UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
****

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 51 00

INTERIOR LIGHTING

05/20, CHG 2: 11/21

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 DEFINITIONS
1.4 SUBMITTALS
1.5 QUALITY ASSURANCE
1.5.1 Luminaire Drawings
1.5.2 Luminaire Design Data
1.5.3 ANSI/IES LM-79 Test Report
1.5.4 ANSI/IES LM-80 Test Report
1.5.5 ANSI/IES TM-21 Test Report
1.5.6 ANSI/IES TM-30 Test Report
1.5.7 LED Driver and Dimming Switch Compatibility Certificate
1.5.8 Photometric Plan
1.5.8.1 Computer-generated Photometric Plans
1.5.8.2 Schematic Photometric Plan Calculations
1.5.8.3 Final Photometric Plan Calculations
1.5.9 Occupancy/Vacancy Sensor Coverage Layout
1.5.10 Test Laboratories
1.5.11 Regulatory Requirements
1.5.12 Standard Products
1.5.12.1 Alternative Qualifications
1.5.12.2 Material and Equipment Manufacturing Date
1.6 WARRANTY
1.6.1 Luminaire Warranty
1.6.2 Lighting Controls Warranty
1.7 OPERATION AND MAINTENANCE MANUALS
1.7.1 Lighting System
1.7.2 Lighting Control System

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

2.2 LUMINAIRES
2.2.1 Luminaire Samples
2.2.2 Luminaires
2.2.2.1 Luminaire Conversion Kits
2.2.3 Luminaires for Hazardous Locations
2.3 LIGHT SOURCES
2.3.1 LED Light Sources
2.3.1.1 Linear LED Lamps
2.4 LED DRIVERS
2.4.1 Remote LED Drivers
2.5 LIGHTING CONTROLS
2.5.1 System
2.5.1.1 Localized Control Systems
2.5.1.1.1 Local Area Controller
2.5.1.2 Centralized Control Systems
2.5.1.2.1 Lighting Relay Panel
2.5.1.2.2 Lighting Control Panel
2.5.1.2.3 Gateway
2.5.1.2.4 Lighting Contactor
2.5.2 Devices
2.5.2.1 Switches
2.5.2.2 Digital Switch Timers
2.5.2.3 Wall Box Dimmers
2.5.2.4 Scene Wallstations
2.5.2.5 Occupancy/Vacancy Sensors
2.5.2.5.1 Passive Infrared Sensors
2.5.2.5.2 Ultrasonic Sensors
2.5.2.5.3 Dual Technology Sensors
2.5.2.5.4 High Bay Sensors
2.5.2.5.5 Integrated Sensors
2.5.2.5.6 Power Packs
2.5.2.6 Photosensors
2.5.2.7 Time Clocks
2.6 EXIT AND EMERGENCY LIGHTING EQUIPMENT
2.6.1 Exit Signs
2.6.1.1 Exit Signs with Battery Backup
2.6.1.2 Remote-Powered Exit Signs
2.6.2 Emergency Lighting Unit (ELU)
2.6.3 LED Emergency Drivers
2.6.4 Self-Diagnostic Circuitry for LED Drivers
2.6.5 Mini Inverters
2.6.6 Central Emergency Lighting System
2.6.6.1 Operation
2.6.6.2 Charger
2.6.6.3 Batteries
2.6.6.4 Accessories
2.6.6.5 Enclosure
2.7 LUMINAIRE MOUNTING ACCESSORIES
2.7.1 Suspended Luminaires
2.7.2 Recess and Surface Mounted Luminaires
2.7.3 Luminaire Support Hardware
2.7.3.1 Wire
2.7.3.2 Wire for Humid Spaces
2.7.3.3 Threaded Rods
2.7.3.4 Straps
2.7.4 Power Hook Luminaire Hangers
2.8 EQUIPMENT IDENTIFICATION
2.8.1 Manufacturer's Nameplate
2.8.2 Labels

2.9 FACTORY APPLIED FINISH

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Light Sources
3.1.2 Luminaires
3.1.2.1 Suspended Luminaires
3.1.2.2 Recessed and Semi-Recessed Luminaires
3.1.2.3 Field Applied Painting
3.1.3 LED Drivers
3.1.3.1 Remote LED Drivers
3.1.4 Exit Signs
3.1.5 Lighting Controls
3.1.5.1 Scene Wallstations
3.1.5.2 Occupancy/Vacancy Sensors
3.1.5.3 Photosensors
3.2 FIELD QUALITY CONTROL
3.2.1 Tests
3.2.1.1 Lighting Control Verification Tests
3.2.1.2 Emergency Lighting Test
3.3 CLOSEOUT ACTIVITIES
3.3.1 Commissioning
3.3.2 Training
3.3.2.1 Maintenance Staff Training
3.3.2.2 End-User Training

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC / NASA	**UFGS-26 51 00 (May 2020)**
	Change 2 - 11/21

Preparing Activity: NAVFAC	**Superseding**
	UFGS-26 51 00 (May 2016)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
****

SECTION 26 51 00

INTERIOR LIGHTING
05/20, CHG 2: 11/21

****
NOTE: This guide specification covers lighting and lighting control system requirements for interior installations.

This specification does not cover all possible methods or requirements for interior lighting; therefore, designer should add special information required to suit a specific project. Industry publications and websites exist to aid the designer in choosing the best lighting system for the project. These include, but are not limited to, the Illuminating Engineering Society (IES) 'Lighting Handbook, 10th Edition' and 'RP-1-12 - American National Standard Practice for Office Lighting'; National Fire Protection Association (NFPA) 101 - 'Life Safety Code'; the DesignLights Consortium (DLC); US Department of Energy's Federal Energy Management Program (FEMP) and ENERGY STAR program.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

****
NOTE: For supplemental information regarding

Section 26 51 00, including PDF and CAD downloads of luminaire plates, go to:
http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufg

****

****

NOTE: This section contains the following luminaire plates (also referred to as 'sketches' or 'details'.) These are available in metric (SI) and U.S. Customary (IP) system dimensions. Plate titles and style numbers are unchanged for both units.

Do not include list of plates, or plates themselves, in project specifications. Use luminaire plates as details on drawings whenever possible. If special features are required for a project, do not modify plates, but indicate these changes on notes in luminaire schedule. The "NL" style numbers and dates must remain on the drawing details. If additional luminaire types are needed that are not covered in plates, provide additional sketches or details on drawings, but do not label as NL plate type.

Luminaire list is now divided into 2004 sketches and 2016 sketches. Use the 2016 sketches instead of the 2004 unless use of legacy technology is strictly necessary. Indicate on luminaire schedule if the luminaire is from the 2016 or 2004 list if the same sketch number is used.

2016 PLATE NUMBER	TITLE
NL-1	DIRECT/INDIRECT LED LUMINAIRE
NL-2	FLAT LENS LED LUMINAIRE
NL-3	SURFACE LED WRAPAROUND
NL-4	LINEAR LED SLOT
NL-5	ROUND LED LUMINAIRE
NL-6	DIRECT/INDIRECT LED PENDANT
NL-7	DIRECT WAL-MOUNTED LINEAR
NL-8	INDIRECT WALL MOUNT
NL-9	RECESSED LINEAR WALL WASH
NL-10	INDIRECT COVE LIGHT
NL-11	ADJUSTABLE RECESSED DOWNLIGHT
NL-12	FIXED RECESSED DOWNLIGHT
NL-13	WALLWASH RECESSED DOWNLIGHT
NL-14	LED TRACK LIGHTING
NL-15	LED UNDERCABINET LIGHT
NL-16	LED ROUND CEILING SURFACE MOUNT

2016 PLATE NUMBER	TITLE
NL-17	LED DECORATIVE ACCENT PENDANT
NL-18	LED DECORATIVE WALL SCONCE
NL-19	LED UP/DOWN WALL SCONCE
NL-20	LED FOOD SERVICE LIGHT
NL-21	LED HIGH ABUSE LIGHT
NL-22	LED HAZARDOUS LOCATION LIGHT
NL-23	LED INDUSTRIAL LIGHT
NL-24	LED INDUSTRIAL HIGH-BAY
NL-25	LED INDUSTRIAL LOW-BAY
NL-26	LED EMERGENCY LIGHTING UNIT (ELU)
NL-27	EDGE-LIT EXIT SIGN
NL-28	EXIT SIGN
NL-29	LED NICHE POOL LUMINAIRE
NOTE: Do not include this index in project specification.	

****

****

NOTE: Include the following information on the project drawings:

1. Luminaire schedule indicating luminaire symbol; luminaire type; NL plate number and type designation; light source; voltage; input watts; delivered lumen output; efficacy; CCT; CRI; LED driver; dimming; mounting; BUG rating if applicable; and any other applicable options or notes.

2. Location and mounting height of all luminaires (including normal and emergency) for each given area or room.

3. Referenced NL plate number or detail (if no NL plate is available) for each luminaire type provided.

4. All accessories required, such as mounting hardware, emergency battery back-up inverters, remote LED drivers, sensors and control equipment, and central emergency system components.

5. Occupancy, vacancy, and photosensor locations, mounting, and technology type. For occupancy and vacancy control, note if the sensor is Passive Infrared, Ultrasonic, or Dual-Tech. For photosensor, note if the sensor is open-loop or closed-loop.

6. Control strategy description for each given area or room. If the lighting controls manufacturer will not be providing shop drawings showing sensor locations and mounting heights, provide this information on the project plans.

7. Manual control wall stations, switches, and dimmers.

8. EMI filters, surge suppression, or shielding required.

****

****

NOTE: Demolition work that involves disposal of fluorescent and HID lamps and ballasts will require the use of Section 02 84 16 HANDLING OF LIGHTING BALLASTS AND LAMPS CONTAINING PCBs AND MERCURY.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A580/A580M	(2023) Standard Specification for Stainless Steel Wire
ASTM A641/A641M	(2019) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or

	Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1008/A1008M	(2021a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM B164	(2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B633	(2023) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM D4674 REV A	(2002; R 2010) Standard Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments

CALIFORNIA ENERGY COMMISSION (CEC)

CEC Title 20	(2019) Appliance Efficiency Regulations / Public Utilities and Energy Division 2. State Energy Resources Conservation and Development Commission
CEC Title 24	(2016) Building Energy Efficiency Standards For Residential and Nonresidential Buildings

EUROPEAN UNION (EU)

Directive 2011/65/EU	(2011) Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment

ILLUMINATING ENGINEERING SOCIETY (IES)

ANSI/IES LM-79	(2019) Approved Method: Electrical and Photometric Measurements of Solid State Lighting Products
ANSI/IES LM-80	(2020) Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules
ANSI/IES LS-1	(2020) Lighting Science: Nomenclature and Definitions for Illuminating Engineering
ANSI/IES TM-15	(2020) Technical Memorandum: Luminaire Classification System for Outdoor Luminaires
ANSI/IES TM-21	(2021) Technical Memorandum: Projecting Long-TermLuminous, Photon, and Radiant Flux Maintenance of LED Light Sources

ANSI/IES TM-30	(2020) Technical Memorandum: IES Method for Evaluating Light Source Color Rendition
IES Lighting Library	IES Lighting Library

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2023) National Electrical Safety Code
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C78.54	(2019) Specification Sheet for Tubular Fluorescent Replacement and Retrofit LED Lamps
NEMA 77	(2017) Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria
NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2017) Electric Lamps— Specifications for the Chromaticity of Solid State Lighting Products
NEMA C82.77-10	(2020) Harmonic Emission Limits - Related Power Quality Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA SSL 1	(2016) Electronic Drivers for LED Devices, Arrays, or Systems
NEMA SSL 3	(2011) High-Power White LED Binning for General Illumination
NEMA SSL 7A	(2015) Phase-Cut Dimming for Solid State Lighting: Basic Compatibility
NEMA WD 1	(1999; R 2020) Standard for General Color Requirements for Wiring Devices
NEMA WD 7	(2011; R 2016; R 2021) Occupancy Motion Sensors Standard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
NFPA 101	(2021; TIA 21-1) Life Safety Code
NFPA 110	(2022) Standard for Emergency and Standby Power Systems

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices

UNDERWRITERS LABORATORIES (UL)

UL 20	(2018; Reprint May 2023) UL Standard for Safety General-Use Snap Switches
UL 94	(2023; Reprint May 2023) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 844	(2012; Reprint Oct 2021) UL Standard for Safety Luminaires for Use in Hazardous (Classified) Locations
UL 916	(2015; Reprint Oct 2021) UL Standard for Safety Energy Management Equipment
UL 917	(2006; Reprint Aug 2013) UL Standard for Safety Clock-Operated Switches
UL 924	(2016; Reprint Dec 2022) UL Standard for Safety Emergency Lighting and Power Equipment
UL 1472	(2015) UL Standard for Safety Solid-State Dimming Controls
UL 1598	(2021; Reprint Jun 2021) Luminaires
UL 1598C	(2014) Standard for Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits
UL 1993	(2017) Self-Ballasted Lamps and Lamp Adapters
UL 2043	(2013) Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in

	Air-Handling Spaces
UL 8750	(2015; Reprint Sep 2021) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products

1.2 RELATED REQUIREMENTS

****
NOTE: For the purpose of this document, interior luminaires include those in the interior portion of buildings or facilities, luminaires attached to the exterior of a building, and luminaires mounted in parking garages. Luminaires that are not attached to the exterior of a building and that are intended to illuminate exterior areas are specified in Section 26 56 00 EXTERIOR LIGHTING.
****

Materials not considered to be luminaires, luminaire accessories, or lighting equipment are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Luminaires and accessories that are mounted in exterior environments and not attached to the exterior of the building are specified in Section 26 56 00 EXTERIOR LIGHTING. Cybersecurity requirements are specified in Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS. Commissioning requirements are specified in Section 01 91 00.15 BUILDING COMMISSIONING. Emergency lighting requirements are specified in Section 26 52 00.00 40 EMERGENCY LIGHTING.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications and on the drawings, must be as defined in IEEE 100 and ANSI/IES LS-1.

b. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in ANSI/IES LM-80.

c. For LED luminaires, "Luminaire Efficacy" (LE) is the appropriate measure of energy efficiency, measured in lumens/watt. This is gathered from LM-79 data for the luminaire, in which absolute photometry is used to measure the lumen output of the luminaire as one entity, not the source separately and then the source and housing together.

d. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.4 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals

required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force, and NASA projects, or choose the second bracketed item for Army projects.
****

****
Luminaire shop drawings are required for custom luminaires, luminaires specified to a specific custom length, or linear luminaires with lengths greater than 2.5 meters 8 feet.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Luminaire Drawings; G[, [_____]]

Occupancy/Vacancy Sensor Coverage Layout; G[, [_____]]; S

Lighting Control System One-Line Diagram; G[, [_____]]

Sequence of Operation for Lighting Control System; G[, [_____]]

SD-03 Product Data

Luminaires; G[, [_____]]

Light Sources; G[, [_____]]

LED Drivers; G[, [_____]]

Luminaire Warranty; G[, [_____]]

Lighting Controls Warranty; G[, [_____]]

Local Area Controller; G[, [_____]]

Lighting Relay Panel; G[, [_____]]

Lighting Control Panel; G[, [_____]]

Gateway; G[, [_____]]

Lighting Contactor; G[, [_____]]

Switches; G[, [_____]]

Digital Switch Timers; G[, [_____]]

Wall Box Dimmers; G[, [_____]]

Scene Wallstations; G[, [_____]]

Occupancy/Vacancy Sensors; G[, [_____]]

Photosensors; G[, [_____]]

Time Clocks; G[, [_____]]

Power Packs; G[, [_____]]

Power Hook Luminaire Hangers; G[, [_____]]

Mini Inverters; G[, [_____]]

Exit Signs; G[, [_____]]

Emergency Drivers; G[, [_____]]

Energy Star Label For Residential Luminaires; S

Linear LED Lamps; G[, [_____]]

[SD-04 Samples

Luminaire Samples; G[, [_____]]

] SD-05 Design Data

Luminaire Design Data; G[, [_____]]

Photometric Plan; G[, [_____]]

SD-06 Test Reports

ANSI/IES LM-79 Test Report; G[, [_____]]

ANSI/IES LM-80 Test Report; G[, [_____]]

ANSI/IES TM-21 Test Report; G[, [_____]]

ANSI/IES TM-30 Test Report; G[, [_____]]

Occupancy/Vacancy Sensor Verification Test; G[, [_____]]

Photosensor Verification Test; G[, [_____]]

SD-07 Certificates

LED Driver and Dimming Switch Compatibility Certificate; G[, [_____]]

SD-10 Operation and Maintenance Data

Lighting System, Data Package 5; G[, [_____]]

Lighting Control System, Data Package 5; G[, [_____]]

Maintenance Staff Training Plan; G[, [_____]]

End-User Training Plan; G[, [_____]]

1.5 QUALITY ASSURANCE

Data, drawings, and reports must employ the terminology, classifications and methods prescribed by the IES Lighting Library as applicable, for the lighting system specified.

1.5.1 Luminaire Drawings

****

NOTE: Aiming diagrams are required for applications with directional luminaires, such as art lighting, track lighting, and wallwash applications.

****

Include dimensions, accessories installation details, and construction details. Photometric data, including CRI, CCT, LED driver type,[aiming diagram,] zonal lumen data, and candlepower distribution data must accompany shop drawings.

1.5.2 Luminaire Design Data

a. Provide safety certification and file number for the luminaire family that must be listed, labeled, or identified in accordance with the NFPA 70. Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).

b. Provide long term lumen maintenance projections for each LED luminaire in accordance with ANSI/IES TM-21. Data used for projections must be obtained from testing in accordance with ANSI/IES LM-80.

1.5.3 ANSI/IES LM-79 Test Report

Submit test report on manufacturer's standard production model of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data in IES format as outlined under "14.0 Test Report" in ANSI/IES LM-79.

1.5.4 ANSI/IES LM-80 Test Report

Submit report on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data as outlined under "8.0 Test Report" in ANSI/IES LM-80.

1.5.5 ANSI/IES TM-21 Test Report

Submit test report on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Testing must be performed at the same operating drive current as specified luminaire. Include all applicable and required data, as well as required interpolation information as outlined under "7.0 Report" in ANSI/IES TM-21.

1.5.6 ANSI/IES TM-30 Test Report

Submit color vector graphic in accordance with ANSI/IES TM-30 on manufacturer's standard production LED light source (package, array, or module) of specified luminaire. Include spectral distribution of test LED light source.

1.5.7 LED Driver and Dimming Switch Compatibility Certificate

Submit certification from the luminaire, driver, or dimmer switch manufacturer that ensures compatibility and operability between devices without flickering and to specified dimming levels.

1.5.8 Photometric Plan

****

NOTE: Require photometric plans and design criteria to be submitted if the project is a Design-Build project and will not have a engineer or designer producing photometrics during design.

****

1.5.8.1 Computer-generated Photometric Plans

Computer-generated photometric plans for each space are required to verify proposed luminaires and locations meet the required performance criteria of the design using the applicable light loss factor (LLF).

Target illumination levels are provided for each Interior Application. Depending on the application and the recommendations provided by the IES, values are given as one of the following:

a. Minimum: No values anywhere on the calculation grid may be less than this value, within a 10 percent margin of error.

b. Minimum Average: An average, taken over the entire task area for the application, may not be less than this value, within a 10 percent margin of error.

c. Maximum: No values anywhere on the calculation grid may be greater than this value, within a 10 percent margin of error.

d. Maximum Average: An average, taken over the entire task area for the application, may not be greater than this value, within a 10 percent margin of error.

e. Uniformity: Unless otherwise noted, uniformity is calculated as a ratio of the average calculated illuminance over the minimum calculated illuminance of the calculation grid.

1.5.8.2 Schematic Photometric Plan Calculations

Schematic photometric plan calculations must include:

a. Horizontal illuminance measurements at workplane or other designated height above finished floor, taken at a maximum of every 305 mm one foot across the task area.

b. Average maintained illuminance level.

c. Minimum and maximum maintained illuminance levels.

d. Lighting power density (Watts per square meter) (Watts per square foot).

e. LLF. Recommended LLF is 0.81 for LED luminaires but LLF varies based on environment and application.

1.5.8.3 Final Photometric Plan Calculations

Final photometric plan calculations must include:

a. Horizontal illuminance measurements at workplane or other designated height above finished floor, taken at a maximum of every 305 mm one foot across the task area.

b. Where applicable, vertical illuminance measurements at designated surface, taken at a maximum of every 305 mm one foot across task area.

c. Minimum and maximum maintained illuminance levels.

d. Average maintained illuminance level.

e. Average to minimum and maximum to minimum ratios for horizontal illuminance.

f. Lighting power density (Watts per square meter) (Watts per square foot).

g. LLF. Recommended LLF is 0.81 for LED luminaires but LLF varies based on environment and application.

1.5.9 Occupancy/Vacancy Sensor Coverage Layout

Provide floor plans showing coverage layouts of all devices using manufacturer's product information.

1.5.10 Test Laboratories

Test laboratories for the ANSI/IES LM-79 and ANSI/IES LM-80 test reports must be one of the following:

a. National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program for both LM-79 and LM-80 testing.

b. One of the qualified labs listed on the Department of Energy - LED Lighting Facts Approved Testing Laboratories List for LM-79 testing.

c. One of the EPA-Recognized Laboratories listed for LM-80 testing.

1.5.11 Regulatory Requirements

Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70, unless more stringent requirements are specified or indicated. Provide luminaires and assembled components that are approved by and bear the label of UL for the applicable location and conditions unless otherwise specified.

1.5.12 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design, and workmanship. Products must have been in satisfactory commercial or industrial use for six months prior to bid opening. The six-month period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the six-month period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.12.1 Alternative Qualifications

Products having less than a six-month field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.12.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than six months prior to date of delivery to site, unless specified otherwise.

1.6 WARRANTY

Support all equipment items by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6.1 Luminaire Warranty

****

NOTE: In applications where color rendition and color detection are a high priority, require warranty for color maintenance.

****

Provide and transfer to the government the original LED luminaire manufacturers standard commercial warranty for each different luminaire manufacturer used in the project.

a. Provide a written five year minimum replacement warranty for material, luminaire finish, and workmanship. Provide written warranty document that contains all warranty processing information needed, including customer service point of contact, whether or not a return authorization number is required, return shipping information, and closest return location to the luminaire location.

(1) Finish warranty must include failure and substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

(2) Material warranty must include:

(a) All LED drivers and integral control equipment.

(b) Replacement when more than 15 percent of LED sources in any lightbar or subassembly(s) are defective, non-starting, or operating below 70 percent of specified lumen output.

[(c) Replacement when more than 15 percent of LED sources in any lightbar or subassembly(s) show a color shift greater than 0.003 delta u'v' from the zero hour measurement stated in the ANSI/IES LM-79 Test Report.

] b. Warranty period must begin in accordance with the manufacturer's standard warranty starting date.

c. Provide replacements that are promptly shipped, without charge, to the using Government facility point of contact and that are identical to or an improvement upon the original equipment. All replacements must include testing of new components and assembly.

1.6.2 Lighting Controls Warranty

Provide and transfer to the government the original lighting controls manufacturers standard commercial warranty for each different lighting controls manufacturer used in the project. Warranty coverage must begin from date of final system commissioning or three months from date of delivery, whichever is the earliest. Warranty service must be performed by a factory-trained engineer or technician.

a. Unless otherwise noted, provide a written five year minimum warranty on the complete system for all systems with factory commissioning. Provide warranty that covers 100 percent of the cost of any replacement parts and services required over the five years which are directly attributable to the product failure. Failures include, but are not limited to, the following:

(1) Software: Failure of input/output to execute switching or dimming commands.

(2) Damage of electronic components due to transient voltage surges.

(3) Failure of control devices, including but not limited to occupancy sensors, photosensors, and manual wall station control devices.

b. Provide a written five year minimum warranty on all input devices against defect in workmanship or materials provided by device manufacturer.

c. Provide a written five year minimum warranty on all control components attached to luminaires against defect in workmanship or materials.

1.7 OPERATION AND MAINTENANCE MANUALS

1.7.1 Lighting System

Provide operation and maintenance manuals for the lighting system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the lighting system for the building. Additional O&M Manual requirements for the Army are provided in Section 01 78 24.00 10 FACILITY DATA REQUIREMENTS. Additional requirements for the Navy are provided in Section 01 78 24.00 20 FACILITY DATA WORKBOOK (FDW). Include the following:

a. Manufacturers' operating and maintenance manuals.

b. Luminaire shop drawings for modified and custom luminaires.

c. Luminaire Manufacturers' standard commercial warranty information as specified in paragraph LUMINAIRE WARRANTY.

1.7.2 Lighting Control System

****

NOTE: Lighting control panel schedules are not required for localized control systems.

****

Provide operation and maintenance manuals for the lighting control system in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA that provide basic data relating to the design, operation, and maintenance of the lighting control system for the building. Include the following:

a. Lighting control system layout and wiring plan.

b. Lighting control system one-line diagram.

c. Product data for all devices, including installation and programming instructions.

d. Occupancy/vacancy sensor coverage layout.

e. Training materials, such as videos or in-depth manuals, that cover basic operation of the lighting control system and instructions on modifying the lighting control system. Training materials must

include calibration, adjustment, troubleshooting, maintenance, repair, and replacement.

f. Sequence of operation descriptions for each typical room type, including final programming, schedules, and calibration settings.

[g. "As-built" lighting control panel schedules.

]PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

2.2 LUMINAIRES

****
NOTE: For luminaires used in residential applications, include requirements for Energy Star Label. If building-mounted exterior luminaires are specified on this project, require compliance with BUG rating as indicated in the luminaire schedule.
****

UL 1598, NEMA C82.77-10. Provide luminaires as indicated in the luminaire schedule and NL plates or details on project plans, complete with light source, wattage, and lumen output indicated. All luminaires of the same type must be provided by the same manufacturer. Luminaires must be specifically designed for use with the driver and light source provided.

[Provide luminaire with Energy Star Label For Residential Luminaires in accordance with Energy Star.

][2.2.1 Luminaire Samples

****
NOTE: Only require the acquisition of samples for luminaire installations that warrant mock-ups, such as wall grazing unique materials, for custom luminaires, or for applications where aesthetics are of high priority.
****

Submit one sample of each luminaire type [_____], complete with light source, LED driver rated for 120 V operation, and 2 meters 6 feet pigtail with 3-prong Edison plug. Sample will be returned to the Contractor for installation in the project work.

]2.2.2 Luminaires

****
NOTE: Provide design information including delivered lumen output, L70 lumen maintenance data, and luminaire efficacy in the luminaire schedule on project plans.

Luminaires attached to the exterior of the building are included in this interior lighting specification. For any interior project with exterior building-mounted luminaires, select the requirements for exterior luminaires, including BUG

rating.

If there are any recessed luminaires that are in contact with insulation, require those luminaires to be IC-rated. If the project is located in the City of Chicago or a jurisdiction that has adopted Chicago amendments to the NEC, select Chicago Plenum requirements.

****

UL 8750, ANSI/IES LM-79, ANSI/IES LM-80. For all luminaires, provide:

a. Complete system with LED drivers and light sources.

b. Housings constructed of non-corrosive materials. All new aluminum housings must be anodized or powder-coated. All new steel housings must be treated to be corrosion resistant.

c. ANSI/IES TM-21, ANSI/IES LM-80. Minimum L70 lumen maintenance value of 50,000 hours unless otherwise indicated in the luminaire schedule. Luminaire drive current value must be identical to that provided by test data for luminaire in question.

d. Minimum efficacy as specified in the luminaire schedule. Theoretical models of initial lamp lumens per watt are not acceptable. If efficacy values are not listed in the luminaire schedule, provide luminaires that meet the following minimum values:

Luminaire Style	Minimum Luminaire Efficacy
Recessed 1 by 4, 2 by 4, and 2 by 2	100 LPW
Recessed Downlight (fixed, adjustable, wallwash)	80 LPW
Linear, Accent (undercabinet, cove)	45 LPW
Linear, Ambient (indirect wall mount, linear pendent)	100 LPW
High Bay, Low Bay, and Industrial Locations	100 LPW
Food Service and Hazardous Locations	60 LPW
Other (track, residential diffusers)	50 LPW
Exterior Wall Sconce	50 LPW
Steplight	30 LPW
Parking Garage Luminaire	100 LPW

e. UL listed for dry or damp location typical of interior installations.[Any luminaire mounted on the exterior of the building must be UL listed for wet location typical of exterior installations.]

f. LED driver and light source package, array, or module are accessible for service or replacement without removal or destruction of luminaire.

g. Lenses constructed of heat tempered borosilicate glass, UV-resistant acrylic, or silicone.[Provide polycarbonate vandal-resistant lenses as indicated.] Sandblasting, etching and polishing must be performed as indicated in the luminaire description.

[h. ANSI/IES TM-15. Provide exterior building-mounted luminaires that do not exceed the BUG ratings as listed in the luminaire schedule. If BUG ratings are not listed in the luminaire schedule, provide luminaires that meet the following minimum values for each application and mounting conditions:

Lighting Application	Mounting Conditions	BUG Rating
Exterior Wall Sconce	Above 1.2 meters 4 feet AFF	B1-U0-G2
Exterior Wall Sconce	Below or at 1.2 meters 4 feet AFF	B4-U0-G4
Steplight	Above 1.2 meters 4 feet AFF	B1-U1-G2
Steplight	Below or at 1.2 meters 4 feet AFF	B4-U1-G4
Parking Garage Luminaire	Ceiling mounted	B4-U4-G3

][i. For all recessed luminaires that are identified to be in contact with insulation, provide luminaires that are IC-rated.

][j. For all recessed luminaires that are to be installed in air plenums, require housings that are Chicago Plenum rated.

]2.2.2.1 Luminaire Conversion Kits

****
NOTE: Provide LED luminaire conversion kits to replace non-LED light sources in renovation or energy conservation projects, only where entire luminaires are not replaced.
****

Provide luminaire conversion kits that meet UL 1598C Standard for Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits.

2.2.3 Luminaires for Hazardous Locations

In addition to requirements stated herein, provide LED luminaires for hazardous locations which conform to UL 844 or which have Factory Mutual certification for the class and division indicated.

2.3 LIGHT SOURCES

NEMA ANSLG C78.377, NEMA SSL 3. Provide type, delivered lumen output, and wattage as indicated in the luminaire schedule on project plans.

2.3.1 LED Light Sources

****
NOTE: A color temperature of 3500 K is standard for

most applications. When specifically desired by the designer, a nominal color temperature of 2700 K, 3000 K, or 4000 K may be selected. The highest allowable CCT is 4100 K.

In applications where color rendition and color detection are a high priority, require that LED light sources meet the recommended fidelity and gamut indices as determined by ANSI/IES TM-30. Additionally, select color maintenance requirements.

For projects in the state of California, require compliance with CEC Title 20.

Refer to UFC 3-530-01 for CRI allowances in maintenance and recreational spaces.

****

[CEC Title 20.]Provide LED light sources that meet the following requirements:

a. NEMA ANSLG C78.377. Emit white light and have a nominal CCT of [3000][2700][3500][4000] Kelvin.

b. Minimum Color Rendering Index (CRI) of [80][90][95 with an R9 value of 95].[Fidelity index greater than or equal to 80, gamut index between 97 and 110, determined in accordance with ANSI/IES TM-30.]

c. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

d. Light source color consistency by utilizing a binning tolerance within a 3-step McAdam ellipse.

[e. Color maintenance value of no greater than 0.003 (delta u'v') at 6000 hours as listed in ANSI/IES LM-79 Test Report.

][2.3.1.1 Linear LED Lamps

****

NOTE: Minimum beam angle of 270-degrees is preferred over 180-degrees, but is less common. If target light levels and optical performance of linear LED lamp is critical for the specified application, select 270-degree beam angle.

Provide linear LED Lamps to replace fluorescent light sources in renovation or energy conservation projects, only where entire luminaires are not replaced or LED conversion kits are not available. Do not use UL 1993 Type B, UL 1993 Type C, or any hybrid Linear LED Lamps.

****

Provide linear LED Lamps that are compatible with existing instant-start or programmed-start ballasts, and meet the following additional requirements:

a. UL 1993 UL Type A linear LED lamp.

b. Power Factor greater than or equal to 0.90 at full input power and across specified dimming range.

c. Maximum Total Harmonic Distortion (THD) less than or equal to 20 percent at full input power and across specified dimming range.

d. Lumen per watt efficacy no less than 120.

e. Minimum beam angle of [270][180] degrees.

f. Lamp datasheet complies with ANSI C78.54. Manufacturer must provide list of all ballasts that are compatible for use with lamp.

]2.4 LED DRIVERS

****
NOTE: Dimmable LED drivers should be specified with dimming down to at least 10 percent. Dimmable drivers with a dimming range down to 1 percent should be specified for applications where audio/visual presentations are common such as conference and meetings rooms, and hospitality.
****

NEMA SSL 1, UL 8750. Provide LED drivers that are electronic, UL Class 1 or Class 2, constant-current type and that comply with the following requirements:

a. The combined driver and LED light source system does not exceed the minimum luminaire efficacy values as listed in the luminaire schedule provided.

b. Operates at a voltage of [120-277][120][277] volts at 50/60 hertz, with input voltage fluctuations of plus/minus 10 percent.

c. Power Factor (PF) greater than or equal to 0.90 at full input power and across specified dimming range.

d. Maximum Total Harmonic Distortion (THD) less than 20 percent at full input power and across specified dimming range.

e. Operates for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.

f. Withstands Category A surges of 2 kV without impairment of performance. Provide surge protection that is integral to the driver.

g. Integral thermal protection that reduces the output power to protect the driver and light source from damage if the case temperature approaches or exceeds the driver's maximum operating temperature.

h. 47 CFR 15. Complies with the requirements of the Federal Communications Commission (FCC) rules and regulations, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

i. Class A sound rating.

j. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS)

compliant.

k. Provide dimming capability as indicated in the luminaire schedule on project plans.[Dimmable drivers must dim down to [10][5][1] percent. Dimmable drivers must be controlled by a [Class 2 low voltage 0-10VDC controller] [Digital Addressable Lighting Interface (DALI)] dimming signal protocol unless otherwise specified. LED drivers of the same family/series must track evenly across multiple luminaires at all light levels.]

[2.4.1 Remote LED Drivers

****
NOTE: Do not allow use of remote drivers unless specifically noted on the lighting plate and luminaire schedule.
****

Provide remote LED Drivers that are UL listed for dry locations typical of interior installations. Provide LED driver in junction box or housing with mounting plate. Housing must allow for field connections to occur inside the housing or must contain mechanical connections.

]2.5 LIGHTING CONTROLS

****
NOTE: Include a version of Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS edited specifically for the lighting control system where a control system is specified.
****

Provide network certification for all networked lighting control systems and devices in accordance with the requirements of Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS. Provide lighting control systems that do not switch off battery-operated or emergency backup luminaires or exit signs in path of egress. Provide system with override of lighting control devices controlling luminaires in path of egress with activation of fire alarm system.

2.5.1 System

Provide lighting control system that operates the lighting system as described in the lighting control strategies in the project plans. Submit Sequence of Operation for Lighting Control System describing the operation of the proposed lighting control system and devices. Sequence of Operation must provide the strategies identified in the lighting control strategies.

2.5.1.1 Localized Control Systems

Provide room or area-wide lighting control system capable of manual control, time-based control, and receiving input from photosensors and occupancy/vacancy sensors.

2.5.1.1.1 Local Area Controller

****
NOTE: Select requirement for daylight harvesting

capabilities for all regularly-occupied spaces with access to daylight. Task oriented areas such as offices, conference rooms, and classrooms require continuous dimming of electric lighting per UFC 3 530 01.

When using receptacle load control in private offices, allow capability for receptacle load control via the localized control system. Only use receptacle load control for areas with non-critical loads such as computer monitors, task lights, or personal convenience devices.

Select Item g. if Local Area Controller is connected to luminaires in the path of egress.

****

Provide controller designed for single area or room with the following requirements:

a. Operates at a voltage of [120-277][120][277] volts at 50/60 hertz.

b. [2][_____] zone, with [1][2][_____] relay[s] rated 20 amps[each] with one manual [switch][dimmer] per zone.

c. Provide inputs for occupancy/vacancy sensors, photosensors, and low-voltage wall switches.

[d. Provide daylight harvesting capability with full-range dimming control with input from photosensor.

][e. Provide capability for receptacle load control from occupancy sensors.

][f. Provide full 'OFF' function with input from external time clock input.

][g. Capable of 0-10V dimming.

][h. AV interface via [RS-232][RS-485][ethernet and CAT5].

][i. Provide override 'ON' function with input from Fire Alarm Control Panel for all emergency lighting. Controller must not turn off power to emergency batteries or exit signs.

]2.5.1.2 Centralized Control Systems

Provide a centralized lighting control system capable of manual control, time-based control, receiving input from photosensors and occupancy/vacancy sensors, with the capabilities of controlling, monitoring, and programming changes from one centralized on-site location, and integration with other building systems.

2.5.1.2.1 Lighting Relay Panel

****

NOTE: Select NEMA 1 enclosure for indoor use with normal conditions, NEMA 3R for indoor or outdoor use when weather resistance is necessary, and NEMA 4 if a watertight enclosure is necessary.

****

UL 924. Enclose panel hardware in a [surface][flush]-mounted, NEMA [1][3R][4], painted, steel enclosure with lockable access door and ventilation openings. Internal low-voltage compartment must be separated from line-voltage compartment of enclosure with only low-voltage compartment accessible upon opening of door. Provide additional remote cabinets that communicate back to main control panel as required. Provide Lighting Control Panels that meet the following criteria:

a. Input voltage of [120][277][120-277] at 50/60 Hz, with internal low voltage power supply as required.

b. [8][16][32][_____] single-pole latching relays rated at [20][30] amps, [120-277][120][277] volts. Provide provision for relays to close upon power failure. Provide relays designed for 10 years of use at full rated load.

c. Relay control module operates at 24 VDC and is rated to control a minimum of [8][16][32][_____] relays.

[d. Capable of 0-10V dimming.

]2.5.1.2.2 Lighting Control Panel

****

NOTE: Select NEMA 1 enclosure for indoor use with normal conditions, NEMA 3R for indoor or outdoor use when weather resistance is necessary, and NEMA 4 if a watertight enclosure is necessary.

When providing a control panel that interfaces with the building automated control system, reference IES Technical Memorandum IES TM-23-11 for technical information on various protocols, architectures and topologies for such systems. Include Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION for UMCS and integration requirements.

For projects in the state of California, require compliance with CEC Title 24.

****

UL 916, 47 CFR 15[, CEC Title 24]. Provide an electronic, programmable lighting control panel complete with microprocessor, capable of providing lighting control with input from internal programming, digital switches,[time clocks,] and other control devices.

Enclose panel hardware in a [surface][flush]-mounted, NEMA [1][3R][4], painted, steel enclosure with lockable access door and ventilation openings. Internal low-voltage compartment must be separated from line-voltage compartment of enclosure with only low-voltage compartment accessible upon opening of door. Provide additional remote cabinets that communicate back to main control panel as required. Provide Lighting Control Panels that meet the following criteria:

a. Input voltage of [120][277][120-277] at 50/60 Hz, with internal low-voltage VDC power supply as required.

b. Solid-state, microprocessor-based, internal astronomical time clock. Microprocessor must have nonvolatile memory and must reset automatically after power interruptions of up to 90 days.

c. Interface for providing local programming and control capability, with physical key-locked cover or programmed security access code to prevent unauthorized use.

d. Dimming modules capable of [0-10V][DALI] dimming.

e. Modules and control panels include multichannel output with [_____] channels, with multiple inputs for manual control, photosensors, and occupancy/vacancy sensors.

[f. Control processor is configured to interface with [BACnet in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS][LONworks in accordance with Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS] compliant network via [native compatibility][gateway].

][g. Outputs that require line-voltage switching are provided by relays which are designed for 10 years of use at full rated load.

][h. Control processor indicates failure of normal power and which circuits are supplied by alternative power source if connected to emergency lighting units.

][i. Provide building automation system write access points to lighting control system for [manual override][building schedules][utility demand response events].

][j. Provide building automation read access points to lighting control system for [occupancy status per room or area][current lighting load in kilowatts][calculated energy use in kilowatt-hours][utility demand response priorities].

]2.5.1.2.3 Gateway

****
NOTE: When specifying BAS interface, coordinate with HVAC specifier to ensure the requirements are described in both specifications. Include Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION for UMCS and integration requirements.
****

Provide gateway in accordance with Section 25 10 10 UTILITY MONITORING AND CONTROL SYSTEM (UMCS) FRONT END AND INTEGRATION. Provide hardware and software to enable the BAS to monitor, control, display, and record data for use in processing reports. Provide [BACnet][LONworks][_____] communication interface that enables remote control and monitoring of lighting from a workstation according to read access points and write access points listed in this section. Control features and monitoring points displayed locally at lighting panel must be available through the Gateway. Provide Gateway that meets the following requirements:

a. Microprocessor-based communications device that perform bi-directional

protocol translation.

b. Support full bi-directional communication and translation.

c. Contain its own microprocessor, RAM, battery, communication ports, and power supply.

[d. Support an additional 5 percent points for future expansion.

]2.5.1.2.4 Lighting Contactor

NEMA ICS 2, NEMA ICS 6. Provide an electrically[mechanically]-held lighting contactor housed in a NEMA [1][12][3R][4][4X][_____] enclosure. Provide contactor with one [_____] [normally-open(NO)][normally closed(NC)], single[double] pole contacts, rated 600 volts, 30 amps. Provide coil operating voltage of [24][120][277][480][_____] volts.

2.5.2 Devices

2.5.2.1 Switches

Provide line-voltage toggle switches as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. When used for non-digital loads, devices must be rated at 20 Amps inductive load, and be compatible with the lighting control systems.

2.5.2.2 Digital Switch Timers

Provide line-voltage toggle switches that allow manual control to ON and automatically switches lighting load to OFF. Device operates with the use of paddle, button, or toggle, and operates at [120-277][120][277] volts. Device allows for programming of auto off timer from [2][5][10] minutes to [1][6][12] hours.

2.5.2.3 Wall Box Dimmers

****

NOTE: Coordinate dimming range with LED driver specifications.

The majority of dimmers for LED light sources use 0-10V technology to dim light sources. If a Digital Addressable Lighting Interface (DALI) system is specified, then all dimmers and drivers must be compatible with a DALI system.

****

UL 1472, UL 20, IEEE C62.41, NEMA 77, NEMA SSL 7A. Dimmers must provide flicker-free, continuously variable light output throughout the dimming range of [10][5][1] percent to 100 percent. Devices must be capable of operating at their full rated capacity regardless of being single or ganged-mounted, and be compatible with three-way and four-way switching scenarios.

Provide wall-box dimmers that meet the following requirements:

a. Device operates as [part of a lighting control system][an independent control device].

b. Device operates with the use of a vertical slider, paddle, rotary, button, or toggle with adjacent vertical slider.

c. Finish of device matches switches and outlets in the same area.

d. Back box in wall has sufficient depth to accommodate body of switch and wiring.

e. Dimmer is capable of controlling [0-10 volt][DALI] LED drivers. Dimmers and the drivers they control must be provided from the same manufacturer or tested and certified as compatible for use together.

f. Radio frequency interference suppression is integral to device.

2.5.2.4 Scene Wallstations

Provide scene wallstations that are compatible with the other components of the lighting control system and capable of Class 1 or 2 wiring methods in accordance with the NEC and local codes. Provide devices that contain on/off group, preset scene functions, or dim up/dim down interface through front panel. Programming of new scenes or zone assignments must be accomplished by authorized personnel from the space being controlled. Provide labeling for each button, including laminated sheet with scene descriptions to be posted near each scene controller.

2.5.2.5 Occupancy/Vacancy Sensors

****

NOTE: Indicate whether sensor layouts are shown on project plans or on manufacturer shop drawings. If indicating that manufacturer will provide shop drawings for sensor locations, provide sequence of operations in project documentation.

In general, use sensors that are wallbox mounted, wall-mounted, ceiling-mounted, or integral to luminaire for most interior applications. Keep in mind wallbox mounted sensors may be ineffective when obstructions such as partitioned workstations and storage shelving exist. Use high-bay sensors or wall-mounted sensors for areas with ceilings higher than 3.6 meters 12 feet. Ceiling-mounted sensors are not recommended in locations where pendent-mounted luminaires are within 1.2 meters 4 feet of the sensor.

Maximum and minimum load requirements depend on the operating voltage of the sensor. If low voltage sensors are specified, select low voltage in Item A, and the maximum load requirement in Item E.

Select the paragraph describing the characteristics of PIR sensors if PIR sensors are used. Select the paragraph describing the characteristics of ultrasonic sensors if ultrasonic sensors are used. Select both paragraphs and the section discussing dual tech if dual tech sensors are used.

For projects in the state of California, require

compliance with CEC Title 24 and CEC Title 20.
*****

]2.5.2.5.1 Passive Infrared Sensors

Provide Passive Infrared Sensors (PIR) sensors that detect occupancy by sensing heat and movement in the area of coverage. Provide sensors are constructed of a housing of high-impact, injection-molded thermoplastic. Provide PIR sensors that are temperature compensated, with a dual element sensor and a multi-element fresnel lens of POLY IR4 material.

2.5.2.5.2 Ultrasonic Sensors

Provide ultrasonic sensors that detect occupancy by sensing a change in pattern of reflected ultrasonic waves in the area of coverage. Provide sensors that are constructed of a housing of high-impact, injection-molded thermoplastic. Provide ultrasonic sensors that operate at 40 kHz.

2.5.2.5.3 Dual Technology Sensors

Provide dual technology sensors that meet the requirements for PIR sensors and ultrasonic sensors indicated above. If either the PIR or ultrasonic sensing registers occupancy, the luminaires must remain on.

2.5.2.5.4 High Bay Sensors

Provide occupancy/vacancy sensors specifically designed for high-bay mounting applications for all [ceiling-mounted sensors][sensors integral to luminaires] mounted above 10 meters 35 feet using PIR technology. Provide high-bay sensors with interchangeable lenses for 360 degree open area coverage or narrow rectangular warehouse aisle coverage.[Provide sensors that are designed to mount directly to or adjacent to high- or low-bay luminaires.]

2.5.2.5.5 Integrated Sensors

****
NOTE: If integrated sensors are used independently of any other lighting control system component, then the sensors do not need to communicate to a local area controller or lighting control panel.
****

Provide integrated occupancy/vacancy sensors that mount directly to the luminaires as indicated in project plans.[Sensor mounts to standard junction box or directly to luminaire using a [straight][drop] nipple mount.][Provide sensors that communicate to [lighting control panel][local area controller] via [RJ45][SPDT relay][_____].]

2.5.2.5.6 Power Packs

****
NOTE: For projects in the state of California, require compliance with CEC Title 24.
****

UL 2043[, CEC Title 24]. Provide power packs to provide power to lighting control sensors as required in accordance with the manufacturer's specifications. Provide power packs that meet the following requirements:

a. Operate at an input voltage of [120][277][120-277] VAC, with an output voltage [12-24][12][24] VDC at 225 mA.

b. Constructed of plenum-rated, high-impact thermoplastic enclosure.

c. Utilizes zero-crossing circuitry to prevent damage from inrush current.

d. Maximum load rating of 16 [_____] amps for electronic [_____] lighting loads.

e. Directive 2011/65/EU. Restriction of Hazardous Substances (RoHS) compliant.

2.5.2.6 Photosensors

****

NOTE: Open-loop photosensors are recommended in spaces where occupant interference is frequent or when reflectances may shift over time.

For projects in the state of California, require compliance with CEC Title 24 and CEC Title 20.

****

[CEC Title 24, CEC Title 20.]Provide photosensors that meet the following requirements:

a. Detect changes in ambient lighting level and enable dimming as required by sequence of operation by operating in [an open-loop][a closed-loop] system.

b. Contain a detection cone, where the base of the cone may be circular or an elongated shape, and where the smallest angle between the edge and the axis of the cone is between 20 and 50 degrees. The cone axis may be tilted to the vertical when installed to give the sensor preferred directionality.

c. Sensors are [ceiling-mounted][wall-box-mounted][wall-mounted][mounted integral to luminaire] with sensitivity, filtering, range and viewing angle to meet requirements of sequence of operation, scope of work and construction documents.

d. Time delay that is adjustable from 1 to 30 seconds ON delay, and 1 to 30 minutes OFF delay to prevent cycling, with deadband adjustment of 25 percent to 100 percent above lower setpoint.

e. Output dimming signal is linear to light level with less than 1 percent variation. Cadmium sulfide photo-resistors are not acceptable.

f. Sensor is not combined in the same housing or location with occupancy or vacancy sensors if the proper location for one function compromises the successful operation of the other function, or in any way reduces the system's ability to meet the design intent.

2.5.2.7 Time Clocks

****

NOTE: Choose astronomic time clocks if any areas to be controlled by the time clock receive daylight. If the building schedule or use changes depending on the day of the week, select a 7 day time clock.

****

UL 917, NEMA ICS 6. House time clock in a surface-mounted, lockable, NEMA [1][3R][4] enclosure constructed of painted steel or plastic polymer. Provide electronic type time clock that meets the following criteria:

a. [Astronomic][24 hour][7 day][365 day] programming function, providing a total of [56][96][2000][4000] on/off set points.

b. [24 hour][12 hour AM/PM] type digital clock display format.

c. Power outage back-up for time clock utilizing [a capacitor][alkaline batteries][lithium battery] which provides coverage for a minimum of [seven][four][_____] days.

d. Capable of controlling a minimum of [1][2][4][8][12][16][_____] channels or loads.

e. Contacts are rated for [30] [_____] amps at 120-277 VAC resistive load in a [SPST][DPST][SPDT][DPST] [normally open (NO)][normally closed (NC)] configuration.

f. Contains [function that allows automatic control to be skipped on certain selected days of the week][manual bypass or remote override control][daylight savings time automatic adjustment][EEPROM memory module][momentary function for output contacts][ability for photosensor input].

2.6 EXIT AND EMERGENCY LIGHTING EQUIPMENT

****

NOTE: Select a central emergency control system if the building contains an emergency backup generator for critical loads other than egress lighting.

****

2.6.1 Exit Signs

****

NOTE: For Navy projects, provide LED exit signs with battery backup unless specifically instructed otherwise. Normal mode of power to these signs must be the branch circuit serving normal lighting in the same area, ahead of any local switching. The emergency mode of power is the exit sign's self-contained emergency battery pack. Provide remote-powered exit signs only when providing centrally distributed AC or DC emergency power system.

****

UL 924, NFPA 101. Provide wattage as indicated in the luminaire schedule on project plans. Provide LED Exit Signs that meet the following criteria:

a. [Housing constructed of [UV-stable, thermo-plastic][clear polycarbonate housing][painted, die-cast aluminum][painted steel].][Edge-lit type with clear acrylic, edge-lit face and aluminum trim having [clear aluminum][white][chrome][brass][_____] finish.]

b. UL listed for [damp][wet] location.

c. Configured for [universal][ceiling][wall][end] mounting.

d. 150 mm 6 inch high, 19 mm 3/4 inch stroke [red][green] lettering on face of sign with chevrons on either side of lettering to indicate direction.

e. Single or double face as indicated in project plans and luminaire schedule.

2.6.1.1 Exit Signs with Battery Backup

Equip with automatic power failure device, test switch, and pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery must be sealed, maintenance free nickel-cadmium type, and must operate unattended for a period of not less than five years. Emergency run time must be a minimum of 1-1/2 hours. LEDs must have a minimum rated life of 10 years.[Provide self-diagnostic circuitry integral to emergency LED driver.] In lieu of battery, can use a nonradioactive photoluminescent plate.

2.6.1.2 Remote-Powered Exit Signs

Provide exit sign that contains provision for [120-277 VAC][120 VAC][277 VAC][6-48 VDC] input from remote source.

2.6.2 Emergency Lighting Unit (ELU)

UL 924, NFPA 101. Provide emergency lighting units (ELUs) completely assembled with wiring and mounting devices, ready for installation at the locations indicated. Provide in [UV-stable, thermo-plastic] [painted, die-cast aluminum] [painted steel] housing with [UL damp label] [UL wet label] as indicated. Emergency lighting units must be rated for 12 volts, except units having no remote-mounted light sources and having no more than two unit-mounted light sources may be rated six volts. Equip units with brown-out sensitive circuit to activate battery when input voltage falls to 75 percent of normal. Equip with [two] [_____] LED light sources, automatic power failure device, test switch, and pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery must be sealed, maintenance free [lead-calcium] [nickel-cadmium] [_____] type, and must operate unattended for a period of not less than five years. Emergency run time must be a minimum of 90 minutes. LEDs must have a minimum rated life of 10 years.[Provide self-diagnostic circuitry integral to emergency LED driver.]

2.6.3 LED Emergency Drivers

****

NOTE: Provide information on minimum total power in watts of LED(s) in emergency mode to satisfy requirements of NFPA 101, Life Safety Code.

****

UL 924, NFPA 101. Provide LED emergency driver with automatic power failure detection, test switch and LED indicator (or combination switch/indicator) located on luminaire exterior, and fully-automatic solid-state charger, battery and inverter integral to a self-contained housing.[Provide self-diagnostic function integral to emergency

driver.] Integral nickel-cadmium[lead-calcium][_____] battery is required to supply a minimum of 90 minutes of emergency power at [5][7][10][_____] watts, [10-50][_____] VDC[compatible with LED forward voltage requirements], constant output. Driver must be RoHS compliant, rated for installation in plenum-rated spaces and damp locations, and be warranted for a minimum of five years.

2.6.4 Self-Diagnostic Circuitry for LED Drivers

UL 924, NFPA 101. Provide emergency lighting unit with fully-automatic, integral self-testing/diagnostic electronic circuitry. Circuitry must provide for a one minute diagnostic test every 28 days, and a 30 minute diagnostic test every six months, minimum. Any malfunction of the unit must be indicated by LED(s) visible from the exterior of the luminaire. A manual test switch must also be provided to perform a diagnostic test at any given time.

2.6.5 Mini Inverters

UL 924, NFPA 101. Provide mini inverters that are designed to provide power to emergency luminaires. Provide mini inverters that are suitable for [dry] [damp] [wet] installations, operate at a voltage of [120-277] [120] [277] volts at 50/60 hertz, and are capable of operating 0-10V dimming override. Provide mini inverters that supply a minimum of 90 minutes of emergency power.

2.6.6 Central Emergency Lighting System

UL 924, NFPA 101, NFPA 110 level 1, NFPA 70.. Provide a central power system providing emergency power at [277] [120] volts, 60 hertz, for a minimum period of [90] [_____] minutes. Design the system to handle surges during loss and recovery of the voltage, and to deliver its full rated output to the designated lamp load. Provide [batteries] [backup ac source] for power.

2.6.6.1 Operation

Provide system such that when the lighting system loses normal supply voltage, it automatically disengages itself from the normal input line, and switches to a self-contained inverter with built-in protection when the output is shorted or overloaded. Ensure that, when normal line voltage resumes, the emergency system automatically switches back to normal operation. Size the transfer switch for this function to handle [125] [_____] percent of full load. Provide the battery system with self-contained inverters with overload protection.

2.6.6.2 Charger

Provide a completely automatic battery charger that maintains the batteries in a fully charged condition and recharges the batteries to full capacity within [24] [_____] hours after full discharge in accordance with UL 924.

2.6.6.3 Batteries

Provide sealed [lead-acid] [nickel-cadmium] batteries, maintenance-free for a period of not less than [10] [_____] years under normal operating conditions.

2.6.6.4 Accessories

Provide visual indicators to indicate normal power, inverter power, and battery-charger operation. Provide a low-voltage test switch to simulate power failure by interrupting the input line, voltage meter, electrolyte level detector to automatically disable the charging circuit in the event of a fault, and low-voltage cutoff to prevent extreme battery power dissipation.

2.6.6.5 Enclosure

Provide a free-standing cabinet with floor stand and constructed of [2.7] [_____] millimeter [12] [_____]-gage sheet steel with baked-on enamel finish and a locking latch.

2.7 LUMINAIRE MOUNTING ACCESSORIES

2.7.1 Suspended Luminaires

****
NOTE: Coordinate pendent sway bracing details with the architect where required for seismic mitigation. The architect may prefer to provide pendent sway bracing details in locations where appearance is important. Specify shock absorbing hangers for luminaires in certain hazardous locations if indicated.
****

a. Provide hangers capable of supporting twice the combined weight of luminaires supported by hangers.

b. Hangers must allow luminaires to swing within an angle of 45 degrees. Brace pendents 1.2 meters 4 feet or longer to limit swinging.[Provide with swivel hangers to ensure a plumb installation for rigid stem pendents. Provide cadmium-plated steel with a swivel-ball tapped for the conduit size indicated.]

c. Single-unit suspended luminaires must have [cable][twin-stem] hangers. Multiple-unit or continuous row luminaires with a separate power supply cord must have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end.

d. Provide all linear pendent and surface mounted luminaires with two supports per four-foot section or three per eight-foot section unless otherwise recommended by manufacturer.

[e. Provide rods in minimum 4.57 mm 0.18 inch diameter.

]2.7.2 Recess and Surface Mounted Luminaires

Provide access to light source and LED driver from bottom of luminaire. Provide trim [and lenses]for the exposed surface of flush-mounted luminaires as indicated on project drawings and specifications. Luminaires recessed in ceilings which have a fire resistive rating of one hour or more must be enclosed in a box which has a fire resistive rating equal to that of the ceiling. For surface mounted luminaires with brackets, provide flanged metal stem attached to outlet box, with threaded

end suitable for supporting the luminaire rigidly in design position. Flanged part of luminaire stud must be of broad base type, secured to outlet box at not fewer than three points.

2.7.3 Luminaire Support Hardware

2.7.3.1 Wire

ASTM A641/A641M. Galvanized, soft tempered steel, minimum 2.7 mm 0.11 inches in diameter, or galvanized, braided steel, minimum 2 mm 0.08 inches in diameter.

2.7.3.2 Wire for Humid Spaces

****

NOTE: Select stainless steel or nickel copper alloy wire for facilities where high humidity can be expected such as large kitchens and dishwashing areas. Use nickel copper alloy when hangers are used in indoor pool environments. When spacing of hangar wires exceeds 1.2 meters 4 feet or when heavy luminaires are supported, specify eight or 10 gauge wire.

****

ASTM A580/A580M. Composition 302 or 304, annealed stainless steel, minimum 2.7 mm 0.11 inches in diameter.

ASTM B164. UNS NO4400, annealed nickel-copper alloy, minimum 2.7 mm 0.11 inches in diameter.

2.7.3.3 Threaded Rods

Threaded steel rods, 4.76 mm 3/16 inch diameter, zinc or cadmium coated.

2.7.3.4 Straps

Galvanized steel, 25 by 4.76 mm one by 3/16 inch, conforming to ASTM A653/A653M, with a light commercial zinc coating or ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

2.7.4 Power Hook Luminaire Hangers

UL 1598. Provide an assembly consisting of through-wired power hook housing, interlocking plug and receptacle, power cord, and luminaire support loop. Power hook housing must be cast aluminum having two 19 mm 3/4 inch threaded hubs. Support hook must have safety screw. Luminaire support loop must be cast aluminum with provisions for accepting 19 mm 3/4 inch threaded stems. Power cord must include 410 mm 16 inches of 3 conductor No. 16 Type SO cord. Assembly must be rated 120 volts or 277 volts, 15 amperes.

2.8 EQUIPMENT IDENTIFICATION

2.8.1 Manufacturer's Nameplate

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be

acceptable.

2.8.2 Labels

UL 1598. All luminaires must be clearly marked for operation of specific light sources and LED drivers. The labels must be easy to read when standing next to the equipment, and durable to match the life of the equipment to which they are attached. Note the following light source characteristics in the format "Use Only _____":

a. Correlated Color Temperature (CCT) and Color Rendering Index (CRI) for all luminaires.

b. Driver and dimming protocol.

All markings related to light source type must be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when light sources are in place. LED drivers must have clear markings indicating dimming type and indicate proper terminals for the various outputs.

2.9 FACTORY APPLIED FINISH

****

NOTE: This paragraph covers only the basic painting requirements for most electrical equipment. Include any special finishes for high or low temperatures and corrosive atmospheres.

****

NEMA 250. Provide all luminaires and lighting equipment with factory-applied painting system that as a minimum, meets requirements of corrosion-resistance testing.

PART 3 EXECUTION

3.1 INSTALLATION

IEEE C2, NFPA 70.

3.1.1 Light Sources

When light sources are not provided as an integral part of the luminaire, deliver light sources of the type, wattage, lumen output, color temperature (CCT), color rendering index (CRI), and voltage rating indicated to the project site and install just prior to project completion, if not already installed in the luminaires from the factory.

3.1.2 Luminaires

****

NOTE: The electrical designer must coordinate these requirements with architectural plans and specifications. Ensure requirements for antiterrorism/force protection for luminaires in suspended ceilings are included in and coordinated with Section 09 51 00 ACOUSTICAL CEILINGS by referencing ASTM E580 seismic requirements in that section.

Luminaires for facilities located in earthquake zones must have additional supports and restraining devices as described in UFC 1-200-01, "DoD Building Code (General Building Requirements)" and UFC 3-310-04, "Seismic Design for Buildings".

Coordinate pendent sway bracing details with the architect. The architect may prefer to provide pendent sway bracing details in locations where appearance is important.

****

Set luminaires plumb, square, and level with ceiling and walls, in alignment with adjacent luminaires and secure in accordance with manufacturers' directions and approved drawings. Provide accessories as required for ceiling construction type indicated on Finish Schedule. Luminaire catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a luminaire may be installed. Provide wires, straps, or rods for luminaire support in this section. Install luminaires with vent holes free of air blocking obstacles.

3.1.2.1 Suspended Luminaires

Measure mounting heights from the bottom of the luminaire for ceiling-mounted luminaires and to center of luminaire for wall-mounted luminaires. Obtain architect approval of the exact mounting height on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Support suspended luminaires from structural framework of ceiling or from inserts cast into slab.

a. Provide suspended luminaires with 45 degree swivel hangers so that they hang plumb and level.

b. Locate so that there are no obstructions within the 45 degree range in all directions.

c. The stem, canopy and luminaire must be capable of 45 degree swing.

d. Rigid pendent stem, aircraft cable, rods, or chains 1.2 meters 4 feet or longer excluding luminaire must be braced to prevent swaying using three cables at 120 degree separation.

e. Suspended luminaires in continuous rows must have internal wireway systems for end to end wiring and must be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces.

f. Utilize aligning splines on extruded aluminum luminaires to assure minimal hairline joints.

g. Support steel luminaires to prevent "oil-canning" effects.

h. Match supporting pendents with supported luminaire. Aircraft cable must be stainless steel.

i. Match finish of canopies to match the ceiling, and provide low profile canopies unless otherwise shown.

j. Maximum distance between suspension points must be 3.1 meters 10 feet or as recommended by the manufacturer, whichever is less.

3.1.2.2 Recessed and Semi-Recessed Luminaires

a. Support recessed and semi-recessed luminaires independently from the building structure by a minimum of two wires, straps or rods per luminaire and located near opposite corners of the luminaire. Secure horizontal movement with clips provided by manufacturer. Ceiling grid clips are not allowed as an alternative to independently supported luminaires.

b. Support round luminaires or luminaires smaller in size than the ceiling grid independently from the building structure by a minimum of four wires, straps or rods per luminaire, spaced approximately equidistant around.

c. Do not support luminaires by acoustical tile ceiling panels.

d. Where luminaires of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support each independently and provide at least two 19 mm 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the luminaire.

e. Luminaires installed in suspended ceilings must also comply with the requirements of Section 09 51 00 ACOUSTICAL CEILINGS.

f. Adjust aperture rings on all applicable ceiling recessed luminaires to accommodate various ceiling material thickness. Coordinate cut-out size in ceiling to ensure aperture covers cut-out entirely. Install aperture rings such that the bottom of the ring is flush with finished ceiling or not more than 1.6 mm 1/16 inch above. Do not install luminaires such that the aperture ring extends below the finished ceiling surface.

[g. For luminaire recessed in plaster ceilings, provide plaster frames for setting. Install setting such that the bottom of the frame is flush with finished ceiling. Support luminaires with plaster frames utilizing yokes or leveling lugs. Do not mount luminaires or support elements to ducts or pipes. Yokes must support a luminaire by no fewer than two bolts each.

]3.1.2.3 Field Applied Painting

****

NOTE: Use and coordinate paint and coating requirements with Section 09 90 00 PAINTS AND COATINGS when provided in the job. If Section 09 90 00 PAINTS AND COATINGS is not provided or when requirements are beyond what is specified in Section 09 90 00 PAINTS AND COATINGS, specify the requirements in this paragraph.

****

Provide field applied painting for luminaire type [_____]. Paint lighting equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Provide painting as specified in Section 09 90 00 PAINTS AND COATINGS.

3.1.3 LED Drivers

Provide LED drivers integral to luminaire as constructed by the manufacturer.

[3.1.3.1 Remote LED Drivers

Locate Remote LED Drivers within the maximum distance allowed to minimize voltage drop. Do not locate remote LED drivers further from the light source than specified by the manufacturer. Locate remote LED drivers in dry, well-ventilated, and accessible location, above accessible ceilings or behind a removable wall or ceiling panel. Mount housing or junction box so that it is rigidly and securely fastened in place. Install LED drivers such that components are not in contact with combustible materials unless listed for such condition. Remote LED drivers must be grounded in accordance with NFPA 70.

Provide separate compartments for Class 2 wiring connections and for Class 1 wiring connections. Separation must be barrier-type within the same box or separate boxes with close connector conduit fittings. Field connections must be inside housing or junction box or secured by a quick disconnect wire connector.

]3.1.4 Exit Signs

****
NOTE: Select the second paragraph if a central emergency system is specified. Requirements for central emergency systems are included in Section 26 52 00.00 40 EMERGENCY LIGHTING.
****

NFPA 101. Wire exit signs and emergency lighting units ahead of the local switch, to the normal lighting circuit located in the same room or area.

[Connect exit signs on separate circuits and serve from [an emergency panel][a separate circuit breaker][a fused disconnect switch]. Provide only one source of control, which would be [the circuit breaker in the emergency panel][the separate circuit breaker][the fused disconnect switch]. Paint source of control red and provide lockout capability.

]3.1.5 Lighting Controls

****
NOTE: Include a version of Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS edited specifically for the lighting control system where a lighting control system is specified.
****

Refer to Section 25 05 11.[_____] CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS for additional lighting control installation requirements.

3.1.5.1 Scene Wallstations

Submit labeling templates for all scene wallstations, ganged faceplates and other manual control cover plates. Label each scene control button with approved scene description.

3.1.5.2 Occupancy/Vacancy Sensors

****

NOTE: Include sensor testing requirement here when project does not include a separate commissioning specification. When it does, provide sensor testing requirements in the commissioning specification. Coordinate commissioning requirements with Section 01 91 00.15 BUILDING COMMISSIONING.

****

a. Provide quantity of sensor units indicated as a minimum. Provide additional units to give full coverage over controlled area. Full coverage must provide hand and arm motion detection for office and administration type areas and walking motion for industrial areas, warehouses, storage rooms and hallways.

b. Locate ceiling-mounted sensors no closer than 2 meters 6 feet from the nearest HVAC supply or return diffuser.

c. Locate the sensor(s) as indicated and in accordance with the manufacturer's recommendations.

3.1.5.3 Photosensors

****

NOTE: Include sensor testing requirement here when project does not include a separate commissioning specification. When it does, provide sensor testing requirements in the commissioning specification. Coordinate commissioning requirements with Section 01 91 00.15 BUILDING COMMISSIONING.

****

Locate and aim sensor as indicated and in accordance with the manufacturer's recommendations. Adjust sensor set-point in accordance with the manufacturer's recommendations and for the indicated light level of the area of coverage, measured at the work plane.

3.2 FIELD QUALITY CONTROL

3.2.1 Tests

3.2.1.1 Lighting Control Verification Tests

Verify lighting control system and devices operate according to approved sequence of operations. Verification tests are to be completed after commissioning.

a. Verify occupancy/vacancy sensors operate as described in sequence of operations. Provide testing of sensor coverage, sensitivity, and time-out settings in all spaces where sensors are placed. This is to be completed only after all furnishings have been installed. Submit occupancy/vacancy sensor verification test.

b. Verify photosensors operate as described in sequence of operations. Provide testing of sensor coverage, aiming, and calibration in all spaces where sensors are placed. This is to be completed only after

all furnishings have been installed. Submit photosensor verification test.

c. Verify wall box dimmers and scene wallstations operate as described in sequence of operations.

3.2.1.2 Emergency Lighting Test

Interrupt power supply to demonstrate proper operation of emergency lighting. If adjustments are made to the lighting system, re-test system to show compliance with standards.

3.3 CLOSEOUT ACTIVITIES

3.3.1 Commissioning

****
NOTE: Coordinate commissioning requirements with Section 01 91 00.15 BUILDING COMMISSIONING.
****

NFPA 101. Commission all components of the lighting system and lighting control system in accordance with Section 01 91 00.15 BUILDING COMMISSIONING. Factory Trained Field Service Technician is responsible for calibration and programming sequences for input devices and systems in accordance with the requirements described in the sequence of operation.

3.3.2 Training

3.3.2.1 Maintenance Staff Training

Submit a Maintenance Staff Training Plan at least 30 calendar days prior to training session that describes training procedures for Owner's personnel in the operation and maintenance of lighting and lighting control system. Provide on-site training which demonstrates full system functionality, assigning schedules, calibration adjustments for light levels and sensor sensitivity, integration procedures for connecting to third-party devices, and manual override including information on appropriate use. Provide protocols for troubleshooting, maintenance, repair, and replacement, and literature on available system updates and process for implementing updates.

3.3.2.2 End-User Training

Submit an End-User Training Plan at least 30 calendar days prior to training session that describes training procedures for end-users on the lighting control system. Provide users with a list of control devices located within user-occupied spaces, such as photosensors and occupancy and vacancy sensors, including information on the proper operation and schedule for each device. Provide demonstration for each type of interface. Provide users with the building schedule as currently commissioned, including conditional programming based on astronomic time clock functionality. Provide users with the correct contact information for maintenance personnel who will be available to address any lighting control issues.

Provide laminated instructions to the user at each scene wallstation. Provide only instructions relevant to the functionality of the specific scene wallstation. Provide a description of each labeled scene control button. If the room utilizes occupancy/vacancy sensors or photosensors, include a description of this functionality on the instruction sheet.

-- End of Section --