

## COMMISSIONING GUIDE SPECIFICATIONS

### SECTION 16997 ELECTRICAL TESTING REQUIREMENTS

Spec writer:

The following guide specifications are intended to be reviewed, modified and inserted into the noted specification section to meet these specific commissioning needs and requirements for the current project. Any modifications to these specifications shall only be made after consultation with the Owner's representative and with approval of the engineer of record. Where there are check boxes or fill-in blanks, fill in as appropriate and delete all but the choice(s) that apply. Delete all direction boxes.

Spec Writer: A/E and design phase CA should:

1. Review the functional test requirements and add or change requirements, as necessary, for the current project. Delete requirements for equipment not existing in the current project.
2. Make sure that every piece of mechanical equipment or system has a unique test requirement or is listed as a component of a system with testing requirements given. Use the format of this section for new test requirements.
3. Include intersystem test requirements where significant interactions or interlocks exist between systems.

#### PART 1 - GENERAL

##### 1.1. INCLUDED SYSTEMS AND EQUIPMENT

- A. The following is a list of the equipment and system test requirements included in this section:
1. Lighting sweep controls
  2. Daylight dimming controls
  3. Emergency power and UPS system
  4. General Indoor Light Levels

##### 1.2 DESCRIPTION

- A. This section specifies the functional testing requirements for Division 15 systems and equipment. From these requirements, the Commissioning Authority (CA) shall develop step-by-step procedures to be executed by the Subs. The general functional testing process, requirements and testing methods definitions are described in Section 17100. The test requirements for each piece of equipment or system contain the following:

1. The contractors responsible to execute the tests, under the direction of the CA.

Spec Writer: In some commissioning scenarios on simpler equipment, the CA actually performs hands-on testing without the assistance of any contractors. When this is the case, it should be specifically mentioned in the testing requirements for each type of equipment, so the contractors do not bid work they are not responsible for.

In the example language below, it is assumed that the CA will not perform any significant equipment testing without some contractor assistance, other than the service water heating system.

2. A list of the integral components being tested.
3. Prefunctional checklists associated with the components.
4. Functions and modes to be tested.
5. Required conditions of the test for each mode.
6. Special procedures.
7. Required methods of testing.
8. Required monitoring.
9. Acceptance criteria.
10. Sampling strategies allowed.

### 1.3 PREREQUISITES

The following applicable generic prerequisite checklist items are required to be listed on each written functional test form and be completed and checked off by CA prior to functional testing.

- All related equipment has been started up and start-up reports and prefunctional checklists submitted and approved ready for functional testing:
- All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.

\_\_\_\_\_  
Controls Contractor Signature or Verbal

\_\_\_\_\_  
Date

- All A/E punchlist items for this equipment corrected.
- These functional test procedures reviewed and approved by installing contractor.
- Safeties and operating ranges reviewed by the CA.
- Test requirements and sequences of operation attached.
- Schedules and setpoints attached.
- Sufficient clearance around equipment for servicing.
- Record of all values for pre-test setpoints changed to accommodate testing has been made and a check box provided to verify return to original values (control parameters, limits, delays, lockouts, schedules, etc.).
- Other miscellaneous checks of the prefunctional checklist and start-up reports completed successfully.

### 1.4 MONITORING.

- a. Monitoring is a method of testing as a stand-alone method or to augment manual testing.
- b. All points listed in the required monitoring section of the test requirements which are control system monitored points shall be trended by the controls contractor. Other points shall be monitored by the CA using dataloggers. At the option of the CA, some control system monitoring may be replaced with datalogger monitoring. At the CA's request, the controls contractor shall trend up to 20% more points than listed at no extra charge.

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- c. Hard copies of monitored data must be in columnar format with time down the left column and at least 4 columns of point values on the same page. Graphical output is a desirable option, if the system can produce it.

PART 2 - PRODUCTS

-- NOT APPLICABLE --

PART 3 - EXECUTION

**1. LIGHTING SWEEP CONTROLS**

- A. Parties Responsible to Execute Functional Test
1. Controls contractor: operate the controls
  2. Electrical contractor: assist in testing sequences
  3. CA: to witness, direct and document testing.
- B. Integral Components or Related Equipment Being Tested Prefunctional Checklist ID  
PC-\_\_\_\_\_
1. Lighting Sweep Controls
- C. Prerequisites The applicable prerequisite checklist items listed in the beginning of Section 16997 shall be listed on each functional test form and checked off prior to functional testing.
- D. Functions / Modes Required To Be Tested and Test Methods  
The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

<u>Function / Mode</u>	<u>Test Method</u> Manual (demonstration), Monitoring, Either or Both
<b>MISCELLANEOUS FUNCTIONS</b>	
1. All specified functions and features are set up, debugged and fully operable.	Verbal discussion of features
2. Power failure and battery backup and power-up restart functions.	Demonstration
3. Security and access codes.	Demonstration
4. Verify override duration setting.	Demonstration
5. Scheduling features fully functional and setup, including holidays.	Observation in terminal screens or printouts
6. Date and time setting in central computer and verify that field panels read the same time.	Demonstration
<b>SWEEP FUNCTIONS</b>	
7. 50% of the zones with a minimum of 2 zones per controller or relay must be verified by turning on at least 25% of the lights in the zone and witnessing an actual sweep.	Either
<b>OVERRIDE FUNCTIONS</b>	
8. <u>Manual occupant overrides:</u> 25% of the local override switches, with a minimum of 4 switches must be verified by turning the override switches ON after a sweep and seeing the lights turn back on. 100% of the remainder of the switches should be sight verified to be in place.	Either
9. <u>Telephone and keypad overrides:</u> Test the telephone overrides by calling in for 50% of the zones. Test 50% of the keypad overrides.	Either

- E. Special Procedures (other equipment to test with, etc.; reference to function ID)

None

F. Required Monitoring

1. None required, though monitoring can substitute for manual testing for all functions. See section 1.4 above.

G. Acceptance Criteria (referenced by function or mode ID)

- 1-9 For the conditions, sequences and modes tested, the sweep controls, integral components (All) and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

H. Sampling Strategy for Identical Units

1. Sample the units per the above table. If 10% of the units in the first sample fail the functional performance tests, test another 10% of the group (the 2nd sample). If 10% of the units in the 2nd sample fail, test all remaining units in the whole group, fully at the contractor's expense.

END OF REQUIREMENTS FOR SWEEP CONTROL TEST

**2. DAYLIGHT DIMMING CONTROLS**

- A. Parties Responsible to Execute Functional Test
1. Controls contractor: operate the controls
  2. Electrical contractor: assist in testing sequences
  3. CA: to witness, direct and document testing.
- B. Integral Components or Related Equipment Being Tested Prefunctional Checklist ID  
PC-\_\_\_\_\_
1. Daylight Dimming Controls
- C. Prerequisites The applicable prerequisite checklist items listed in the beginning of Section 16997 shall be listed on each functional test form and checked off prior to functional testing.
- D. Functions / Modes Required To Be Tested and Test Methods  
The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

<u>Function / Mode</u>	<u>Test Method</u> Manual (demonstration), Monitoring, Either or Both
<b>MISCELLANEOUS FUNCTIONS</b>	
1. All specified functions and features are set up, debugged and fully operable.	Verbal discussion of features
2. Power failure and battery backup and power-up restart functions.	Demonstration
3. Occupant over-ride functions and duration setting.	Demonstration
4. Scheduling features fully functional and setup, including holidays.	Observation in terminal screens or printouts
5. Date and time setting in central computer.	Demonstration
<b>DIMMING FUNCTIONS</b>	
6. Test the sequence of operation for all features and modes.	Manual
7. Test the dimming controls during “live” conditions verifying that amperage changes in light fixtures are proportional to external light changes, and that the light levels at the specified datum points remain within specified limits. Verify this over a broad area for all areas affected. Verify that all, and only, specified light fixtures are dimming.	Either
8. Verify that delays and ramp times are set and functioning so that the speed of change of light fixture output is slow enough to be judged non-bothersome to occupants.	Manual
9. Verify that dimming does not cause lower than specified light levels in adjacent “non-dimmed” spaces.	Manual
10. Verify that the controls and sensors are not easily overridden or disabled by occupants.	Visual inspection
11. Verify that the photo sensor is in an adequate location and is not being affected by direct sunlight or obstructions.	Visual inspection

- E. Special Procedures (other equipment to test with, etc.; reference to function ID)  
None

- F. Required Monitoring
1. None required, though monitoring can substitute for manual testing for most functions.  
See section 1.4 above.
- G. Acceptance Criteria (referenced by function or mode ID)
- 1-11 For the conditions, sequences and modes tested, the dimming controls, integral  
(All) components and related equipment respond to changing conditions and parameters  
appropriately as expected, as specified and according to acceptable operating practice.
- H. Sampling Strategy for Identical Units
1. Each photosensor and its controlled zone must be tested (no sampling).

END OF REQUIREMENTS FOR DAYLIGHT DIMMING TEST

**3. EMERGENCY POWER AND UNINTERRUPTIBLE POWER SUPPLY SYSTEM**

- A. Parties Responsible to Execute or Participate in Functional Test
1. Controls contractor: operate the controls
  2. Electrical contractor: provide all testing instruments and assist in testing sequences and debugging
  3. Mechanical contractor: assist in testing sequences and debugging
  4. Electrical design engineer: assist in testing sequences
  5. Security system contractor, local and remote monitoring site: report communication response
  6. Owner staff at regional monitoring site: report communication response
  7. Owner project and facility representatives: assist in testing sequences and debugging
  8. Commissioning authority: coordinate and document testing

- |  |  |
|--|--|
| <p>B. <u>Integral Components or Related Equipment Being Tested</u></p> <ol style="list-style-type: none"> <li>1. Generator</li> <li>2. Automatic transfer switch</li> <li>3. Uninterruptible power supply</li> <li>4. Building control, HVAC, lighting, fire alarm, telecommunications, elevator and security systems</li> </ol> | <p><u>Prefunctional Checklist ID</u></p> <p>PC- _____</p> <p>PC- _____</p> <p>PC- _____</p> <p>-----</p> |
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**Spec Writer:**

There is a wide variation in the industry as to what is sufficient testing for emergency power systems. More critical emergency power loads and generators feeding UPS systems and critical UPS loads warrant the more rigorous tests. Less critical applications will frequently omit the infrared metering and the powerline load profiler, detailed frequency and voltage stabilization tests mentioned below.

- C. Prerequisites The applicable prerequisite checklist items listed in the beginning of Section 16997 shall be listed on each functional test form and checked off prior to functional testing.
- D. Functions / Modes Required To Be Tested and Test Methods  
The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

<u>Function / Mode</u>	<u>Test Method</u> Manual (demonstration), Monitoring, Either or Both
<b>Generator and ATS</b>	
1. Document and witness startup, checkout and testing by factory representative as specified and including the following:	Demonstration
2. Safeties and alarms (including high and low oil pressure, high temperature, over-speed, derangements, etc.)	Manual
3. Sequences of operation with load bank: From a cold start, verify starting functions by recording times for engine start, ATS transfer ON, delay to OFF, engine cool down, etc.	Either
4. Load bank generator to 100% for 1 hour. Record every 5 min.: volts & amps (each phase), frequency, using load profiler, engineer coolant temp. and oil pressure.	Combination



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<u>Function / Mode</u>	<u>Test Method</u> Manual (demonstration), Monitoring, Either or Both
5. Voltage and frequency regulation over various loads. Verify that frequency and voltage is within specified ranges at steady state and step loads of 0%-50%, 0%-100%, 100%-50% and 50%-100% in that order using a power line load profiler. Verify that frequency stability (rate of change) is adequate.	Combination
6. Using actual building emergency loads, tune the generator output frequency and voltage for use by the UPS, using a load profiler or oscilloscope. (This could be done during the Integrated Building Test).	Combination
7. Verify annunciations to BAS and remote monitoring sites.	Monitoring
8. During the above tests use an infrared meter on the ATS contacts and look for hot spots and significant variations between contracts.	Manual
9. Monitor and instrument as required to make positive observations of test results.	Either
10. Operation during Integrated Test.	Manual
<b>UPS</b>	
11. By actual power outage, verify sequence of operation of UPS. Use actual UPS loads if possible, else use load bank: at what voltage UPS starts, time to transfer back to E-power, etc. Verify proper frequency window and slew rate with powerline analyzer. Tune UPS and generator governor as necessary. Partially drain batteries and verify charging sequences.	Manual
12. Simulate all alarms critical malfunctions and verify annunciations and protective device functioning.	Manual
13. Verify annunciations to BAS and remote monitoring sites.	Monitoring
14. During the above tests use an infrared meter on the UPS contacts and look for hot spots and significant variations between contracts.	Manual
15. Monitor and instrument as required to make positive observations of test results.	Either
16. Operation during Integrated Test.	Manual
<b>Integrated Building Test</b>	
17. The emergency power and UPS system and all integral components will be tested together through actual power outages with as much emergency loads operating as possible. Physical verification of emergency power to all emergency powered systems and equipment, including lighting, HVAC, telecommunications, fire alarm, elevator (test actual recall function), security, lighting and the controls system shall be documented. Communication responses to remote monitoring reception points, the local building automation system and visual points within the building will be documented. Critical voltage sensing, timing, delays, voltages, amperages and groundings will be documented.	Manual

E. Special Procedures (other equipment to test with, etc.; reference to function ID)  
None, except as noted.

F. Required Monitoring

1. See Requirements 4, 5, 8. See Section 1.4 above.

G. Acceptance Criteria (referenced by function or mode ID)

1-17 For the conditions, sequences and modes tested, the emergency power and UPS system,  
(All) integral components and related equipment respond to changing conditions and  
parameters appropriately as expected, as specified and according to acceptable operating  
practice.

H. Sampling Strategy for Identical Units

1. None. Test all.

END OF REQUIREMENTS FOR EMERGENCY POWER SYSTEM TEST

#### 4. GENERAL INDOOR LIGHT LEVELS

This is a performance test to verify that the lighting systems can provide fixed light levels equal to the specifications. Dynamic tests of occupancy sensors and daylight dimming systems are not included in this test.

A. Parties Responsible to Execute Functional Test

1. Commissioning authority
2. Contractor or A/E witness optional

B. Integral Components or Related Equipment Being Tested

none

C. Prerequisites

none

D. Test Conditions

The test shall be performed at night, with lights on in adjacent rooms open to the tested space. Doors from the tested space shall be closed.

E. Special Procedures

1. Space should be normally furnished and wall, floor and ceiling finishes complete.

F. Required Monitoring

none

G. Acceptance Criteria

1. Average light levels in the tested space at the workplane elevation shall not be less than 10% below nor greater than 30% above the specified light level range for the space.

H. Sampling Strategy

At least 10% of all space zones and rooms shall be verified to be realizing proper light levels, chosen by the Owner.

If 10% of the spaces in the first sample fail the functional performance tests, test another 10% of the group (the 2nd sample). If 10% of the spaces in the 2nd sample fail, test all remaining spaces, fully at the contractor's expense.

END OF REQUIREMENTS FOR INDOOR LIGHT LEVELS TEST

END OF THIS GUIDE SPECIFICATION SECTION