**PART 1 - GENERAL**

* 1. **SECTION INCLUDES**
1. Section Includes:
2. General requirements for Commissioning (Cx) of lighting systems components, lighting controls and HVAC systems line voltage interconnection components, including installation, start-up, testing and documentation according to construction documents and Commissioning Plan (CxP).
3. Standard procedures for the execution of commissioning work shall be in conformance with Division 1, Section 01 9113 General Commissioning Requirements. Coordinate work with the Commissioning Services Provider (CxSP).
	1. **RELATED REQUIREMENTS**

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| **EDIT NOTE: EDIT THIS SECTION AS APPLICABLE TO EACH PROJECT.** |

* 1. Division 01 - General Requirements.
	2. Section 01 9113: General Commissioning Requirements.
	3. Section 01 7900: Maintenance and Operations Staff Demonstration and Training.
	4. Section 23 80 00: Heating, Ventilation, and Air Conditioning Equipment.
	5. Section 23 08 00: HVAC Systems Commissioning.
	6. Section 23 09 23: Environmental Control and Energy Management Systems.
	7. Section 23 08 13: Environmental Controls and Energy Management System Commissioning.
	8. Section 26 05 00: Common Work Results for Electrical.
	9. Section 26 05 13: Basic Electrical Materials and Methods.
	10. Section 26 05 26: Grounding and Bonding.
	11. Section 26 05 19: Low Voltage Wires (600 Volt AC).
	12. Section 26 05 86: Motors and Drives.
	13. Section 26 24 19: Motor Control Center and Motor Control Devices.
	14. Section 26 09 23: Lighting Control Systems.
	15. Section 26 55 63: Theatrical Lighting and Stage Dimming Systems (Middle and High Schools).
	16. Section 26 55 66: Theatrical Lighting and Stage Dimming Systems (Elementary Schools).
	17. **REFERENCES**

Applicable codes, standards, and references: inspections and tests shall be in accordance with the following applicable codes and standards:

1. National Electrical Testing Association – NETA.
2. National Electrical manufacturer’s Association – NEMA.
3. American Society for Testing and Materials – ASTM.
4. Institute of Electrical and Electronic Engineers – IEEE.
5. American National Standards Institute – ANSI.
6. National Electrical Safety Code – NESC.
7. California Building Code – CBC.
8. California Electrical Code – CEC.
9. California Green Building Standards Code (CalGreen).
10. Conglomerate for High Performance Schools (CHPS).
11. Insulated Power Cables Engineers Association – IPCEA.
12. Occupational Safety and Health Administration – OSHA.
13. National Institute of Standards and Technology – NIST.
14. National Fire Protection Association – NFPA.
15. California Electrical Code.
16. ANSI/NFPA 70B – Electrical Equipment Maintenance.
17. NFPA 70E – Electrical Safety Requirements for Employee Work Places.
18. ANSI/NFPA 101– Life Safety Code.
	1. **SUBMITTALS**
19. Submittals shall include the following:
20. Submit required Cx submittals in accordance with Division 1 Specification Sections.
21. Copy of the Architect’s reviewed and accepted submittals to the CxSP via the OAR.
22. List of team members who will represent the CONTRACTOR in the Pre-functional Equipment Checks and Functional Performance Testing, at least two weeks prior to the start of Pre-functional Equipment Checks.
23. Detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, checklist documentation and field checklist forms to be used by factory or field technicians, and a copy of full details of OWNER-contracted tests, full factory testing reports, if any, and Warranty information, including responsibilities of OWNER to keep Warranty in force, clearly defined.
24. Detailed manufacturer’s recommended procedures and schedules for Pre-functional Equipment Checks, supplemented by CONTRACTOR’s specific procedures, and Pre-functional Tests, at least four weeks prior to the start of Pre-functional Performance Tests.
25. After facility’s commission is complete, submit completed Pre-functional Equipment Checklists and Functional Performance Test checklists organized by system and by subsystem. Bind information in a single package. The results of failed tests shall be included along with a description of the corrective actions taken.

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| **EDIT NOTE: EDIT THE FOLLOWING ARTICLE AS APPLICABLE TO REFLECT PROJECT SPECIFIC REQUIREMENTS.** |

* 1. **MEETINGS, SEQUENCING AND SCHEDULING**
	2. Meetings: Attend (Cx) meetings as required under Section 01 9113 and the Cx Plan.
	3. Sequencing and Scheduling: The work described in this Section shall begin only after work required in related Division 26 Sections has been successfully completed, and tests, inspection reports and Operation and Maintenance manuals required in Division 26 Sections have been submitted and approved. The start-up and Pre-functional Equipment Checklists shall be completed and submitted to the OWNER’s Authorized Representative (OAR) prior to the functional performance tests. Refer to the project’s Cx Plan for more details.
		+ 1. Coordinate electrical work with the work of other trades prior to scheduling of any Cx procedures.
			2. Coordinate the completion of electrical testing, inspection, and calibration prior to start of Cx activities.
			3. Cx activities shall be scheduled in accordance with project’s Cx plan.
	4. **QUALITY CONTROL**

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| **EDIT NOTE: EDIT THE FOLLOWING ARTICLE AS APPLICABLE TO REFLECT PROJECT SPECIFIC REQUIREMENTS.** |

1. Comply with OWNER’s Quality Control Specifications, Sections 01 4516 – 01 4519, as applicable.
2. Incorporate manufacturer's recommended Cx procedures for the systems and equipment to be commissioned under this Section.

**PART 2 - PRODUCTS**

* 1. **TEST EQUIPMENT**
	2. Equipment to be utilized in the commissioning process shall meet the following requirements:
		+ 1. Provide test equipment as necessary for the equipment and systems to be commissioned.
			2. Provide testing equipment and accessories that are free of defects and certified for use.
			3. Provide testing equipment with current calibration labels per NIST Standards.
			4. Testing equipment shall be UL Listed.

**PART 3 – EXECUTION**

* 1. **COMMISSIONING PROCESS REQUIREMENTS**
1. Work to be performed prior to commissioning:
	* 1. Complete all phases of the work so the system(s) can be started, tested, adjusted, balanced, and otherwise commissioned.
		2. Start-up services required to bring each system into full operational state and ready for functional performance testing:
	1. Completion of authorized manufacturer representative’s start-up procedures and recommendations.
		* 1. Provide Manufacture’s start-up completed forms.
	2. Completion of pre-functional checklists.
	3. Copy of required manufacturer and field testing.
	4. Motor rotation check.
	5. Control sequences of operation.
	6. Full and partial load performance.
		1. If modifications or corrections to the installed systems are required to bring the system(s) to acceptance levels due to CONTRACTOR’s incorrect installation or defective materials, such modifications or corrections shall be made at no additional cost to the OWNER.
		2. Functional tests shall not start until each system is complete and the above items have been documented and submitted to the Engineer of Record, Cx Services Provider and OWNER for review.
2. Pre-commissioning Responsibilities: Inspection, calibration and testing of the equipment and devices necessary to commission the following systems:
3. Electrical Lighting Systems.
4. Lighting Controls.
5. HVAC line voltage electrical components.
6. Line voltage interface of Environmental Controls and Energy Management System with other systems.
7. Photovoltaic Systems.
8. Commissioning Process Requirements: Refer to Section 01 9113 General Commissioning Requirements, related sections and Cx Plan for information on meetings, start-up plans, Pre-Functional and Functional Performance Testing (FPT), operations and maintenance data, and other Commissioning activities.
	1. **PREPARATION**
9. Provide certified electricians and/or qualified personnel as required with adequate tools and equipment necessary to perform Cx activities.
10. Provide all equipment required for the commissioning of equipment and systems indicated in article 3.01.B.
11. Provide certified testing agency personnel or report(s) as required in the Cx Plan.
	1. **TESTING**
12. Testing documentation shall include the following minimum information:
	1. Test number.
	2. Equipment used for the test, with manufacturer and model number and date of last calibration.
	3. Date and time of the test.
	4. Indication of whether the record is the first commissioning test, or a retest following correction of a previously identified issue.
	5. Identification of the system, subsystem, assembly, or equipment.
	6. Conditions under which the test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of the test.
	7. Systems and assemblies test results, performance and compliance with contract requirements.
	8. Issue number and description of corrected issue that prompted retesting.
	9. Name and signature(s) of witnesses and the person(s) who performed the test(s).
13. Test lighting and controls systems to verify performance, operation, functionality, light levels, energy usage, and compliance with construction documents.
14. Start up, test and document results under the observation of the CxSP.
15. Execute the Functional Performance Test (FPT) under the observation of the CxSP.
16. Provide completed and signed FPTs to CxSP for inclusion in the commissioning report.
17. Functions and Testing Conditions:
18. Occupancy sensors and timer controls for lighting:
19. Verify that specified functions and features are set up, debugged and fully operable at time of test.
20. Verify that occupant override feature functions as intended in the contract documents.
21. Verify that sensors response times/durations are set properly.
22. Test the sequence of operation for features and modes and confirm that adjustable times match the design specifications and contract documents.
23. Verify that sensors are located per manufacturer’s recommendations.
24. Electric lighting dimming, photocells and controls:

Test the dimming controls during daytime when conditions are such that controls should be dimming electric lighting.

Verify that amperage changes in light fixtures are proportional to external light changes. Verify that dimmed light levels uniformity at the specified work plane remain within specified limits.

Verify that delays and ramp times are set and functioning so that the speed of change of light fixture output is slow enough to not bother occupants, and in compliance with the specifications.

Verify that dimming does not cause lower than specified light levels in adjacent “non-dimmed” spaces.

Verify that the controls and sensors cannot be easily overridden or disabled by occupants.

Verify that dimming systems in places of assembly are interfaced with the Central Fire Alarm system.

Verify that dimmed lighting in these areas shall come back to full bright during a fire alarm or emergency condition.

1. Illumination Levels, Night Conditions:

1) Verify that lighting throughout the building is operating automatically.

2) Test with doors closed (to simulate actual occupancy) and after finishes are complete.

1. Illumination Levels, Day Conditions:

Verify that lighting levels comply with average maintained foot-candle levels shown on plans.

Verify that lighting throughout the building is operating automatically.

2) Test with doors closed (to simulate actual occupancy), after finishes are complete, and room is furnished.

3) Test at different times during the day, or under OWNER-approved simulated conditions, to ensure proper system response and to determine that lighting levels are within specified requirements.

4) In classrooms and educational spaces test the system for the different pre-determined settings. Quiet time, AV mode, all on/off, up/down dimming, and standard operations.

1. Lighting Power Density: Verify building lighting power density. Perform the test with interior lighting turned on and any manual or automatic controls temporarily overridden. Provide statement of compliance with 100% design energy report. Measurements shall be taken at least one minute after lights are turned on.
2. Emergency Lighting System: Verify that the system operates automatically under any condition, without human intervention, and that it resets back to normal operations after the power failure or emergency condition is over or cleared.
3. Acceptance Criteria:
4. Lighting Controls: For the conditions, sequences and modes tested; dimming, occupancy, photocell, and timing controls, integral components and related equipment shall respond to changing conditions and parameters defined in the Contract Documents.
5. Illumination Levels: Average light levels in the tested space at the work plane elevation shall be in the range of plus or minus 10% of the specified light level range for the space.
6. Lighting Power Density: Average instantaneous lighting power density shall be within plus or minus ten percent of that indicated in the Construction Documents.
7. Power factors on lighting circuits shall be greater or equal to 0.95, or as required by lighting fixture specifications.
8. Electrical system total harmonic distortion shall be smaller than 20%.
9. Electrical equipment AIC ratings shall be as indicated in construction drawings.
10. Feeders % voltage drop. Flag feeders with voltage drop greater than 3%.
11. Sampling Strategy for Identical Units:
12. Lighting Controls: Test all automatic interior lighting controls.
13. Illumination Levels: Test all spaces, zones and rooms to verify as proper light levels.
14. HVAC Electrical Component Testing
	1. Document HVAC Division 23 electrical components using the startup procedure submitted by CONTRACTOR and accepted by the CxSP.
	2. Complete and submit Start-up, Pre-functional, and Functional Checklists.
	3. Verify the following information prior to HVAC system equipment startup.
		* + 1. Voltage.
				2. Phase.
				3. Motor Size.
				4. Lock Rotor Amperage.
				5. Full Load Amperage.
15. Minimum and Maximum Circuit Ampacity.
16. Feeder protection or branch circuit protection, breaker or fuse size as applicable.
	1. Coordinate and check corresponding unit electrical protection.
	2. **ADJUSTING**

Incorrect installations, including improper adjustments may result in additional work being required for Cx acceptance.

Perform work required to correct installations not meeting contract requirements at no additional cost to the OWNER.

Corrective work shall be completed in a timely manner to permit completion of the Cx process.

Refer to the Cx Plan for retesting requirements necessary to achieve required system performance.

If the systems’ Cx deadline, as defined in the Cx Plan, goes beyond the scheduled completion of commissioning without resolution of the problem, the OWNER reserves the right to obtain supplementary services or equipment to resolve the problem.

* + - * 1. The cost of additional and/or supplementary services inquired by OWNER as a result of CONTRACTOR’s lack of performance, or inability to resolve identified issues will be solely the responsibility of the CONTRACTOR.
	1. **TRAINING**
		+ 1. Provide training and documentation as required in construction documents.

END OF SECTION