



The California State University

**Office of the
Chancellor**

Task Order Construction Agreement (TOCA) Master Enabling Agreement (MEA) Design Delivery Method for Indoor Lighting Design

JANUARY 2021

TABLE OF CONTENTS

<i>Section</i>	<i>Contents</i>	<i>Page</i>
1.0	INTRODUCTION	1
2.0	TOCA LIGHTING SYSTEM DESIGN REQUIREMENT OVERVIEW	3
2.1	Indoor Lighting System Alteration and Replacement Bridging Document	3
2.2	Title 24 Energy Code Building Lighting System Design Criteria	4
2.3	Title 24 Energy Use and Performance	8
2.5	Luminaire Selection Criteria	11
2.6	Lighting Control System Criteria	14
2.7	Building Occupancy and Spaces	21
2.8	Daylight Zones	22
2.9	Performance Verification, Testing and Commissioning	23
APPENDIX A	Title 24 Compliance Requirements, Forms, and Documentation	
APPENDIX B	Lighting Guide Specifications	
APPENDIX C	Lighting Controls Specifications	
APPENDIX D	Additional Lighting Project Related Specifications	
APPENDIX E	CSU Building Space Types	

1.0 INTRODUCTION

This document has been prepared to assist CSU campuses with the procurement of replacement lighting systems for building interior spaces using the Task Order Construction Agreement (TOCA) and Collaborative Design Build project delivery method under a Master Enabling Agreement (MEA). This delivery method requires the development of a set of Bridging Documents to be given to the TOCA Contractor for scope of work, schedule, and pricing. TOCA scope of work includes site surveys, design, plan check, construction, testing commissioning and closeout. The schedule will be based on site access, work hours, construction activity and material delivery lead times. The TOCA Contractor pricing will include material unit costs and overall pricing for labor and miscellaneous material and other expenses to complete the scope of work. The scope of work includes preparation of construction plans for Owner's reviews and Authority Having Jurisdiction (AHJ) review and approval, including plan check, MSR, life safety and the Office of Fire Safety (CSU/CSFM).

At the time this document was prepared, the 2019 California Building Standards Code (California Code of Regulations) was in effect. References to sections included in this document are to Part 6 California Energy Code unless noted otherwise. Indoor lighting system alteration projects must comply with the California Building Standards Codes including:

- Part 1 California Administrative Code
- Part 2 California Building Code
- Part 3 California Electric Code
- Part 4 California Mechanical Code
- Part 6 California Energy Code
- Part 9 California Fire Code
- Part 11 California Green Building Standards Code

There are many references to the 2019 California Title 24, Part 6 Building Energy Efficiency Code Standards (Energy Code) included in this document. The 2019 Energy Code became effective January 1, 2020. The Energy Code is updated on a three year cycle. Future updates to the Energy Code will become mandatory when effective and supersede the 2019 requirements. **For simplicity, all references to the T24 Energy Code "Sections" in this document are preceded by the word "Section" and followed by the section number.**

Appliances and lighting system controls equipment, LED lamps, products, and devices must be certified to the California Energy Commission (CEC) by the manufacturer that it meets requirements under Title 24, Part 6, and associated appendices. The CEC website includes information regarding mandatory requirements for energy efficiency and demand controls that can be accessed by visiting [Appliance Efficiency Regulations - Title 20 \(ca.gov\)](https://www.energy.ca.gov/appliance), for lighting efficacy and for lighting controls demand response capability [Demand Responsive Lighting Control \(ca.gov\)](https://www.energy.ca.gov/lighting).

Lighting system replacement projects can include retrofit of existing luminaires, luminaire replacement, wiring, and controls modification and replacement. Luminaire component modifications include replacing the ballasts or drivers and the associated lamps, permanently changing the light source, and changing the optical system such as reflectors. Lighting Wiring alterations include wiring alterations that add a branch circuit feeding luminaires; that relocate, modify, or replace wiring between a switch or panel board and luminaires; or that replace lighting control panels, panel boards or branch circuit wiring.

Title 24 Part 6 allows existing lighting controls to remain in place under certain criteria as noted in part 2.6 of this document. In some limited cases, new lighting controls for alterations are not required. However, building lighting systems alterations that exceed 10,000sqft or that include lighting branch circuit modifications or additions will require new lighting controls compliant with applicable 2019 T24 requirements. Lighting control system selection requires careful thought and planning. Luminaire controls can be autonomous or networked or both. Lighting controls can be wired and wireless. A digital lighting management system can be used to control other loads such as plug load and HVAC conditioning for occupied and unoccupied spaces through the use of occupancy sensors. The lighting controls can be networked with the Building Automation System (BAS) and Energy Management System (EMS) using Wi-Fi to allow occupancy sensing devices to be used to better manage ventilation rates and heating and cooling set points. Plug loads can be controlled using wireless RF signals that are transmitted by the digital lighting controller based on occupancy. Plug load and ventilation system control is possible using the occupancy sensors that also control the luminaires in a room or space. It is recommended that future use applications for the lighting control system include energy management and control of “other loads in addition to lighting”. These applications should be considered when selecting a lighting control system. Evaluate the network communications and control options available from each lighting control system manufacturer to be able to leverage the lighting control system for the most comprehensive applications for California Title 24 Energy Code compliance and for energy savings through control of lighting, heating, cooling, and plug loads.

The TOCA Contractor will need to utilize the services of a qualified electrical system designer and lighting system designer. These services may be provided by the TOCA contractor but must also be bid out. The TOCA Request for Proposal (RFP) Bridging Document should include a requirement for the TOCA contractor to provide the qualifications of the electrical designer and lighting designer with their bid. Additional professional services may be required including architectural, structural, and mechanical. Construction plans are required to be prepared and submitted for each phase of design development and design review as identified in the CSU Procedure Guide. The construction documents must be submitted for plan check review. Before construction can begin, the Campus must submit the plans to a CSU approved third party plan reviewer who will review the building lighting system replacement plans and specifications for compliance with all applicable Codes and Standards. The plans will include the required California T24 Energy Code Compliance forms for a lighting system replacement project.

Compliance with the Energy Standards is required. Compliance with the building life safety Code for emergency egress is also required.

The CSU requires lighting replacement projects to exceed the T24 Energy Code minimum performance requirements by 10% or more. In other words, the installed replacement lighting system with lighting controls shall use at least 10% less energy than permitted by T24 Energy Code. This requirement can be exceeded with lighting system controls including vacancy sensors and daylight sensors. Lighting system controls that are properly specified, tested, and commissioned are key to achieving energy reduction targets. Commissioning is required for all newly constructed nonresidential buildings to ensure that the controls operate as planned and expected. For lighting system replacement projects, performance verification is required. Performance verification is required during design by comparing the T24 performance requirements specified on the certificate(s) of compliance with the energy savings calculations prepared by the designer. The energy savings calculations compare the energy use before the lighting system replacement with the energy use after the project is complete.

The performance is also verified upon completion of lighting controls system commissioning as required by the California Energy Commission (CEC) Acceptance Test Technician Certification Program (ATTCP). Refer to the CEC website, [Acceptance Test Technician Certification Provider Program Frequently Asked Questions](#) for details. California Advanced Lighting Certified Training Program (CALCTP) certified acceptance testing technicians are approved to perform the T24 Energy Code required commissioning testing and project certification.

If required, compliance documents submitted to an approved nonresidential data registry shall be certified and signed by the applicable responsible person. The nonresidential data registry shall assign a unique registration number to the document(s), provided the documents are completed correctly and a certification/signature is provided by the responsible person.

2.0 TOCA LIGHTING SYSTEM DESIGN REQUIREMENT OVERVIEW

2.1 Indoor Lighting System Alteration and Replacement Bridging Document

A Bridging Document will need to be prepared in advance of soliciting proposals from a pre-qualified TOCA Contractor utilizing the MEA process. The campus can work from the Bridging Document template provided in the E-TOCA package. The items listed below will be used to define the project scope of work for each building. Including as much information for the existing building lighting systems and scope of work will result in a better outcome.

The Bridging Document should include:

1. List of Buildings and building areas included in the project. Note if the area for lighting system replacement in each building is over 10,000 square feet.

2. Building record plans including lighting plans, electrical plans, and panel schedules.
3. Reference to CAD files of the building record files that are available.
4. Architectural plans showing the egress pathways, exit signs, and all fire rated assemblies.
5. Provide a list of hazardous materials and where they are located in each building. This list should include asbestos, asbestos contaminated ceiling tiles and painted surfaces containing lead at a minimum. Requirements for abatement must be addressed. Exceptions to compliance requirements for alterations apply where disturbance of asbestos would be required unless the disturbance is associated with abatement efforts.
6. List work required in addition to lighting system replacement. This might include ceiling tile replacement, ceiling grid replacement or repairs, patching and painting, removal and replacement of ceiling mounted devices, or other repairs.
7. Identify any modifications to the existing reflective ceiling plan and any new work to address lighting system deficiencies.
8. Include the Owner's Project Requirements (OPR). The OPR will specify design and performance requirements. It may also identify acceptable manufacturers for luminaires, luminaire details, lighting control systems, egress lighting power sources, ceiling grid manufacturer, ceiling tile manufacturer, and other details unique to a building or the Campus.
9. Guide specifications for luminaires and lighting controls. Refer to the Guide specifications included in the Appendices. The Guide Specifications or Campus standards, or other specifications should be included in the Bridging Document.
10. List of lighting control systems and vendors that exist in the buildings included in the project scope of work and lighting control system vendors preferred by the Campus.

2.2 Title 24 Energy Code Building Lighting System Design Criteria

2.2.1 The 2019 T24 Energy Code includes specific requirements for indoor lighting systems additions, alterations and replacements that include:

1. Energy used for lighting must be separately metered for additions. This is not a mandatory requirement for alteration and replacement projects. Provisions for metering must be identified. In existing buildings, the panelboards are likely to include a combination of loads for lighting, plug load, equipment, and appliances. Submetering of lighting loads is possible when submeters with current transformers are installed for each lighting branch circuit are installed.
2. All lighting power allowances are based on LED lighting technology.

3. Compliance with the standard is allowed for other appropriate lighting technologies, however, LED luminaires are preferred and should be required over other technologies. Other technologies must be pre-approved prior to selection and specification.
4. Occupancy and vacancy sensors are required unless otherwise specifically exempted based on room type. Refer to section 2.5 for more details.
5. New requirements for Altered Indoor Lighting systems. Refer to 2.2.2 and 2.2.3 for additional information.

2.2.2 An alteration is any change to a building's indoor lighting system, outdoor lighting system, sign lighting, or envelope that is not an addition. Luminaire alterations include removing and reinstalling more than 10 percent of the existing luminaires, replacing or removing and adding luminaires, and redesign of the lighting system that includes adding, removing, or replacing walls or ceilings.

Alterations to lighting branch circuit wiring are considered Alterations to the lighting system. Alterations to indoor lighting systems are not required to separate existing general, floor, wall, display or ornamental lighting on shared circuits or controls. New or completely replaced lighting circuits are required to comply with the control separation requirements of Section 130.1(a)3 and 130.1(c)1D. For projects where new feeders and branch circuits are added, the voltage drop requirements from Section 130.5(c) apply.

Alterations or renovations to existing conditioned spaces have their own rules for energy compliance.

The Energy Standards compliance goals for the lighting alterations are twofold. First, the installation must meet the lighting power level specified in the Energy Standards, and second, the installation must provide the lighting controls functionality specified in the Energy Standards.

The alteration rules are:

1. The Energy Standards apply only to those portions or components of the systems being altered. Untouched portions or components need not comply with the standards.
2. If an indoor lighting, outdoor lighting, or sign lighting alteration increases the energy use of the altered systems, the alteration must comply with the current standards.
3. Alterations must comply with the mandatory measures for the altered components.
4. Alterations to the lighting systems must comply with the requirements in Section 141.0(b)2I when 10 percent or more of the luminaires serving an enclosed space are altered.

5. Three types of alterations are covered by the standard:
- Entire luminaire alterations affect the entire luminaire such as the complete replacement of old luminaires with new.
 - Completely disconnecting the luminaire from the circuit, modifying it, and reinstalling it. Luminaire component modifications include replacing the ballasts or drivers and the associated lamps in the luminaire, permanently changing the light source of the luminaire, or changing the optical system of the luminaire.
 - Moving or modifying the walls or ceilings of the space along with modifying the space's lighting system. Wiring alterations add a circuit feeding luminaires; replace, modify, or relocate wiring between a switch or panel board and luminaires; or replace lighting control panels, panel boards, or branch circuit wiring. Wiring modifications will trigger compliance with the 2019 Energy Code requirements, as applicable.

The 2019 Energy Standards allow the same three options for meeting the installed power and associated control requirements as the 2016 standards, and specify a set of requirements for lighting power allowance and controls for each of the following cases:

1. Option 1: The altered lighting power that does not exceed Table 140.6-C and the lighting control requirements specified in T24 Part 6 Table 141.0-F. Refer to Table 2.5 below.
2. Option 2: The altered lighting power that is equal to or less than 80 percent of Table 140.6-C and the lighting control requirements specified in T24 Part 6 Table 141.0-F. Refer to Table 2.5 below.
3. Option 3: Where the alteration is within a building or tenant space of 5,000 sq. ft. or less, or that include one-for-one luminaire alterations to more than 50 luminaires or component modifications where the total rated power of the new luminaires achieve at least a 40% power reduction over the pre-alteration existing luminaires in the occupancy, and the lighting control requirements specified in T24 Part 6 Table 141.0-F. Refer to Table 2.5 below.

Altered lighting systems must meet one of the three Options listed above.

- Option 1 requires the lighting power density to be equal to or less than the w/sqft value allowed for area occupancy type, this is a prescribed value.
- Option 3 allows the maximum installed lighting power to be determined by totaling and taking a percentage of the currently installed lighting power, rather than by measuring the square footage of the space and multiplying it by a lighting power allowance.
- Options 2 and 3 are likely to result in a lower lighting power than Option 1, and therefore multi-level lighting controls (Section 130.1(b)), daylighting controls (Section 130.1(d)), and demand responsive controls (Section

130.1(e)) are not required for Options 2 and 3. The control requirements for each option are described in Table 2.5 below.

Alterations to indoor lighting systems should be such that they do not prevent the operation of existing, unaltered controls, and do not alter controls to remove functions specified in Section 130.1. Alterations to indoor lighting systems are not required to separate existing general, floor, wall, display, or ornamental lighting on shared circuits or controls. New or completely replaced lighting circuits shall comply with the control separation requirements of Section 130.1(a)4 and 130.1(c)1D.

2.2.3 Indoor Lighting Exceptions

The following indoor lighting alterations are not required to comply with the lighting requirements in the Energy Standards:

1. Alterations where less than 10 percent of existing luminaires are being altered.
2. Alteration of portable luminaires, luminaires affixed to moveable partitions, or lighting excluded by Section 140.6(a)3.
3. In an enclosed space where there is only one luminaire.
4. Disturbance of asbestos directly caused by any alterations unless the alterations are made in conjunction with asbestos abatement.
5. One-for-one luminaire alteration of up to 50 luminaires either per complete floor of the building or per complete tenant space, within a twelve month period, is treated as a repair rather than an Alteration per Exception 6 to Section 141.0(b)2l.
6. Alteration limited to addition of lighting controls or replacing lamps, or ballasts, or drivers. When both the lamp and ballast/driver are replaced during the same project, the Alteration requirements apply.
7. Routine maintenance and Repairs of lighting components, systems or equipment already installed in an existing building do not trigger the Energy Code. No compliance measures are required.
8. Acceptance testing requirements are not required for indoor alteration projects where controls are added to 20 or fewer luminaires.

The Energy Code defines maintenance tasks and repairs as:

- Lamp replacements
- Ballast replacements
- Replacements of lamp holders or lenses
- Maintenance measures that do not increase energy use of equipment being serviced

- Alterations caused directly by the disturbance of asbestos

2.3 Title 24 Energy Use and Performance

- 2.3.1 With either the prescriptive or performance compliance paths, there are mandatory measures that always must be met. Mandatory measures include lighting system and equipment efficiency. The minimum mandatory levels are sometimes superseded by more stringent prescriptive or performance requirements. For lighting system replacements, alterations and additions, all mandatory requirements must be met, including lighting power densities.
- 2.3.2 If the design fails to meet even one requirement, then the system does not comply with the prescriptive approach. In this case, the performance approach provides more flexibility to the building lighting designer for choosing alternative energy efficiency features.
- 2.3.3 The prescriptive lighting power requirements are determined by one of three methods: the complete building method, the area category method, or the tailored method. These approaches are described in Chapter 5 of Title 24 Energy Code. The allowed lighting varies according to the requirements of the building occupancy or task requirements. When using the prescriptive approach for a lighting system addition, the indoor lighting included in the addition must meet the lighting requirements of Sections 110.0; 110.9, 130.0 through 130.5, 140.3, and 140.6.
- 2.3.4 The performance approach (Chapter 11 of T24) allows greater flexibility than the prescriptive approach. It is based on an energy simulation model of the building. The performance approach requires an approved computer compliance program that models a proposed building, determines its allowed energy budget, calculates its energy use, and determines when it complies. Design options such as window orientation, shading, thermal mass, zonal control, and building configuration are all considered in the performance approach. In addition to flexibility, it helps find the most cost-effective solution for compliance.

When using the performance approach, the indoor lighting in the addition must meet the lighting requirements of Sections 110.0; 110.9; 130.0 through 130.5; and one of the following two options of the performance requirements:

1. The addition alone with Section 140.1; or
2. The existing building plus the addition plus the alteration.

The performance approach may be used for:

- envelope or mechanical compliance alone
- envelope and mechanical compliance
- envelope and indoor lighting compliance, or

- envelope, mechanical, and indoor lighting compliance

Indoor lighting compliance must be combined with envelope compliance. The performance approach does not apply to outdoor lighting, sign lighting, exempt process load, some covered process loads (e.g., refrigerated warehouses), or solar ready applications.

Time-dependent valuation (TDV) energy is the “currency” for the performance approach. TDV energy considers the type of energy (electricity, gas, or propane) and when it is saved or used. Energy saved when California is likely to have a statewide system peak is worth more than when supply exceeds demand.

- 2.3.5 At the time a building permit application is submitted to the enforcement agency, the applicant also submits building lighting plans and emergency egress plans with the required energy compliance documentation.

2.4 Title 24 Certification Forms and Documentation Requirements

- 2.4.1 The nonresidential indoor lighting requirements are the same for conditioned and unconditioned spaces. However, the Energy Standards do not allow lighting power trade-offs to occur between conditioned and unconditioned spaces. Therefore, most nonresidential indoor lighting compliance forms are required to be separately completed for conditioned and unconditioned spaces.

- 2.4.2 The following is an explanation of the nonresidential lighting compliance documentation numbering:

- NRCC, Nonresidential Certificate of Compliance
- NRCA, Nonresidential Certificate of Acceptance
- NRCI, Nonresidential Certificate of Installation
- LTI, Lighting, Indoor
- LTO, Lighting, Outdoor
- LTS, Lighting, Sign
- E, primarily used by enforcement authority
- A, primarily used by acceptance tester

- 2.4.3 The following forms are required with a Building Permit Application and shall be completed and signed by the designer:

- NRCC-LTI-E, Lighting – Indoor
- NRCC-PRF-01-E, Performance Lighting in Conditioned Spaces
- NRCC-LTO-E, Lighting – Outdoor
- NRCC-LTS-E, Lighting – Sign

2.4.4 There are six different Certificates of Installation used during construction that are to be completed and signed by the installing Contractor, and available for the Inspector, and delivered to the Campus Project Manager, as applicable to the building lighting system Alterations, listed as follows:

- NRCI-LTI-01-E, Certificate of Installation, Indoor Lighting.
- NRCI-LTO-01-E, Certificate of Installation, Outdoor Lighting
- NRCI-LTI-02-E, Certificate of Installation, Lighting Control Systems
- NRCI-LTI-04-E, Certificate of Installation, Two Interlocked Lighting Systems
- NRCI-LTI-05-E, Certificate of Installation, Power Adjustment Factors
- NRCI-LTI-06-E, Certificate of Installation, Video Conference Studio Lighting

2.4.5 There are five different Certificates of Installation used during construction that are to be completed and signed by the installing Acceptance Test Technician, and available for the Inspector, and delivered to the Campus Project Manager, as applicable to the building lighting system Alterations, listed as follows:

- NRCA-LTI-02-A, Indoor Lighting-Automatic Shut-Off Control
- NRCA-LTI-03-A, Indoor Lighting-Automatic Daylighting Control
- NRCA-LTI-04-A, Indoor Lighting-Demand Response Control
- NRCA-LTI-05-A, Indoor Lighting-Institutional Tuning PAF

2.4.6 The Certificates of Installation are primarily used as declarations, signed by a person with an approved license, that what was claimed on the Certificates of Compliance is actually what was installed.

The required nonresidential indoor lighting Certificates of Installation include the following:

- NRCI-LTI-01-E: Must be submitted for all buildings for indoor lighting systems. This is the general Certificate of Installation used to declare that what was proposed in the Certificates of Compliance is actually what was installed. In addition to the NRCI-LTI-01-E, the following Certificates of Installation are also required if the job includes any of the measures covered by these Certificates of Installation. If any of the requirements in any of these Certificates of Installation fail the respective installation requirements, then that application shall not be recognized for compliance with the lighting standards. These additional Certificates of Installation are different than Certificates of Acceptance, in that Certificates of Installation consist primarily of declarations that each of the minimum requirements has been met, while Certificates of Acceptance include tests which must be conducted.
- NRCI-LTO-01-E: Must be submitted for all buildings for outdoor lighting systems. This is the general Certificate of Installation used to declare that

what was proposed in the Certificates of Compliance is actually what was installed.

- NRCI-LTI-02-E: Must be submitted whenever a lighting control system, and whenever an Energy Management Control System (EMCS), have been installed to comply with any of the lighting control requirements.
- NRCI-LTI-04-E: Must be submitted for two interlocked systems serving an auditorium, a convention center, a conference room, a multipurpose room, or a theater to be recognized for compliance. See Section 5.6.4 of this chapter for two interlocked system requirements.
- NRCI-LTI-05-E: Must be submitted for a Power Adjustment Factor (PAF) to be recognized for compliance. See Section 5.6.5 of this chapter for requirements of PAFs.
- NRCI-LTI-06-E: Must be submitted for additional wattage installed in a video conferencing studio to be recognized for compliance.

2.5 Luminaire Selection Criteria

New luminaires and retrofit kits should be LED and comply with Title 20, Appliance Efficiency Regulations. Lighting equipment, products, and devices must be appropriately certified. Refer to Sections 110.0(b), 110.1, and 110.9(a).

Luminaires and light sources emit light and provide illumination to spaces. The Energy Standards include a system of classification to account for the power of luminaires and lighting systems and to use the information for compliance purpose. Below is the list of various types of luminaires as described and classified in Section 130.0(c) of the Energy Standards:

- Luminaires with line-voltage lamp holders
- Luminaires with ballasts
- Inseparable solid-state lighting (SSL) luminaires and SSL luminaires with remote ballasts
- LED tape lighting and LED linear lighting
- Modular lighting systems
- Other lighting equipment

For meeting the prescriptive or performance requirements for indoor lighting, the wattage of all planned lighting systems, including permanent lighting and portable lighting, shall be determined as follows:

- The wattage of luminaires with line-voltage lamp holders not containing permanently installed ballast or transformers shall be the maximum rated wattage of the luminaire.

- For recessed luminaires with line-voltage medium base sockets, wattage shall not be less than 50 watts per socket, or the rated wattage of the installed JA8 compliant lamps.
- The 2019 Energy Standards allow the wattage of JA8 lamps to be used as the wattage of recessed luminaires. This provides another option for designers, engineers, and installers for their compliance use of luminaires with line-voltage lamp holders.
- The wattage of luminaires with permanently installed or remotely installed ballasts shall be the operating input wattage of the rated lamp/ballast combination.
- The wattage of inseparable SSL luminaires and SSL luminaires with remote ballasts shall be the maximum rated input wattage of the SSL luminaires.
- LED tape lighting can be installed in length by installers on a project site as determined by the lighting design requirements. LED tape lighting is not like legacy luminaires which are manufactured in a pre-determined dimension per customer order. The wattage of the luminaire or lighting system shall be the sum of the installed length of the tape lighting times its rated linear power density in W/ft (or the maximum rated input wattage of the driver or power supply providing power to the lighting system).
- Track mounted luminaires as well as rail mounted luminaires are examples of modular lighting systems. The wattage of modular lighting systems that allow the addition or relocation of luminaires without altering the wiring of the systems shall be the greater of 30 watts per linear foot of track or plug-in busway; or the rated wattage of all of the luminaires in the system. For power-over-Ethernet lighting system, the wattage shall be the total power rating of the system less any installed non-lighting devices.

2.5.1 Luminaires shall be labelled with its wattage as follows:

1. The maximum rated wattage or re-lamping rated wattage of a luminaire shall be listed on a permanent, preprinted, factory-installed label, as specified by UL 1574, 1598, 2108, or 8750, as applicable.
2. Peel-off and peel-down labels that allow the maximum labeled wattage to be changed are prohibited, except for luminaires meeting all of the following requirements:
 - a. The luminaires can accommodate a range of lamp wattages without changing the luminaire housing, ballast, transformer, or wiring.
 - b. They have a single lamp.
 - c. They have an integrated ballast or transformer.
 - d. Peel-down labels are layered such that the rated wattage reduces as successive layers are removed.

- e. Qualifies as one of the following three types of luminaires:
 - i. High intensity discharge luminaires having an integral electronic ballast with a maximum re-lamping rated wattage of 150 watts.
 - ii. Low-voltage luminaires (does not apply to low voltage track systems) ≤ 24 volts with a maximum re-lamping rated wattage of 50 watts.
 - iii. Compact fluorescent luminaires having an integral electronic ballast with a maximum re-lamping rated wattage of 42 watts.

2.5.2 Considerations for Linear Fluorescent Replacement with Linear LED Lamp

Linear LED lamps are designed to replace linear fluorescent lamps. There are three types of UL Listed LED products for linear tube replacements; UL Type A, UL Type B, and UL Type C. Some linear LED lamp products can operate as multiple product types. These hybrid products, also called dual-mode products, are currently available in UL Types AB and AC.

1. UL Type A consists of Linear LED lamp with an internal driver that is designed to operate with a linear fluorescent lamp ballast.
2. UL Type B consists of Linear LED lamp with an internal driver that must be connected directly to line voltage for power.
3. UL Type C consists of Linear LED lamp with an external driver that is designed to replace the linear fluorescent lamp and ballast.

A large portion of the linear LED lamp market focuses on the UL Type A electrical configuration due to its low cost, ease of retrofit, and wide-availability. Given the universal design of UL Type A products, system efficacy is often sacrificed. A recent California Lighting Technology Center (CLTC) market assessment shows system efficacy of UL Type A products can be 12 to 24 percent less efficacious than UL Type B and UL Type C products. For this reason UL Type A products are not recommended.

Interoperability issues between existing ballasts and UL Type A linear LED lamps can lead to poor performance or premature product failure. Results from CLTC testing of UL Type A linear LED lamps paired with commonly installed ballasts indicate that more than 50 percent of the configurations operated with significantly different light output and power compared to the manufacturer reported values for the lamp when paired with a manufacturer-specified ballast.

When installed correctly, UL Type C linear LED lamps are better at preventing customers from changing the LED retrofit back to the original technology. Since UL Type C requires ballast removal and replacement with a LED driver, reversal back to fluorescent from LED would require significant work compared to UL Type A LED lamps, which only requires a lamp replacement. UL Type B linear LED lamps also prevent customers from changing back to their original technology because of wiring differences; however, UL Type B introduces other potential hazards as the main electrical voltage would now be present at

the fixture lamp holders. For this reason, UL type C LED lamp products are recommended over Type A and Type B options.

There are other considerations when selecting a linear LED lamp replacement product including the product life, dimming, color quality, CLTC has prepared the following minimum performance requirements for LED linear lamps which should be followed when replacing linear fluorescent lamps with linear LED lamps:

- UL Type C electrical architecture (Not Type A or Type B)
- Light output to 2250 lumens for bare 4 foot lamps and 1125 lumens for bare 2 foot lamps
- 120 lumens per watt system efficiency
- Dimming from 100 percent to 10 percent
- Be able to pare with lighting control devices
- No greater than 30 percent flicker at 200Hz when paired with control devices per Title 24 JA10.
- Color fidelity R value greater than 90 per IES TM-30-18
- Beam angle of at least 220 degrees with no less than 20 percent flux emitted in the 100-180 degree zone
- Physical dimensions of the driver to be verified to “fit” into existing luminaire housing before purchase.

2.6 Lighting Control System Criteria

Lighting controls and equipment installed in nonresidential buildings must comply with the applicable requirements in Section 110.9, Section 130.0, Section 130.1, and Section 130.2 of the Energy Standards. Requirements apply to nonresidential, high rise residential, hotel and motel buildings. These Standards also reference device specific requirements contained in Section 1605.3 of the Appliance Efficiency Regulations.

For the purposes of the Energy Standards, lighting controls are separated into two categories – self-contained lighting controls and lighting control systems. Self-contained lighting controls are unitary lighting control Modules that do not require any additional components to be fully functional. Self-contained lighting controls must be certified to the Energy Commission and listed in the appliance efficiency database to be sold or offered for sale in California. If a self-contained lighting control is not certified to the Energy Commission, it cannot be used to comply with the Energy Standards.

Lighting control systems require two or more components to provide all of the functionality required to make up a fully functional and compliant lighting control. Lighting control systems do not need to be listed in the appliance efficiency data base; however, a certificate of installation NRCI-LTI-02-E must be submitted for an installed lighting control

system or energy management control system to certify that it complies with the Energy Standards.

Both categories of lighting controls must meet specific performance and certification requirements contained in the Energy Standards and Appliance Efficiency Regulations. If a lighting control product is intended to meet multiple control requirements under the Energy Standards, it must also meet multiple requirements under Title 20. For example, if an ultrasonic occupancy sensor is installed to comply with the shut-off control requirements contained in the Energy Standards then it must comply with all the specific device requirements for an occupancy sensor contained in State Standards for Non-Federally-Regulated Appliances (Title 20, Section 1605.3).

If that same device also contains an integrated photo sensor and is intended to serve as part of daylighting control system, then it must also comply with all of the applicable requirements for a daylighting control contained in Title 20. Automatic time switch controls, daylighting controls, dimmers and occupant sensing controls must meet mandatory device requirements contained in Section 110.9 of the Energy Standards as well as requirements contained in Section 1605.3 of the Appliance Efficiency Regulations.

Control Requirements for Indoor Lighting System Alterations
Table 2.5 (2019 T24, Part 6, Table 141.0-F)

Control Specifications		Trigger	Projects Complying with Section 141.0(b)2li	Projects Complying with Sections 141.0(b)2lii & 141.0(b)2liii
Manual Area Controls	130.1(a)1 – Be readily accessible.	Enclosed areas with ceiling-height partitions of any size.	Required	Required
	130.1(a)2 – Be located in the same enclosed area with the lighting fixture it controls.		Required	Required
	130.1(a)3 – Provide separate control of general, display, ornamental and special effects lighting.		Only required for new or completely replaced circuits	Only required for new or completely replaced circuits
Multi-Level Controls	130.1(b) – Allow level of lighting to adjust up and down.	Enclosed areas 100 square feet or larger with connected lighting load that exceeds 0.5 Watts per square foot.	Required	Not Required
	130.1(c)1 – Be controlled by an occupant sensing control, automatic time-switch control, or other control capable of automatically shutting OFF all lighting when the space is typically unoccupied.		Required	Required
	130.1(c)2 – Countdown timers switches may be used to comply with shut-OFF control requirements in closets less than 70 square feet and server aisles in server rooms.		Required	Required
	130.1(c)3 – Manual override for automatic time-switch controls shall turn lighting off after 2 hours.		Required	Required

Control Specifications		Trigger	Projects Complying with Section 141.0(b)2li	Projects Complying with Sections 141.0(b)2lii & 141.0(b)2liii
Shut-OFF Controls	130.1(c)4 – Holiday override for automatic time-switch controls shall turn lighting off for at least 24 hours and be able to resume normal scheduled operation.	All installed indoor lighting (except healthcare facilities).	Required	Required
	130.1(c)5 – Spaces required to use occupant sensing controls to shut OFF all lighting.		Required	Required
	130.1(c)6 – Space required to use full or partial-OFF occupant sensing controls to shut OFF all lighting.		Required	Required
	130.1(c)7 – Partial-OFF occupancy sensors		Required	Required
	130.1(c)8 – Hotel/motel guest room card key controls		Required	Required
Automatic Daylighting Controls	130.1(d) – Automatically adjust the power of the installed lighting up and down to keep the total light level stable as the amount of incoming daylight changes.	<p>General lighting totaling at least 120 Watts in Skylit Daylit Zones and Primary Sidelit Daylit Zones, and with at least 24 square feet of glazing.</p> <p>General lighting totaling at least 60 Watts in the combined primary and Secondary Sidelit Daylit Zones in parking garages with at least 36 square feet of glazing.</p>	Required	Not Required
Demand Responsive Controls	130.1(e) – Lighting reduction in response to an automated demand response signal.	Alterations larger than 10,000 square feet that have LPD \geq 0.5 Watts per square foot. Healthcare buildings are exempt.	Required	Not Required

2.6.1 Area Controls

The first type of mandatory lighting controls are area controls. These are manual on/off controls that separately control lighting in each area. An area is any space enclosed by ceiling height partitions or walls. These controls form the primary layer of any lighting control system. Area controls have been required under the Energy Standards since their inception in 1978.

2.6.2 Multi-Level Lighting Controls

The second control layer consists of multi-level lighting controls. These controls give occupants the ability to use all of the light, some of the light, or none of the light in an area. There are specific control steps depending on what type of light is installed.

Multi-Level Lighting Controls and Uniformity Requirements

Luminaire Type	Minimum Required Control Steps (percent of full rated power ¹)				Uniform level of illuminance shall be achieved by:
Line-voltage sockets except GU-24	Continuous dimming 10-100%				
Low-voltage incandescent systems					
LED luminaires and LED source systems					
GU-24 rated for LED					
GU-24 sockets rated for fluorescent > 20 watts	Continuous dimming 20-100%				
Pin-based compact fluorescent > 20 watts ²					
GU-24 sockets rated for fluorescent ≤ 20 watts	Minimum one step between 30-70%				Stepped dimming; or Continuous dimming; or Switching alternate lamps in a luminaire
Pin-based compact fluorescent ≤ 20 watts ²					
Linear fluorescent and U-bent fluorescent ≤ 13 watts					
Linear fluorescent and U-bent fluorescent > 13 watts	Minimum one step in each range:				Stepped dimming; or Continuous dimming; or Switching alternate lamps in each luminaire, having a minimum of 4 lamps per luminaire, illuminating the same area and in the same manner
	20-40%	50-70%	75-85%	100%	
Track Lighting	Minimum one step between 30 – 70%				Step dimming; or Continuous dimming; or Separately switching circuits in multi-circuit track with a minimum of two circuits.
HID > 20 watts	Minimum one step between 50 – 70%				Stepped dimming; or Continuous dimming; or Switching alternate lamps in each luminaire, having a minimum of 2 lamps per luminaire, illuminating the same area and in the same manner.
Induction > 25 watts					
Other light sources					

Luminaire Type	Minimum Required Control Steps (percent of full rated power ¹)	Uniform level of illuminance shall be achieved by:
1. Full rated input power of ballast and lamp, corresponding to maximum ballast factor 2. Includes only pin based lamps: twin tube, multiple twin tube, and spiral lamps		
<p>EXCEPTION 1 to Table 130.1-A Minimum Required Control Steps: Classrooms with a connected general lighting load of 0.7 watts per square feet or less shall have a minimum of one control step between 30-70 percent of full rated power, regardless of luminaire type.</p> <p>EXCEPTION 2 to Table 130.1-A Minimum Required Control Steps: Library stack aisles, aisle ways and open areas in warehouses, parking garages, parking areas, loading, and unloading areas, stairwells, and corridors shall have a minimum of one control step between 20-60 percent of full rated power, regardless of luminaire type.</p>		

2.6.3 Shut-off Controls

Shut-off controls automatically turn off or reduce light output when the space is normally vacant. Shut-off controls include time-based control devices as well as occupancy controls.

In addition to lighting controls installed to comply with Section 130.1(a) (manual on and off controls located in each area); Section 130.1(b) (multi-level lighting controls); Section 130.1(d) (automatic daylighting controls); and Section 130.1(e) (demand responsive controls), all installed indoor lighting shall be equipped with shut-off controls that meet the following requirements (Section 130.1(c)1):

1. Must be controlled with one or more of the following automatic shut-OFF controls:
 - a. Occupant sensing control
 - b. Automatic time-switch control
 - c. Other control capable of automatically shutting off all of the lights when the space is typically unoccupied
2. Separate controls for lighting on each floor, other than lighting in stairwells
3. Separate controls for a space enclosed by ceiling height partitions not exceeding 5,000 square feet
4. Spaces larger than 5,000 square feet will have more than one separately controlled zone (where each zone does not exceed 5,000 square feet). The area controlled may exceed 5,000 square feet, but may not exceed 20,000 square feet in Auditoriums, Convention Centers and Arenas.
5. The following applications are exempted from the shut-off controls requirements of Section 130.1(c)1:
 - a. An area that is in 24-hour use every day of the year.
 - b. Lighting complying with occupant sensing control requirements of Section 130.1(c)5 instead of Section 130.1(c)1. This exception applies

to those areas where occupant sensing controls are required to shut off all lighting. These areas include offices 250 sq. ft. or smaller, multipurpose rooms of less than 1,000 sq. ft., classrooms of any size, conference rooms of any size, or restrooms of any size in accordance with Section 130.1(c)5.

- c. Lighting complying with partial off occupant sensing controls requirements of Section 130.1(c)7 instead of Section 130.1(c)1. This exception applies to those areas where partial off occupant sensing controls are required. These areas include stairwells and common area corridors that provide access to guestrooms and dwelling units in accordance with Section 130.1(c)7A, or parking garages, parking areas, and loading and unloading areas in accordance with Section 130.1(c)7B.
- d. Up to 0.1 watts per sq. ft. of lighting may be continuously illuminated for egress lighting purpose.
- e. Electrical equipment rooms.
- f. Lighting that is designated as emergency lighting and connected to an emergency power source or battery supply and is intended to function in emergency mode only when normal power is absent.

2.6.4 Automatic Daylighting Controls

Automatic daylighting controls automatically control lighting in daylight areas, dimming the lighting when sufficient daylight is available. These controls may be required depending on your building design where daylight zones exist and are identified.

When the daylighting control requirements of Section 130.1(d) are triggered by the addition of skylights to an existing building and the lighting system is not recircuited the daylighting control need not meet the multi-level requirements in Section 130.1(d). Daylit areas must be controlled separately from non-daylit areas. An automatic control must be able to reduce lighting power by at least 65 percent when the daylit area is fully illuminated by daylight.

2.6.5 Demand response Controls

Demand response controls are capable of receiving and automatically responding to a demand response signal sent from a utility or 3rd-party program implementer. Demand responsive controls allow you to reduce your lighting load when electricity prices are temporarily raised or the electricity supply in your area is critically low. Demand response is required for lighting system additions complying with Section 140.0(b)2li. Demand response provisions are not required for projects complying with Sections 140.0(b)2lii, and 140.0(b)2liii.

2.5.6 Optional Controls

Additional lighting controls can also be installed voluntarily to achieve credits or “power adjustment factor allowances” against the total installed lighting power of a project. Lighting power density of building space types is capped under the prescriptive compliance approach in the Energy Standards. Installation of additional lighting controls will further reduce the overall energy consumption of the lighting system, so credit is given for these measures, allowing building owners and designers to add some additional lighting in the space, if needed. Power adjustment factors are available for four specific control measures, which go beyond the mandatory measures contained in the Energy Standards.

- Daylight dimming plus off
- Occupant sensing controls used in large, open plan offices
- Institutional tuning
- Demand responsive controls used in buildings less than 10,000 square feet.

2.6.6 Wireless Communications

Wireless communications for lighting control systems consist of several options including Wi-Fi, Bluetooth and Zigbee protocols. One or more of the wireless protocols will be used in a wireless lighting control system. Wireless area controllers will communicate with devices using star, cluster, mesh or tree topologies. Care must be exercised when installing wireless controllers near other wireless communication devices such as Wi-Fi wireless access points (WAP) and other transmitters in order to avoid interference issues between systems. In general, a minimum of six feet of separation is required between controllers to reduce interference issues between systems. Lighting control system communications transmit less information than other networks allowing greater distances for coverage. Signal levels for wireless controllers should be simulated and measured when determining the location for wireless controllers within a building to assure proper area coverage and operation of the lighting system controls. Building construction type can influence the signal level requiring additional wireless controllers in some cases.

- Wi-Fi communications will allow for network connections and remote monitoring of the lighting control system and devices. Wi-Fi is necessary for integration with Campus networks, building-to-building communications, remote monitoring, BAS and EMS applications as well as demand control and IoT level system operations. Wi-Fi uses IEEE 802.11 wireless standard with a range of 2.4Ghz-5Ghz.
- Bluetooth communications are local within the building and between devices. Bluetooth can be used for lighting controls where the total area is less than 10,000 sqft because the areas are exempt from demand control and do not require network connections. This will save on first cost of installation; however, the lighting controls cannot be remotely monitored unless the controller also has a network connection. Bluetooth uses IEEE 802.15.1 wireless standard and operates at 2.4Ghz.

- ZigBee communications are typically employed in mesh network applications where the devices require a higher level of integration from the wireless lighting controller as compared to Bluetooth. ZigBee mesh networks are self-healing in the sense that a malfunctioning device will not interrupt the mesh network communications and operation. ZigBee communications can cover a larger area than Bluetooth. ZigBee uses IEEE 802.15.4 wireless standard and operates at 900Mhz-2.4Ghz.

2.7 Building Occupancy and Spaces

2.7.1 The nonresidential standards apply to all California Building Code (CBC) occupancies of Group A, B, E, F, H, L, M, R, S, and U. If buildings are directly or indirectly conditioned, they must meet all mechanical, envelope, indoor, and outdoor lighting requirements of the standards. Buildings that are not directly or indirectly conditioned must only meet the indoor and outdoor lighting requirements. Refer to the California Building Code 2019 Chapter 3, Occupancy Classification and Use, for specific information regarding building occupancy.

For CSU Campuses the following types of buildings fall within the CBC Occupancy types:

- Group A: Assembly Group; Theaters, Concert Halls, TV and Radio Studios, Cafeterias, Restaurants, Dining Facilities, Art Galleries, Exhibition Halls, Dance Halls, Community Halls, Indoor Swimming, Gymnasiums, Bowling Alleys, Arenas, Lecture Halls, Libraries, Museums
- Group B, Business Group; Banks, Educational Facilities above 12th Grade, Data Processing, Laboratories, Print Shops, Radio and Television Stations
- Group E; Educational Group; Education through 12th grade, Day Care
- Group F, Factory Group; Repair Shops not classified as Group H
- Group F-1, Moderate Hazard, Electric generation Plants, Engine rebuilding, Machinery, Laundries, Woodworking, Trailers
- Group F-2, Low-Hazard; Metal Fabrication
- Group H, High Hazard; Generation or Storage of Hazardous Materials.
- Group L, Laboratories; Laboratory suites
- Group M, Mercantile; Stores, Retail, Markets, Motor Fuel Dispensing.
- Group R, Residential; Apartments, Hotels, Dormitories, Fraternities and Sororities
- Group S, Storage; Buildings used for storing materials
- Group U, Utility; Agriculture buildings, Barns, Communication Equipment structures less than 1500sqft, Livestock shelters,

An unconditioned space is neither directly nor indirectly conditioned. Both the requirements for lighting and minimum skylight area apply to unconditioned space.

Some typical examples of spaces that may be unconditioned:

- Enclosed parking structures
- Automotive workshops
- Enclosed entry courts or walkways
- Enclosed outdoor dining areas
- Greenhouses
- Loading docks
- Warehouses
- Mechanical/electrical equipment rooms

These spaces are not always unconditioned. The specifics of each case must be determined.

2.8 Daylight Zones

Daylighting can be used as an effective strategy to reduce electric lighting energy use by reducing electric lighting power in response to available daylight. Addresses mandatory requirements for daylighting.

Automatic daylighting controls are required in daylit zones to automatically shut off lighting when sufficient daylight is available.

Areas having skylights and windows are classified according to daylit zones. The three different types of daylit zones are defined as follows:

- A Skylit Daylit Zone is the rough area in plan view under each skylight, plus 0.7 times the average ceiling height in each direction from the edge of the rough opening of the skylight, minus any area on a plan beyond a permanent obstruction that is taller than one-half the distance from the floor to the bottom of the skylight.

The bottom of the skylight is measured from the bottom of the skylight well (for skylights having wells), or the bottom of the skylight if no skylight well exists. For the purpose of determining the Skylit Daylit Zone, the geometric shape of the Skylit Daylit Zone shall be identical to the plan view geometric shape of the rough opening of the skylight; for example, the Skylit Daylit Zone plan area for a rectangular skylight must be rectangular. For a circular skylight, the zone plan area must be circular.

- Primary Sidelit Daylit Zone is the area in plan view and is directly adjacent to each vertical glazing, one window head height deep into the area, and window

width plus 0.5 times window head height wide on each side of the rough opening of the window, minus any area on a plan beyond a permanent obstruction that is 6 feet or taller as measured from the floor.

- Secondary Sidelit Daylit Zone is the area in plan view and is directly adjacent to each vertical glazing, two window head heights deep into the area, and window width plus 0.5 times window head height wide on each side of the rough opening of the window, minus any area on a plan beyond a permanent obstruction that is 6 feet or taller as measured from the floor.

Note: In all cases, modular furniture walls should not be considered a permanent obstruction.

The daylighting controls in the Skylit Daylit Zone and the Primary Sidelit Daylit Zone are mandatory and cannot be traded away for other efficiency measures when using the performance approach (whole building energy simulation). The daylighting controls requirements in the Secondary Sidelit Daylit Zone is prescriptive and can be traded away for other efficiency measures in the performance approach. If code compliance is accomplished with the prescriptive approach, then daylighting controls will be required in both the primary and Secondary Sidelit Daylit Zones, and these two zones must be controlled separately from each other.

Mandatory daylighting controls are required in the following daylit zones:

- Luminaires providing general lighting that are at least 50 percent in the Skylit Daylit Zones or the Primary Sidelit Daylit Zones shall be controlled independently by fully functional automatic daylighting controls that meet the applicable device requirements and meet the applicable requirements below:
 - All Skylit Daylit Zones and Primary Sidelit Daylit Zones must be shown on the building plans.
 - Luminaires in the Skylit Daylit Zone must be controlled separately from those in the Primary Sidelit Daylit Zones.
 - Luminaires that fall in both a Skylit and Primary Sidelit Daylit Zone must be controlled as part of the Skylit Daylit Zone .

2.9 Performance Verification, Testing and Commissioning

For a lighting control system to be recognized for compliance with the lighting control requirements in the Energy Standards, including an energy management control system acting as a lighting control, the system must be documented on the appropriate certificates of compliance and installation.

The Energy Code requirements for testing and commissioning requirements apply to all building lighting replacement projects that include additions and alterations that are not specifically exempted. Testing and commissioning requirements are triggered when new lighting controls are installed that control more than 20 luminaires. Acceptance testing requirements are not required for indoor alteration projects where controls are added to

20 or fewer luminaires. The TOCA Contractor scope of work must include testing and commissioning activity unless it is specifically excluded and completed by the Campus as a separate contract. Regardless of who is responsible for all project testing and commissioning it is required to be completed unless otherwise exempted By the Energy Code for the lighting replacement project.

Commissioning is required for all newly constructed nonresidential buildings and for lighting replacement projects when controls are installed to ensure that the controls operate as planned and expected. The acceptance testing requirement of 130.4 is not required for alterations where lighting controls are added to control 20 or fewer luminaires, as noted above.

In the design phase, the responsible person (usually the designer) must review the plans and specifications to ensure that they conform to the acceptance requirements, typically done prior to signing a Certificate of Compliance (NRCC). In reviewing the plans, the responsible person notes the appropriate Certificate of Compliance then lists all the respective acceptance tests that will be performed and the parties responsible for performing the tests. An exhaustive list is required so that when the acceptance tests are discussed during bid or scope negotiations, all parties are aware of the scope of acceptance testing on the project.

A field technician assumes responsibility for performing the required acceptance requirement procedures. In some cases, the same field technician may not perform all the required acceptance tests for a project. The tests are intended to identify all performance deficiencies, which may require repeating the test until the specified systems and equipment are performing in accordance with the acceptance requirements.

The field technician who performs the testing signs the Certificate of Acceptance to certify the information recorded on the certificate is true and correct. A responsible person ensures performance of the scope of work specified by the Certificate of Acceptance and reviews the test results provided by the field technician. The responsible person signs the Certificate of Acceptance to indicate his or her overall responsibility for the project. As noted previously, the responsible person may also perform the field technician's responsibilities, and if so, must also sign the field technician declaration on the Certificate of Acceptance. If the acceptance test requires a certified acceptance test technician (ATT), the responsible person must be a certified ATT to perform the acceptance test.

2.9.1 Acceptance requirements ensure that equipment, controls, and systems operate as required and specified. The acceptance testing requirement of 130.4 is not required for alterations where lighting controls are added to control 20 or fewer luminaires. There are three steps to acceptance testing:

- Visual inspection of the equipment and installation.
- Review of the certification requirements.
- Functional tests of the systems and controls.

Third-party review of the information provided on the Certificate of Acceptance forms is not required for lighting.

Individual acceptance tests may be performed by one or more field technicians under the responsible charge of a licensed contractor or design professional, (responsible person) eligible under Division 3 of the Business and Professions Code, in the applicable classification, to accept responsibility for the scope of work specified by the Certificate of Acceptance document. The responsible person must review the information on the Certificate of Acceptance form and sign the form to certify compliance with the acceptance requirements. Typically, the individuals who participate in the acceptance testing/verification procedures are contractors, engineers, or commissioning agents. The individuals who perform the field testing/verification work and provide the information required for completion of the acceptance form (field technicians) are not required to be licensed contractors or licensed design professionals. Only the responsible person who signs the Certificate of Acceptance form certifying compliance must be licensed.

2.9.2 The acceptance tests required for nonresidential indoor lighting include the following:

- Lighting controls.
- Automatic daylighting controls.
- Demand responsive lighting controls.
- Institutional tuning for power adjustment factor.

Instructions for completing the Certificates of Acceptance are imbedded in the certificates.

The completed and signed Certificate of Acceptance must be submitted to the Campus Project Manager. There is no general requirement for a Certificate of Acceptance to be submitted to any other regulatory agency or to an Acceptance Test Technician Certification Provider (ATTCP), though specific contractual agreements may require such submissions. The project Inspector of Record or Project Manager and Engineer of Record will review the NRCA documents during inspection and can verify certified ATT status by noting whether the NRCA document was completed electronically through an ATTCP. Lighting controls NRCA documents should not be accepted if completed by hand or electronically outside the ATTCP online interface. Additionally, there is a place for ATTs to enter their certification numbers on the signature block for every NRCA document they sign. ATTCPs list their ATTs (names and certification numbers) on their websites. Depending on which ATTCP logo is shown on the submitted lighting controls NRCA document, the inspector could look up an ATT certification number, if necessary.

APPENDIX A

TITLE 24 COMPLIANCE REQUIREMENTS, FORMS, AND DOCUMENTATIONS

Visit <https://energycodeace.com/NonresidentialForms/2019>* to access the following CA Building Energy Efficiency Standards – 2019 Non-Residential Compliance forms applicable to lighting projects:

- Non-Residential Certificate of Compliance (NRCC)
 - NRCC-LTI-E, Lighting - Indoor
 - NRCC-LTO-E, Lighting - Outdoor
 - NRCC-LTS-E, Lighting – Sign
- Non-Residential Certificate of Acceptance (NRCA)
 - NRCA-LTI-02-A, Shutoff Lighting Control
 - NRCA-LTO-02-A, Outdoor Lighting Control
 - NRCA-LTI-03-A, Automatic Daylighting Control
 - NRCA-LTI-04-A, Demand Responsive Lighting Control
 - NRCA-LTI-05-A, Institutional Tuning PAF
- Non-Residential Certificate of Installation (NRCI)
 - NRCI-LTI-01-E, Indoor Lighting
 - NRCI-LTO-01-E, Outdoor Lighting
 - NRCI-LTI-02-E, Lighting Control Systems (EMCS)
 - NRCI-LTI-04-E, Two Interlocked Lighting Systems
 - NRCI-LTI-05-E, Power Adjustment Factors
 - NRCI-LTI-06-E, Video Conference Studio Lighting

* redirected from <https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2019-building-energy-efficiency> 2019 Compliance Forms - 2019 Nonresidential Compliance Forms

APPENDIX B

LIGHTING GUIDE SPECIFICATION

SECTION 26 5100 – INTERIOR LIGHTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Interior luminaires.
- B. Emergency lighting units.
- C. Ballasts and drivers.
- D. Luminaire accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 0537 - Boxes.
- B. Section 26 0553 - Identification for Electrical Systems.
- C. Section 26 2726 - Wiring Devices: Manual wall switches and wall dimmers.

1.03 REFERENCE STANDARDS

- A. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).
- B. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.
- C. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- E. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2006.
- F. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 2006.
- G. CEC - California Electric Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.
- H. NFPA 101 - Life Safety Code; 2015.
- I. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- J. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- K. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Comply with Section 26 0500 for additional submittal requirements and procedures.
- B. Shop Drawings
 - 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
 - 2. Provide photometric calculations where luminaires are proposed for substitution upon request.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting

Appendix B

Lighting Guide Specifications

requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63 standard format upon request.
- D. Field Quality Control Reports.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- G. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of CEC.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.07 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.08 WARRANTY

- A. Comply with Section 26 0500 for additional warranty requirements.
- B. Provide three-year manufacturer warranty for all LED luminaires, including drivers.
- C. Provide five-year pro-rata warranty for batteries for emergency lighting units.

PART 2 - PRODUCTS

2.01 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

Appendix B
Lighting Guide Specifications

2.02 LUMINAIRES

- A. Provide products that comply with requirements of CEC.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings, and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.03 EMERGENCY LIGHTING UNITS

- A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 120-minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- C. Battery
 - 1. Sealed maintenance-free nickel-cadmium unless otherwise indicated.
 - 2. Size battery to supply all connected lamps.
- D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- E. Provide low-voltage disconnect to prevent battery damage from deep discharge.
- F. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.
- G. Accessories:
 - 1. Provide compatible accessory mounting brackets where indicated or required to complete installation.

2.04 BALLASTS AND DRIVERS

- A. Ballasts/Drivers - General Requirements:
 - 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
 - 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

Appendix B
Lighting Guide Specifications

2.05 ACCESSORIES

- A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.
- B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size , field-painted as directed.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with CEC.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).
- D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- E. Suspended Luminaires:
 - 1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
 - 2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 - 3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet (1.2 m) between supports.
 - 4. Install canopies tight to mounting surface.
 - 5. Unless otherwise indicated, support pendants from swivel hangers.
- F. Install accessories furnished with each luminaire.
- G. Bond products and metal accessories to branch circuit equipment grounding conductor.
- H. Install University provided Enlighted sensors and fixture control units.
- I. Emergency Lighting Units:
 - 1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
 - 2. Install lock-on device on branch circuit breaker serving units.
- J.

Appendix B
Lighting Guide Specifications

- K. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

3.03 FIELD QUALITY CONTROL

- A. Comply with Section 26 0500 for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.04 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

- A. Just prior to Substantial Completion, replace all lamps that have failed.

3.06 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 26 5600 – EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Exterior luminaires.
- B. Drivers.
- C. Luminaire accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0537 - Boxes.
- C. Section 26 0923 - Lighting Control Devices
- D. Section 26 2726 - Wiring Devices

1.03 REFERENCE STANDARDS

- A. 47 CFR 15 - Radio Frequency Devices; current edition.
- B. ANSI C136.10 - American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing.
- C. IEEE C2 - National Electrical Safety Code.
- D. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low Voltage (1000V or less) AC Power Circuits.
- E. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information.
- F. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid State Lighting Products.
- G. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules.
- H. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- I. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems.
- J. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers.
- K. CEC - California Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- M. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

Appendix B
Lighting Guide Specifications

1.05 SUBMITTALS

- A. Shop Drawings:
 - 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
 - 2. Provide photometric calculations where luminaires are proposed for substitution upon request.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.
 - b. Include IES LM-79 test report upon request.
 - 2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63 standard format upon request.
 - 3. Lamps: Include rated life and initial and mean lumen output.
- C. Field Quality Control Reports: Include test report indicating measured illumination levels.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- E. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- F. Project Record Documents: Record actual connections and locations of luminaires and any pull or junction boxes.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of CEC.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 WARRANTY

- A. Provide three-year manufacturer warranty for all LED luminaires, including drivers.

Appendix B
Lighting Guide Specifications

PART 2 - PRODUCTS

2.01 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 LUMINAIRES

- A. Provide products that comply with requirements of CEC.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, drivers, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.
- H. LED Luminaires
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.
- I. Exposed Hardware: Stainless steel.

2.03 DRIVERS

- A. Minimum Efficiency/Efficacy: Provide drivers complying with all current applicable federal and state driver efficiency/efficacy standards.
- B. Electronic Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.

2.04 LAMPS

- A. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
- B. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
- C. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
- D. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Architect to be inconsistent in perceived color temperature.

Appendix B
Lighting Guide Specifications

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper location and at proper mounting heights and are properly sized to accommodate conductors in accordance with CEC.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA/IESNA 501 (exterior lighting).
- D. Install accessories furnished with each luminaire.
- E. Install University provided Enlighted 2-wire sensor and fixture control units.
- F. Bond products and metal accessories to branch circuit equipment grounding conductor.
- G. Install lamps in each luminaire.

3.04 FIELD QUALITY CONTROL

- A. Inspect each product for damage and defects.
- B. Operate each luminaire after installation and connection to verify proper operation.
- C. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.
- D. Measure illumination levels at night with calibrated meters to verify conformance with performance requirements. Record test results in written report to be included with submittals.

3.05 CLEANING

- A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- B. Just prior to Substantial Completion, replace all lamps that have failed.

Appendix B
Lighting Guide Specifications

3.07 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

APPENDIX C

LIGHTING CONTROLS SPECIFICATIONS

SECTION 26 09 23 - LIGHTING CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation and connection of the lighting controls.
- B. Digital Lighting Management System shall accommodate the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories that suit the required lighting and electrical system parameters

1.2 RELATED WORK

- A. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Interface of lighting controls with HVAC control systems. Provided by the TOCA Contractor or Campus.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26. Provided by the TOCA Contractor or Campus.
- C. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring. Provided by the TOCA Contractor or Campus.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents. Provided by the TOCA Contractor or Campus.
- E. Section 26 24 16, PANELBOARDS: Panelboard enclosure and interior bussing used for lighting control panels. Provided by the TOCA Contractor or Campus.
- F. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems. Provided by the TOCA Contractor or Campus.
- G. Section 26 51 00, INTERIOR LIGHTING: Luminaire ballast and drivers used in control of lighting systems. Provided by the TOCA Contractor or Campus. Use Guide Specification for Scoping Document.

1.3 QUALITY ASSURANCE

- A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Manufacturer Qualifications: Company specializing in manufacturing of centralized and distributed lighting control systems with a minimum of 10 years documented experience.
- C. Installer Qualifications: Company certified by the manufacturer and specializing in installation of networked lighting control products with minimum three years documented experience.
- D. System Components: Demonstrate that individual components have undergone quality control and testing prior to shipping.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 30 00 and Paragraph, SUBMITTALS in Section 26 05 00, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
 - 1. Shop Drawings:
 - a. Submit the following information for each type of lighting controls.
 - b. Material and construction details.

- c. Physical dimensions and description.
 - d. Wiring schematic and connection diagram.
 - e. Installation details. Show location of all devices, including at minimum sensors, load controllers, and switches/dimmers for each area on reflected ceiling plans.
 - f. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies
 - g. Network riser diagram including floor and building level details. Include network cable specification. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.
2. Manuals:
- a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals, including technical data sheets, wiring diagrams, and information for ordering replacement parts.
 - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Certifications: Two weeks prior to final inspection, submit the following.
- a. Certification by the Contractor that the lighting control systems have been properly installed and tested.
 - b. Title 24 Acceptance Testing Documentation: Submit Certification of Acceptance and associated documentation for lighting control acceptance testing performed in accordance with CAL TITLE 24 P6, as specified in Part 3 of this specification under "COMMISSIONING".
4. Closeout Submittals:
- a. Project Record Documents: Record actual installed locations and settings for lighting control devices.
 - b. Operation and Maintenance Manual:
 - a. Include approved Shop Drawings and Product Data.
 - b. Include Sequence of Operation, identifying operation for each room or space.
 - c. Include manufacturer's maintenance information.
 - d. Operation and Maintenance Data: Include detailed information on device programming and setup.
 - e. Include startup and test reports.
 - f. All final software and program files prepared for the project to configure, program and make adjustments to all devices and for all controls. Include all ethernet addresses assigned to all devices, and all network communication settings.
 - c. Required Title 24 lighting Test and Commissioning Certification forms.

1.5 PRE-INSTALLATION MEETINGS

- A. Convene minimum two weeks prior to commencing Work of this section. Meeting to be attended by contractor, Project Manager, system installer, factory authorized manufacturer's representative, and representative of all trades related to the system installation.
- B. Review installation procedures and coordination required with related Work and the following:

1. Confirm the location and mounting of all devices, with special attention to placement of switches, dimmers, and any sensors.
 2. Review the specifications for low voltage control wiring and termination.
 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
 4. Discuss requirements for integration with other trades
- C. Inspect and make notes of job conditions prior to installation:
1. Record minutes of the conference and provide copies to all parties present.
 2. Identify all outstanding issues in writing designating the responsible party for follow-up action and the timetable for completion.
 3. Installation shall not begin until all outstanding issues are resolved to the satisfaction of the Project Manager.

1.6 WARRANTY

- A. Manufacturer shall provide a 5 year limited warranty on products within this installation, except where otherwise noted, and consisting of a one for one device replacement.

1.7 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. National Electrical Manufacturer's Association (NEMA):
- C136.10-10American National Standard for Roadway and Area Lighting Equipment—Locking-Type Photocontrol Devices and Mating Receptacles—Physical and Electrical Interchangeability and Testing
- ICS-1-15Standard for Industrial Control and Systems General Requirements
- ICS-2-05Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
- ICS-6-16Standard for Industrial Controls and Systems Enclosures
- C. National Fire Protection Association (NFPA):
- 70-17National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
- 20-10Standard for General-Use Snap Switches
- 98-16Enclosed and Dead-Front Switches
- 773-16Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting
- 773A-16Nonindustrial Photoelectric Switches for Lighting Control
- 916-15Standard for Energy Management Equipment Systems
- 917-06Clock Operated Switches

924-16Emergency Lighting and Power Equipment (for use when controlling emergency circuits).

E. FCC Emission Standards

PART 2 - PRODUCTS

2.1 ELECTRONIC TIME SWITCHES

- A. Electronic, solid-state programmable units with alphanumeric display; complying with UL 916 and or 917.
 - 1. Contact Configuration: //SPST// //DPST// //DPDT//.
 - 2. Contact Rating: //30-A inductive or resistive 120-277 volt// //20-A ballast load, 120-277 volt//.
 - 3. Astronomical Clock: Capable of switching a load on at sunset and off at sunrise, and automatically changing the settings each day in accordance with seasonal changes of sunset and sunrise. Additionally, it shall be programmable to a fixed on/off weekly schedule.
 - 4. Power Backup: Battery or capacitor for schedules and time clock.

2.2 ELECTROMECHANICAL-DIAL TIME SWITCHES

- A. Electromechanical-dial time switches; complying with UL 917.
 - 1. Contact Configuration: //SPST// //DPST// //DPDT//.
 - 2. Contact Rating: //30-A inductive or resistive, 120-277 volt// //20-A ballast load, 120-277 volt//.
 - 3. Wound-spring reserve carryover mechanism to keep time during power failures.

2.3 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Solid state, with //SPST// //DPST// dry contacts rated for 1800 VA tungsten or 1000 VA inductive, complying with UL 773A.
 - 1. Light-Level Monitoring Range: 16.14 to 108 lx (1.5 to 10 fc), with adjustable turn-on and turn-off levels.
 - 2. Time Delay: 15-second minimum.
 - 3. Surge Protection: Metal-oxide varistor.
 - 4. Mounting: Twist lock, with base-and-stem mounting or stem-and-swivel mounting accessories as required.

2.4 TIMER SWITCHES

- A. Digital switches with backlit LCD display, 120/277 volt rated, fitting as a replacement for standard wall switches.
 - 1. Compatibility: Compatible with all ballasts.
 - 2. Warning: Audible warning to sound during the last minute of "on" operation.
 - 3. Time-out: Adjustable from 5 minutes to 12 hours.
 - 4. Faceplate: Refer to wall plate material and color requirements for toggle switches, as specified in Section 26 27 26, WIRING DEVICES. Consult with Campus Project Manager regarding Campus standards.

2.5 CEILING-MOUNTED PHOTOELECTRIC SWITCHES

- A. Solid-state, light-level sensor unit, with separate relay unit.
 - 1. Sensor Output: Contacts rated to operate the associated relay. Sensor shall be powered from the relay unit.
 - 2. Relay Unit: Dry contacts rated for 20A ballast load at 120 volt and 277 volt, for 13A tungsten at 120 volt, and for 1 hp at 120 volt.
 - 3. Monitoring Range: //108 to 2152 lx (10 to 200 fc)// //1080 to 10 800 lx (100 to 1000 fc)//, with an adjustment for turn-on and turn-off levels.
 - 4. Time Delay: Adjustable from 5 to 300 seconds, with deadband adjustment.
 - 5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.6 SKYLIGHT PHOTOELECTRIC SENSORS

- A. Solid-state, light-level sensor; housed in a threaded, plastic fitting for mounting under skylight; with separate relay unit.
 - 1. Sensor Output: Contacts rated to operate the associated relay, complying with UL 773A. Sensor shall be powered from the relay unit.
 - 2. Relay Unit: Dry contacts rated for 20A ballast load at 120 volt and 277 volt, for 13A tungsten at 120 volt, and for 1 hp at 120 volt.
 - 3. Monitoring Range: 10,800 to 108,000 lx (1000 to 10,000 fc), with an adjustment for turn-on and turn-off levels.
 - 4. Time Delay: Adjustable from 5 to 300 seconds, with deadband adjustment.
 - 5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.7 INDOOR OCCUPANCY SENSORS

- A. Wall- or ceiling-mounting, solid-state units with a power supply and relay unit, suitable for the environmental conditions in which installed.
 - 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a 1 to 15 minute adjustable time delay for turning lights off.
 - 2. Sensor Output: Contacts rated to operate the connected relay. Sensor shall be powered from the relay unit.
 - 3. Relay Unit: Dry contacts rated for 20A ballast load at 120 volt and 277 volt, for 13A tungsten at 120 volt, and for 1 hp at 120 volt.
 - 4. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 - 6. Bypass Switch: Override the on function in case of sensor failure.
 - 7. Manual/automatic selector switch.
 - 8. Automatic Light-Level Sensor: Adjustable from 21.5 to 2152 lx (2 to 200 fc); keep lighting off when selected lighting level is present.
 - 9. Faceplate for Wall-Switch Replacement Type: Refer to wall plate material and color requirements for toggle switches, as specified in Section 26 27 26, WIRING DEVICES.

- B. Dual-technology Type: Ceiling mounting; combination PIR and ultrasonic detection methods, field-selectable.
 - 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 150 mm (6-inch) minimum movement of any portion of a human body that presents a target of not less than 232 sq. cm (36 sq. in), and detect a person of average size and weight moving not less than 305 mm (12 inches) in either a horizontal or a vertical manner at an approximate speed of 305 mm/s (12 inches/s).
- C. Detection Coverage: Shall be sufficient to provide coverage as required by sensor locations shown on drawing.

2.8 INDOOR VACANCY SENSOR SWITCH

- A. Wall mounting, solid-state units with integral sensor and switch.
 - 1. Operation: Manually turn lights on with switch and sensor detects vacancy to turn lights off.
 - 2. Switch Rating: 120/277 volt, 1200 watts at 277 volt, 800 watts at 120 volt unit.
 - 3. Mounting:
 - a. Sensor: Suitable for mounting in a standard switch box.
 - b. Time-Delay and Sensitivity Adjustments: Integral with switch and accessible for reprogramming without removing switch.
 - 4. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
 - 5. Switch: Manual operation to turn lights on and override lights off.
 - 6. Faceplate: Refer to wall plate material and color requirements for toggle switches, as specified in Section 26 27 26, WIRING DEVICES.

2.9 OUTDOOR MOTION SENSOR (PIR)

- A. Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 degrees F (minus 40 to plus 54 degrees C).
 - 1. Operation: Turn lights on when sensing infrared energy changes between background and moving body in area of coverage; with a 1 to 15 minute adjustable time delay for turning lights off.
 - 2. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outdoor junction box.
 - b. Relay: Internally mounted in a standard weatherproof electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 3. Bypass Switch: Override the on function in case of sensor failure.
 - 4. Automatic Light-Level Sensor: Adjustable from 11 to 215 lx (1 to 20 fc); keep lighting off during daylight hours.
- B. Detector Sensitivity: Detect occurrences of 150 mm (6-inch) minimum movement of any portion of a human body that presents a target of not less than 232 sq. cm (36 sq. in).
- C. Detection Coverage: Shall be sufficient to provide coverage as required by sensor locations shown on drawing.

- D. Individually Mounted Sensor: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
1. Relay Unit: Dry contacts rated for 20A ballast load at 120 volt and 277 volt, for 13A tungsten at 120 volt, and for 1 hp at 120 volt.
 2. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

SPEC WRITER NOTE:

- **Choose lighting control system type from the following: Relay Panel (Network or Stand Alone), Distributive Relay Modules, Electrically Operated Breaker Panel or Digital Addressable Lighting Interface (DALI). Designer's attention is called to AIC-rating limitations of lighting control relays and electrically-operated circuit breakers.**
- **Provide a Zone / Relay Control Schedule for the system indicating zone / relay, rooms controlled and devices used for control.**
- **Provide a Sequence of Operation Schedule for system indicating on and off initiation per zone / relay including control device type or time schedule and initiation priorities.**

//2.10 LIGHTING CONTROL SYSTEM – RELAY PANEL TYPE (NETWORK)

A. System Description:

1. The lighting control system shall be a network of lighting relay panels connected to a digital network and controlled through a system server / central station. Lighting control devices connect to the relay panels and communicate via the panel controller with the system server. System includes all associated network interfaces and wiring, relay panels, control modules, input modules, panel processors, relays, photocells, switches, dimmers, time clock, and occupancy sensors.
2. System shall include server / central station with operating software, data network, and BACnet IP communication with other systems as described. System communication protocol shall be compatible with the building automation system specified in Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
3. System server / central station shall provide programmable operation of lights connected via system relays and controlled with system devices. System software shall provide control of relays and control devices, time and sequence scheduling, timed out and blink light operation and monitoring and reporting of system events and components. Initial programming shall be as shown on plans and schedules.

- B. Server / Central Control Station: Lighting control system manufacturer shall be responsible to assure coordination between system devices, network and control system server/ central station such that system performs as described. Server / central control station shall have a minimum 80 GB hard drive, //2// //4// //8// GB RAM, 3 GHz speed minimum, three Ethernet ports, 1024 x 768 resolution graphic card, and 3 USB 2.0 ports. Server shall be provided with monitor, keyboard and mouse, and plugged into a receptacle connected to an equipment emergency circuit as a minimum.
- C. Cabinet: Steel with hinged, locking door. Barriers separate low-voltage and line-voltage components.
- D. Directory: Identifies each relay as to load controlled.
- E. System Power Supply: Transformer and full-wave rectifier with filtered dc output for panel, controllers and control devices. Feed from an equipment emergency circuit at a minimum.
- F. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type, rated 20 A, 125 volt AC for tungsten filaments and 20 A, 277 volt AC for electronic ballasts, 50,000 cycles at rated capacity.

- G. Control Devices: All occupancy sensors (Ultrasonic, IR and Dual Technology type), photocells, switches and timers shall be provided with system and designed to operate on system network. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission.

//2.11 LIGHTING CONTROL SYSTEM – RELAY PANEL TYPE (STAND ALONE)

A. System Description:

1. The lighting control system shall be with lighting relay panels. Lighting control devices connect to the relay panels and communicate via the panel controller. System includes all interfaces and wiring, relay panels, control modules, input modules, panel processors, relays, photocells, switches, dimmers, time clock, and occupancy sensors.
 2. System shall include the capability of BACnet IP communication with other systems as described. System communication protocol shall be compatible with the building automation system specified in Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
 3. Panel Controller shall provide programmable operation of lights connected via system relays and controlled with system devices. System software shall provide control of relays and control devices, time and sequence scheduling, timed out and blink light operation and monitoring and reporting of system events and components. Initial programming shall be as shown on plans and schedules.
- B. Panel Controller: Comply with UL 508; programmable, solid-state, astronomic 365-day control unit with non-volatile memory, mounted in preassembled relay panel with low-voltage-controlled, latching-type, single-pole lighting circuit relays. Controller shall be capable of receiving inputs from control devices and other sources. Where indicated, a limited number of digital or analog, low-voltage control-circuit outputs shall be supported by control unit and circuit boards associated with relays.
- C. Cabinet: Steel with hinged, locking door. Barriers separate low-voltage and line-voltage components.
- D. Directory: Identifies each relay as to load controlled.
- E. System Power Supply: Transformer and full-wave rectifier with filtered dc output for panel, controllers and control devices. Feed from an equipment emergency circuit at a minimum.
- F. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type, rated 20 A, 125 volt AC for tungsten filaments and 20 A, 277 volt AC for electronic ballasts, 50,000 cycles at rated capacity.
- G. Control Devices: All occupancy sensors (Ultrasonic, IR and Dual Technology type), photocells, switches and timers shall be provided with system and designed to operate on system network. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission.

//2.12 LIGHTING CONTROL SYSTEM – DISTRIBUTIVE RELAY TYPE

A. System Description:

1. The lighting control system shall be a network of remote relay modules connected to a digital network via network hubs and controlled through a system server / central station. Lighting control devices connect to the relay modules and communicate via the digital network with the system server. System includes all associated network interfaces and wiring, hubs, relay modules, relays, photocells, switches, dimmers, time clock, and occupancy sensors. System shall utilize distributed relays modules, allowing these relay modules to be located above accessible ceilings in or adjacent to rooms they are controlling.
2. System shall include server / central station with operating software, data network, and BACnet IP communication with other systems as described. System communication protocol shall be

compatible with the building automation system specified in Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

3. System server / central station shall provide programmable operation of lights connected via system relays and controlled with system devices. System software shall provide control of relays and control devices, time and sequence scheduling, timed out and blink light operation and monitoring and reporting of system events and components. Initial programming shall be as shown on plans and schedules.
- B. Server / Central Control Station: Lighting control system manufacturer shall be responsible to assure coordination between relay modules, network hubs and control system server/ central station such that system performs as described. Server / central control station shall have a minimum 80 GB hard drive, //2// //4// //8// GB RAM, 3 GHz speed minimum, three Ethernet ports, 1024 x 768 resolution graphic card, and 3 USB 2.0 ports. Server shall be provided with monitor, keyboard and mouse, and plugged into a receptacle connected to an equipment emergency circuit as a minimum.
- C. Network Hub: Network Hub shall contain processor and astronomic time clock for control and monitoring of lighting. Network Hub shall be fed from an equipment emergency circuit at a minimum.
- D. Relay Modules: Mounted in NEMA enclosure with physically separate 120/277 volt wiring compartment from low voltage control wiring. Provide low voltage digital communication to control devices as shown on drawings and schedules. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission. Dimmable relay modules shall be provided where indicated. Relay modules shall contain up to 4 relays. Relay modules shall be labeled with room number that relays control lighting within.
- E. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type, rated 20 A, 125 volt AC for tungsten filaments and 20 A, 277 volt AC for electronic ballasts, 50,000 cycles at rated capacity.
- F. Control Devices: All occupancy sensors (Ultrasonic, IR and Dual Technology type), photocells, switches and timers shall be provided with system and designed to operate on system network. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission.

//2.13 LIGHTING CONTROL SYSTEM – CIRCUIT BREAKER PANEL TYPE

- A. Controller: Panelboard mounted in compliance with UL 916, programmable, solid-state, astronomic 365-day timing and control unit with non-volatile memory. Controller shall be integral to panelboard as specified in Section 26 24 16, PANELBOARDS. Controller shall be capable of receiving inputs from sensors and other sources, and capable of timed overrides and/or blink-warning on a per-circuit basis. Controller communication protocol shall be compatible with the building automation system specified in Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. Panelboard shall use low-voltage-controlled, electrically operated molded-case branch circuit breakers or molded-case branch circuit breakers with switching accessories. Circuit breakers and a limited number of digital or analog, low-voltage control-circuit outputs shall be individually controlled by control module. Panelboard shall also comply with Section 24 26 16, PANELBOARDS.
- B. Electrically Operated, Molded-Case Circuit-Breaker Panelboard: Per Section 26 24 16, PANELBOARDS.
- C. Electrically Operated, Molded-Case Circuit Breakers: Per Section 26 24 16, PANELBOARDS.
- D. Switching Endurance Ratings: Rated at least 20,000 open and close operations under rated load at 0.8 power factor.

//2.14 LIGHTING CONTROL SYSTEM – DIGITAL ADDRESSABLE LIGHTING INTERFACE (DALI)

A. System Description:

1. The lighting control system shall consist of digital lighting control network connecting DALI compliant digital addressable ballasts, control modules and lighting control devices directly with a system server / central control station. Individually addressable electronic ballasts, control modules, and control devices are operated from signals received through DALI-compliant bus from variety of DALI compliant digital controllers and interfaces and programmed through the system server / central control station. System includes all associated network bus and wiring, DALI controllers and interfaces, panels, photocells, switches, dimmers, time clock, and occupancy sensors. System shall utilize DALI compliant ballast and dimming modules provided with light fixtures.
2. System shall include server / central station with DALI operating software, data network, and BACnet IP communication with other systems as described. System communication protocol shall be compatible with the building automation system specified in Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
3. System server / central station shall provide programmable operation of lights connected via system bus and controlled with system devices. System software shall provide control of DALI ballast, control modules and control devices, time and sequence scheduling, timed out and blink light operation and monitoring and reporting of system events and components. Initial programming shall be as shown on plans and schedules.

- B. Server / Central Control Station: Lighting control system manufacturer shall be responsible to assure coordination between relay modules, network hubs and control system server/ central station such that system performs as described. Server / central control station shall have a minimum 80 GB hard drive, //2// //4// //8// GB RAM, 3 GHz speed minimum, three Ethernet ports, 1024 x 768 resolution graphic card, and 3 USB 2.0 ports. Server shall be provided with monitor, keyboard and mouse, and plugged into a receptacle connected to an equipment emergency circuit as a minimum.

- C. Control Devices: All occupancy sensors (Ultrasonic, IR and Dual Technology type), photocells, switches and timers shall be provided with system and be DALI compliant. Devices shall be designed to operate on system network. Supplemental DALI compliant signal repeaters and controllers shall be provided as required. This equipment shall be identified in shop drawing submission.

2.15 DISTRIBUTED DIGITAL LIGHTING CONTROL SYSTEM

- A. System General: Provide Digital Lighting Management System (DLM) complete with all necessary enclosures, wiring, and system components to ensure a complete and properly functioning system as indicated on the Drawings and specified herein. If a conflict is identified, between the Drawing and this Specification, contact the Architect for clarification prior to proceeding.

1. Space Control Requirements: Provide occupancy/vacancy sensors with Manual- or Partial-ON functionality as indicated in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors and Manual-On switches.
2. Task Lighting / Plug Loads: Provide automatic shut off of non-essential plug loads and task lighting in spaces as required by the applicable energy code. Provide Automatic-ON of plug loads whenever spaces are occupied. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.

3. Daylit Areas: Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by relevant local building energy code:
 - a. All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylit zones.
 - b. Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.
 - c. Multiple-level switched daylight harvesting controls may be utilized for areas marked on drawings.
 - d. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
 4. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.
- B. Equipment Required: Lighting Control and Automation system as defined under this section covers the following equipment.
1. Digital Lighting Management (DLM) local network: Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.
 2. Digital Room Controllers: Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.
 3. Digital Plug Load Controllers: Self-configuring, digitally addressable, single relay, plenum-rated application-specific controllers. Selected models include integral current monitoring capabilities.
 4. Digital Fixture Controllers: Self-configuring, digitally addressable one relay fixture-integrated controllers for on/off/0-10V dimming control.
 5. Digital Occupancy Sensors: Self-configuring, digitally addressable, calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
 6. Digital Switches: Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.
 7. Handheld remotes for personal control: On/Off, dimming and scene remotes for control using infrared (IR) communications. Remote may be configured in the field to control selected loads or scenes without special tools.
 8. Digital Daylighting Sensors: Single-zone closed loop, multi-zone open loop and single-zone dual-loop daylighting sensors with two-way active infrared (IR) communications for daylight harvesting using switching, bi-level, tri-level or dimming control.
 9. Configuration Tools: Handheld remote for room configuration and relay panel programming provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away.
 10. Digital Lighting Management (DLM) segment network: Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded) to connect multiple DLM local networks for centralized control

11. Network Bridge: Provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.
 12. Wireless Network Bridge and Border Router: Provides Wireless Network Bridges that automatically create BACnet objects for all DLM devices on their local network (room) and communicate that information over a standalone wireless mesh 6LoWPAN network to a Border Router. The Border Router manages the formation and communication of the mesh network, and provides an ethernet network connection to upstream intelligent devices, such as a Segment Manager.
 13. Segment Manager: BACnet MS/TP-based controller with web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
 14. Programming and Configuration Software: Optional PC-native application capable of accessing DLM control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.
 15. Digital Lighting Management Relay Panel and Zone Controller: Provides up to 8, 24, or 48 mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS). Zero relay Zone Controller primarily supports Digital Fixture Controller applications.
 16. Emergency Lighting Control Unit (ELCU): Allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building
- C. Local Network: DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.
1. Features of the DLM local network include:
 - a. Plug n' Go automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.
 - b. Simple replacement of any device in the local DLM network with a standard off the shelf unit without requiring significant commissioning, configuration or setup.
 - c. Push n' Learn configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.
 - d. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.
 2. Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.
 3. If manufacturer's pre-terminated Cat5e cables are not used for the installation each cable must be individually tested and observed by authorized service representative following installation.

2.16 DIGITAL LOAD CONTROLLERS (ROOM, PLUG LOAD AND FIXTURE CONTROLLERS)

- A. Digital Load Controllers: Digital controllers for lighting zones, fixtures and/or plug loads automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide controllers to match the room lighting and plug load control

requirements. Controllers are simple to install, and do not have dip switches/potentiometers, or require special configuration for standard Plug n' Go applications. Control units include the following features

1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
2. Simple replacement using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf device.
3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are assigned starting with load 1 to a maximum of 64, assigned based on each controller's device ID's from highest to lowest.
4. Device Status LEDs to indicate:
 - a. Data transmission
 - b. Device has power
 - c. Status for each load
 - d. Configuration status
5. Quick installation features including:
 - a. Standard junction box mounting
 - b. Quick low voltage connections using standard RJ-45 patch cable
6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:
 - a. Turn on to 100 percent
 - b. Turn off
 - c. Turn on to last level
7. Each load be configurable to operate in the following sequences based on occupancy:
 - a. Auto-on/Auto-off (Follow on and off)
 - b. Manual-on/Auto-off (Follow off only)
8. Polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.
9. BACnet object information shall be available for the following objects:
 - a. Load status
 - b. Schedule state, normal or after-hours
 - c. Demand Response enable and disable
 - d. Room occupancy status
 - e. Total room lighting and plug loads watts
 - f. Electrical current
 - g. Total watts per controller
 - h. Total room watts/sq ft.
 - i. Force on/off all loads
10. UL 2043 plenum rated

11. Manual override and LED indication for each load
12. Zero cross circuitry for each load
13. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
14. Dimming Room Controllers shall share the following features:
 - a. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
 - b. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
 - c. The following dimming attributes may be changed or selected using a wireless configuration tool:
 - 1) Establish preset level for each load from 0-100 percent
 - 2) Set high and low trim for each load
 - 3) Initiate lamp burn in for each load of either 0, 12 or 100 hours
 - d. Override button for each load provides the following functions:
 - 1) Press and release for on/off control
 - 2) Press and hold for dimming control
 - e. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
 - f. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.
 - g. Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.
 - h. All configurations shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.
- B. On/Off Room Controllers shall include:
 1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 20A total load
 2. One or two relay configuration
 3. Simple 150 mA switching power supply (Only 4 100 series devices on a Cat 5e local network)
 4. Three RJ-45 DLM local network ports with integral strain relief and dust cover
- C. On/Off/0-10V Dimming KO Mount Room Controllers shall include:
 1. Dual voltage (120/277 VAC, 60 Hz) capable rated for 10A total load
 2. Optional real time current and voltage monitoring (with - M Monitoring option).
 3. One or two relays configurations
 4. Smart 150 mA switching power supply
 5. Two RJ-45 DLM local network ports. Provide molded strain relief ring

6. One dimming output per relay
 - a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting
 7. Units capable of providing both Class 1 or Class 2 wiring for the 0-10V output
- D. On/Off/0-10V Dimming Enhanced Room Controllers shall include:
1. Dual voltage (120/277 VAC, 60 Hz) capable or 347 VAC, 60 Hz. 120/277 volt models rated for 20A total load; 347 volt models rated for 15A total load
 2. Built in real time current monitoring
 3. One, two or three relays configurations
 4. Smart 250 mA switching power supply
 5. Four RJ-45 DLM local network ports. Provide integral strain relief
 6. One dimming output per relay
 - a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting.
- E. On/Off/ Forward Phase Dimming Room Controllers shall include:
1. Dual voltage (120/277 VAC, 60 Hz) rated for 20A total load, with forward phase dimmed loads derating to 16A for some load types
 2. Built in real time current monitoring
 3. One or two relays configurations
 4. Smart 250 mA switching power supply
 5. Four RJ-45 DLM local network ports. Provide integral strain relief
 6. One dimming output per relay
 - a. Line Voltage, Forward Phase Dimming - Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads.
- F. Plug Load Controllers shall include:
1. 120 VAC, 60 Hz rated for 20A total load. Controller carries application-specific UL 20 rating for receptacle control.
 2. One relay configuration with additional connection for unswitched load
 3. Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated).
 4. Factory default operation is Auto-on/Auto-off, based on occupancy
 5. Real time current monitoring of both switched and un-switched load
 6. Switching power supply
 - a. Simple 150mA - Only 4 100 series devices on a Cat 5e local network
 - b. Smart 250mA
 7. RJ-45 DLM local network ports

- a. Three RJ-45 ports
 - b. Four RJ-45 ports
- 8. Provide a wireless transmitter that can be connected to any Cat 5e network of the lighting controls that will communicate the room's occupancy state to receptacles mounted in the area with integral relays. Binding of the transmitter to the receptacles shall be accomplished by pressing a test button on the transmitter, and then a test button on the receptacle.
- G. Fixture Controllers shall include
 - 1. A form factor and product ratings to allow various OEM fixture manufacturers to mount the device inside the ballast/driver cavity of standard-sized fluorescent or LED general lighting fixtures.
 - 2. One 3A 120/277V rated mechanically held relay.
 - 3. Programmable behavior on power up following the loss of normal power:
 - a. Turn on to 100 percent
 - b. Turn off
 - c. Turn on to last level
 - 4. Requirement for 7 mA of 24VDC operating power from the DLM local network.
 - 5. Fixture Controller does not require a connection to a neutral conductor to operate, and unlike other types of Load Controllers it does not contribute power to the DLM local network to drive accessory devices.
 - 6. Power to drive the Fixture Controller electronics can come from any Room or Plug Load Controller,
 - 7. 0-10V dimming capability via a single 0-10 volt analog output from the device for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Fixture Controller.
 - 8. Connect to a single or dual RJ-45 adaptor with 24 inch leads. Single adaptor mounts in a 1/2 inch KO and dual adaptor in a 2.2 by 1.32 inch rectangular hole for connection to the DLM local network.
 - 9. Adaptor leads are insulated for use in a fixture cavity, and the lead length allows the OEM fixture manufacturer flexibility to position the Fixture Controller and the RJ45 jack in the best locations on each fixture.
 - 10. A complete set of dimming features described above in the paragraph detailing On/Off/Dimming Enhanced Room Controllers.

2.17 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR

- A. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 - 1. Digital calibration and pushbutton configuration for the following variables:
 - a. Sensitivity, 0-100 percent in 10 percent increments
 - b. Time delay, 1-30 minutes in 1 minute increments
 - c. Test mode, Five second time delay
 - d. Detection technology, PIR, Ultrasonic or Dual Technology activation and/or re-activation.
 - e. Walk-through mode

2. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
 3. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - e. Ultrasonic and Passive Infrared
 - f. Ultrasonic or Passive Infrared
 - g. Ultrasonic only
 - h. Passive Infrared only
 - i. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 4. One or two RJ-45 port(s) for connection to DLM local network.
 5. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
 6. Device Status LEDs, which may be disabled for selected applications, including:
 - a. PIR detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 7. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 8. Manual override of controlled loads.
 9. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
- B. BACnet object information shall be available for the following objects:
1. Detection state
 2. Occupancy sensor time delay
 3. Occupancy sensor sensitivity, PIR and Ultrasonic
- C. Units shall not have any dip switches or potentiometers for field settings
- D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

2.18 DIGITAL WALL SWITCH OCCUPANCY SENSORS

- A. Digital Occupancy Sensors shall provide scrolling LCD display for digital calibration and electronic documentation. Features include the following:
1. Digital calibration and pushbutton configuration for the following variables:
 - a. Sensitivity: 0-100 percent in 10 percent increments
 - b. Time delay: 1-30 minutes in 1 minute increments
 - c. Test mode: Five second time delay
 - d. Detection technology: PIR, Dual Technology activation and/or re-activation.
 - e. Walk-through mode
 - f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
 2. Programmable control functionality including:
 - a. Each sensor may be programmed to control specific loads within a local network.
 - b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
 - c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.
 - d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
 - 1) Ultrasonic and Passive Infrared
 - 2) Ultrasonic or Passive Infrared
 - 3) Ultrasonic only
 - 4) Passive Infrared only
 3. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
 4. Two RJ-45 ports for connection to DLM local network.
 5. Two-way infrared (IR) transceiver to allow remote programming through handheld configuration tool and control by remote personal controls.
 6. Device Status LEDs including
 - a. PIR detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding
 7. Assignment of any occupancy sensor to a specific load within the room without wiring or special tools.
 8. Assignment of local buttons to specific loads within the room without wiring or special tools
 9. Manual override of controlled loads
 10. All digital parameter data programmed into an individual wall switch sensor shall be retained in non-volatile FLASH memory within the wall switch sensor itself. Memory shall have an expected life of no less than 10 years.

- B. BACnet object information shall be available for the following objects:
 - 1. Detection state
 - 2. Occupancy sensor time delay
 - 3. Occupancy sensor sensitivity, PIR and Ultrasonic
 - 4. Button state
 - 5. Switch lock control
 - 6. Switch lock status
- C. Units shall not have any dip switches or potentiometers for field settings.
- D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.
- E. Two-button wall switch occupancy sensors, when connected to a single relay dimming room or fixture controller, shall operate in the following sequence as a factory default:
 - 1. Left button
 - a. Press and release - Turn load on
 - b. Press and hold - Raise dimming load
 - 2. Right button
 - a. Press and release - Turn load off
 - b. Press and hold - Lower dimming load
- F. Low voltage momentary pushbuttons shall include the following features:
 - 1. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 - 2. The following button attributes may be changed or selected using a wireless configuration tool:
 - a. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
 - b. Individual button function may be configured to Toggle, On only or Off only.
 - c. Individual scenes may be locked to prevent unauthorized change.
 - d. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 - e. Ramp rate may be adjusted for each dimmer switch.
 - f. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.

2.19 DIGITAL WALL SWITCHES

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:
 - 1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 - 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.

3. Configuration LED on each switch that blinks to indicate data transmission.
 4. Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 - d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
 5. Programmable control functionality including:
 - a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
 - b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.
 6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.
- B. BACnet object information shall be available for the following objects:
1. Button state
 2. Switch lock control
 3. Switch lock status
- C. Two RJ-45 ports for connection to DLM local network.
- D. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.
- E. Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.
1. Individual button function may be configured to Toggle, On only or Off only.
 2. Individual scenes may be locked to prevent unauthorized change.
 3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 4. Ramp rate may be adjusted for each dimmer switch.
 5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.

2.20 DIGITAL WALL SWITCH AND TIMER FOR CORRELATED COLOR TEMPERATURE (CCT)

- A. Digital CCT Preset Switch and CCT Timer Wall Switch for control of Correlated Color Temperature (CCT) in a room require fixtures with below listed CCT capable Logic Module with DLM Control Card - 1 per each independent lighting orientation (eg. direct and indirect), and circuit feed, up to a maximum 8 foot linear LED array or 2 individual down lights. Logic Module characteristics are determined by the specific module installed (Blanco 1, Blanco 2, Blanco 3, or Araya 5) and the LED array. Adjustment of CCT shall precisely trace the Black Body Curve across the LED array's tunable range to replicate natural daylight within the built environment. Only white LED's shall be used for maximum efficacy except for Araya 5. Lighting Fixtures, Lamps, and Ballasts are specified in Section 16500.
1. Each Logic Module with a DLM Control Card to be individually addressable by the system. All other DLM hardware and software products will treat the combo Logic Module/DLM Control

Card as a single DLM load and a single DLM device, with the capability of controlling them individual or as part of a group with other DLM load devices in the space, or over the room-to-room network.

2. CCT functionality to be implemented as an additional channel of information for any DLM load device. DLM's standard system capabilities to apply without reduction - either a max of 24, 48, or 96 DLM devices on the local network based on the power device, and a max of 64 loads. Loads that are not CCT capable will ignore any CCT command, so that CCT loads can be added to any existing DLM network without problem to existing programming and devices.
3. CCT and minimum CCT level determined by specific version of logic module used:
 - a. Blanco 1 - No CCT capability, but dimming to .1% minimum.
 - b. Blanco 2 - 2 Channel CCT and dimming to .1% minimum. CCT range from 3000 - 5000K unless specified differently in the fixture schedule.
 - c. Blanco 3 - 3 Channel CCT and .1% minimum dimming level. CCT range from 2700 - 6500K.
 - d. Araya 5 - 5 Channel CCT and 1% minimum dimming level. CCT range from 1650 - 8000K.
4. CRI shall not be less than 90 (85 for Araya 5) throughout the entire CCT range.
5. Color consistency of 2 MacAdam ellipses over the life of the source.
6. Closed loop thermal and optical feedback to compensate for thermally induced output variation and lumen depreciation over time.
7. Integrated driver and LED array assemblies to address inherent LED variability and complex non-linear relationships between system components.
8. A unique, programmable color model for each color tuning light source enabled by in-line dynamic spectral capture of each LED and custom color model generation.
- B. Low voltage CCT Preset Switch and CCT Wall Switch Timer shall include the same hardware features specified in the proceeding paragraph Digital Wall Switches and be connected to the room's DLM Cat 5e local network cable.
- C. 5 Button CCT Preset Switch to control CCT capable loads via its 4 buttons and rocker.
 1. Default Plug n' Go behavior will be that the Preset Switch will bind to all CCT capable loads in the room on connection. Individual loads can be added or removed via normal Push n' Learn programming either manually, via hand held commissioning tool, or LMCS software.
 2. The four preset buttons provide default settings of 100%, 75%, 50% and 25% of available CCT range. Buttons can be programmed to a user's preferred presets by specifying a specific Kelvin temperature, or DLM percentage of controlled fixture's CCT range (0-100%). Pressing and holding preset button for 5 seconds to record new preset level to that button based on last changed fixture's current setting.
 3. CCT Present Switch shall also include a single rocker that provides full range control of all bound load's CCT level.
- D. CCT Timer Wall Switch to provide automatic time of day events to bound CCT loads in a space.
 1. Once the time, date, and location are set, a default program provides a typical daylight cycle with CCT adjustments in the morning and evening to mimic the CCT cycle of sunrise through sunset.
 2. A single schedule of CCT events will apply to every day of the week, adjusting automatically for sunrise and sunset if astronomic events are programmed.
 3. User can choose between 6 astronomic based events or 8 standard time events. Astronomic events can use Sunrise and Sunset (with offsets) and Morning, Mid Day, and Evening event times. Each event to define a single CCT transition that includes a start time, finish time, and

CCT level to be achieved at finish. Systems that require multiple messages to fixtures to achieve a single event transition shall not be allowed.

4. Longitude and latitude input capability for accurate astronomic controls including seasonality adjustment based on geographic location.
5. Main override button to be capable of any one of the following:
 - a. Control intensity of all assigned CCT loads On/Off, or
 - b. Ability to override CCT level and automatically resume schedule after timed override expires, or
 - c. Ability to override CCT level and manually resume schedule
6. CCT transitions to occur inside the fixture's logic modules even when lights are off, so that when the fixtures go on to any dimming level they will do so at the proper CCT level for that time. Any time the lights are on, the Timer shall show the current Kelvin temperature for the lights.
7. Scheduling and settings can be entered on-screen directly using the CCT Timer Wall Switch high resolution display and/or via LMCS software.

2.21 DLM HANDHELD USER INTERFACE REMOTES

- A. Battery-operated handheld devices in 1, 2 and 5 button configurations for remote switching or dimming control. Remote controls shall include the following features:
 1. Two-way infrared (IR) transceiver for line of sight communication with DLM local network within up to 30 feet.
 2. LED on each button confirms button press.
 3. Load buttons may be bound to any load on a load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.
 4. Inactivity timeout to save battery life.
- B. Provide with a wall mount holster and mounting hardware for each remote.

2.22 DIGITAL DAYLIGHTING SENSORS

- A. Digital daylighting sensors shall work with load controllers and relay panels to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.
 1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.
 2. Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.
 3. Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone
- B. Digital daylighting sensors shall include the following features:
 1. Sensor's internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. Photodiode shall not measure energy in either the ultraviolet or infrared spectrums. Photocell shall have a sensitivity of less than 5 percent for any wavelengths less than 400 nanometers or greater than 700 nanometers.
 2. Sensor light level range shall be from 1-6,553 foot-candles (fc).

3. Capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
4. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.
5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
6. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
7. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
8. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
9. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
10. Configuration LED status light on device that blinks to indicate data transmission.
11. Status LED indicates test mode, override mode and load binding.
12. Recessed switch on device to turn controlled load(s) ON and OFF.
13. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:
 - a. Light level
 - b. Day and night setpoints
 - c. Off time delay
 - d. On and off setpoints
 - e. Up to three zone setpoints
 - f. Operating mode - on/off, bi-level, tri-level or dimming
14. One RJ-45 port for connection to DLM local network.
15. A choice of accessories to accommodate multiple mounting methods and building materials. Photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62 inch thick. Extended tube photosensors accommodate mounting materials from 0.62 to 1.25 inches thick. Mounting brackets are compatible with J boxes and wall mounting photosensor to be mounted on included bracket below skylight well.
16. Any load or group of loads in the room can be assigned to a daylighting zone
17. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).
18. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.

- C. Closed loop digital photosensors shall include the following additional features:
 - 1. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.
 - 2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.
 - 3. Automatically establishes application-specific setpoints following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of loads.
- D. Open loop digital photosensors shall include the following additional features:
 - 1. An internal photodiode that measures light in a 60-degree angle (cutting off the unwanted light from the interior of the room).
 - 2. Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.
 - 3. Each of the three discrete daylight zones can include any non overlapping group of loads in the room.
- E. Dual loop digital photosensors shall include the following additional features:
 - 1. Close loop portion of dual loop device must have an internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from sources outside of this cone
 - 2. Open loop portion of dual loop device must have an internal photodiode that can measure light in a 60 degree angle, cutting off the unwanted light from the interior of the room.
 - 3. Automatically establishes application-specific set-points following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of load.
 - 4. Device must reference closed loop photosensor information as a base line reference. The device must be able to analyze the open loop photosensor information to determine if an adjustment in light levels is required.
 - 5. Device must be able to automatically commission setpoints each night to provide adjustments to electrical lighting based on changes in overall lighting in the space due to changes in reflectance within the space or changes to daylight contribution based on seasonal changes.
 - 6. Device must include extendable mounting arm to properly position sensor within a skylight well.

2.23 DIGITAL PARTITION CONTROLS

- A. Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by reconfiguring the connected digital switches and occupancy sensors.
- B. Four-button low voltage pushbutton switch for manual control.
 - 1. Two-way infrared (IR) transceiver for use with configuration remote control.
 - 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 - 3. Configuration LED on each switch that blinks to indicate data transmission.

4. Each button represents one wall; Green button LED indicates status.
5. Two RJ-45 ports for connection to DLM local network.
- C. Coordinate contact closure interface for automatic control via input from limit switches on movable walls specified in Section 10 22 43 - Sliding Partitions .
 1. Operates on Class 2 power supplied by DLM local network.
 2. Includes 24VDC output and four input terminals for maintained third party contract closure inputs.
 3. Input max. sink/source current: 1-5mA
 4. Logic input signal voltage High: > 18VDC
 5. Logic input signal voltage Low: < 2VDC
 6. Four status LEDs under hinged cover indicate if walls are open or closed; supports LMPS-104 as remote status indicator.
 7. Two RJ-45 ports for connection to DLM local network.

2.24 DLM SEGMENT NETWORK

- A. Provide a segment network using linear topology, BACnet-based MS/TP subnet to connect DLM local networks (rooms) and LMCP relay panels for centralized control.
 1. Each connected DLM local network shall include a single network bridge (LMBC-300), and the network bridge is the only room-based device that is connected to the segment network.
 2. Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate "in" and "out" terminations, for segment network connections.
 3. Segment network utilizes 1.5 twisted pair, shielded, cable supplied by the lighting control manufacturer. Maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms.
 4. Network wire jacket is available in high visibility green, white, or black.
 5. Substitution of manufacturer-supplied cable is not permitted and may void the warranty, if non-approved cable is installed, and if terminations are not completed according to manufacturer's specific requirements.
 6. Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device.
 7. Segment networks shall be capable of connecting to any of the following: BACnet-compliant BAS (provided by others) directly via MS/TP, or BACnet/IP via an NB-ROUTER or LMSM Unit. Systems whose room-connected network infrastructure require gateway devices to provide BACnet data to a BAS are unacceptable

2.25 NETWORK BRIDGE

- A. Network bridge module connects a DLM local network to a BACnet-compliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. Network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.
 1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
 2. Provide Plug n' Go operation to automatically discover room devices connected to the local

network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.

3. Network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical MS/TP termination per room are not acceptable. Standard BACnet objects shall be provided as follows:
 - a. Read/write the normal or after hours schedule state for the room
 - b. Read the detection state of each occupancy sensor
 - c. Read the aggregate occupancy state of the room
 - d. Read/write the On/Off state of loads
 - e. Read/write the dimmed light level of loads
 - f. Read the button states of switches
 - g. Read total current in amps, and total power in watts through the load controller
 - h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
 - i. Activate a preset scene for the room
 - j. Read/write daylight sensor fade time and day and night setpoints
 - k. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells
 - l. Set daylight sensor operating mode
 - m. Read/write wall switch lock status
 - n. Read watts per square foot for the entire controlled room
 - o. Write maximum light level per load for demand response mode
 - p. Read/write activation of demand response mode for the room
 - q. Activate/restore demand response mode for the room

2.26 WIRELESS NETWORK BRIDGES AND BORDER ROUTER

- A. Wireless Network Bridges connect to a DLM local network (room) and use IEEE 802.15.4 6LoWPAN for communication between rooms and to a Border Router that oversees the formation and configuration of the wireless network. Each local network shall include a wireless network bridge that connects to the other DLM devices on the local network, and a group of Wireless Bridges shall connect to a Border Router.
- B. Features of the Wireless Network Bridges shall be as follows:
 1. Network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.
 2. Wireless Bridges provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the Border Router via the wireless network. No commissioning shall be required for set up of the network bridge on the local network.

3. Wireless Bridges shall incorporate dual internal omni-directional antennas with diversity to provide wide and robust communication, and so the antennas will be protected against accidental contact with other objects in the space.
 4. Two LEDs shall be included on the bridge to provide feedback about the local network (red) and wireless network (blue) health.
 5. Wireless Network bridge shall automatically create standard BACnet objects for selected DLM devices to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM devices on each local network. BACnet objects will be created for the addition or replacement of any given DLM device for the installed life of the system. Products requiring that an application-specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID per room are not acceptable. Standard BACnet objects shall be provided as follows:
 - a. Read/write the normal or after hours schedule state for the room
 - b. Read the detection state of each occupancy sensor
 - c. Read the aggregate occupancy state of the room
 - d. Read/write the On/Off state of loads
 - e. Read/write the dimmed light level of loads
 - f. Read the button states of switches
 - g. Read total current in amps, and total power in watts through the load controller
 - h. Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings
 - i. Activate a preset scene for the room
 - j. Read/write daylight sensor fade time and day and night setpoints
 - k. Read the current light level, in foot-candles, from interior and exterior photosensors and photocells
 - l. Set daylight sensor operating mode
 - m. Read/write wall switch lock status
 - n. Read watts per square foot for the entire controlled room
 - o. Write maximum light level per load for demand response mode
 - p. Read/write activation of demand response mode for the room
 - q. Activate/restore demand response mode for the room
- C. Features of the Wireless Border Router shall be:
1. The Wireless Border Router shall manage the formation and configuration of the 6LoWPAN wireless mesh network, and provide connectivity via wired 10/100 Ethernet to a local area network that may include a LMSM Segment Manager or Building BAS System.
 2. Border Router shall provide key information about the health of the mesh network in the form of signal quality, device status, network status, and other real-time network information such as energy monitoring.
 3. The LMBR shall have dual internal omni-directional antennas with diversity to ensure reliable communication with Wireless Network Bridges, and provide a user interface for set up and configuration.
 4. Include an internal MicroSD card and a Real-time clock with supercap back-up. Border Router shall get power for operation via a 120V outlet (in non-plenum applications) and a dedicated

DLM LMPB Power Booster connected to a Cat 5e to DC barrel connector (for plenum applications).

D. Communication between the Wireless Network Bridges and the Border Router

1. The communication between the Wireless Bridges and the Border Router shall be via a standalone wireless mesh network that does not require interface with any other wireless network in the space. The mesh network shall allow communication between all rooms as long as they are within 100' of another connected room.
2. The Wireless Bridges shall communicate over a 6LoWPAN 2.4 GHz IEEE 802.15.4 network and use AES 128 bit Key Encryption for network security.
3. In addition to IEEE IPV6, the Border Router shall have available Constrained Application Protocol (CoAP), Routing Protocol for Low Power Networks (RPL), and Stateless Multicast RPL Forwarding (SMRF).
4. The wireless protocol shall allow BACnet communication to be transported transparently between the Network Bridge and any front end BAS devices such as the LMSM Segment Manager.

2.27 LMCP LIGHTING CONTROL PANELS AND LMZC ZONE CONTROLLER

A. Hardware: Provide LMCP lighting control panels in the locations and capacities as indicated on the Drawing and schedules. Each panel shall be of modular construction and consist of the following components:

1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 - 8 relays, 1 - 24 relays and 6 four-pole contactors, or 1 - 48 relays and 6 four-pole contactors.
2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. LMCP panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.
3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. Interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. Interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. Panel interiors shall include the following features:
 - a. Removable, plug-in terminal blocks with connections for all low voltage terminations.
 - b. Individual terminal block, override pushbutton, and LED status light for each relay.
 - c. Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only.
 - d. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate digital networks, each capable of supplying 250mA to connected devices.
 - e. True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.
 - f. Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.
 - g. Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay

- override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.
- h. Relay group status shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.
4. Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:
- a. Electrical:
 - 1) 30 amp ballast at 277V
 - 2) 20 amp ballast at 347V
 - 3) 20amp tungsten at 120V
 - 4) 30 amp resistive at 347V
 - 5) 1.5 HP motor at 120V
 - 6) 14,000 amp short circuit current rating (SCCR) at 347V
 - 7) Relays shall be specifically UL 20 listed for control of plug-loads
 - b. Mechanical:
 - 1) Replaceable, 1/2 inch KO mounting with removable Class 2 wire harness.
 - 2) Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.
 - 3) Dual line and load terminals each support two #14 - #12 solid or stranded conductors.
 - 4) Tested to 300,000 mechanical on/off cycles.
5. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.
6. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.
7. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic bypass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700.
8. Integral system clock shall provide scheduling capabilities for panel-only projects without DLM segment networks or BAS control.
- a. Each panel shall include digital clock capability able to issue system wide automation commands to up to 11 other panels for a total of 12 networked lighting control panels. Clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
 - b. Clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.
 - c. Clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.

- d. Clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
 - 1) Scheduled ON / OFF
 - 2) Manual ON / Scheduled OFF
 - 3) Astro ON / OFF (or Photo ON / OFF)
 - 4) Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)
 - e. User interface shall be a portable IR handheld remote control capable of programming any panel in the system
 - f. Clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
 - g. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.
9. Lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection.
10. Lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet protocol.
- a. Panel shall have provision for an individual BACnet device ID and shall support the full 222 range (0 - 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
 - b. Panel shall support MS/TP MAC addresses in the range of 0 - 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.
 - c. Lighting control relays shall be controllable as binary output objects in the instance range of 1 - 64. The state of each relay shall be readable and writable by the BAS via the object present value property.
 - d. Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 - 64.
 - e. The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 - 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.
 - f. Setup and commissioning of panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
 - 1) Binary output objects in the instance range of 1 - 64 (one per relay) for on/off control of relays.
 - 2) Binary value objects in the instance range of 1 - 99 (one per channel) for normal hours/after hours schedule control.
 - 3) Binary input objects in the instance range of 1 - 64 (one per relay) for reading true

on/off state of the relays.

- 4) Analog value objects in the instance range of 101 - 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
 - g. Description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.
 - h. BO and BV 1 - 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (<http://www.bacnet.org/Addenda/Add-135-2010aa.pdf>)
 - i. Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.
 - j. Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.
11. In addition to the LMCP Relay Panels, an LMZC Zone Controller panel shall be available for zero-relay applications. The panel is designed for applications where LMFC Fixture Controllers or other distributed load controllers are used to switch and/or dim the controlled loads. Key similarities to and differences from the LMCP panel design shall include:
 - a. Use the same intelligence board as the LMCP relay panel.
 - b. Shall not include relay driver boards or relays.
 - c. Have a removable interior section to facilitate installation, and a Tub/Cover. Cover is for surface mounting applications only.
 - d. Tub shall have two interior KOs to allow installation of LMPB-100 Power Boosters. Each installed Power Booster can provide an additional 150 mA for either of the two available DLM local networks provided by the LMZC.
 - e. All programming and networking (whether DLM Local Network and/or Segment Network) capabilities in the LMZC Zone Controller shall be similar to capabilities for LMCP relay panels, except for functions designed for panel-mounted HDR relays.
 12. To aid in project start up, if LMFC Fixture Controllers are connected to an LMZC Zone Controller, Plug n' Go automatic configuration will establish a unique sequence of operation so that all LMFC-controlled fixtures will turn on to 50 percent output when any digital occupancy sensor detects motion.
- B. User Interface: Each lighting control panel system shall be supplied with at least one handheld configuration tool. As a remote programming interface the configuration tool shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. User interface shall have the following panel-specific functions as a minimum:
1. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
 2. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.
 3. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive and shall be configurable as to whether the event is

active on holidays. Holidays are also defined through the User Interface.

4. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive and shall be configurable as to whether the event is active on holidays.
5. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.
6. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.

2.28 SEGMENT MANAGER

- A. For networked applications, the Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP traffic via a configurable port (default is 80) or 256 bit AES encrypted SSL TCP/IP traffic via a configurable port (default is 443).
- B. Each segment manager shall have integral support for at least three segment networks. Segment networks may alternately be connected to the segment manger via external BACnet-to-IP interface routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as shown on the Drawings.
- C. Operational features of the Segment Manager shall include the following:
 1. Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.
 2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser. The Segment Manager shall not require installation of any lighting control software on an end-user PC.
 3. Log in security capable of restricting some users to view-only or other limited operations.
 4. Segment Manager shall provide two main sets of interface screens - those used to initially configure the unit (referred to as the config screens), and a those used to allow users to dynamic monitor the performance of their system and provide a centralized scheduling interface. Capabilities using the Config Screens shall include:
 - a. Automatic discovery of DLM devices and relay panels on the segment network(s). Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels.
 - b. Allow information for all discovered DLM devices to be imported into the Segment Manager via a single XML based site file from the LMCS Software, significantly reducing the time needed to make a system usable by the end user. Importable information can include text descriptions of every DLM component and individual loads, and automatic creation of room location information and overall structure of DLM network. Info entered into LMCS should not have to be re-entered manually via keystrokes into the Segment Manager
 - c. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.
 - d. Ability to view and modify DLM device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.

- e. Provide capabilities for integration with a BAS via BACnet protocol. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the segment manager: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug-load power; load ON/OFF state; load dimming level; panel channel schedule state; panel relay state; and Segment Manager Group schedule state control. Any of above items shall be capable of being moved into an "Export Table" that will provide any integrator with only the data they need, and by using the Export Table effectively create a firewall between the integrator's request for info and the overall system performance.
5. Capabilities using the Segment Manager's Dashboard Screens shall include:
 - a. A dynamic "tile" based interface that allows easy viewing of each individual room's lighting and plug load power consumption, and lighting and plug load power density (power consumption information requires Enhanced DLM Room and Plug Load Controllers with integral current transducers. Tiles will be automatically organized according to location so a single tile for the building summarizes all information for tiles beneath it on every floor, in every area, in every room. Tiles use three color coded energy target parameters, allowing an owner to quickly identify rooms that are not performing efficiently. Tiles for rooms with occupancy sensors shall include an icon to indicate whether that room is occupied. Tiles shall be clickable, and when clicked the underlying hierarchical level of tiles shall become visible. Tile interface shall be accessible via mouse, or touch screen devices. Tiles shall be created automatically by the segment manager, based on the information found during the device discovery and/or information included in a file imported in from LMCS (such as tagged descriptions for each room) without any custom programming.
 - b. Ability to set up schedules for DLM local networks (rooms) and panels. Schedules shall be capable of controlling individual rooms with either on/off or normal hours/after hours set controlled zones or areas to either a normal hours or after hours mode of operation. Support for annual schedules, holiday schedules and unique date-bound schedules, as well as astro On or astro Off events with offsets. Schedules shall be viable graphically as time bars in a screen set up to automatically show scheduled events by day, week or month.
 - c. For fixtures that are accessible via the Segment Network, and have CCT capability as specified under paragraph Digital Wall Switch and Timer For Correlated Color Temperature, the Segment Manager will provide schedule functionality similar to the CCT Wall Timer, allowing all CCT fixtures across the entire facility to be scheduled together.
 - d. Ability to provide a simple time vs. power graph based on information stored in each Segment Manager's memory (typically two to three days' data).
 6. If shown on the Drawings, Segment Managers shall be integrated into a larger control network by the addition of a Network Supervisor package. The Supervisor is a server level computer running a version of the Segment Manager interface software with dedicated communication and networking capability, able to pull information automatically from each individual Segment Manager in the network. By using a Supervisor, information for individual Segment Managers can be accessed and stored on the Supervisor's hard drive, eliminating the risk of data being overwritten after a few days because of Segment Manager memory limits.
 7. Segment Manager shall allow access and control of the overall system database via Native Niagara AX FOX connectivity. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable.

2.29 EMERGENCY LIGHTING CONTROL DEVICES

- A. Emergency Lighting Control Unit - A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - 1. 120/277 volts, 50/60 Hz, 20 amp ballast rating
 - 2. Push to test button
 - 3. Auxiliary contact for remote test or fire alarm system interface

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the CEC, Title 24 Part 6 Energy Code, manufacturer's instructions, as shown on the drawings, and as specified.
- B. Aim outdoor photoelectric sensor according to manufacturer's recommendations. Set adjustable window slide for 1 footcandle turn-on.
- C. Aiming for wall-mounted and ceiling-mounted motion sensor switches shall be per manufacturer's recommendations.
- D. Set occupancy sensor "on" duration to //5// //10// //15// minutes.
- E. Locate photoelectric sensors as indicated and in accordance with the manufacturer's recommendations. Adjust sensor for the available light level at the typical work plane for that area.
- F. Label time switches and contactors with a unique designation.
- G. Program lighting control panels per schedule on drawings.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform in accordance with the manufacturer's recommendations.
- B. Upon completion of installation, conduct an operating test to show that equipment operates in accordance with requirements of this section.
- C. Test for full range of dimming ballast and dimming controls capability. Observe for visually detectable flicker over full dimming range.
- D. Test occupancy sensors for proper operation. Observe for light control over entire area being covered.
- E. Comply with Title 24 Energy Code and California Green Building Code test and commissioning requirements.

SPEC WRITER NOTE: Include the following paragraph for larger systems with multiple sensors or controls that work thru a solenoid-breaker or relay panel.

- //E. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory-authorized technician who will verify all adjustments and sensor placements.//

3.3 COMMISSIONING ASSISTANCE

- A. Title 24 Acceptance Testing Service; Include additional costs for Lighting Control Manufacturer to provide a technician for one additional day while the CLCATT performs lighting control acceptance testing in accordance with CAL TITLE 24 P6 including submission of required documentation.

3.4 FOLLOW-UP VERIFICATION

- A. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the lighting control devices are in good operating condition and properly performing the intended function in the presence of //Resident Engineer// or // COR//.

SPEC WRITER NOTE: Include the following paragraph for larger systems with multiple sensors or controls that work thru a solenoid-breaker or relay panel.

3.5 INSTRUCTION

- A. Furnish the services of a factory-trained technician for one 8-hour training period for instructing personnel in the maintenance and operation of the lighting control system on the dates requested by the //Resident Engineer // or //COR//.
- B. Contractor shall submit written instructions on training and maintenance as reviewed in training session.

3.6 PRODUCT SUPPORT AND SERVICE

- A. Factory telephone support shall be available at no cost to the Owner following acceptance. Factory assistance shall consist of assistance in solving application issues pertaining to the control equipment.

END OF SECTION

APPENDIX D

ADDITIONAL LIGHTING PROJECT SPECIFICATIONS

Appendix D
Additional Lighting Project Related Specifications

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

07 8400 FIRESTOPPING

DIVISION 26 – ELECTRICAL

26 0500 COMMON WORK RESULTS FOR ELECTRICAL
26 0501 MINOR ELECTRICAL DEMOLITION
26 0519 LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
26 0526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
26 0529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
26 0534 CONDUIT
26 0537 BOXES
26 0553 IDENTIFICATION FOR ELECTRICAL SYSTEMS
26 0801 COMMISSIONING OF ELECTRICAL SYSTEMS
26 0923 LIGHTING CONTROL DEVICES
26 2726 WIRING DEVICES
26 5100 INTERIOR LIGHTING
26 5600 EXTERIOR LIGHTING

END OF SECTION

SECTION 07 8400 – FIRESTOPPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Firestopping systems.
- B. Firestopping of all joints and penetrations in fire resistance rated and smoke resistant assemblies, whether indicated on drawings or not, and other openings indicated.
- C. Provide firestopping in conjunction with work specified in the following Divisions:
 - 1. Division 26: Holes or voids created to extend electrical systems through fire-rated roofs, floors, and walls.

1.02 RELATED REQUIREMENTS

- A. Section 26 0534 – Conduit

1.03 REFERENCES

- A. ASTM E814 – Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
- B. UL (DIR) – Online Certifications Directory; current listings at database.ul.com.
- C. UL (FRD) – Fire Resistance Directory; current edition.

1.04 SUBMITTALS

- A. Comply with Section 26 0500 for additional submittal requirements and procedures.
- B. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- C. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

PART 2 - PRODUCTS

2.01 FIRESTOPPING - GENERAL REQUIREMENTS

- A. Manufacturers
 - 1. A/D Fire Protection Systems Inc.
 - 2. 3M Fire Protection Products.
 - 3. Hilti, Inc.
 - 4. Nelson FireStop Products.
- B. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

2.02 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Through Penetration Firestopping: Use any system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

Appendix D
Additional Lighting Project Related Specifications

2.03 FIRESTOPPING PENETRATIONS THROUGH CONCRETE AND CONCRETE MASONRY CONSTRUCTION

- A. Penetrations Through Walls By:
 - 1. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - 2. 2 Hour Construction: UL System W-J-1067; Hilti FS-ONE MAX Intumescent Firestop Sealant.

2.04 FIRESTOPPING PENETRATIONS THROUGH GYPSUM BOARD WALLS

- A. Penetrations By
 - 1. Uninsulated Metallic Pipe, Conduit, and Tubing:
 - a. 1 Hour Construction: UL System W-L-1054; Hilti FS-ONE MAX Intumescent Firestop Sealant.
 - 2. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
 - a. 1 Hour Construction: UL System W-L-2128; Hilti FS-ONE MAX Intumescent Firestop Sealant.

2.05 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements.
- B. Firestopping at Uninsulated Metallic Pipe and Conduit Penetrations, of diameter 4 inches or less: Caulk or putty.
- C. Firestopping at Combustible Pipe and Conduit Penetrations, of diameter 4 inches or less: Any material meeting requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.

3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

3.04 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.05 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

Appendix D
Additional Lighting Project Related Specifications

SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Electrical submittals and product data.
- B. Additional Electrical bid, workmanship, and installation requirements.
- C. Common electrical implementation and closeout requirements.

1.02 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. This section covers general work of all Sections under Division 26.
- C. The Division 26 Specifications and Drawings are complementary, what is called for by one is binding. Items shown on the Drawings are not necessarily included in the Specifications and vice versa.
- D. Use the more stringent requirement when specified materials or methods exceed what is required by applicable Codes and Standards.
- E. The following sections should be reviewed to ensure the requirements for this project are met:
 - 1. Section 26 0801 - Commissioning of Electrical Systems

1.03 REFERENCES

- A. Publications and standards listed below form a part of this specification to the extent referenced. The most recent version, adopted by the Authority Having Jurisdiction, will apply.
 - 1. CEC - California Electrical Code, Title 24, Part 3, including all applicable Amendments and Supplements, as based on NFPA 70.
 - 2. CBC - California Building Code, Title 24, Part 2
 - 3. CFC - California Fire Code, Title 24, Part 9
 - 4. IECA - Insulated Cable Engineers Association
 - 5. NFPA - National Fire Protection Association
 - 6. NEMA - National Electrical Manufacturers Association
 - 7. NECA - National Electrical Contractors Association
 - 8. ANSI - American National Standards Institute
 - 9. IEEE - Institute of Electrical and Electronic Engineers
 - 10. UL - Underwriters Laboratories
 - 11. CAL/OSHA - State of California Low-Voltage Electrical Safety Orders
 - 12. CAL/OSHA - State of California High Voltage Electrical Safety Orders
 - 13. Codes and regulations noted in other Sections in Division 26, applicable State and Local Codes and Ordinances.
- B. If any of the requirements of the above Codes and Standards are in conflict with one another, or with the requirements of these specifications, the most stringent requirement shall govern. The University's Representative shall determine the most stringent requirement.

Appendix D
Additional Lighting Project Related Specifications

1.04 SUBMITTALS AND DEFERRED SUBMITTALS

- A. Refer to Division 01 for additional requirements.
- B. The project schedule shall be submitted to the University's Representative prior to acceptance of shop drawing submittals. The schedule shall include timeframe for mobilization, shop drawings, construction, milestone dates of critical path items to be installed, testing, adjusting, energization, commissioning, closeout documentation, and demobilization.
- C. A written statement from the Contractor shall be included with each submittal that the equipment, hardware or accessory item complies with all the requirements of the project specification and associated drawings.
 - 1. The Contractor shall submit the specification section showing compliance with each respective paragraph, specified items, and features that apply to the items included in the submittal.
 - 2. All exceptions shall be clearly identified, in writing, by referencing respective paragraph and other requirements along with proposed alternative.
- D. Submit all Division 26 shop drawings and product data grouped and referenced by the specification technical section numbers.
- E. Organize submittals in same sequence as they appear in Specification Sections, articles or paragraphs.
- F. Shop Drawings and Deferred Submittals
 - 1. Provide coordination and supplemental design shop drawings in PDF and unlocked with all reference files in AutoCAD (.dwg). Confirm with the University's Representative the version of AutoCAD required.
 - 2. Provide all other shop drawings in PDF format. Provide a minimum of 8.5 inches by 11 inches paper size if required by University's Representative.
 - 3. Shop drawings shall contain job title and references to the applicable specification section.
 - 4. Include installation details for equipment including proposed location, layout and arrangement, accessories, piping, and other items that must be shown to assure a coordinated installation.
 - 5. Internal wiring diagrams of equipment shall show wiring as actually furnished with equipment installed for this project and with all optional items clearly identified as included or excluded. Clearly identify external wiring connections. Identify and obliterate superfluous material.
 - 6. Indicate adequate clearances for working space operation, maintenance, and replacement of operating equipment devices. Identify all access provisions and requirements.
 - 7. For each manufactured item, provide current manufacturer's descriptive literature of cataloged products, certified equipment drawings, diagrams, instruction manuals, performance and characteristic curves if applicable, and catalog cuts. Identify model, catalog number, options included, ratings, Code and UL compliance for every item submitted for review. Include sufficient information to indicate complete compliance with Contract Documents. Use highlighting and arrows to identify required information and options being provided. Line thru options not being provided.
 - 8. If equipment is not approved, revise the submittal to show acceptable equipment and resubmit in a timely manner.

Appendix D
Additional Lighting Project Related Specifications

9. If paper submittals are required, prepare submittal material in accordance with the following:
 - a. Insert all literature in standard 3-ring binders for 8-1/2 inch by 11 inch pages with individual tabs. Do not staple literature on different products together.
 - b. Provide 3 sets of the 3-ring binders with same original manufacturer's literature.
 - c. Number all binders on the outside of the cover and indicate the Specification Section. Mark Binder No. 1 Architects copy, No. 2 Engineers copy, and No. 3 University's Representative copy.
 - d. Provide an index with binder. This index shall follow the same sequence as the Specifications.
10. Product data, shop drawings and submittals: Submittals shall be prepared by the Contractor and delivered to the University's Representative for approval and prior to purchase, fabrication, and installation for detailed product data, options, shop drawings, procedures and lists that are required in the specifications and on the plans including the following items, but not limited to:
 - a. Conduit and fittings.
 - b. Flexible Conduits, expandable fittings, and connection fittings.
 - c. Fasteners and supports for light fixtures, equipment, conduits, tray, pullboxes, and devices.
 - d. Lighting fixtures and all associated equipment (lamps, ballasts, power supplies, controllers, photo and occupancy sensors, etc.).
 - e. Motion sensing switches and systems.
 - f. Lighting Controls system devices, and accessories.
 - g. Grounding Connection Materials and accessories.
 - h. Light fixtures with fixture photometrics, lumen output, color temperature, and other features.
 - i. Photometrics for area of light fixture installation.
- G. Whenever more than one (1) manufacturer's product is specified in the project documents, the first named product is the basis of design and the use of alternate-named manufacturer's products or substitutes by the Contractor may require modifications in that design. If such alternatives are proposed or used by the Contractor, there may be additional design work required. The architect and engineers will provide the design fees to modify the issued drawings for the work to incorporate that alternate into the documents within 15 days of receipt of the substitution request. The Contractor shall pay all costs required to make necessary revisions and modifications to the design, including all professional fees to the Architect and Engineers for the evaluation and revisions or modifications of the documents resulting from the substitution or selection of an alternate manufacturer submitted by the Contractor.
- H. All submittals must be delivered to the University's Representative within the number of days allowed after the Notice to Proceed or contract award. Failure to submit any or all items shall not result in a delay in the schedule or a schedule extension. If more time is required to compile a specific submittal, then a formal request in writing may be submitted, requesting more time. This request should list the item or system, the specification section involved, the reason for the delay, and the date when this item will be submitted. This will be reviewed by the University's Representative and a response regarding schedule and time extension will be prepared within one week.

Appendix D
Additional Lighting Project Related Specifications

- I. The Contractor shall be responsible for all equipment ordered and/or installed prior to receipt of shop drawings returned from the University's Representative bearing the University's Representative stamp of "Reviewed and Approved Without Comment", or "Approved with comment". All corrections or modifications required for equipment as noted on the shop drawings shall be made by the Contractor if equipment has been purchased or installed. Contractor shall pay all costs to remove equipment from the job site and/or returned at the request of the University's Representative, without additional compensation.
- J. Standard Compliance: When materials or equipment provided by the Contractor must conform to the standards of organizations such as American National Standards Institute / Institute of Electrical and Electronics Engineers (ANSI / IEEE) or National Electrical Manufacturers Association (NEMA), submit proof of such conformance to the University's Representative for approval. If an organization uses a label or listing from a Nationally Recognized Testing Laboratory (NRTL) to indicate compliance with a particular standard, the label or listing will be acceptable evidence, unless otherwise specified. In lieu of the label or listing, and where acceptable to University's Representative, submit a certificate from an independent testing organization, which is competent to perform acceptance testing and is approved by the University's Representative. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; or "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material". The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard. Certifications shall be documents prepared specifically for this Contract, printed on the manufacturer's letterhead, and signed by the manufacturer's official authorized to sign certificates of compliance or conformance.
- K. Certified Test Reports: Before delivery of materials and equipment, certified copies of all test reports specified in individual sections shall be submitted for approval.
- L. Re-submittals will be reviewed for compliance with comment made on the original submittal only and should be marked with a resubmittal number and dated.

1.05 SUBSTITUTIONS

- A. Coordinate with the requirements of Division 26, all applicable sections.
- B. Products or systems listed as "no substitutions" or "no known equal" shall be provided as specified, "no equal".
- C. Products or systems noted as "or equal": A product or system of equivalent design, construction and performance will be considered. Submit all pertinent data and product information for review. Provide the specified products or systems if proposed substitution is found unacceptable.

1.06 MATERIALS FURNISHED

- A. Refer to applicable Division 26 Sections for complete product specifications, including Manufacturers' names and model numbers used for materials, processes or equipment, the standards of quality, utility and appearance.
- B. All equipment shall be delivered to the job site bearing the label of Underwriters Laboratories, or other testing laboratory acceptable to authority having jurisdiction, where listing exists for the class of equipment.
- C. For equipment specified by manufacturer's catalog number, include all accessories, controls, etc., listed in catalog as standard with equipment. Furnish optional or additional accessories as specified in project documents.

Appendix D
Additional Lighting Project Related Specifications

- D. Where no specific make of material or equipment is mentioned, use products of reputable manufacturer that conform to requirements of system and other applicable specification sections.
- E. Equipment and material damaged during transportation, installation, or operation is considered as totally damaged and will be replaced by Contractor with new. Variance from this requirement shall be permitted only with written approval from the University's Representative.
- F. Provide an University's approved and authorized representative to constantly supervise Work specified. Check all materials prior to installation for conformance with Drawings, Specifications, and reviewed Shop Drawings.
- G. Each purchase order or subcontract issued by the Contractor shall include project requirements for submittal data, startup services, commissioning, Operation & Maintenance (O&M) manuals, data and training.

1.07 WARRANTY

- A. Comply with the requirements of Division 01, and all other project requirements.
- B. Provide a written Contractor's one-year guarantee for all workmanship and materials installed for this project unless otherwise indicated to be longer in other Division 26 Sections. Guarantee period shall be effective from time of work acceptance or as defined in Division 01, whichever date succeeds the other.
- C. Refer to project specifications for requirements to provide manufacturer's written warranty that includes all terms, conditions, exclusions, and duration.
- D. Provide the University with extended warranty options when requested.

1.08 DEFINITION OF TERMS

- A. The following terms used in Division 26 documents shall be defined as follows:
 - 1. Provide: Shall mean furnish, install, connect, and test unless otherwise indicated.
 - 2. Furnish: Shall mean purchase and deliver to project site.
 - 3. Install: Shall mean to physically install and connect the items in-place.
 - 4. Connect: Shall mean make final electrical connections for a complete operating piece of equipment or system.
 - 5. Equal: Shall be of the same quality, appearance and utility to that specified, as determined by the University's Representative. The Contractor bears the burden of proof of equality.
 - 6. Exposed: Shall mean exposed to view and readily accessible after construction is completed.
 - 7. Concealed: Shall mean hidden from view after construction is completed.
 - 8. Utility Area: Shall mean electrical, mechanical and communications equipment rooms, elevator machine room, equipment yards, and other locations where utility and utilization equipment and systems are installed.
 - 9. As directed: Shall be as directed by the University's Representative.
 - 10. As required: Shall be as required by project documents, applicable code requirements, good building practice, the conditions prevailing, the University, or the University's Representative.
 - 11. As selected: Shall be as selected by the University's Representative.

Appendix D
Additional Lighting Project Related Specifications

12. University's Representative: Shall mean person/group designated by University to represent the University.
13. Inspector of Record (IOR): Shall mean the person who is responsible for inspecting and approving the installation, and the person who is the representative for the Authority Having Jurisdiction.
14. Extra low voltage: Shall mean voltages of less than 90 volts line to ground.
15. Low voltage: Shall mean voltages of over 100 volts line to neutral to maximum of 600 volts line to line.

PART 2 - INSTALLATION AND QUALITY

2.01 ELECTRICAL WORKMANSHIP AND QUALIFICATIONS REQUIREMENTS

- A. The electrical project includes the entire scope of work included and referenced in the project documents including complete installation of equipment, cable, and materials required for a complete and operable system after completion of testing, energization, and commissioning of the new equipment. Contactor shall include all costs to achieve these requirements in Contract bid price.
- B. Employment of any person on any job in the capacity of an electrician is not permitted unless such person has qualified for and holds a valid Journeyman Electrician Pocket Card or General Journeyman Electrician Certificate issued by the State of California Division of Apprenticeship Standards, except, Contractor may employ electrical helpers or apprentices on any job of electrical construction, new or existing, when the work of such helpers or apprentices is performed under the direct and constant personal supervision of a journeyman electrician holding a valid Pocket Card accepted by the State of California Division of Apprenticeship Standards:
 1. Each Pocket Card carrying journeyman electrician will be permitted to be responsible for the quality of workmanship for a maximum of one helper or apprentice during any same time period, provided the nature of the work is such that good supervision can be maintained and the quality of workmanship achieved is the best and as required by the latest edition of the California Electric Code.
 2. Before each journeyman electrician commences work, deliver to University's Representative at the project site, a photocopy of the journeyman's valid Pocket Card.
 3. All splicing and termination work on systems operating in excess of 600V shall be performed exclusively by a Journeyman electrician with a minimum of 5 years verifiable work experience making the types of splices and terminations required in the project scope of work. The Journeyman electrician shall possess and provide evidence of training through completion of a certification program for making splices and terminations. The Contractor shall submit resumes and training certificates to the University's Representative for review and approval for all Journeyman electricians, who will be making splices and terminations, 30 days in advance of any work activity.
- C. Make installation in a neat, finished and safe manner, according to the latest published NECA Standard of Installation under competent supervision.

2.02 SCHEDULE OF WORK

- A. Coordinate with the requirements of Division 26, all applicable sections.
- B. Provide full-time supervisory staff to coordinate and maintain work force for project work sequencing requirements as detailed in the University approved project schedule.

Appendix D
Additional Lighting Project Related Specifications

- C. When requested by the University, submit a project recovery schedule to return the project to the approved completion dates.

2.03 SITE VISITATION

- A. Coordinate with the requirements of Bidding and Contract Requirements, Instruction to Bidders.
- B. Visit the site prior to bidding and become familiar with existing conditions and other factors that may affect the execution of work. Include all related costs in the initial bid proposal.
- C. Contractor shall visit the site and verify dimensions and scale shown on the plans and details prior to submitting a bid. Scale and dimensions shown are diagrammatic and shall not be used in preparing a bid estimate or for ordering material and equipment.

2.04 SAFETY

- A. The electrical installation shall comply with all regulations on safety aspects issued by the Labor Department and other authorities from time to time. These include but are not limited to the following:
 - 1. Construction Sites (Safety) Regulations including California Code of Regulations, Title 8, Division 1, Department of Industrial Relations.1.
 - 2. Factories and Industries Undertakings Electricity Regulations.
 - 3. IEC 60364-7-704: Construction and Demolition Site Installation.
 - 4. Electricity Ordinances.
 - 5. Construction Site Safety Manuals and Cal-OSHA requirements.
- B. Coordinate and provide all barriers, fences, covers, warning tape, and plaques required to warn and protect workers and the public from all hazardous conditions during performance of the Work.
- C. The Contractor shall ensure that all workers utilize Personal Protective Equipment required for each task necessary to complete the scope of work.
- D. Provide all training and job site safety instructions for Contractor and University's personnel prior to performing construction activities. Conduct safety meetings prior to implementing switching procedures required for electrical system shutdowns and energization.
- E. The Contractor shall designate a safety officer who will conduct daily observation of workplace activity to assure compliance with safe work practices required to safeguard workers and the public from hazards. Provide the University with weekly written reports on job site safety. Report any and all incidents to the University's Representative immediately.

2.05 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Examine site related work and surfaces before starting work of any Section.
- C. Report to University's Representative, in writing, conditions which will prevent proper execution of this work.
- D. Beginning work of any Section without reporting unsuitable conditions to University's Representative constitutes acceptance of conditions by Contractor. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no additional cost to University.
- E. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall- mounting items, unless indicated otherwise.

Appendix D
Additional Lighting Project Related Specifications

- F. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom and working space consistent with these requirements.
- G. Equipment: Install equipment and materials to facilitate service, maintenance, and repair or replacement of both electrical equipment and other nearby installations and systems. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- H. Right of Way: Give right of way to gravity and piping systems installed at a required slope.
- I. Install work uniform, level and plumb, in relationship to lines of the building. Do not install any diagonal or otherwise irregular work unless so indicated on the drawings or approved by the University's Representative.

2.06 INSTALLATION

- A. Provide a complete properly operating system for each item of equipment called for under this work. Installation shall be in accordance to equipment manufacturer's instructions, the best industry practices and the contract documents.
- B. Review Shop Drawings for work done by other trades.
- C. For the purposes of clarity and legibility the contract drawings are essentially diagrammatic. Verify all dimensions by field measurements.
- D. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work.
- E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to comply with the Codes and coordinate installation with other systems and appurtenances.
- F. Install systems, materials, and equipment to comply with approved submittal data, approved deferred submittal and coordination drawings, to greatest extent possible. Comply with arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer the conflict to the Architect and/or Engineer.
- G. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Rearrangement or relocation of electrical work that block access to mechanical duct inspection or servicing panels, valves, fire damper actuators and similar apparatus shall be done at Contractor's own expense.
- H. Access to Equipment: Locate switches, trapeze hangers, and pullboxes to provide easy access for operation, repair, and maintenance, and if concealed, provide access doors and assist with layout. Access doors shall be installed by the framer and supplied by Electrical Contractor.
- I. Conduit Systems
 - 1. Worked into complete, integrated arrangement with like elements to make work neat and appearing finished.
 - 2. Where exposed, install parallel with walls or structural elements: vertical runs plumb; horizontal runs level or parallel with structure as appropriate: groups racked together neatly with straight runs and bends both parallel and uniformly spaced.
 - 3. Install as high as practicable to maintain adequate head room shown or required. Coordinate with Work of other Divisions to achieve proper headroom. Arrange conduits to maximize space to install future raceways.

Appendix D
Additional Lighting Project Related Specifications

4. Clearance: Do not obstruct spaces required by code in front of electrical equipment, access doors, etc.
5. It shall be unacceptable to combine circuits, conduits, cables, pull boxes, or junction boxes of extra low voltage systems and low voltage systems. No combining of communications systems with power systems will be permitted, unless the combination is necessary for termination within an equipment assembly.

2.07 COORDINATION

- A. Arrange and coordinate the electrical system installation with other trades to provide inserts, chases, slots, and openings in other building components during progress of construction, to allow for electrical installations. Do any cutting and patching required due to improperly located or omitted openings with the approval of the University's Representative, who must also approve any additional changes resulting from relocation or omission of openings. Cutting or drilling in any structural member is prohibited without prior written approval of the University.
- B. Coordinate arrangement, mounting, and support of electrical equipment:
 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 3. To allow right of way priority for piping and conduit installed at required slope
 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
 5. To allow for clearance of electrical systems, equipment, and materials installations with other building components.
- C. Coordinate installation of required supporting devices, sleeves, and openings in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- D. Coordinate installing large equipment requiring positioning before closing in the building.
- E. Coordinate the exact placement of all concrete foundations or related concrete pads with concrete contractor that relate to electrical equipment.
- F. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- G. Coordinate work of this Division 26 with work of all other divisions. Conduct work in a manner to cooperate with all other trades for proper installation of all items of equipment. Consult the Drawings of all other trades or crafts to avoid conflicts with cabinets, counters, equipment, structural members and mechanical and plumbing work. In general, the architectural drawings govern but resolve conflicts with the Architect and/or Engineer prior to rough - in. Coordinate rough-in and wiring requirements for all mechanical, kitchen, and medical equipment with equipment supplier and installer. Make installation in accordance with rough-in and wiring diagrams provided for Contractors use.
- H. Verify the physical dimension of each item of electrical equipment to fit the available space. Contractor is responsible for coordinating electrical equipment space requirements with the allotted space provisions, and access for determining routes through the construction area for final installation.

Appendix D
Additional Lighting Project Related Specifications

- I. Coordinate underground work with other contractors working on the site. Perform coordination with contractors installing storm sewer, sanitary sewer, water and irrigation lines, to avoid conflicts. Common trenches may be used with other trades, providing clearances required by codes, ordinances, and project requirements are maintained.
- J. Perform tracing and identification of existing underground utilities before trenching and excavation. Make adjustments to conduit and duct bank routes and pullbox, handhole and vault locations and all electrical equipment as necessary to avoid interference and in order to complete the installation.

2.08 DRAWINGS AND COORDINATION WITH OTHER WORK

- A. Exact routing of wiring and locations of outlets, panels, etc., shall be governed by structural conditions, obstructions and existing conditions. Architect / Engineer reserves right, at no increase in price, to make any reasonable change in locations of electrical items, exposed at ceiling and/or on walls, to group them into orderly relationships and/or increase their utility. Contractor shall verify Architects / Engineer requirements in this regard prior to roughing-in.
- B. Dimensions, location of doors, partitions, and similar physical features shall be taken from architectural drawings for exact location of outlets to center with Architectural features, panels, etc., at the approximate location shown on Electrical Drawings.
- C. Verify dimensions and the correct location of equipment and coordinate with other trades for any requirement, notify University's Representative of all changes of location requirements before proceeding with the roughing-in of connection.
- D. Mounting heights of brackets, outlets, etc., shall be as required to suit equipment served.
- E. Drawings indicate, generally, routes of all branch circuits. All runs to panels are indicated as starting from nearest outlet, pointing in direction of panel. Continue all such circuits to panel as though routes were indicated in their entirety.
- F. All scaled and figured dimensions are approximate of typical equipment of the class indicated. Before proceeding with any Work, carefully check and verify all dimensions, sizes, and mounting requirements with the approved submittals and drawings to see that the equipment being installed will fit into the spaces provided.
- G. The Contractor shall be responsible for verifying that equipment being provided will fit dimensionally in locations shown on Drawings.

2.09 CONNECTIONS TO EXISTING WORK

- A. Install new work and connect to existing work with minimum interference or interruption to existing facilities and systems.
- B. Provide temporary power where indicated as being required to be provided by the Contractor during shutdowns of existing services.
- C. Schedule all outages with written consent of University. Perform this work at no additional charges and at times authorized that do not interfere with normal operation of existing facilities.
- D. Maintain continuous operation of existing facilities as required with temporary utility connections between new and existing.
- E. Do not interrupt alarm and emergency systems without consent of University. Provide temporary systems to maintain alarms and emergency systems when required for occupancy.
- F. Connect new work to existing work in neat and acceptable manner.
- G. Restore existing disturbed work to original condition including finish, enclosure integrity, maintenance, continuity of wiring, and operability as required.

Appendix D
Additional Lighting Project Related Specifications

2.10 TEMPORARY FACILITIES

- A. Provide temporary light, power, alarm, and detection services as necessary during the construction period and as required to maintain operation of existing systems and occupancy of facilities.
- B. Existing building distribution equipment, devices, circuits, and power shall not be used for construction without written permission of the University.
- C. Contractor shall provide temporary power apparatus, wiring, and outlets required for use for construction. Contractor shall provide and install temporary power meters and disconnects when connection to the University's utility source is permitted by the University. University shall be reimbursed for the direct cost of energy used by the Contractor.

2.11 NOISE CONTROL

- A. Contractor shall refer to the project documents and identify locations where operating equipment and device noise, vibration restrictions, and limits are to be complied with based on Codes, Ordinances, or University's criteria.
- B. Perform necessary sound rated wall sealing for the electrical work in compliance with project requirements.
- C. Back to back or straight through boxes in walls are not permitted unless specifically noted on the drawings.
- D. Route raceways along corridors or other noncritical noise space to minimize penetrations through sound rated walls. Seal raceway penetrations through sound rated walls.
- E. Do not install noise and vibration producing devices on walls common to occupied spaces unless specifically noted on the drawings. Where such devices must be mounted on common walls, install using shock mounted or vibration and noise isolated methods to prevent the transmission of device inherent noise and vibration to the occupied space.
- F. Ballasts, contactors, starters, transformers and like equipment which are found to be noticeably noisier than other similar equipment installed for the project will be deemed defective and shall be replaced.

2.12 EQUIPMENT

- A. Equipment Installation
 - 1. Follow manufacturer's directions and recommendations in all cases where the apparatus and devices used on this contract are provided with directions covering points not shown on the drawings or covered in these specifications.
 - 2. Provide complete electrical connections, and interconnections, for all items of equipment including incidental wiring, materials, devices and labor necessary for a finished working installation.
 - 3. Where equipment ratings differ from those shown in the project documents, the Contractor shall be responsible to provide the required changes to supply the load. Submit all changes to the University's Representative for approval prior to installation.
 - 4. Verify the location and method for connecting to each item of equipment prior to roughing-in.
 - 5. Check voltage and phase of each item of equipment before connection.
 - 6. Furnish all code required disconnects, whether or not specifically shown in the contract documents and manufacturer's literature.
- B. Equipment Support and Seismic Restraint

Appendix D
Additional Lighting Project Related Specifications

1. Install equipment seismic anchorage in compliance with the IBC and California Amendments and requirements from the local agency having jurisdiction.
2. Securely support fixtures from the building structure. Provide bracing and seismic restraints to limit motion during a seismic event.
3. Support all junction boxes, pull boxes, or other raceway terminating housings located above the suspended ceiling from the floor above, roof or penthouse floor structure to prevent sagging or swaying as shown on drawing details.
4. Securely support conduits and raceways from the building structure.
5. Minimum support capacity for all equipment devices: Not less than four times the ultimate weight of the object being supported from the building structure or anchored to the structural floor, or structural engineer's specified supports based on structural engineer's calculations and details
6. Seismic Protection Criteria: Electrical equipment installations shall be protected from earthquakes. Seismic anchorage requirements of the CBC apply to this project. Protection criteria shall be a Horizontal Force Factor as prescribed by the CBC multiplied by the equipment weight considered passing through the machinery center of gravity in any horizontal direction.
 - a. Unless vibration isolation is required to protect equipment against structure transmitted noise and/or vibration, equipment shall be protected from earthquakes by rigid structurally sound attachment to the load supporting structure. The force factor and anchorage shall be determined by calculations performed by a registered California Structural engineer whether the isolators are present or not.
 - b. Vibration isolated equipment shall be protected by protected spring isolators. Seismic snubbers and protected spring isolators shall be seismic protection rated in three principal axes by independent laboratory testing or analysis by an independent licensed structural engineer.
 - c. Construction of all electrical gear, and equipment such as switchgear, switchboard, motor control center, panelboard, transformer and similar equipment shall meet seismic requirements per the CBC and IBC.
 - d. If structural plans and details do not call out the seismic supports or has changed the method of attachment per plans then the Contractor shall be responsible for the design of his own seismic restraint systems. Contractor shall provide structural calculation and shop drawings for electrical equipment support. These drawing and calculations shall be prepared, sealed and signed by a Registered California Structural Engineer, and submitted for review and approval.
 - e. Seismic protection, labor, materials and design shall be included in the Contract bid price.

2.13 POWER AND COMMUNICATIONS SWITCHING

- A. Confine the extent of each service interruption to the smallest collection of equipment necessary to safely perform testing, tie-in and cut-over.
- B. Coordinate with University for interruption of services necessary to accomplish the Work.
- C. Coordinate with utility company and University all work associated with utility company power and communications distribution systems.
- D. Coordinate with University for interruption of services and connections to other projects on campus.

Appendix D
Additional Lighting Project Related Specifications

- E. Placing equipment in service: Electrical equipment shall not be energized or placed in service until all pre-energization tests and inspections are complete and approved by the University and

2.14 CUTTING AND PATCHING

- A. Coordinate necessary cutting and patching for the electrical work in compliance with Division 26.
- B. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- C. Neatly patch and finish any surface damaged by this work to match adjacent undisturbed surfaces; for instance, repair surfaces where raceways pass through finished floors or walls. Install new fireproofing where existing firestopping has been disturbed. Clean and remove all dirt and debris. Perform this work to the satisfaction of the University's Representative.
- D. Where equipment installations or connections require the installation of an access panel, provide a properly sized and installed access panel similar to those used for mechanical equipment access.

2.15 PROTECTION OF WORK

- A. Protect all electrical work and equipment against damage by other trades, weather conditions or any other causes. Equipment found damaged or in other than new condition will be rejected as defective.
- B. Keep all electrical equipment covered or closed to exclude dust, dirt and splashes of plaster, cement or paint and shall be free of all such contamination before acceptance. Keep enclosures and trims in new condition, free of rust, scratches and other finish defects. If damaged, properly refinish in a manner acceptable to the University's Representative.
- C. Provide a temporary source of power to energize circuits, such as heaters and battery systems that are required to protect the equipment from damage or other deteriorating agents.

PART 3 - EXECUTION

3.01 EQUIPMENT IDENTIFICATION AND LABELING

- A. Refer to Section 26 0553 - Identification for Electrical Systems for identification requirements, including Arc Flash Hazard Labels.

3.02 CLEANING AND PAINTING

- A. Clean interior and exterior surfaces of equipment and raceways of all dirt, cement, plaster, and other debris. Protect interior of equipment from dirt during construction and clean thoroughly before energizing.
- B. Clean out cracks, corners and surfaces on equipment to be painted, remove grease and oil spots so that paint may be applied without further preparation. Include surface preparations, priming, and finish coating for electrical cabinets, exposed conduit, pull and junction boxes.
- C. Refinish and touch up paint:
 - 1. Clean damaged and disturbed surface areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 - 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
 - 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer. Paint color to match existing color.

Appendix D
Additional Lighting Project Related Specifications

- 4. Repair damage to PVC surfaces or paint finishes with matching touchup coating recommended by manufacturer.
- D. Refinish or replace Work supplied with final finish equivalent to new condition if damaged to satisfaction of University's Representative.
- E. After other Work is accomplished, thoroughly clean exposed conduit, panels (interiors and exteriors), fixtures, and equipment and leave in satisfactory condition, free of debris, dirt, dust, and other contaminants.

3.03 FIELD QUALITY CONTROL

- A. After installation inspect installed components for damage and faulty work, including the following, but not limited to:
 - 1. Electrical component supporting devices.
 - 2. Electrical equipment components.
 - 3. Raceways
- B. Correct all items identified as a result of inspections and observations during construction in a timely manner.
- C. Correct all items identified in the University's final inspection lists prior to energization and final acceptance of the Work.

3.04 COMMISSIONING

- A. See to Section 26 0801, Commissioning of Electrical Systems, for system commissioning requirements.
- B. The Electrical Contractor is responsible to provide assistance to the Commissioning Agent throughout the entire commissioning process to ensure that all systems are operating in a manner consistent with the Design Intent. The work is not complete until the Commissioning Agent and the University's Representative have signed off on the commissioned systems.
- C. The Contractor shall provide all labor and required tools requested by the Commissioning Agent to complete the system commissioning work. Provide and schedule equipment Factory Representative for this work when needed.
- D. Work for Contractor noted in Section 26 0801, Commissioning of Electrical Systems, along with support shall be included in the Contract bid price.
- E. Commissioning Agent shall be responsible to prepare and submit the final commissioning report.

3.05 TRAINING

- A. Upon completion and energization of each system provide training program and instructions to the University's personnel for each system that is installed as part of the Work. Refer to individual specification sections for additional requirements.
- B. All training shall be videotaped and delivered to University's Representative in DVD format unless otherwise noted.
- C. Coordinate the training schedule with University's Representative.
- D. Equipment Operation & Maintenance (O&M) manuals shall be provided at least 2 weeks prior to the scheduled personnel training.
- E. Contractors bid shall include the total cost for trainer's site visits and include all shipping, travel, lodging, per diem and local transportation.

Appendix D
Additional Lighting Project Related Specifications

3.06 RECORD DRAWINGS AND CLOSEOUT DOCUMENTATION

- A. Maintain up to date record set of electrical prints on a daily basis during the course of construction, including deferred submittal drawings. Use green to indicate deletions and red to indicate additions. Use same symbols and follow as much as possible the same drafting procedures used on Contract Drawings. The prints are subject to weekly review by the University's Representative to ascertain that they are current. The IOR shall review the as-built drawings prior to approval of Contract progress payments. In addition to the requirements specified in Division 01, final electronic AutoCAD files for Record Drawings shall indicate at least the following:
1. Changes to raceway systems, size and location, for both exterior and interior; changes to locations of control devices; busways; distribution, changes in wire sizes, circuit designations of branch circuitry; fuse and circuit breaker size and arrangements. Changes to control, schedules, and one line drawings and details.
 2. Changes on equipment locations (exposed and concealed), dimensioned from prominent building lines.
 3. Approved substitutions, Contract Modifications, and actual equipment and materials installed shall be shown on the plans. Reference to RFI responses and directives alone is not acceptable.
 4. All field changes shown on field markup drawings.
- B. Prepare closeout record documents in accordance with the requirements of this section and Division 01 Section Closeout and Procedures and Project Record Documents.
- C. Provide PDF files for review of record and deferred submittal drawings by the University's Representative, Engineer, and Architect. Contractor shall make revisions and corrections as noted to the Record Documents review.
- D. After approval of record drawings, provide two full-size, hardcopy sets of As-Built Record Drawings and (2) CDs of identical electronic unlocked with all reference files in AutoCAD (.dwg) or Revit files with PDFs of As-Built drawing files and As-Built drawings of the deferred submittals. Confirm with University's Representative version of AutoCAD or Revit software. Each drawing sheet shall be a separate file with sheet name.
- E. Provide special tools and/or spare parts as required by Division 26 specifications. Provide written proof of delivery submittal for approval.
- F. Create a Project Closeout Document Reference Index for review.
- G. Coordinate the requirements of all sections of Division 26 and the associated electrical drawings for the closeout requirements. Prepare electronic files in PDF format for the list of items below, but not limited to. Follow file format described in submittals, above. Arrange all electronic Product Data Sheets on Record Document CDs by component type, as listed on the approved Project Closeout Document Reference Index. Document Reference Index shall be grouped into the Closeout Document Folder under the division identified in the Project Checklist.
1. All approved submittals for all equipment and deferred submittal equipment, items and products installed in the Project compiled as one.
 2. Equipment and deferred submittal equipment System Block Diagrams, Point-to-Point Wiring Diagrams, and Terminal Identification.
 3. Equipment Installation manual, maintenance manual, parts lists, operation manual, programming manuals, as-built data sheets, and manufacturers test reports.
 - a. The O&M manual shall include the following information for equipment as minimum:

Appendix D
Additional Lighting Project Related Specifications

- 1) Manufacturers' names and addresses.
 - 2) Product catalogs, exploded views and brochures, complete with technical and performance data for all equipment, marked to indicate actual items furnished and intended use and incorporating all amendments made.
 - 3) As-built wiring diagrams, including single-line and three-line wiring diagrams.
 - 4) As-built programming and sequence of operations for programmable equipment.
 - 5) Provide 3 hard bound copies when required by the University.
 - 6) Provide PDF copies in the closeout documentation.
4. Provide all documentation required from the manufacturer to honor the equipment and material warranty.
 5. Provide manufacturer's written warranty.
 6. Include a copy of all project RFI logs with dates and the listings of issues and resolutions.
 7. Include all Submittal logs with dates and final approval documentation.
 8. Provide a letter signed by the Contractor that states that the completed electrical installation of electrical equipment, raceway, cables, is warranted for a period of 1 year from the University's accepted of Notice of Completion.
 9. Provide a list of all special tools and spare parts that have been delivered to the University with the University's Representative signature.
- H. After review of closeout documents by the University's Representative, Engineer, and Architect, Contractor shall make additions, revisions, and corrections as noted to these documents and provide updated sets. Each PDF shall have a separate PDF file for its own component and not one PDF for all items.

END OF SECTION

SECTION 26 0501 – MINOR ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Electrical demolition.
- B. Materials.
- C. Implementation Requirements

1.02 RELATED REQUIREMENTS

- A. Polychlorinate Biphenyl (PCB) Remediation: Removal of equipment and materials containing substances regulated under the Federal Toxic Substances Control Act (TSCA), including but not limited to those containing PCBs and mercury.

1.03 SUBMITTALS

- A. Sustainable Design Documentation: Submit certification or removal and appropriate disposal of abandoned cables containing lead stabilizers.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as shown on Drawings.
- B. Demolition drawings are based on casual field observation and existing record documents.
- C. Report discrepancies to University and/or Architect before disturbing existing installation.
- D. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

- A. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
 - 1. PEC- and DEHP-containing lighting ballasts.

Appendix D
Additional Lighting Project Related Specifications

2. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.
- D. Remove exposed abandoned conduit.
- E. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- F. Repair adjacent construction and finishes damaged during demolition and extension work. Seal all holes, patch all indentations and spalled areas, paint and texture surface to match existing.
- G. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- H. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR

- A. Comply with provisions of Section 26 0500.
- B. Clean and repair existing materials and equipment that remain or that are to be reused.

END OF SECTION

SECTION 26 0519 – LOW-VOLTAGE ELECTRIC POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Single conductor building wire.
- B. Wiring connectors.
- C. Electrical tape.
- D. Wire pulling lubricant.
- E. Cable ties.

1.02 RELATED REQUIREMENTS

- A. Section 26 0501 - Minor Electrical Demolition: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems
- C. Section 26 0553 - Identification for Electrical Systems

1.03 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).
- D. FS A-A-59544 – Cable and Wire, Electrical (Power, Fixed Installation), Federal Specification.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- F. NETA ATS – Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- G. CEC - California Electric Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.
- H. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- I. UL 183 – Manufactured Wiring Systems; Current Edition, Including All Revisions.
- J. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- K. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- L. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- M. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables; Current Edition, Including All Revisions.
- N. UL 719 – Nonmetallic-Sheathed Cables; Current Edition, Including All Revisions.

Appendix D
Additional Lighting Project Related Specifications

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate the installation of direct burial cable with other trades to avoid conflicts with piping or other potential conflicts.
 - 3. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- B. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring, gutters, enclosures, etc. to accommodate substituted conductors.
- C. Manufacturer's Installation Instructions: Indicated application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of CEC.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum seven years' documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by CEC and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of CEC.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.

Appendix D
Additional Lighting Project Related Specifications

- C. Provide new conductors and cables manufactured not more than one year prior to installation.
- D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- E. Comply with NEMA WC 70.
- F. Comply with FS A-A-59544 where applicable.
- G. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- H. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- I. Conductors for Grounding and Bonding: Also comply with Section 26 0526.
- J. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
- K. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
 - 2. Control Circuits: 18 AWG.
- L. Where conductor size is not indicated, size to comply with CEC but not less than applicable minimum size requirements specified.
- M. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - 3. Color Code:
 - a. 480Y/277V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.

Appendix D
Additional Lighting Project Related Specifications

- b. 208Y/120V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
- c. Equipment Ground, All Systems: Green.
- d. For modifications or additions to existing wiring system, comply with existing color code when existing color complies with CEC and is approved by the authority having jurisdiction.
- e. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 - 1. Copper Building Wire:
 - a. Cerro Wire LLC
 - b. Encore Wire Corporation
 - c. Southwire Company
 - d. Rome
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
 - 2. Control Circuits: Stranded
- D. Insulation Voltage Rating: 600V.
- E. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2 , except as indicated below.
 - a. Size 4 AWG and Larger: Type XHHW-2.
 - b. Installed Underground: Type XHHW-2.
 - c. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

2.04 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 0526.

Appendix D
Additional Lighting Project Related Specifications

- C. Wiring Connectors for Splices and Taps
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- D. Wiring Connectors for Terminations
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 - 4. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
 - 5. Conductors for Control Circuits: Use crimped terminals with closed loop ends for all connections.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F (105 degrees C) for standard applications and 302 degrees F (150 degrees C) for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
 - 1. Manufacturers
 - a. 3M
 - b. Ideal Industries, Inc.
 - c. NSI Industries LLC
 - d. Wago Wall-Nuts.
- H. Mechanical Connectors: Provide bolted type or set-screw type.
 - 1. Manufacturers
 - a. Burndy LLC
 - b. Ilsco
 - c. Thomas & Betts Corporation
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
 - 1. Manufacturers
 - a. Burndy LLC
 - b. Ilsco
 - c. Thomas & Betts Corporation

Appendix D
Additional Lighting Project Related Specifications

- J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal with closed loop end or other configuration where required by terminal.
1. Manufacturers:
 - a. Burndy LLC
 - b. Ilsco
 - c. Thomas & Betts Corporation

2.05 WIRING ACCESSORIES

- A. Electrical Tape:
1. Manufacturers:
 - a. 3M
 - b. Plymouth Rubber Europa
 2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
 3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
 - a. Product: 3M Scotch #33 Plus.
 4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
 5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil (3.2 mm); suitable for continuous temperature environment up to 176 degrees F (80 degrees C).
 6. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
 7. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
1. Manufacturers
 - a. 3M
 - b. American Polywater Corporation
 - c. Ideal Industries, Inc.
- C. Cable Ties: Material and tensile strength rating suitable for application.

Appendix D
Additional Lighting Project Related Specifications

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage wire and cable has been completed.
- B. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with CEC.
- C. Verify that field measurements are as shown on the drawings.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic. Dimensions are to be verified by contractor prior to submitting a bid, and prior to purchase and installation. Where dimensions are provided in the plans, they are for reference only.
 - 2. When circuit destination is indicated and routing is not shown, determine exact routing required.
 - 3. Arrange circuiting to minimize splices.
 - 4. Include circuit lengths required to install connected devices within 10 ft of location shown.
 - 5. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is permitted, under the following conditions:
 - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - b. Increase size of conductors as required to account for ampacity derating.
 - 6. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install products in accordance with manufacturer's instructions.
- C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.
- D. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.

Appendix D
Additional Lighting Project Related Specifications

4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- E. Secure and support conductors and cables in accordance with CEC using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- F. Install conductors with a minimum of 12 inches (300 mm) of slack at each outlet.
- G. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- H. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with CEC.
- I. Make wiring connections using specified wiring connectors.
 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 3. Do not remove conductor strands to facilitate insertion into connector.
 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- J. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrinking tube.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations, but apply outer covering of moisture sealing electrical tape.
 3. Wet Locations: Use heat shrink tubing.
- K. Insulate ends of spare conductors using vinyl insulating electrical tape.
- L. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

Appendix D
Additional Lighting Project Related Specifications

- M. Identify conductors and cables in accordance with Section 26 0553.
- N. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
 - 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- C. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 26 0526 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.

1.02 RELATED REQUIREMENTS

- A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
- B. IEEE Standard 80 - Guide for Safety in AC Substation Grounding.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
- E. CEC – California Electric Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.
- F. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Comply with Section 26 0500 for additional submittal requirements and procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components, listing all physical and electrical characteristics and ratings. Indicate NRTL listing and labeling compliance to listed standards. Clearly mark on each data sheet the specific item(s) being submitted and the proposed application.
- C. Shop Drawings
 - 1. Include locations of items to be bonded and methods of connection.
- D. Manufacturer's installation Instructions.
- E. Project Record Documents: Record actual locations of grounding electrode system components and connections. The location of each ground rod, ground rod assembly, and other grounding electrodes shall be identified and record of ground resistance tests.
- F. Measured resistance values shall be submitted for review.

Appendix D
Additional Lighting Project Related Specifications

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
 - 3. Notify University's Representative of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Sequencing
 - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of CEC.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum seven years documented experience.
- C. Product is listed and classified by Underwriters Laboratories Inc. or approved nationally recognized testing laboratory as suitable for the purpose specified and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do Not use products for applications other than as permitted by CEC and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with CEC but not less than applicable minimum size requirements specified.
- E. Ground conductors shall have green insulation. Where continuous color-coded conductors are not commercially available, provide a minimum 2-inch green color tape band in direction of cable path, non-aging, plastic tape in accordance with CEC. Color band to be within 2 inches of the cable connector or termination.
- F. Bonding Pigtails: Insulated copper conductor, identified green, sized per code, and provided with termination screw or lug. Provide solid conductors for #10 AWG or smaller and stranded conductors for #8 AWG or larger.

Appendix D
Additional Lighting Project Related Specifications

- G. Grounding System Resistance
 - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by University's Representative. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 - 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements
 - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 2. Provide products listed and labeled as complying with UL 467 where applicable.
 - 3. Green THW/THWN insulated copper wire where commercially available.
- B. Conductors for Grounding and Bonding, in Addition to other Requirements of this spec:
 - 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use 4/0 bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
 - 2. Factory Pre-Fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equivalent gage of specified conductors.
- C. Connectors for Grounding and Bonding
 - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 - 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 - a. Exceptions: Use mechanical connectors for connections to electrodes at ground access wells.
 - 3. Unless otherwise indicated, use 2-hole lug compression connectors, or exothermic welded connections for accessible connections.
 - a. Exceptions: Use exothermic welded connections for connections to metal building frame if permitted to do so on structural drawings. Use steel tap or hole that was factory provided otherwise use structural grounding clamp without drilling into the steel.
 - 4. Manufacturers - Mechanical and Compression Connectors
 - a. Advanced Lightning Technology (ALT).
 - b. Burndy LLC.
 - c. Harger Lightning & Grounding.
 - d. Thomas & Betts Corporation.
 - e. OZ/Gedney.

Appendix D
Additional Lighting Project Related Specifications

5. Manufacturers - Exothermic Welded Connections
 - a. Burndy LLC.
 - b. Cadweld, a brand of Erico International Corporation.
 - c. ThermOweld, a brand of Continental Industries, Inc.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as shown on the drawings.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1 and CEC.
- C. Make grounding and bonding connections using specified connectors.
 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- D. Identify grounding and bonding system components in accordance with Section 26 0553 Identification for Electrical Systems.

3.03 FIELD QUALITY CONTROL

- A. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
- B. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION

SECTION 26 0529 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

- A. Section 26 0534 - Conduit.
- B. Section 26 0537 - Boxes.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- F. CEC - California Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. Comply with Section 26 0500 for additional submittal requirements and procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-metallic cable racking systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

Appendix D
Additional Lighting Project Related Specifications

1.06 QUALITY ASSURANCE

- A. Comply with CEC.
- B. Comply with CBC.

PART 2 - PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Do not use products for applications other than as permitted by CEC and product listing.
 - 4. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Comply with MFMA-4.
 - 2. All strut framing systems installed outdoors shall be hot-dipped galvanized steel. All fasteners shall be galvanized steel suitable for the hot dipped galvanized steel materials.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
- F. Rack Supports in Manholes
 - 1. Install nonmetallic cable racking system with stanchion and arms.
 - 2. Cable rack shall be constructed of nonmetallic UL Listed Glass Reinforced Polymer.
- G. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

Appendix D
Additional Lighting Project Related Specifications

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Use nonmetallic UL Listed glass reinforced polymer stanchions and racking arms for cable racking within manholes.
 - 5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A. Inspect support and attachment components for damage and defects.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 0534 - CONDUIT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Flexible Metal Conduit (FMC).
- C. Electrical metallic tubing (EMT)
- D. Conduit fittings.
- E. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 26 0500 – Common Work Results for Electrical.
- C. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- D. Section 26 0529 - Hangers and Supports for Electrical Systems.
- E. Section 26 0537 – Boxes.
- F. Section 26 0553 – Identification for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).
- B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT).
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association.
- D. NECA 101 - Standard for Installing Steel Conduits (Rigid, EMT); National Electrical Contractors Association.
- E. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association; 2012 (ANSI/NEMA FB 1).
- F. CEC – California Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.
- G. UL 2 – Flexible Metal Conduit; Current Edition, Including All Revisions.
- H. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- I. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- J. UL 797 – Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- K. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.
- L. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

Appendix D
Additional Lighting Project Related Specifications

1.04 SUBMITTALS

- A. Comply with Section 26 0500 for additional submittal requirements and procedures.
- B. Product Data: Provide for each type and size of conduit, liquid tight flexible, conduit bodies, fittings, showing characteristics and dimensions.
- C. Shop drawings of any fire rated assembly and roof penetrations: provide proposed locations of penetrations and methods for sealing.
- D. Cable pulling tension calculations:
 - 1. Submit cable pulling tension calculations as indicated on the drawings.
 - 2. Submit cable pulling tension calculations for all cables rated above 600 volts.
- E. Structural Engineers stamped and approved drawings for conduits not attached to building walls, not using C-clamps to building I beams and/or trapeze as noted this specification.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination
 - 1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop, and as required by code.
 - 2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment that is installed for this project or is existing and to be interconnected for this project.
 - 4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
 - 5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Sequencing
 - 1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points, and cable pulling tension calculations are approved.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of CEC.
- B. Product is listed and classified by Underwriters Laboratories Inc. or approved nationally recognized testing laboratory as suitable for the purpose specified and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- C. Inspect for damage and replace as needed.
- D. Protect conduit that is not sunlight and ultra-violet resistant from sunlight.

Appendix D
Additional Lighting Project Related Specifications

PART 2 - PRODUCTS

2.01 CONDUIT APPLICATIONS

- A. Conduit and associated fittings shall only be used for applications as permitted by CEC and product listing.
- B. The minimum size of conduit shall be ¾ inch unless otherwise specified.
- C. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- D. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit (RMC) or electrical metallic tubing (EMT).
- E. Exposed, Interior, Not Subject to Physical Damage:
 - 1. Use galvanized steel rigid metal conduit (RMC) or electrical metallic tubing (EMT).
 - 2. Locations Not subject to Physical Damage shall include electrical rooms, control rooms, data / telephone rooms, and offices, and protected locations in Processing plant rooms, industrial process, and utilization equipment where conduits are 9 feet above finished grade.
- F. Exposed, Interior, Subject to Physical Damage:
 - 1. Use galvanized steel rigid metal conduit (RMC).
- G. Exposed, Exterior, outdoor areas: Use galvanized steel rigid metal conduit (RMC) or PVC-coated galvanized steel rigid metal (P-RMC).
- H. Connections to Luminaries above Accessible Ceilings: Use flexible metal conduit (FMC).

2.02 CONDUIT APPLICATIONS

- A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from damage and corrosion, and integrity and interior shape is verified by pulling a mandrel through them.
- B. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Exceptions to the minimum conduit size of ¾ inch is ½ inch for flex connections to lighting fixtures or as noted on drawings.
- E. Where conduit size is not indicated, size to comply with CEC but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: CEC, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- B. Fittings
 - 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.

Appendix D
Additional Lighting Project Related Specifications

3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.04 ELECTRICAL METALLIC TUBING (EMT)

- A. Description: CEC, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- B. Fittings:
 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.
 3. Connectors and Couplings: Use compression (gland).
 - a. Do not use indenter type or set-screw connectors or couplings.

2.05 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
- C. Provide continuous-fiber polyline/nylon cord in spare conduits with average breaking strength of not less than 200 pound-force.

PART 3- EXECUTION

3.01 EXAMINATION

- A. Verify that field dimensions and measurements are as shown on drawings.
- B. Verify scale and dimensions when provided.
- C. Verify routing and termination locations of conduit prior to rough-in.
- D. Verify that mounting surfaces are ready to receive conduits.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Use suitable caps to protect installed conduits against entrance of dirt and moisture. Install caps on end of all stubbed out underground conduits.
- E. Conduit Routing
 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 2. When conduit destination is indicated and routing is not shown, determine exact routing required.
 3. Unless otherwise approved, do not route conduits exposed:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.

Appendix D
Additional Lighting Project Related Specifications

d. across building exterior surfaces.

4. Arrange conduit to maintain adequate headroom, clearances, and access.
5. Combining conduit runs of conduit homeruns for any different systems from those shown on the drawings is not acceptable.
6. It shall be unacceptable to combine circuits, conduits, cables, pull boxes, or junction boxes of extra low voltage systems and low voltage systems. No combining of communications systems with power systems will be permitted, unless the combination is necessary for termination within an equipment assembly.
7. Arrange conduit to provide no more than the equivalent of three 90 degree bends between pull points.
8. Arrange conduit to provide no more than 150 feet between pull points.
9. Route conduits above water and drain piping inside of buildings where possible.
10. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
11. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
12. Maintain minimum clearance of 12 inches between conduits and hot surfaces exceeding 104 degrees F.
13. Group parallel conduits in the same area together on a common rack.
14. Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations.

F. Conduit Support

1. Secure and support conduits in accordance with CEC and Section 26 0529 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent supports that are attached to the building structure. Do not provide support from piping, ductwork, ceiling grid, or other systems.
3. Use conduit strap to support single surface-mounted conduit.
4. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
5. Use conduit clamp to support single conduit from beam clamp.
6. Use of wire for support of conduits is not permitted. Remove temporary supports.
7. The use of trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits require the submittal of structural drawings stamped and approved.
8. Provide structural drawings and details stamped and approved for all conduits that are not supported from walls or not supported from building I beams using beam C-clamps.
9. Non-metal conduit couplings and expansion joints shall be located no closer than 12-inches from support hangers.

G. Connections and Terminations

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.

Appendix D
Additional Lighting Project Related Specifications

3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Where spare conduits stub up thru floors and not terminated in a box or enclosure, provide threaded couplings equipped with threaded plugs set flush with finished floor, unless otherwise noted.
7. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
8. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
9. Provide bell end bushings for conduit entries into underground manholes, pullboxes, and terminating inside equipment from underground.

H. Penetrations

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Seal around penetration with acoustical material to maintain the integrity of acoustical rating where occurs.
5. Pack space between conduit, sleeve in rated walls with non-combustible materials. Install fire marshal approved firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

I. Conduit Movement Provisions

1. Where conduits are subject to flexure from seismic earth movement, provide (expansion/contraction, angular misalignment, and parallel deflection) fittings and/or flexible conduit assembly consisting of a combination of approved fittings and conduit to prevent damage to enclosed conductors, conduits, or connected equipment. Approved assembly shall meet total movement requirements provided by the structural engineer or as indicated on the drawings. The locations include, but is not limited to:
 - a. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 - b. Where conduits are subject to seismic earth movement.
2. Where conduits are subject to thermal movement, provide (expansion/ contraction, angular misalignment, and parallel deflection) fittings and/or flexible conduit assembly consisting of a combination of approved fittings and conduit to prevent damage to enclosed conductors, conduits, or connected equipment. The locations include, but not limited to:
 - a. Where conduits are outside and straight runs longer than 150 feet.
 - b. Where shown or noted on the drawings.

Appendix D
Additional Lighting Project Related Specifications

- c. As required by the conduit manufacturer.
- J. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
 - 1. Where conduits of a long run of 100 feet or more outside pass from outdoors into conditioned interior spaces. Sealing fitting also with drain.
 - 2. Where conduits of a long run of 200 feet or more outside and then go down and pass into a building or underground. Sealing fitting also with drain.
 - 3. Where conduits penetrate coolers or freezers.
- K. Provide pull string in all empty conduits and in conduits where conductors are to be installed by others. Leave minimum slack of 18 inches at each end. Add tag at each end identifying opposite end location.
- L. Provide grounding and bonding in accordance with Section 26 0526.
- M. Identify conduits in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

- A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by the manufacture. Replace components that exhibit signs of corrosion.
- B. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter prior to conductor installation.

END OF SECTION

SECTION 26 0537 – BOXES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.

1.02 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0534 - Conduit
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- D. Section 26 0553 - Identification for Electrical Systems.
- E. Section 26 2726 – Wiring Devices.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- D. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- E. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
- F. CEC – California Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.
- G. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.
- H. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Comply with Section 26 0500 for additional submittal requirements and procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
 - 1. Underground Boxes/Enclosures: Include reports for load testing in accordance with SCTE 77 certified by a professional engineer or an independent testing agency upon request.
- C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.

Appendix D
Additional Lighting Project Related Specifications

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by CEC.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to CEC.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to CEC.
5. Coordinate the work with other trades to provide wall space suitable for installation of flush-mounted boxes and concealed conduits where indicated.
6. Notify University's Representative of any conflicts with, or deviations from, the contract documents. Obtain direction before proceeding with work.

1.06 QUALITY ASSURANCE

A. Conform to requirements of CEC.

- B. Assure product is listed and classified by Underwriters Laboratories Inc. or approved nationally recognized testing laboratory as suitable for the purpose specified and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 BOXES

A. General Requirements

1. Do not use boxes and associated accessories for applications other than as permitted by CEC and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with CEC but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
6. Assure grounding system continuity as required by CEC and install all required bonding fittings and conductors.

Appendix D
Additional Lighting Project Related Specifications

- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use cast iron boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
 4. Use raised covers suitable for the type of wall construction and device configuration where required.
 5. Use shallow boxes where required by the type of wall construction.
 6. Do not use "through-wall" boxes designed for access from both sides of wall.
 7. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 8. Nonmetallic Boxes: Comply with NEMA OS 2, and list and label as complying with UL 514C.
 9. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 10. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices: 4-inch square by 2-1/8 inch deep (100 by 38 mm) trade size.
 - b. Ceiling Outlets: 4-inch octagonal or square by 2-1/8 inch deep (100 by 38 mm) trade size.
 11. Wall Plates: Comply with Section 26 2726, Wiring Devices.
 12. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation.
 - b. Hubbell Incorporated; Bell Products.
 - c. Hubbell Incorporated; RACO Products.
 - d. O-Z/Gedney, a brand of Emerson Industrial Automation.
 - e. Thomas & Betts Corporation.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions and measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

Appendix D
Additional Lighting Project Related Specifications

- B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and CEC.
- D. Provide separate boxes for emergency power, low-voltage communication and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for extra low voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- H. Box Locations
 - 1. Locate boxes to be accessible after all conduit and equipment are installed.
 - 2. Unless dimensioned, box locations indicated are approximate.
 - 3. Locate boxes as required for devices installed under other sections or by others.
 - a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 2726, Wiring Devices.
 - 4. Locate boxes so that wall plates do not span different building finishes.
 - 5. Locate boxes so that wall plates do not cross masonry joints.
 - 6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 - 7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 - 8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
 - 9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual non-communicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
 - 10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0534, Conduit.
 - 11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the University's Representative:
 - a. Concealed above accessible suspended ceilings.
 - b. Electrical rooms.
 - c. Mechanical equipment rooms.

Appendix D
Additional Lighting Project Related Specifications

- I. Box Supports:
 - 1. Secure and support boxes in accordance with CEC and Section 26 0529, Hangers and Supports for Electrical Systems, using suitable supports and methods in accordance with structural engineer's details. Where no structural details are provided, the contractor shall provide and submit structural details for review and approval by the authority having jurisdiction.
 - 2. Do not provide support from piping, ductwork, or other systems.
 - 3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
 - 4. Use far-side support to secure flush-mounted device boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.
- J. Install boxes plumb and level.
- K. Flush-Mounted Boxes:
 - 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch (6mm) or does not project beyond finished surface.
 - 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 - 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch (3mm) at the edge of the box.
- L. Install boxes as required to preserve insulation integrity.
- M. Close unused box openings.
- N. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- O. Provide grounding and bonding in accordance with Section 26 0526, Grounding and bonding for Electrical Systems.
- P. Identify boxes in accordance with Section 26 0553, Identification for Electrical Systems.

3.03 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material prior to installation of conductors.

3.04 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 0553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.

1.02 RELATED REQUIREMENTS

- A. Section 26 0519 – Low-Voltage Electrical Power Conductors and Cable.
- B. Section 26 0534 – Conduit.
- C. Section 26 0537 – Boxes.

1.03 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.
- C. CEC – California Electrical Code; Most Recent Addition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.
- D. NFPA 70E – Standard for Electrical Safety in the Workplace.
- E. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Comply with Section 26 0500 for additional submittal requirements and procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Shop Drawings: Provide nameplate and label schedule in Microsoft Excel that includes all information, including proposed designations, materials, legends, and formats for each label or nameplate required to be installed for power and communications equipment and cables. The Microsoft Excel spreadsheet shall be submitted and approved prior to fabrication and installation.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of CEC, UL, and OSHA requirements for equipment labeling and hazard warning identification.
- B. Labels and nameplates shall be the colors designated in this spec unless otherwise noted.

1.06 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.
- B. Do not install identification products until final surface finishes and painting are completed.
- C. Nameplates and labels shall be installed so they are readily visible and legible.

Appendix D
Additional Lighting Project Related Specifications

PART 2 - PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Nameplates and labels shall confirm to the drawings and University's electrical equipment and cable numbering schemes.
- B. Identification for Equipment
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchgear, Switchboards, Motor Control Centers, and Power Distribution Panelboards
 - 1) Use identification nameplate to identify the name of the power equipment.
 - 2) Identify power source and circuit number. Where applicable include location when not within sight of equipment.
 - 3) Use identification nameplate to identify main and tie devices.
 - 4) Use identification nameplate to identify load(s) served for each feeder and branch device. Identify spares. Do not identify spaces.
 - b. Lighting and Appliance Panelboards
 - 1) Use identification nameplate to identify the name of the panelboard.
 - 2) Identify power source and circuit number. Where applicable include location when not within sight of equipment.
 - 3) Identify main overcurrent protective device.
 - 4) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 5) For panelboards without a door, use identification nameplate to identify load(s) served for each branch device and spares. Do not identify spaces.
 - c. Enclosed Switches, Enclosed Circuit Breakers, and Motor Controllers
 - 1) Use identification nameplate to identify the name of the switch, breaker, or controller.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Use identification nameplate to identify load(s) served including location when not within sight of equipment.
- C. Identification for Conductors and Cables
 - 1. Color Coding for Power Conductors 600V and Less: Comply with Section 26 0519, Low-Voltage Electrical Power Conductors Cables.
 - 2. Use wire and cable markers to identify circuit number and source panel number or other designation indicating control and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection. Branch circuit number is not required in the source panel.

Appendix D
Additional Lighting Project Related Specifications

- b. Within boxes with splices.
- 3. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
- 4. Use underground warning tape to identify direct buried cables.
- D. Identification for Raceways
 - 1. Use voltage warning label to identify accessible conduits and raceways with voltages over 600 volts at maximum intervals of 20 feet.
 - 2. Use handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
- E. Identification for Devices
 - 1. Use identification label or engraved wall plate to identify serving branch circuit and source panel for all receptacles. Provide identification on inside surface of wall plate for all receptacles in general public areas or in areas as directed by University Representative.
 - 2. Use identification label or engraved wall plate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.

2.02 WIRE AND CABLE MARKERS

- A. Manufacturers
 - 1. Brady Corporation
 - 2. Thomas & Betts
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean surface to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Branch Devices: On device cover plate or adjacent to device.

Appendix D
Additional Lighting Project Related Specifications

- 2. Interior Components: Legible from the point of access.
- 3. Conductors and Cables: Legible from the point of access.
- C. Install nameplates and identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates and identification plates to surfaces of enclosures using silicone adhesive or stainless steel screws or rivets. The use of double sided tape is unacceptable.
- E. Install Identification Labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

- A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.
- B. Replace any nameplates or labels that do not match the University's identification scheme, or project documents.

END OF SECTION

SECTION 26 2726 – WIRING DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Wall plates.
- B. Implementation requirements

1.02 RELATED REQUIREMENTS

- A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0537 - Boxes.
- D. Section 26 0553 - Identification for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- D. NEMA WD 1 - General Color Requirements for Wiring Devices.
- E. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- F. CEC – California Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements, as based on NFPA 70.
- G. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Comply with Section 26 0500 for additional submittal requirements and procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of CEC.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.06 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

Appendix D
Additional Lighting Project Related Specifications

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Materials and equipment for patching and extending work: As specified in individual sections.
- B. Hubbell Incorporated
- C. Leviton Manufacturing Company, Inc.
- D. Lutron Electronics Company, Inc.
- E. Pass & Seymour, a brand of Legrand North America, Inc.
- F. Source Limitations: Where possible, provide products for each type of wiring device produced by a single manufacturer and obtained from a single supplier.
- G. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.

2.02 WALL PLATES

- A. Manufacturers
 - 1. Hubbell Incorporated
 - 2. Leviton Manufacturing Company, Inc.
 - 3. Lutron Electronics Company, Inc.
 - 4. Pass & Seymour, a brand of Legrand North America, Inc.
 - 5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B. Wall Plates: Comply with UL 514D.
 - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 - 2. Screws: Metal with slotted heads finished to match wall plate finish.
 - 3. Provide screwless wallplates with concealed mounting hardware where indicated.
- C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.
- D. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- E. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.
- F. Premarked Wall Plates: Factory labeled as indicated; hot stamped for nylon wall plates and engraved for metal wall plates.
- G. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
- H. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

Appendix D
Additional Lighting Project Related Specifications

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with CEC.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0537 as required for installation of wiring devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switches: 42 inches above finished floor.
 - 2. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.
- I. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- J. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.
- K. Install wiring devices plumb and level with mounting yoke held rigidly in place.

Appendix D
Additional Lighting Project Related Specifications

- L. Install wall switches with OFF position down.
- M. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- N. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- O. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- P. Identify wiring devices in accordance with Section 26 0553.

3.04 FIELD QUALITY CONTROL

- A. Inspect each wiring device for damage and defects.
- B. Operate each wall switch with circuit energized to verify proper operation.
- C. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.05 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.06 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

APPENDIX E

CSU BUILDING SPACE TYPES

Lighting Power Allowance Updates from 2016 to 2019
For the Complete Building Method

Type of Building	Lighting Power Allowance (W/ft ²)	
	2019	Δ
Assembly	0.7	↓0.7
Gymnasium	0.65	New
Library	0.7	↓0.5
Healthcare	0.9	New
Office	0.65	↓0.15
Parking Garage	0.13	↓0.07
Restaurant	0.7	↓0.4
Retail Store	0.9	New
Classroom	0.65	↓0.3
Sports Arena	0.75	New
Theater	0.7	↓0.6
Performing Arts Theater	0.8	↓0.5
All Other Buildings	0.4	↓0.1