

## **SECTION 260800**

### **COMMISSIONING OF ELECTRICAL SYSTEMS**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Section 019100 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 019100 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the Owner Affairs will manage the commissioning process.
- B. Systems to be commissioned:
  - 1. Electrical equipment connected to Normal and/or Essential power systems, including the following:
    - a. Transformers.
    - b. Primary service electrical systems.
    - c. Feeders & Distribution Conductors
    - d. Main Switchboards
    - e. Branch-circuit switchboards & panelboards.
    - f. Lighting systems.
  - 2. Generators
  - 3. Standard & Emergency Outlets
  - 4. Automatic Transfer Switch
  - 5. Circuit Breakers
  - 6. Controls and instrumentation, including the following:
    - a. Lighting control systems.
  - 7. Photovoltaic System
    - a. Limited to solar-ready infrastructure verification

##### **1.2 RELATED DOCUMENTS**

- A. Section 019100 Commissioning General Requirements

##### **1.3 DEFINITIONS**

- A. For complete list of definitions, Refer to Section 019100 "General Commissioning Requirements."
- B. CxA: Commissioning Authority, as defined in Section 019100 "General Commissioning Requirements."
- C. CxC: Commissioning Coordinator, as defined in Section 019100 "General Commissioning Requirements." A qualified individual appointed by the Contractor to manage the commissioning process on behalf of the Contractor.
- D. CxR: Commissioning Representative, as defined in Section 019100 "General Commissioning Requirements." An individual appointed by a sub-contractor to manage the commissioning process on behalf of the sub-contractor.

## **1.4 SUBMITTALS**

- A. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 019100 GENERAL.
- B. Commissioning Representative (CxR) Assignment and Qualifications. The contractor shall submit the qualifications and resume for proposed persons to be assigned as the project CxRs, with responsibilities and minimum experience outlined below:
  - 1. The Electrical CxR Responsibilities are to perform Electrical systems System Verification Checklists, Functional Performance Testing, and Functional Performance Test Demonstration, and other work required for commissioning
  - 2. The Electrical CxR shall have the following minimum qualifications:
    - a. Journey level or equivalent skill level; vocational school four-year-program graduate or an Associate's degree in mechanical systems, air conditioning, or similar field.
    - b. Degree may be offset by three years' experience in installing, servicing and operating electrical systems in the electrical industry. Generally, required knowledge includes electrical systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of electrical equipment, assemblies, and systems.
- C. Training Plan:
  - 1. The contractor shall submit a comprehensive Training Plan. Specific Training requirements per item are specified in Section 3 of this specification and 019100.
- D. Training Verification: After training has been completed the Contractor shall submit the following information to the Owner and the Commissioning Agent:
  - 1. Training Agenda: For each training module submit the agenda that was used during the training session.
  - 2. Attendance Record: For each training module, submit list of participants and length of instruction time.
  - 3. Training Recording: For Training Modules which require videography (see Technical Specifications) provide the final edited video to the CxA for review.
- E. As Built Drawing Review:
  - 1. The CxA shall provide a list of as built drawings relevant to the Cx Process to the contractor.
  - 2. The contractor shall provide the indicated as built drawings to the CxA for review concurrently with the Design Professionals
  - 3. The CxA shall review selected As built drawings and provide review comments.
- F. O&M Manuals:
  - 1. Prepare O&M manuals according to the contract documents,
  - 2. Include the Final As-Built Control Drawings
  - 3. Submit O&M manuals to CxA for review prior to O&M personnel training.
  - 4. Provide O&M Manuals to the CxA for inclusion in the Systems Manual
- G. System Verification Checklists
  - 1. The Commissioning Agent will prepare and submit System Verification Checklists based on the Systems to be Commissioned.
  - 2. The contractor shall complete the SVCs and submit completed forms to the CxA.
- H. Startup Plan
  - 1. The Contractor shall submit the Startup Plan as specified in this section.
- I. Functional Performance Test:

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1. The Commissioning Agent will prepare and submit Functional Performance Test Procedures. The Contractor shall execute FPT and submit completed forms to the CxA.
  2. The contractor shall complete the FPTs and submit completed forms to the CxA.
- J. Systems Manual: The contractor shall provide the following information to the CxA for use in the Systems Manual. The final System Manual shall be compiled and submitted by the CxA:
1. As-built drawings (by CxC)
  2. As-Built Sequences of Operation for Lighting Controls (by CxC)
  3. Table of Original Setpoints (by CxC)
  4. Recommended schedule of maintenance requirements and frequency per manufacturer's recommendations (by CxC)
  5. Recommended schedule for calibrating sensors and actuators (by CxC)
  6. Equipment O&M (by CxC)
  7. Equipment Preventative Maintenance Schedules (by CxC)
  8. Confirmation of Training (by CxC)

## PART 2 - PRODUCTS

### 2.1 TOOLS

- A. Division 23 shall provide all test equipment necessary to fulfill the testing requirements of this Division. Refer to 019100.
- B. Testing Equipment and Instrumentation Quality and Calibration:
1. Capable of testing and measuring performance within the specified acceptance criteria.
  2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
  3. Be maintained in good repair and operating condition throughout duration of use on Project.
  4. Be recalibrated/repared if dropped or damaged in any way since last calibrated.
- C. Equipment Manufacturer's Proprietary Instrumentation and Tools :
1. Contractor shall provide all Manufacturer's Proprietary Instrumentation and Tools required for execution of FPTs.
  2. Test instrumentation and tools prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:
    - a. Be calibrated by manufacturer with current calibration tags permanently affixed.
    - b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.

## PART 3 - EXECUTION

### 3.1 COMMISSIONING PROCESS

- A. Perform all commissioning activities as defined and specified in section 019100.

### 3.2 Cx ACTIVITY COMMON TO ELECTRICAL SYSTEMS

- A. The following activities are a summary of the required Commissioning Process. Additional requirements for each activity and responsible parties are found in Section 019100. All requirements for Section 019100 apply.

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<b>COMMISSIONING PROCESS</b>		
<b>ACTIVITY</b>	<b>Responsible Party</b>	<b>Description</b>
COMMISSIONING PLAN	CxA	The document that specifies the project specific commissioning process, commissioning scope commissioning team responsibilities, schedules, and documentation requirements of the Commissioning Process.
SUBMITTAL REVIEW	CxA	Contractor Provides Submittals to the CxA concurrently with the Design Professionals. CxA reviews and provides comments.
SYSTEM VERIFICATION CHECKLISTS (SVC)	Authored by CxA Completed by Contractor	SVC forms are generated by the CxA and executed by the contractor to verify that Commissioned Systems are installed, started up, functional and ready for FPT.
START-UP VERIFICATION	Installing Contractor	CxA to verify that the startup activities specified in the contract documents have been executed and deficiencies corrected. Contractor to provide startup forms & reports to CxA for review & comment.
T-24 ACCEPTANCE TESTING VERIFICATION	Contractor	Contractor to provide completed CA Energy Code Certificates of Installation (NRCC-CI) and Certificates of Acceptance (NRCC-CA) form to CxA for review and comment. Design Professional to document which forms are required. Contractor to conduct testing and complete forms.
FUNCTIONAL PERFORMANCE TEST (FPT)	Authored by CxA Executed by Contractor	CxA to author FPT forms. Contractor to conduct physical testing of 100% of commissioned systems following the written protocol and provide the results to the CxA. Contractor to correct any issues or deficiencies.
FUNCTIONAL PERFORMANCE TEST (FPT) DEMONSTRATION	Directed by CxA Executed by Contractor	Contractor to demonstrate operation of a sample of commissioned systems in the presence of the CxA. CxA to direct the demonstration in accordance with the FPT forms. CxA to document demonstration results on the FPT forms.
SYSTEMS MANUAL	Supporting Docs by Contractor Manual by CxA	Compilation and writing of the Systems manual by CxA. Contractor to provided specified supporting documents
AS BUILT DRAWING VERIFICATION	As Built Drawings by Contractor Verification by CxA	Contractor Provides As Built drawings to the CxA concurrently with the Design Professionals. CxA reviews and provides comments.

**Commissioning of Electrical Systems**

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TRAINING VERIFICATION	Training by Contractor Verification by CxA	Contractor to provide records of training conducted to CxA for their verification.
COMMISSIONING REPORTING	CxA	Reports on Cx activity and results prepared by the CxA

**3.3 Cx TESTS COMMON TO ELECTRICAL SYSTEMS**

- A. Provide technicians, instrumentation, tools, and equipment to perform and document the required testing.
- B. Coordinate schedule with, and perform Cx activities at the direction of, CxA
- C. In accordance with the approved SVC and FPT document, test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response in accordance with acceptance criteria.
- D. CX TEST PREPARATION - Prior to Cx Testing:
  - 1. Contractor shall Certify that systems, subsystems, and equipment to be tested have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.
  - 2. Contractor shall Certify that instrumentation and control systems to be tested have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and all systems are set to and maintaining set points as required by the design documents.
  - 3. Contractor shall Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.
- F. If seasonal testing is specified, complete appropriate initial performance tests and documentation, and schedule seasonal tests.

**PART 4 - SYSTEM VERIFICATION CHECKLIST EXAMPLE - These examples are not the final system verification checklists used for this project and are intended to represent the typical rigor of checklists of this type.**



Project Name

Lighting Controls

**Lighting Controls**

Date: \_\_\_\_\_

**System Verification Checklist**

1. Revision			
Revision No.	Name	Company	Date

2. General Notes, Directions, & Abbreviations
<p><b>NOTES:</b></p> <ol style="list-style-type: none"> <li>This checklist does replace the manufacturer's recommended checkout and start-up procedures or report(s).</li> <li>This checklist does not comprehensively address fire and life safety or basic equipment safety controls.</li> <li>Items that do not apply shall be noted with the reasons on this form (N/A = not applicable)</li> <li>Each contractor is to find their designated sections of this checklist and complete it accordingly with respect to their discipline.</li> </ol> <p><b>DIRECTIONS:</b></p> <ol style="list-style-type: none"> <li>System verification checklist to be completed by the sub-contractor(s) prior to the factory startup process. Each discipline is to initial or N/A each item on each list.</li> <li>Contractors are to 100% complete the checklist before requesting CxA to inspect.</li> </ol> <p><b>ABBREVIATIONS:</b></p> <p>Commissioning Agent (CxA), Commissioning Coordinator (CxC), General Contractor (GC), Plumbing Contractor (PC), Mechanical Contractor (MC), Electrical Contractor (EC), Control Contractor (CC), Landscape Contractor (LC), Not Applicable (N/A)</p>

3. Commissioning Agent Final Sign-Off		
The commissioning agent has reviewed and verified the completeness of this checklist. Missing items are noted on the issues log.		
Name	Signature	Date

4. Responsible Party Sign-Off				
The equipment listed here is complete and ready for startup. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor.				
Discipline	Company	Initials	Signature	Date



Project Name

Lighting Controls

<b>5. Issues</b>		
Record any non-conformance items.		
No.	Item	Date Resolved / By
1		Init: _____
2		Init: _____
3		Init: _____
4		Init: _____

<b>6. NOTES</b>	
CxA to record deviations from this form noted items due to RFI/ ASI or other clarifications	
No.	Item
A	
B	
C	
D	



Project Name

Lighting Controls

**7. Prerequisite Verification**

Verify that the following prerequisites have been provided prior to beginning equipment installation.

Deliverable/Submittal	Provided (Y/N)	Issue No
Approved Submittals		
Shop Drawings		
Title 24 Certificates of Installation		

**8. Electrical – Field Devices**

Verify that each of the following items are completed by checking the columns below. Note any discrepancies. The CxA will spot check some of the line items for verification

No	Item	Electrical Contractor
<b>General</b>		
1	Room controller locations labeled (i.e., T Bar label, etc.).	
2	Indoor Photocell sensor(s) located per contract drawings (if applicable).	
3	Outdoor Photocell sensor located per contract drawings (if applicable).	
4	Occupancy switches located per contract drawings.	
5	Room switches – correct type and located per contract drawings.	
6	Maintenance access is adequate for all components.	
<b>CxA had verified the equipment noted by initials</b>		
<b>End of Electrical System Verification Checklist</b>		



**PART 5 - FUNCTIONAL PERFORMANCE TESTING EXAMPLE - These examples are not the final FPT scripts used for this project and are intended to represent the typical rigor of checklists of this type.**



Project Name

Lighting Controls

**Lighting Control System**

Date: \_\_\_\_\_

FUNCTIONAL PERFORMANCE TEST

**1. Revision**

By signing the below, you acknowledge that you have reviewed this test script and reported any comments.

Revision No.	Name	Company	Signature	Date

**2. Pre-Requisite Verification**

By signing the below, you acknowledge that the pre-requisite document has been submitted to the Commissioning Agent. CxA Agent acknowledges receipt

Item	Electrical Contractor	General Contractor	Commissioning Agent	Date
Installation Verification				
Manufacturer Start-up				
Title-24 Acceptance Forms				

**3. Test Attendees**

See sign-in sheet

**4. Execution of Functional Tests**

Prior to execution of functional tests, the CxA has provided a copy of the primary equipment tests to the installing subcontractor (via the GC) who has reviewed the tests for feasibility, safety, warranty, and equipment protection. The CxA oversees, witnesses, and documents the functional testing of all equipment and systems. The subcontractors execute the tests.

**5. Basis of Test**

The following document(s) were used to develop this test:

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Project Name

Lighting Controls

6. Exterior Lighting					
Perform each of the steps below and record the results. Note any unexpected or failed results.					
#	Procedure	Expected Result			Note
Interior Spaces					
1	Verify the exterior lights are operating per the desired time schedule. Expectations: All exterior lights are operating as designed. Enabled per lighting control panel. On at Sunset (Astronomical Control) / Off at Sunrise. Override Switch with exterior photocell.	LCP Enables Lights: YES / NO LCP Disables Lights: YES / NO  Astronomical - Sunset: ON / OFF Astronomical - Sunrise: ON / OFF  Photocell Covered: Lights ON / Lights OFF Photocell Not Covered: Lights ON / Lights OFF			
2	Verify operation of integral motion sensors on W1-type light fixtures. Expectation: When no motion is detected for a period of time, the motion sensors will automatically reduce the light level. Light level will restore to full brightness when someone is detected.	Fixture	No Motion Detected	Motion Detected	Time Delay
		W1	Full 30% OFF	Full 50% OFF	
		W2	Full 50% OFF	Full 50% OFF	
3	Emergency fixtures Expectations: All emergency fixtures are installed per the plans and are tied to lighting inverter or battery pack and function at loss of power.	Using Plans check that emergency fixtures match layout. Record any discrepancies.  Emergency Light Fixture Symbols: EX1, EX2, EM1, EM2, EM3			



Project Name

Lighting Controls

<b>7. Interior Lighting</b>			
Perform each of the steps below and record the results. Note any unexpected or failed results.			
#	Procedure	Expected Result	Note
Interior Spaces			
1	Verify manual ON/OFF control is operational. Expectation: By manually pressing the ON button, the lights will turn on. By pressing the OFF button, the lights will turn off.	See Matrix Below	
2	Verify all Dimmer Switches are operating as designed. Expectation: Dimmer Switches manually increase and decrease the light levels are commanded.	See Matrix Below	
3	Verify all occupancy sensors are operating as design. Expectation: The occupancy sensors can capture movement and shall turn off lights when no movement is sensed by the sensor for 10 mins.	See Matrix Below	
4	Verify all daylight sensors are operating as designed. Expectation: Daylight sensors adjust the brightness of the lights in the room based on the amount of sunlight being received.	See Matrix Below	
5	Emergency fixtures Expectations: All emergency fixtures are installed per the plans and are tied to lighting inverter and function at loss of power.	Using plans below check that emergency fixtures and exit signs match layout. Record any discrepancies.	

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<b>8. Test Procedures - Hatchery Building</b>				
Location	Test 1 Manual ON/OFF Operation	Test 2 Dimmer Switch Operation	Test 3 O.S. sensor Operation (Auto Off)	Test 4 Daylight Sensor

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9. Notes		
Record any negative, N/A, or other abnormal responses below. Indicate is the note is an issue (Y/N)		
#	Item	Issue
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

END OF SECTION