Dos and Don'ts: Lighting Controls Cx (and Design)

Lyn Gomes, kW
Rick Miller, RNM

What we'll cover

- Acronyms

- Do's and Don'ts
- Design
- Commissioning

Acronyms

- Cx – Commissioning
- CxP – Commissioning Provider
- OPR – Owner's Project Requirements
- BOD – Basis of Design
- PFTs – PreFunctional Tests
- FPTs – Functional Performance Tests
- SOO – Sequence of Operation
- FTW – For the Win!

DON'T ignore OPR and BOD

- OPR
  - Who are the occupants?
  - Tasks
  - Level of Control
  - Integration Goals
  - Programming not enough

- BOD
  - Up to Date?
  - Control technologies
  - Basic SOO
  - Energy goals
  - Maintenance

I'll go upstairs and find out what they want. You lot start programming!

DO a thorough design review

- Daylight analysis of site – use Google maps for site influences

- Daylighting design starts with the architects

- Window controls for better daylighting value

- IES recommendations

- Title 24 lighting power density

- Title 24 lighting controls

- Digital lighting controls

- Sequence of Operation - SOO

DON'T ignore Title 24

- Sec 130.1(a) requires separate on/off control for each type of lighting: general, case display, window display, floor and wall display, ornamental, and special effects lighting. Ignoring them will fail the acceptance test.

- Sec 130.1(d) requires the Daylighting Zones to be shown on the plans. Not showing them impedes the acceptance testing.

DO use the Title 24 Forms

- Fill out the NRCC-LTI forms on the drawings.
- Fill out the NRCC-LTO forms on the drawings.
- Fill out the NRCC-ELC form.
- Use the NRCC-CXR forms as a checklist.
- Use the NRCI-LTI forms as a checklist.
- Use the NRCI-LTO forms as a checklist.
- Use the NRCI-ELC form as a checklist.
- Use the NRCA-LTI forms as a checklist.
- Use the NRCA-LTO forms as a checklist.

NRCA-LTI-02

STATE OF CALIFORNIA
LIGHTING CONTROL ACCEPTANCE DOCUMENT
CEC-NRCA-LTI-02-A (Revised 05/15)   CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF ACCEPTANCE	NRCA-LTI-02-A
Lighting Control Acceptance Document	(Page 1 of 5)

01	**Automatic Time Switch Controls Construction Inspection—confirm for all listed in Section B**			
a.	All automatic time switch controls are programmed for (check all):			
	☐ Weekdays			
	☐ Weekend			
	☐ Holidays			
	☐ Override time limit is no more than 2 hours			
	☐ Occupant Sensors and Automatic Time Switch Controls have been certified to the Energy Commission in accordance with the applicable provision in Section 110.9 of the Standards, and model numbers for all such controls are listed on the Commission database as Certified Appliance and Control Devices			
02	**Occupancy Sensor Construction Inspection—confirm for all listed in Section B**			
	☐ Occupancy sensors are not located within four feet of any HVAC diffuser			

02. Occupancy Sensors	1	2	3
Step 1: Simulate an unoccupied condition			
a. Lights controlled by occupancy sensors turn off within a maximum of 30 minutes from start of an unoccupied condition per Standard Section 110.9(b)	Y / N	Y / N	Y / N
b. The occupant sensor does not trigger a false "on" from movement in an area adjacent to the controlled space or from HVAC operation	Y / N	Y / N	Y / N

NRCA-LTI-03

STATE OF CALIFORNIA
AUTOMATIC DAYLIGHTING CONTROL ACCEPTANCE DOCUMENT
CEC-NRCA-LTI-03-A (Revised 05/15)   CALIFORNIA ENERGY COMMISSION

CERTIFICATE OF ACCEPTANCE	NRCA-LTI-03-A		
Automatic Daylighting Control Acceptance Document	(Page 1 of 11)		
03. Sensor and Controls			
Control Loop Type: Open Loop (OL), Closed Loop (CL)			
Sensor Location: Outside (O), Inside Skylight (IS), Near Windows facing out (NW), In Controlled Zone (CZ)			
Sensor Location is Appropriate to Control Loop Type: (Y/N) If control loop type is Open Loop (OL): Enter yes (Y) if location = Outside (O), Inside Skylight (IS), or Near Windows facing out (NW); otherwise, enter no (N). If Control loop type is Closed Loop (CL): Enter yes (Y) if location = In Controlled Zone (CZ); otherwise, enter no (N).			
Location of Light Sensor on Plans: (Y/N)			
c.	If automatic daylighting controls are mandatory, are all general lighting luminaires in daylit zones controlled by automatic daylight controls? (Y/N)		
d.	Documented **general lighting design footcandles**. (Enter footcandle value or "Unknown" (U))		

DO understand Title 24 Exceptions

- 24/7 Operation
- <120W
- <24 sq ft windows
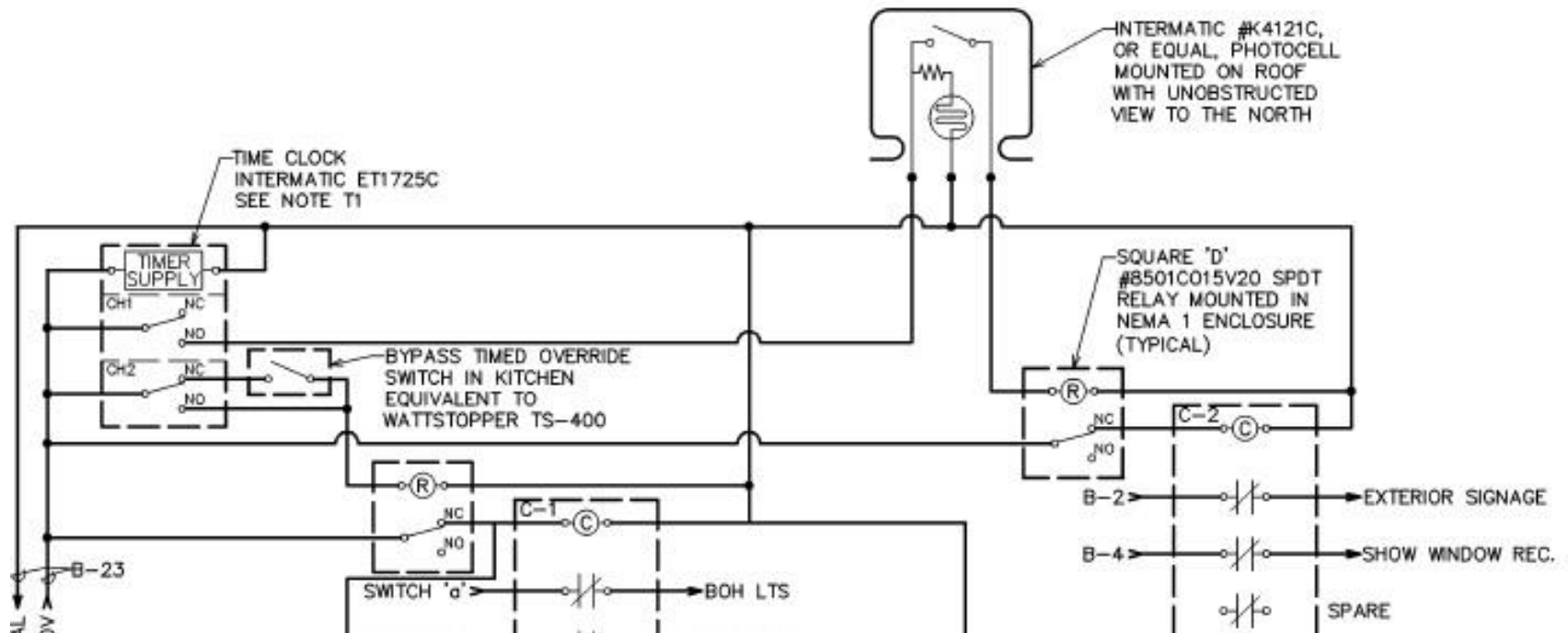- Very efficient
  - <85% ACM (alterations only)
  - <0.5 W/SF

DO insist on a Lighting SOO

- Major sequences
  - Time schedule
  - Occupancy sensors
  - Daylighting
  - Emergency lighting
  - Demand response
  - Janitor override
  - Scene controls

- Hours of operation
- Occ sensors
  - Dwell/delay
  - Trigger/retrigger
    - auto vs manual on
    - PIR vs US vs both
- Daylighting
  - Target lighting levels
  - Fixtures controlled
- Button functions

A Bad SOO

SOO Example

Sequence of Operations

Custom Sequence for 135 Executive Confe...

	1st Floor\135 Executive Con...
Areas Affecte d	
Lights Control led	Type R2
	Type F2
	Type Q
	Type U1d
Light Controls	*Lights* : Dimmed lights are ...
	Occupancy: Lights shall ad...
	the room has been vacated...
	Daylighting : NA
	Time of Day Schedule: Ty...
	hours and the building is oc...
	later date should it become...
	Manual Wall Control: GR...
	noted below. Manual raise/l...
Additional Controls	Emergency Light in this area...
	Emergency Lights include: N...
	Kill Switch: All lights on Qu...
	at entry to turn off upon sign...
	secure. Type D6 lights will t...
	remain occupancy based co...
	Demand Response : Upon ...
	For example if the lights are...
Quantum	This area will be part of Qua...
	for Building Management S...
	Report Occupancy status, a...
	Accept inputs from BMS fo...
Other	Scene 1: All on 80%
	Scene 2: Presentation F2 a...
	Scene 3: Video Conference...
	Scene 4: Party: Q On at 50%...
	wall at 20%

LIGHTING SEQUENCE OF OPERATION

LIGHTING CONTROL SEQUENCE OF OPERATIONS – GENERAL NOTES

A. LIGHTING CONTROL SEQUENCE OF OPERATION FOR EXTERIOR LOCATIONS:

A.A. PC ON/OFF. ON AT DUSK/OFF AT DAWN – PROVIDE PHOTOCELL LOCATED ON ROOF UNLESS NOTED OTHERWISE AND LINKED TO LIGHTING CONTROL SYSTEM. SENSOR SHALL BE SET TO ENABLE LIGHTING CIRCUIT(S) AT DUSK AND DISABLE CIRCUITS AT DAWN. AN OVERRIDE DEVICE SHALL BE PROVIDED TO ENABLE OR DISABLE CIRCUITS FOR MAINTENANCE AND SPECIAL EVENTS.

A.B. PC ON/TC OFF. ON AT DUSK/TIMED OFF – PROVIDE PHOTOCELL LOCATED ON ROOF UNLESS NOTED OTHERWISE AND LINKED TO LIGHTING CONTROL SYSTEM. SENSOR SHALL BE SET TO ENABLE LIGHTING CIRCUIT(S) AT DUSK AND DISABLE CIRCUITS AT PROGRAMMABLE SET TIME WITH AUTOMATIC ADJUSTMENTS FOR DAYLIGHT SAVINGS. AN OVERRIDE DEVICE SHALL BE PROVIDED TO ENABLE OR DISABLE CIRCUITS FOR MAINTENANCE AND SPECIAL EVENTS.

A.C. TC ON/PC OFF. TIMED ON/OFF AT DAWN. – PROVIDE PHOTOCELL LOCATED ON ROOF UNLESS NOTED OTHERWISE AND LINKED TO LIGHTING CONTROL SYSTEM. SENSOR SHALL BE SET TO ENABLE LIGHTING CIRCUIT(S) AT DUSK AND DISABLE CIRCUITS AT PROGRAMMABLE SET TIME WITH AUTOMATIC ADJUSTMENTS FOR DAYLIGHT SAVINGS. AN OVERRIDE DEVICE SHALL BE PROVIDED TO ENABLE OR DISABLE CIRCUITS FOR MAINTENANCE AND SPECIAL EVENTS.

B. LIGHTING CONTROL SEQUENCE OF OPERATION FOR INTERIOR SPACES:

B.A. <xxx> ON/OFF. LOCAL ON/OFF CONTROL ONLY. CONTROL ENABLES OR DISABLES LIGHTING CIRCUIT(S) VIA LOW VOLTAGE CONTROLS LINKED TO LIGHTING CONTROL SYSTEM. LIGHTING IS AUTOMATICALLY DISABLED AT PROGRAMMABLE SET TIME EACH DAY WITH ADJUSTMENTS FOR WEEKENDS, HOLIDAYS AND FACILITIES NORMAL OPERATING HOURS. LOCAL CONTROL CAN ENABLE LIGHTING CIRCUITS FOR A PROGRAMMABLE MAXIMUM OF 30 MINUTES. PROVIDE FLASH WARNING 5 MINUTES PRIOR TO AUTOMATIC DISABLING OF THE LIGHTING CIRCUIT.

B.B. <xxx> ON/OC OFF. LOCAL ON/OFF CONTROL WITH VACANCY OVERRIDE. LOCAL CONTROL ENABLES OR DISABLES LIGHTING CIRCUIT(S) VIA LOW VOLTAGE CONTROLS LINKED TO LIGHTING CONTROL SYSTEM. THE OCCUPANCY SENSOR LINKED TO THE LIGHTING CONTROL SYSTEM REDUCES LIGHTING LEVELS BY MINIMUM 50% AFTER NOT DETECTING AN OCCUPANT FOR PROGRAMMABLE MAXIMUM OF 30 MINUTES AND WILL RESET TO 100% LIGHTING LEVELS IF SPACE IS REOCCUPIED. OCCUPANCY SENSOR DISABLES LIGHTING CIRCUIT AFTER PROGRAMMABLE MAXIMUM OF 60 MINUTES AND WILL NOT AUTOMATICALLY ENABLE LIGHTING CIRCUIT IF ROOM IS REOCCUPIED AFTER MAXIMUM TIME LIMIT. LIGHTING IS AUTOMATICALLY DISABLED AT PROGRAMMABLE SET TIME EACH DAY WITH ADJUSTMENTS FOR WEEKENDS, HOLIDAYS AND FACILITIES NORMAL OPERATING HOURS. LOCAL CONTROL CAN ENABLE LIGHTING CIRCUITS FOR A PROGRAMMABLE MAXIMUM OF 30 MINUTES. PROVIDE FLASH WARNING 5 MINUTES PRIOR TO AUTOMATIC DISABLING OF THE LIGHTING CIRCUIT.

B.C. <xxx> ON/PC 15. LOCAL CONTROL PROVIDES LIGHTING LEVEL SET POINT VIA DIMMING AND ON/OFF CONTROLS LINKED TO LIGHTING CONTROL SYSTEM. SYSTEM IS SET FOR MAXIMUM 15FC AT THE WORK PLANE. LOCAL PHOTOCELL LINKED TO THE LIGHTING CONTROL SYSTEM WILL MAINTAIN LIGHTING LEVELS AND REDUCE ELECTRIC LIGHTING BASED UPON ACTUAL CONDITIONS WITHIN SPACE TO MAINTAIN THE PROGRAMMED MAXIMUM SET POINT. LIGHTING IS AUTOMATICALLY DISABLED IF SET POINT CAN BE

DO coordinate with the Vendor

- Furnish the vendor with Sequence of Operation
- Coordinate on-site activities.
  - Know when the vendor will be updating/uploading software/hardware
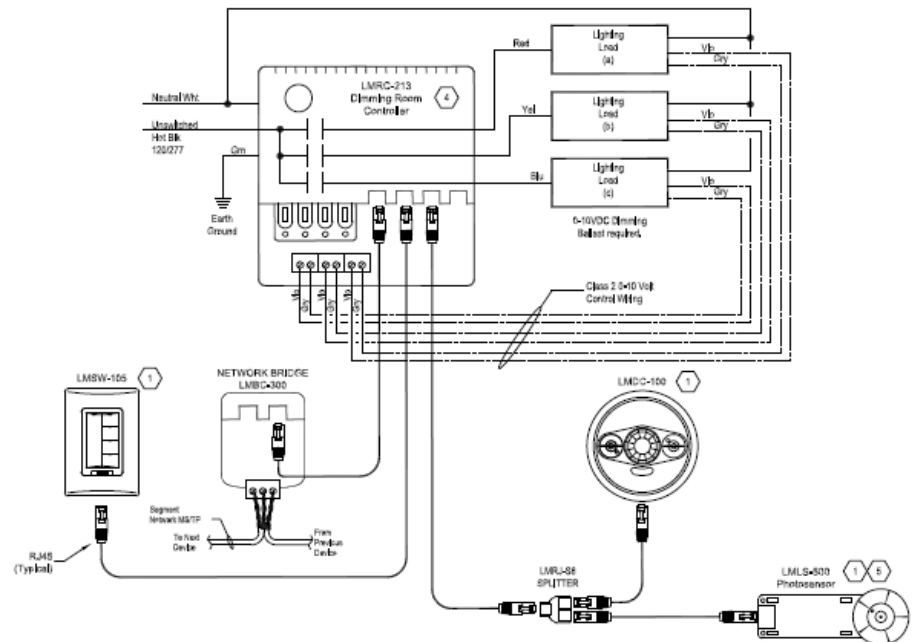
3-ZONE RETAIL LIGHTING CONTROL
NO SCALE

DON'T ignore Existing Controls

- In retrofit projects, learn the details about the existing controls.

- Abandon in place, bypass or remove?

- Ignoring an existing relay time sweep could disable the new controls during off times.

DON'T ignore Occ Sensors

- Don't rely on someone else to correctly locate the occupancy sensors, because "someone else" might not know the limitations.

- Problem Locations: blocked by furniture, too near air flow, sees excessive motion within the room, sees motion beyond the control zone

- Coordinated with HVAC

- Programming of OS: PIR, US, (either, and, or), mode, delay times, dim level, fade time, sensitivity,

DON'T ignore Photo Sensors

- Don't rely on someone else to correctly locate the photosensors, because "someone else" might not know the limitations.

- Open Loop vs Closed Loop

- Don't aim at the sun or at luminaires

- Programming of PS: design illumination, delay times, dim level, fade time, sensitivity

DON'T ignore Interface Details

- Don't simply say "provide interface with BAS" You need to specify:
  - What protocol (BACnet, LonWorks, Modbus)
  - Type of point (B, A, H, N, V)
  - The direction of information flow
  - Precisely what information
  - Clarify whether info is pushed or pulled
  - Define graphic displays

DON'T test too soon

- Don't start functional testing before the other interface systems (BAS, AV, Security, Window Shades) are ready

- Point-to-point tests are 100% done

- Furniture is moved in

- Equipment powered on

TOO SOON JUNIOR

DO Prepare

- Know before you go
- Communicate
- Test daylighting first
- Oversample
- Check before time is up
- Sensitivity

DO Avoid Cheap Stuff

- How 'cheap' is achieved:
  - Product support
  - Quality
  - Set up/configuration
  - Installation
- Project success:
  - Support for design, install, owner
  - Reputation maintained
  - Total project cost
  - Persistence of energy savings

$

Questions?

- Don't ignore the OPR and BOD
- Do a thorough design review
- Do insist on a thorough SOO
- Don't ignore existing controls
- Don't ignore Title 24
- Do use T24 forms
- Don't ignore occupancy sensors or photocells
- Don't ignore interface details
- Do coordinate with the vendor
- Don't test too soon
- Don't use cheap stuff

Thank you!

- Rick Miller, RNM Engineering
  - rickmiller@rnm-eng.com
  - (415) 307-5106

- Lyn Gomes, kW Engineering
  - lgomes@kw-engineering.com
  - (510) 834-6420

Demand Response

- ☐ Which spaces is the Owner comfortable with reducing lighting power? (this should be captured in the OPR and BOD)

- ☐ What should my sequence of operations say?

- ☐ Are there rebates available to offset the cost?

- ☐ What parts of the new T24 make it easier to do DR?

- ☐ Can my lighting control equipment do DR?

- ☐ DR needs acceptance testing?!

Net load - March 31
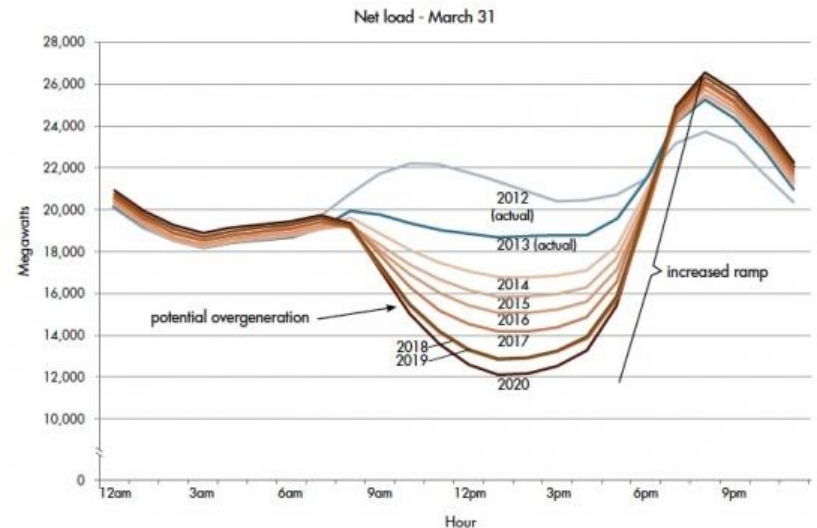
Title 24 SEC 10-103

- ☐ (a)1 Certificates of Compliance
- ☐ (a)2 Certificate(s) of Compliance shall be included with Application for Permit
- ☐ (a)2.B Record Drawings required within 90 days
- ☐ (a)3 Certificates of Installation
- ☐ (a)4 Certificates of Acceptance
- ☐ (b) Information to be provided by Builder.
- ☐ (c) Information to be Provided by Manufacturer

SEC 120.8 Building Commissioning

- ☐ (a) Summary of Commissioning Requirements
- ☐ (b) Owner Project Requirements (OPR)
- ☐ (c) Basis of Design (BOD)
- ☐ (d) Design Phase Design Review
- ☐ (e) Commissioning measures shown on plans
- ☐ (f) Commissioning Plan
- ☐ (g) Functional Performance Testing (FPT)
- ☐ (h) Documentation and Training
- ☐ (i) Commissioning Report

SEC 130.4 Acceptance, Installation

- (a) Lighting Control Acceptance Requirements

- (b) Lighting Control Installation Requirements

- (c) acceptance testing shall be performed by a CLCATT

SEC 141.0 – Additions, Alterations, Repairs

- (a) Additions

  - 1. Prescriptive approach shall comply with Sections 110.0 through 130.5 and Sections 140.2 through 140.9.

  - 2. Performance approach shall comply with Sections 110.0 through 130.5.

SEC 141.0 – Additions, Alterations, Repairs

- (b) Alterations

  - 2. Prescriptive approach shall comply with Sections 110.0 through 110.9, Sections 120.0 through 120.6, and Sections 120.8 through 130.5;

  - F. Spaces with lighting systems installed for the first time shall comply with Sections 110.9, 130.0, 130.1, 130.2, 130.4, 130.5, 140.3(c), 140.6, and 140.7.

  - I.iv. Lighting Wiring Alterations shall comply with Sections 110.9, 130.1, and 130.4.

Resources

- Lighting Cx Basics (2013 NCBC):
  Part 1 http://goo.gl/i5H2eQ Part 2 http://goo.gl/g2UZ8E
- Energy Center of Wisconsin Guide for daylight sensors:
  http://www.ecw.org/project.php?workid=1&resultid=494
- IESNA DG-29-11
- CCC Guide for Commissioning
  http://www.cacx.org/resources/documents/CA_Commissioning_Guide_New.pdf
- kW Matrix for Cx Activities:
  http://kw-engineering.com/
     services/commissioning/Commissioning.pdf