Base)	Dept Rep	Design Team Consultants	Cx Authority (CA)	General Contractor	Sub Trades	
Review Cx Plan	A	N	P	N	P	P	P	P	
Review shop dwgs of equipment/systems being commissioned		N	P		P	S	P	A	
Update checklists for equipment/systems to be commissioned				N	N	A	P	P	
Develop Cx Testing Procedures		N		N	N	P	A	P	
Update and Maintain Cx Plan				N	P	A	P	P	
Create Cx schedule				N		P	A	P	
Review Cx schedule	A			P	P	P	P	P	
Ongoing Cx meetings	N	N		P	N	A	P	P	
Perform Static checks/testing				P	N	P/V	A	P	
Identify Non-conformance Issues				P	N	A	P	P	
Resolve Non-conformance Issues				N	N	V	A	P	
Prepare and submit interim Cx Report	N			N	N	A	N	N	
Perform Start up checks/testing				P	N	P/V	A	P	
Identify Non-conformance Issues				P	N	A	P	P	
Resolve Non-conformance Issues				N	N	V	A	P	
Compile Static/Start Up Checklists as the work is performed				N		A	P	P	
Perform Dynamic Testing of installed systems		N		P	N	P/V	A	P	
Identify Non-conformance Issues				P	N	A	P	P	
Resolve Non-conformance Issues				N	N	V	A	P	
Compile Dynamic Checklists as work is performed				N	P	A	P	P	
Update and submit Cx Report	N			N	N	A	N	N	
Submit O&M Manuals for review and acceptance	S	N	P	P	P	P	A	P	
Submit training schedule for review and acceptance	N		P	N		S	A	P	
Coordinate User Training			P	A		P	P	P	
Conduct User training	N		P	N		V	A	P	
Submit & Review Cx Manual	S	P		P		A	P	P	
POST CONSTRUCTION									
Initiate seasonal Cx	N	N		J	N	J	P	P	
Perform seasonal Cx IAW specs	N	N	P	N	N	P/V	A	P	
Identify Non-conformance Issues				P	N	A	P	P	
Resolve Non-conformance Issues				N	N	V	A	P	
Prepare and submit seasonal Cx Report	S	N	N	P	N	A	P	P	

Commissioning Process

4. COMMISSIONING STATIC VERIFICATION FORMS

1. The Contractor shall be responsible for the completion of all static verification forms. Sample forms emphasizing the level of detail required are included in this document (Appendix 3). The Contractor shall sign the completed forms.
2. The CA shall witness the completed forms.

5. SHOP DRAWINGS

1. A copy of all Shop Drawings shall be forwarded to the Departmental Representative, after review by the Contractor and Design Consultant.
2. The CA shall review the Shop Drawings, comment as necessary, and incorporate the data into the Commissioning Verification Process.
3. The CA shall inform the PM, with a copy to the Departmental Representative, on all Non-Conformance issues using the Non-Conformance Report form.

6. SYSTEMS START-UP VERIFICATION

6.1 Coordination

1. The CA shall witness the systems tests as required by the tender documents and manufacturers' requirements. The Contractor shall provide an on-going updated Schedule for these tests and ensure that the appropriate personnel are present.
2. The Contractor shall provide a minimum written notice of two business / working days to the Departmental Representative as to time and location of each test.

6.2 Forms

1. As a minimum, the Contractor shall use the sample Testing Forms included in the Commissioning Plan as well as any Supplementary Forms developed during the Commissioning Process.

6.3 Signatures

1. When the Tests have been successfully completed, the CA and/or the Departmental Representative and the Contractor shall co-sign the Test Forms.

6.4 Non-conformance:

1. The CA shall report non-conformance results to the PM with a copy to the Departmental Representative.
2. Unsuccessful tests shall be repeated until they are successful at no additional cost to the contract.
3. The CA shall witness all repeated tests and assess the costs incurred by the Crown in hours, travel and other expenses. The Contractor shall be responsible for the costs.

6.5 Mechanical Systems:

1. Start-up Procedures: Witness and verify the start-up procedures for all mechanical systems. Verify that the start-up procedure has been conducted according to the equipment manufacturer's recommendations and as per the contract documents.
2. Contractor shall submit with the shop drawings, the manufacturer's Start-up and Inspection Forms for review by the Consultant and the CA. If appropriate, these forms will become part of the Commissioning Documentation.

6.6 Electrical Systems:

1. Start Up Procedures: Witness and verify the start-up procedures for all electrical systems. Verify that the start-up procedure has been conducted according to the equipment manufacturer's recommendations and as per the contract documents. This procedure must be co-ordinated with the mechanical start-up and performed at the same time. Documentation shall be recorded on the mechanical start-up forms.
2. Contractor shall submit with the shop drawings, the manufacturer's Start-up and Inspection Forms for review by the Consultant and the CA. If appropriate, these forms will become part of the Commissioning Documentation.
3. Provide ESA Certificate of Inspection.

7. SYSTEM DYNAMIC FUNCTIONAL PERFORMANCE TESTS

7.1 Objectives

1. The objectives are to verify:
 1. The performance of individual systems.
 2. That the performance of all systems operating together meets the building performance requirements.

7.2 Mechanical Systems

1. Dynamic Functional Performance Testing shall begin when all the testing, adjusting and balancing required by the contract has been completed, and when the CA has acknowledged that the physical installation of the components and systems being tested are substantially installed in accordance with the contract documents.
2. The CA may use the EMCS as well as any other instrumentation deemed necessary for mechanical systems testing. The EMCS shall be programmed to record print data over a specific time period. The CA/Consultant shall evaluate the performance of the systems by reviewing the EMCS recorded data and other recorded data.
3. Tests shall be conducted systematically for each system identified in the Commissioning Plan.

7.3 Mechanical Systems Dynamic Functional Performance Tests

1. Mechanical Equipment Start-up and Acceptance Forms (see Appendix 2 sample). Note the list below is an example only. The complete list will be provided when all the Shop Drawings and Product Data has been submitted: (include reference to annex, list of systems to be commissioned).
 1. Heat exchanger
 2. circulating pumps
 3. exhaust fans
 4. plumbing accessories
2. Balancing:
 1. Demonstrate a minimum of 30% TAB readings or as per the performance specification whichever is more stringent. Record specified and measured readings on the TAB forms.
3. Energy Management Control System (EMCS):
 1. See appendices for sample test forms.
 2. Prove operation and calibration of EMCS by demonstrating all points for each of the control devices, including Digital points.
 3. Demonstrate all Reset Schedules and make any required adjustments to the schedules.
 4. Demonstrate specific hardware and software features under the direction of the CA or Consultant for Dynamic and Final Performance Tests.
 5. Sound/Vibration Tests
 1. If required the CA shall submit separate test reports for Sound and Vibration obtained from Specialist. Submit a document describing the procedures used in both cases. Submit a copy of the Standards of Acceptance for the equipment for this specific Project.

7.4 Electrical Systems Dynamic Functional Performance Tests

1. Electrical Tests:
 1. Power Quality and grounding
 2. Structured Wiring System.

8. TRAINING

1. The Commissioning Authority shall coordinate the training that is provided by the Contractors and Equipment Manufacturers. This shall include:
 1. Co-ordinating and organizing all training specified.
 2. Selecting the Training Sessions to avoid conflict and allow the Building Operators and Maintenance staff sufficient time to read material before each session (Operation and Maintenance Manuals).
 3. Both Hands On and classroom training will be provided where required as deemed by the Commissioning Authority and / Operations.
 4. The Commissioning Authority and / or the Departmental Representative shall obtain from the Contractor and/ or Manufacturer the Training Materials required to accomplish such Training.
 5. Obtaining the Training Materials from each contractor/manufacturer prior to the training sessions and distributing to the Building Operators and/or Maintenance Staff via the Commissioning Authority and / or Departmental Representative.
 6. The Contractor is responsible to ensure instructors are well versed in the particular system that they are presenting.
 7. The CA is responsible for overseeing and approving the content and adequacy of the training. The CA must interview the facilities manager to determine the special needs and areas where training will be most valuable. The CA and Owner's Site Rep must decide how rigorous the training should be for each piece of equipment/system.
 8. If, at the end of a course, there are questions from trainees that remain unresolved, the instructor will send the answers, in writing, to the CA for transmittal to the trainees, and any training videos should be modified to include the appropriate clarifications.
 9. The CA shall develop criteria for determining that the training was satisfactory completed, including attending some of the training, and upon fulfilment of the criteria, validate training completion. The CA will recommend approval of the training to the Owner's Site Rep using a standard form and the CA and Owner's Site Rep will sign the approval form. Provide completed and signed validation of training forms for all training sessions accomplished. Provide two copies of the signed training validation forms to the Owner's Site Rep.
2. The CA shall arrange for classroom for the Training Sessions if required. The following may be required and shall be supplied by the Contractor:
 1. White board and markers;
 2. Flip board and easel;
 3. Overhead projector and screen;
 4. Chairs and work tables; and
 5. Any other materials and Equipment deemed necessary by the Commissioning Authority and/or the Departmental Representative.
3. Each training session shall cover, as a minimum, the following:
 1. Demonstration of the equipment/system operation.
 2. Description of the equipment/system.
 3. Operating procedures.
 4. Maintenance by the building operator.
 5. Maintenance provided by the manufacturer.
 6. Normal and special tools required for equipment servicing.
 7. Scope of the equipment warranty.

8. A review of the Operations and Maintenance data.
 9. Start up and shut down procedures.
 10. Emergency procedures.
 11. Seasonal switch over.
 12. Training session shall be limited to a maximum of 4 hrs per day per group.
4. Where equipment is part of the mechanical or electrical system, the training sessions shall identify how the equipment interacts with the system.
 5. EMCS and Fire Protection Manufacturer's training requirements are detailed in the contract documents. The Commissioning Authority and/or the Departmental Representative shall coordinate the Training Sessions required.
 6. Additional Training (if applicable):
 1. Whenever the Operations / Commissioning Authority and/or the Departmental Representative determines that there is a need to supplement Contractors and Manufacturer's Training, he shall request the Design Consultant's Participation.
 2. These Training Sessions shall be "Hands On" and in the classroom.
 3. The Training Concept shall be reviewed by the Departmental Representative and/or the Commissioning Authority.
 4. The sessions shall include:
 1. The Design Intent, Complete and up to date Sequence of Operations for each System. This will include a review of the O&M Manual (if applicable).
 2. The operation of the overall mechanical and electrical systems – include occupancy considerations, set points, seasonal change over, start up, shut down, and emergency modes.
 3. The daily operation of the EMCS by the vendor include:
 1. Operator sign-on/off.
 2. Requesting and reviewing reports.
 3. Setting up historical logs
 4. Diagnostic procedures.
 5. Emergency procedures, management procedures.
 6. The daily operation of the fire alarm system and the interface with the Total Building Operation.
 7. Training Records
 1. Prior to any training, the Contractor shall provide each instructor a Training and Orientation Record form. The instructor shall document each training session on the form (duration and general subjects covered).
 2. The instructor shall sign for the session and obtains the signature of each trainee. The instructor also checks off subjects covered on the Agenda. When the training is complete, the Contractor provides a copy of the Training and Orientation Record, and the instructor's Agenda to the Owner's Site Rep and CA. The Owner's Site Rep and CA review all documents and make final approval by signing it.
 8. Training Plan
 1. See Appendix 1 – Sample Training Plan

9. FINAL ACCEPTANCE

1. Prior to the Interim acceptance, the Contractor shall have completed all tests including the System Function Performance Tests.
2. Prior to the Interim acceptance the CA shall assemble all completed testing forms, EMCS and Fire and Life Safety systems occupancy documentation and include them in the Commissioning Report.
3. If a Test on any equipment did not meet the Design Intent or Performance Test, the equipment will be re-tested prior to the system's acceptance, at no additional cost to the contract.
4. The consultants shall issue corrective measures if an acceptable performance is not achieved to the satisfaction of the PM.
5. Acceptance by the Departmental Representative shall not be given until all Test Results are satisfactory.
6. The Commissioning Authority and Design Consultant shall review and accept the results of the System Performance Tests and the CA will submit a Report on the findings to the PM.
7. The Design Consultant will issue a certificate after the completion of seasonal Commissioning.

10. O&M MANUALS AND AS-BUILT DRAWINGS

1. The O&M Manuals are to be produced by the Contractors and are to be submitted in accordance with the contract documents before Substantial Completion. The As-Built drawings are to be maintained throughout the duration of the Project and submitted as soon as possible at time of completion. The As-Built documents will be reviewed by the appropriate Consultants. The Departmental Representative is to review the As-Built Drawings on a monthly basis at the time of the Progress Claim review.
2. Refer to the Project Specifications for exact Instructions and Execution.

11. POST CONSTRUCTION – SEASONAL COMMISSIONING

1. The General Contractor should supply the schedule to return to undertake Seasonal Commissioning prior to substantial completion.
2. After all System commissioning has been accepted by the Departmental Representative on behalf of the Project Manager, the Seasonal Commissioning shall be initiated.
3. The Commissioning Authority shall co-ordinate the Seasonal Commissioning with the Departmental Representative and General Contractor. All trades and manufacturers that are required to perform these tests must be present.
4. The seasonal commissioning results shall be submitted by the Commissioning Authority.

5. Should the Commissioning Authority or Design Consultant identify operational problems during the Seasonal testing, corrective action shall be initiated.
6. Seasonal Commissioning documentation will include System Dynamic Functional Performance Tests in the form of Trend Logs in both text and graphical format.
7. The Test results are documented by the Commissioning Authority and are compiled in the Post-occupancy Report.
8. The Design Consultant issues a final Commissioning certificate.

Appendix 1 – Sample Training Plan

1. General

- Training plan is to be developed as design progresses.
- Contractors commissioning schedule identifies:
 - i. how training is to be implemented;
 - ii. duration of each training session;
 - iii. instructors/trainers and participants; and
 - iv. other.

2. Development of Training Plan

- To be completed by _____ [e.g. within ___ months after award of Contract].

3. Responsibilities

- CA is responsible for training and will monitor all training activities
- CA will prepare agenda and outlines
- CA to arrange videotaping of sessions
- Contractor is responsible for implementation of training activities
- Contractor is responsible for quality of instruction, materials and instructor coordination

4. Instructors

- Instructors / trainers include:
 - i. Designers
 - ii. Contractors
 - iii. Factory-trained/certified equipment suppliers and manufacturers
 - iv. Factory-trained/certified maintenance specialist personnel
 - v. Service contractors holding service contracts for various systems

5. Trainees

- Trainees include:
 - i. Facility (Property) Manager
 - ii. Building operators
 - iii. Maintenance staff
 - iv. Security staff
 - v. Technical specialists
 - vi. Facility occupants as necessary

6. Prerequisite Skills and Qualifications of trainees

- [to be specified _____].

7. Scheduling of training

- Training sessions relating to design:
 - i. Provided by the Designer
 - ii. Presented within three months after contract award
 - iii. To be completed prior to issuance of the Interim Certificate

8. Details of training

- ...

9. Training materials

- Training materials may include:
 - i. "As-built" contract documents
 - ii. Building Management Manual
 - iii. TAB and PV Reports
 - iv. Transparencies for overhead projectors and 35 mm slides

- v. Manufacturers' training videos (after prior screening for suitability)
- vi. Equipment models

10. Videotaping

- Hands-on and classroom sessions will be videotaped for future reference
- To be held only after all systems have been fully commissioned
- Production will be of professional quality

11. Standard of training

- Training will be sufficient to ensure:
 - i. safe, reliable, cost-effective, energy-efficient operation of all systems under all conditions;
 - ii. effective ongoing inspection, measurements of system performance;
 - iii. proper preventive maintenance diagnosis, troubleshooting;
 - iv. ability to update documentation; and
 - v. ability to operate equipment and systems under emergency conditions.

12. Limitations

- ...

13. Demonstrations

- Training will include demonstrations by trained personnel

14. Manufacturers' video-based training

- Video will be used as training tool after Engineer's review and written approval

15. Sample Training Activities (broad outline)

- Architectural
 - i. Waste Management
 - ii. Building Envelope
- Mechanical
 - i. Design Philosophy
 - ii. HVAC Systems
 - iii. BAS, EMCS
 - iv. Refrigeration Systems
 - v. Fire Protection and Suppression Systems
 - vi. Dom. CWS Systems
 - vii. Storm Water Management Systems
- Electrical
 - i. General overview of design
 - ii. Incoming Service and High Voltage Distribution
 - iii. Low Voltage Systems (including low voltage lighting controls, clocks, fire alarm)
 - iv. Telephones, Communications, Signaling Systems
 - v. Security Systems
 - vi. Crash Alarm System
 - vii. Special Systems
 - viii. Lighting Systems
 - ix. Emergency Lighting Systems
 - x. Emergency Power Systems
 - xi. Uninterruptible power systems
 - xii. Isolated Power Systems
 - xiii. Special/Dedicated Electrical Services to Special Areas

Appendix 2 - Detailed List of Building Systems Requiring Commissioning

Division 22 – PLUMBING

- 22 11 18 Domestic Water Piping Copper
- 22 13 19 Non-Potable/Process Water Piping
- 22 42 01 Plumbing Specialties And Accessories

Division 23 - HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

- 23 05 19.01 Thermometers And Pressure Gauges - Piping Systems
- 23 05 29 Hangers And Supports For HVAC Piping And Equipment
- 23 05 93 Testing, Adjusting And Balancing For HVAC
- 23 21 13.02 Hydronic Systems: Steel
- 23 21 23 Hydronic Pumps
- 23 31 13.01 Metal Ducts - Low Pressure To 500 Pa
- 23 33 14 Dampers - Balancing
- 23 33 15 Dampers - Operating
- 23 34 00 HVAC Fans

Division 26 – ELECTRICAL

- 26 05 20 Wire And Box Connectors (0-1000 V)
- 26 05 21 Wires And Cables (0-1000 V)
- 26 05 28 Grounding – Secondary
- 26 24 16.01 Distribution Panelboards Breaker Type
- 26 28 16.02 Moulded Case Circuit Breakers
- 26 28 23 Disconnect Switches - Fused And Non-Fused
- 26 29 10 Motor Starters To 600 V
- 26 29 30 Soft Start Starters