

SECTION 26 51 00

INTERIOR LIGHTING

07/07

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM A 641/A 641M (2003) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

CALIFORNIA ENERGY COMMISSION (CEC)

CEC Title 24 (1978; R 2009) California's Energy Efficiency Standards for Residential and Nonresidential Buildings

GREEN SEAL (GS)

GC-12 (1997) Occupancy Sensors

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

IESNA HB-9 (2000; Errata 2004; Errata 2005) IES Lighting Handbook

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (2007; Errata 2007) National Electrical Safety Code

IEEE C62.41.1 (2002) IEEE Guide on the Surges Environment in Low-voltage (1000V and Less) AC Power Circuits

IEEE C62.41.2 (2002) IEEE Recommended Practice on Characterization of Surges in Low-voltage (1000V and Less) AC Power Circuits

IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2008) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA C78.1381 (1998) Electric Lamps - 250-Watt, 70 Watt, M85 Metal-Halide Lamps

NEMA C78.42 (2004) Standard for High-Pressure Sodium

Lamps

- NEMA C78.43 (2007) Standard for Electric Lamps - Single-Ended Metal-Halide Lamps
- NEMA C78.81 (2005) Electric Lamps - Double-capped Fluorescent Lamps Dimensional and Electrical Characteristics
- NEMA C78.901 (2005) Electric Lamps - Single Base Fluorescent Lamps Dimensional and Electrical Characteristics
- NEMA C82.11 (2002) High-Frequency Fluorescent Lamp Ballasts
- NEMA C82.4 (2002) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)
- NEMA ICS 2 (2000; Errata 2002; R 2005; Errata 2006) Standard 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
- NEMA ICS 6 (1993; R 2006) Standard for Industrial Controls and Systems Enclosures
- NEMA LL 1 (1997; R 2002) Procedures for Linear Fluorescent Lamp Sample Preparation and the TCLP Extraction

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- NFPA 101 (2005; Errata 2006; TIA 2006; TIA 2006) Life Safety Code, 2006 Edition
- NFPA 70 (2007; AMD 1 2008) National Electrical Code - 2008 Edition
- NFPA 90A (2002; Errata 2003; Errata 2005) Standard for the Installation of Air Conditioning and Ventilating Systems

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

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

UNDERWRITERS LABORATORIES (UL)

- UL 1029 (1994; Rev thru Feb 2006) Standard for Safety High-Intensity-Discharge Lamp Ballasts
- UL 1598 (2008; Rev thru Nov 2008) Luminaires

UL 20	(2000 ; Rev thru Dec 2004) Standard for General-Use Snap Switches
UL 50	(2007) Standard for Enclosures for Electrical Equipment
UL 595	(1985; Rev thru Sep 1991) Marine-Type Electric Lighting Fixtures
UL 67	(1993; Rev thru Jul 2008) Standard for Panelboards
UL 773	(1995; Rev thru Mar 2002) Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting
UL 773A	(2006) Nonindustrial Photoelectric Switches for Lighting Control
UL 844	(2006; Rev thru Jul 2006) Standard for Electric Lighting Fixtures for Use in Hazardous (Classified) Locations
UL 924	(2006) Standard for Emergency Lighting and Power Equipment
UL 935	(2001; Rev thru Feb 2006) Standard for Fluorescent-Lamp Ballasts

1.2 RELATED REQUIREMENTS

Materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in this section.

1.3 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.
- b. Average life is the time after which 50 percent will have failed and 50 percent will have survived under normal conditions.
- c. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.4 SYSTEM DESCRIPTION

1.4.1 Lighting Control System

Provide lighting control system as indicated. Lighting control equipment shall include switching circuit breakers, lighting control panelboard, control electronics, power packs, dimming ballasts, occupancy sensors, and light level sensors as required or needed.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Data, drawings, and reports shall employ the terminology, classifications, and methods prescribed by the IESNA HB-9, as applicable, for the lighting system specified.

SD-03 Product Data

Fluorescent lighting fixtures; G
Fluorescent electronic ballasts; G
Fluorescent lamps; G
High-intensity-discharge (HID) lighting fixtures; G
HID ballasts; G
High-pressure sodium (HPS) lamps; G
Metal-halide lamps; G
Incandescent lighting fixtures; G
Incandescent lamps; G
Dimmer switch; G
Lighting contactor; G
Time switch; G
Photocell switch; G
Power hook fixture hangers; G
Exit signs; G
Emergency lighting equipment; G
Occupancy sensors; G
Electronic dimming ballast; G
Dimming ballast controls; G
Light Level Sensor; G
Lighting Control System; G
Switching Circuit Breakers; G
Lighting Control Panelboard; G

SD-10 Operation and Maintenance Data

Lighting Control System, Data Package 5; G

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein, showing all light fixtures, control modules, control zones, occupancy sensors, light level sensors, power packs, dimming ballasts, schematic diagrams and all interconnecting control wire, conduit, and associated hardware.

Operational Service

Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

1.6 QUALITY ASSURANCE

1.6.1 Fluorescent Electronic Ballasts

Submit ballast catalog data as required in the paragraph entitled "Fluorescent Lamp Electronic Ballasts" contained herein. As an option, submit the fluorescent fixture manufacturer's electronic ballast specification information in lieu of the actual ballast manufacturer's catalog data. This information shall include published specifications and sketches, which covers the information required by the paragraph entitled "Fluorescent Lamp Electronic Ballasts" herein. This information may be supplemented by catalog data if required, and shall contain a list of vendors with vendor part numbers.

1.6.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.3 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 shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall 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.

1.6.3.1 Alternative Qualifications

Products having less than a 2-year 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.

1.6.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6.3.3 Energy Efficiency

Comply with National Energy Policy Act and Energy Star requirements for lighting products. Submit documentation for Energy Star and CEC Title 24 qualifications for equipment provided under this section. Submit data indicating lumens per watt efficiency and color rendition index of light source.

1.7 WARRANTY

The equipment items shall be supported 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.

1.7.1 Electronic Ballast Warranty

Furnish the electronic ballast manufacturer's warranty. The warranty period shall not be less than 5 years from the date of manufacture of the electronic ballast. Ballast assembly in the lighting fixture, transportation, and on-site storage shall not exceed 12 months, thereby permitting 4 years of the ballast 5 year warranty to be in service and energized. The warranty shall state that the malfunctioning ballast shall be exchanged by the manufacturer and promptly shipped to the using Government facility. The replacement ballast shall be identical to, or an improvement upon, the original design of the malfunctioning ballast.

1.8 SUSTAINABLE DESIGN REQUIREMENTS

1.8.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.

PART 2 PRODUCTS

2.1 FLUORESCENT LIGHTING FIXTURES

UL 1598. Fluorescent fixtures shall have electronic ballasts unless specifically indicated otherwise.

2.1.1 Fluorescent Lamp Electronic Ballasts

The electronic ballast shall as a minimum meet the following characteristics:

- a. Ballast shall comply with [UL 935](#), [NEMA C82.11](#), [NFPA 70](#), and [CEC Title 24](#) unless specified otherwise. Ballast shall be 100% electronic high frequency type with no magnetic core and coil components. Ballast shall provide transient immunity as recommended by [IEEE C62.41.1](#) and [IEEE C62.41.2](#). Ballast shall be designed for the wattage of the lamps used in the indicated application. Ballasts shall be designed to operate on the voltage system to which they are connected.
 - b. Power factor shall be 0.95 (minimum).
 - c. Ballast shall operate at a frequency of 20,000 Hertz (minimum). Ballast shall be compatible with and not cause interference with the operation of occupancy sensors or other infrared control systems. Provide ballasts operating at or above 40,000 Hertz where available.
 - d. Ballast shall have light regulation of plus or minus 10 percent lumen output with a plus or minus 10 percent input voltage regulation. Ballast shall have 10 percent flicker (maximum) using any compatible lamp.
 - e. Ballast factor shall be between 0.85 (minimum) and 1.00 (maximum). Current crest factor shall be 1.7 (maximum).
 - f. Ballast shall be UL listed Class P with a sound rating of "A."
 - g. Ballast shall have circuit diagrams and lamp connections displayed on the ballast.
 - h. Ballasts shall be programmed start unless otherwise indicated. Programmed start ballasts may operate lamps in a series circuit configuration. Provide series/parallel wiring for programmed start ballasts where available.
 - i. Ballasts for compact fluorescent fixtures shall be programmed start.
 - j. Ballasts for T-5 and smaller lamps shall have end-of-life protection circuits as required by [NEMA C78.81](#) and [NEMA C78.901](#) as applicable.
 - k. Ballast shall be capable of starting and maintaining operation at a minimum of 0 degrees F unless otherwise indicated.
 - l. Electronic ballast shall have a full replacement warranty of 5 years from date of manufacture as specified in paragraph entitled "Electronic Ballast Warranty" herein.
- 2.1.1.1 T-8 Lamp Ballast
- a. Total harmonic distortion (THD): Shall be 10 percent (maximum).
 - b. Input wattage.
 1. 32 watts (maximum) when operating one F32T8 lamp
 2. 62 watts (maximum) when operating two F32T8 lamps
 3. 92 watts (maximum) when operating three F32T8 lamps
 4. 114 watts (maximum) when operating four F32T8 lamps

- c. Ballast efficacy factor.
 - 1. 2.54 (minimum) when operating one F32T8 lamp
 - 2. 1.44 (minimum) when operating two F32T8 lamps
 - 3. 0.93 (minimum) when operating three F32T8 lamps
 - 4. 0.73 (minimum) when operating four F32T8 lamps
- d. Provide three and four lamp fixtures with two ballasts per fixture where multilevel switching is indicated.

2.1.1.2 F17T8 Lamp Ballast

- a. Total harmonic distortion (THD): Shall be 25 percent (maximum).
- b. Input wattage:
 - 1. 34 watts (maximum) when operating two F17T8 lamps.

2.1.1.3 T-5 Long Twin Tube Lamp Ballast

- a. Total harmonic distortion (THD): Shall not be greater than 25 percent when operating one lamp, 15 percent when operating two lamps, and 20 percent when operating three lamps.
- b. Input wattage:
 - 1. 45 watts (maximum) when operating one F40 T-5 lamps
 - 2. 74 watts (maximum) when operating two F40 T-5 lamps
 - 3. 105 watts (maximum) when operating three F40 T-5 lamps
- c. Provide three and four lamp fixtures with two ballasts per fixture where multilevel switching is indicated.

2.1.1.4 F96T8 Lamp Ballast

- a. Total harmonic distortion (THD): Shall not be greater than 30 percent when operating one lamp and 20 percent when operating two lamps.
- b. Input wattage:
 - 1. 56 watts (maximum) when operating one F96T8 lamps
 - 2. 102 watts (maximum) when operating two F96T8 lamps

2.1.2 Fluorescent Lamp [Electronic Dimming Ballast](#)

The electronic ballast shall as a minimum meet the following characteristics:

- a. Ballast shall comply with [NEMA C82.11](#), [UL 935](#), and [NFPA 70](#), unless specified otherwise. Ballast shall provide transient immunity as recommended by [IEEE C62.41.1](#) and [IEEE C62.41.2](#). Ballast dimming capability range shall be from 100 to 5 percent (minimum range) of light output, flicker free. Ballast shall start lamp at any preset

light output setting without first having to go to full light output. Ballast shall be designed for the wattage of the lamps used in the indicated application. Ballasts shall be designed to operate on the voltage system to which they are connected.

- b. Power factor shall be 0.95 (minimum) at full light output, and 0.90 (minimum) over the entire dimming range.
- c. Ballast shall operate at a frequency of 20,000 Hertz (minimum). Ballast shall be compatible with and not cause interference with the operation of occupancy sensors or other infrared control systems. Provide ballasts operating at or above 40,000 Hertz where available.
- d. Ballast factor at full light output shall be between 0.85 (minimum) and 1.00 (maximum). Current crest factor shall be 1.7 (maximum).
- e. Ballast shall be UL listed Class P with a sound rating of "A".
- f. Ballast shall have circuit diagrams and lamp connections displayed on the ballast.
- g. Ballast shall be programmed start. Ballast may operate lamps in a series circuit configuration. Provide series/parallel wiring for programmed start ballasts where available.
- h. Ballasts for compact fluorescent fixtures shall be programmed start.
- i. Ballast shall be capable of starting and maintaining operation at a minimum of 0 degrees F unless otherwise indicated.
- j. Total harmonic distortion (THD): Shall be 20 percent (maximum) over the entire dimming range.
- k. Ballasts for T-5 and smaller lamps shall have end-of-life protection circuits as required by NEMA C78.81 and NEMA C78.901 as applicable.

2.1.2.1 T-8 Lamp Ballast

Input wattage, for indicated lamp quantity shall be:

- a. 35 watts (maximum) when operating one F32T8 lamp.
- b. 70 watts (maximum) when operating two F32T8 lamps.
- c. 104 watts (maximum) when operating three F32T8 lamps.

2.1.3 Dimming Ballast Controls

The dimming ballast controls shall be a slide dimmer with on/off control. The slide dimmer shall be compatible with the ballast and control the ballast light output over the full dimming range. Dimming ballast controls shall be approved by the ballast manufacturer.

2.1.4 Light Level Sensor

UL listed. Light level sensor shall be capable of detecting changes in ambient lighting levels, shall provide a dimming range of 20 percent to 100 percent, minimum, and shall be designed for use with dimming ballast and voltage system to which they are connected. Sensor shall be capable of

controlling 40 electronic dimming ballast, minimum. Sensor light level shall be adjustable and have a set level range from 10 to 100 footcandles, minimum. Sensor shall have a bypass function to electrically override sensor control.

2.1.5 Electromagnetic Ballasts for Compact Fluorescent Lamps

Provide electromagnetic ballasts for compact fluorescent lamps.

2.1.6 Fluorescent Lamps

- a. T-8 rapid start low mercury lamps shall be rated 32 watts (maximum), 2800 initial lumens (minimum), CRI of 75 (minimum), color temperature of 3500 K, and an average rated life of 20,000 hours. Low mercury lamps shall have passed the EPA Toxicity Characteristic Leachate Procedure (TCLP) for mercury by using the lamp sample preparation procedure described in NEMA LL 1.
- b. T-8 instant start lamp, 59 watts (maximum), nominal length of 96 inches, minimum CRI of 75, 5700 initial lumens, color temperature of 3500 K, and average rated life of 15,000 hours.
- c. T-5, long twin tube fluorescent lamp, 40 watts (maximum), 3500 K, 22.6 inches maximum length, 20,000 hours average rated life, 3150 initial lumens, CRI of 80 (minimum), 2G11 Type base, 90 to 100 lumens/watt depending on wattage.
- d. T-8, U shaped fluorescent lamp, 31 watts maximum, 2600 initial lumens (minimum), 3500 K, 75 CRI (minimum), 20,000 hours average rated life, 1.625 inch leg spacing.
- e. Compact fluorescent lamps shall be: CRI 80, minimum, 3500 K, 10,000 hours average rated life, and as follows:
 1. T-4, twin tube, rated 5 watt, 250 initial lumens (minimum) 7 watts, 400 initial lumens (minimum), 9 watts, 600 initial lumens (minimum), and 13 watts, 825 initial lumens (minimum), as indicated.
 2. T-4, double twin tube, rated 13 watts, 900 initial lumens (minimum), 18 watts, 1200 initial lumens (minimum), and 26 watts, 1800 initial lumens (minimum), as indicated.

Average rated life is based on 3 hours operating per start.

2.1.7 Compact Fluorescent Fixtures

Compact fluorescent fixtures shall be manufactured specifically for compact fluorescent lamps with ballasts integral to the fixture. Providing assemblies designed to retrofit incandescent fixtures is prohibited except when specifically indicated for renovation of existing fixtures. Fixtures shall use lamps as indicated, with a minimum CRI of 80.

2.1.8 Open-Tube Fluorescent Fixtures

Provide with self-locking sockets, or lamp retainers (two per lamp). Provide a clear polycarbonate protective sleeve with end caps, over lamp, with 95 percent (minimum) light transmission. The sleeve shall be rated to withstand the thermal profile of the lamp and ballast.

2.1.9 Air Handling Fixtures

Fixtures used as air handling registers shall meet requirements of NFPA 90A.

2.2 HIGH-INTENSITY-DISCHARGE (HID) LIGHTING FIXTURES

UL 1598. Provide HID fixtures with tempered glass lenses when using metal-halide lamps.

2.2.1 HID Ballasts

UL 1029 and NEMA C82.4 and shall be constant wattage autotransformer (CWA) or regulator, high power factor type (minimum 90%). Provide single-lamp ballasts which shall have a minimum starting temperature of minus 30 degrees C. Ballasts shall be:

- a. Designed to operate on the voltage system to which they are connected.
- b. Designed for installation in a normal ambient temperature of 40 degrees C.
- c. Constructed so that open circuit operation will not reduce the average life.

High-pressure sodium (HPS) ballasts shall have a solid-state igniter/starter with an average life in the pulsing mode of 3500 hours at the intended ambient temperature. Igniter case temperature shall not exceed 90 degrees C in any mode.

2.2.2 High-Pressure Sodium (HPS) Lamps

NEMA C78.42 wattage as indicated. 150 watt lamps, if required, shall be 55 volt type.

2.2.2.1 Luminaire Efficiency Rating (LER)

- a. Upward efficiency of 0%
 1. 150-399 watts: minimum 58 LER for closed fixture; minimum 68 for open fixture
 2. 400-999 watts: minimum 63 LER for closed fixture; minimum 84 for open fixture
- b. Upward efficiency of 1%-10%
 1. 150-399 watts: minimum 64 LER for closed fixture; minimum 63 for open fixture
 2. 400-999 watts: minimum 82 LER for closed fixture; minimum 89 for open fixture
 3. 1000+ watts: minimum 109 LER for open fixture
- c. Upward efficiency of 11% to 20%
 1. 150-399 watts: minimum 78 LER for open fixture

2. 400-999 watts: minimum 94 for open fixture

d. Upward efficiency greater than 20%

1. 150-399 watts: minimum 75 LER for closed fixture; minimum 77 for open fixture

2.2.3 Metal-Halide Lamps

a. Double-ended, 70 watt, conforming to NEMA C78.1381

b. Single-ended, wattage as indicated, conforming to NEMA C78.43

2.2.3.1 Luminaire Efficiency Rating (LER)

a. Upward efficiency of 0%

1. 150-399 watts: minimum 41 LER for closed fixture

2. 400-999 watts: minimum 53 LER for closed fixture; minimum 59 for open fixture

3. 1000+ watts: minimum 77 LER for closed fixture

b. Upward efficiency of 1%-10%

1. 150-399 watts: minimum 56 LER for closed fixture

2. 400-999 watts: minimum 62 LER for closed fixture; minimum 64 for open fixture

3. 1000+ watts: minimum 88 LER for open fixture

c. Upward efficiency greater than 20%

1. 150-399 watts: minimum 62 LER for closed fixture; minimum 77 for open fixture

2. 400-999 watts: minimum 65 LER for closed fixture

2.3 INCANDESCENT LIGHTING FIXTURES

Use of incandescent lamps and fixtures is prohibited, unless specifically indicated otherwise. UL 1598.

2.3.1 Incandescent Lamps

Provide the number, type, and wattage indicated.

2.4 RECESS- AND FLUSH-MOUNTED FIXTURES

Provide type that can be relamped from the bottom. Access to ballast shall be from the bottom. Trim for the exposed surface of flush-mounted fixtures shall be as indicated.

2.5 SUSPENDED FIXTURES

Provide hangers capable of supporting twice the combined weight of fixtures supported by hangers. Provide with swivel hangers to ensure a plumb

installation. Hangers shall be cadmium-plated steel with a swivel-ball tapped for the conduit size indicated. Hangers shall allow fixtures to swing within an angle of 45 degrees. Brace pendants 4 feet or longer to limit swinging. Single-unit suspended fixtures shall have twin-stem hangers. Multiple-unit or continuous row fluorescent fixtures shall 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. Rods shall be a minimum 0.18 inch diameter.

2.6 FIXTURES FOR HAZARDOUS LOCATIONS

In addition to requirements stated herein, provide fluorescent fixtures for hazardous locations which conform to UL 844 or which have Factory Mutual certification for the class and division indicated. Fixture shall also conform to UL 595 for marine environments as indicated.

2.7 SWITCHES

2.7.1 Toggle Switches

Provide toggle switches as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.7.2 Incandescent Dimmer Switch

UL 20, single-pole, 600 watt, 120 volt ac, full-range rotary on-off type with built-in electromagnetic interference filter.

2.8 LIGHTING CONTACTOR

NEMA ICS 2, mechanically held contactor. Rate contactor as indicated. Provide in NEMA 1 enclosure conforming to NEMA ICS 6. Contactor shall have silver alloy double-break contacts and coil clearing contacts for mechanically held contactor. Provide contactor with hand-off-automatic selector switch.

2.9 TIME SWITCH

Astronomic dial type or electronic type, arranged to turn "ON" at sunset and turn "OFF" at predetermined time between 8:30 p.m. and 2:30 a.m. or sunrise, automatically changing the settings each day in accordance with seasonal changes of sunset and sunrise. Provide switch rated 120 volts, having automatically wound spring mechanism or capacitor, to maintain accurate time for a minimum of 15 hours following power failure. Provide time switch with a manual on-off bypass switch. Housing for the time switch shall be surface-mounted, NEMA 1 enclosure conforming to NEMA ICS 6.

2.10 PHOTOCCELL SWITCH

UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell rated 120 volts ac, 60 Hz with single pole double-throw (SPDT) contacts for control of mechanically held contactors, rated 1000 W. Switch shall turn on at or below 3 footcandles and off at 2 to 10 footcandles. A time delay shall prevent accidental switching from transient light sources. Provide switch:

- a. In a cast weatherproof aluminum housing with adjustable window slide, rated 1800 VA, minimum.

2.11 POWER HOOK FIXTURE HANGERS

Provide UL listed assembly including through-wired power hook housing, interlocking plug and receptacle, power cord, and fixture support loop. Power hook housing shall be cast aluminum having two 3/4 inch threaded hubs. Support hook shall have safety screw. Fixture support loop shall be cast aluminum with provisions for accepting 3/4 inch threaded fixture stems. Power cord shall include 16 inches of 3 conductor No. 16 Type SO cord. Assembly shall be rated 120 volts or 277 volts, 15 amperes.

2.12 EXIT SIGNS

UL 924, NFPA 70, and NFPA 101. Exit signs shall be self-powered type. Exit signs shall use no more than 5 watts.

2.12.1 Self-Powered LED Type Exit Signs (Battery Backup)

Provide with automatic power failure device, test switch, pilot light, integral self-testing module and fully automatic high/low trickle charger in a self-contained power pack. Battery shall be sealed electrolyte type, shall operate unattended, and require no maintenance, including no additional water, for a period of not less than 5 years. LED exit sign shall have emergency run time of 1 1/2 hours (minimum). The light emitting diodes shall have rated lamp life of 70,000 hours (minimum).

2.13 EMERGENCY LIGHTING EQUIPMENT

UL 924, NFPA 70, and NFPA 101. Provide lamps in wattage indicated. Provide accessories required for remote-mounted lamps where indicated. Remote-mounted lamps shall be as indicated.

2.13.1 Emergency Lighting Unit

Provide as indicated. Emergency lighting units shall be rated for 12 volts, except units having no remote-mounted lamps and having no more than two unit-mounted lamps may be rated 6 volts. Equip units with brown-out sensitive circuit to activate battery when ac input falls to 75 percent of normal voltage and 15 minute time delay feature for areas with HID lighting. Provide integral self-testing module.

2.14 OCCUPANCY SENSORS

UL listed. Comply with GC-12. Occupancy sensors and power packs shall be designed to operate on the voltage indicated. Sensors and power packs shall have circuitry that only allows load switching at or near zero current crossing of supply voltage. Occupancy sensor mounting as indicated. Sensor shall have an LED occupant detection indicator. Sensor shall have adjustable sensitivity and adjustable delayed-off time range of 5 minutes to 15 minutes. Wall mounted sensors shall match the color of adjacent wall plates as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, ceiling mounted sensors shall be white. Ceiling mounted sensors shall have 360 degree coverage unless otherwise indicated.

- a. Ultrasonic sensor shall be crystal controlled and shall not cause detection interference between adjacent sensors.
- b. Infrared sensors shall have a daylight filter. Sensor shall have a fresnel lens that is applicable to space to be controlled.

- c. Ultrasonic/Infrared Combination Sensor
- d. Microwave and audiophonic sensors.

Occupancy detection to turn lights on requires both ultrasonic and infrared sensor detection. Lights shall remain on if either the ultrasonic or infrared sensor detects movement. Infrared sensor shall have lens selected for indicated usage and daylight filter to prevent short wavelength infrared interference. Ultrasonic sensor frequency shall be crystal controlled.

2.15 SUPPORT HANGERS FOR LIGHTING FIXTURES IN SUSPENDED CEILINGS

2.15.1 Wires

ASTM A 641/A 641M, galvanized regular coating, soft temper, 0.1055 inches in diameter (12 gage).

2.15.2 Rods

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

2.16 EQUIPMENT IDENTIFICATION

2.16.1 Manufacturer's Nameplate

Each item of equipment shall 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.

2.16.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. All luminaires shall be clearly marked for operation of specific lamps and ballasts according to proper lamp type. The following lamp characteristics shall be noted in the format "Use Only _____":

- a. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
- b. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
- c. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
- d. ANSI ballast type (M98, M57, etc.) for HID luminaires.
- e. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

All markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Ballasts shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.17 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

2.18 LIGHTING CONTROL SYSTEM

2.18.1 Lighting Control System

a. The lighting control system shall consist of microprocessor-based control electronics with remotely operated circuit breakers mounted to a UL 67 listed lighting panelboard interior and enclosed in a UL 50 listed panelboard enclosure. The circuit breakers shall provide overcurrent protection, and have an AIR rating that meets or exceeds the fault current of the system to which the panelboard is being applied.

b. Each master control panel shall meet or exceed the following capabilities:

1. Sixteen (16) 2-wire input terminals for connection to external low voltage switch contacts.
2. Time of day scheduling to automatically shut off lighting at specific programmed times
3. Direct control of 168 branch circuits in a master/slave sub-net configuration.
4. Provide true status feedback by monitoring branch circuit breaker status based on actual system voltage at load side terminal.
5. Accept remote commands through the facilities Ethernet infrastructure.

c. All lighting control components shall be installed in a conventional panelboard 20 inches wide. Suitable barriers shall be installed to separate Class 2 wiring from power conductors.

2.18.2 Hardware

a. Remotely operated circuit breakers and electronics shall be integral to the lighting panelboard.

b. Remotely Operated Circuit Breakers-all remotely operated branch circuit breakers shall provide overload and short circuit protection suitable for the location in the electrical system, as defined in the panelboard schedules. Remotely operated power switching devices shall have the following:

1. Integral branch circuit overcurrent protection as required by the National Electrical Code (NEC).
2. UL Listed SWD ratings for 15A and 20A 1-, 2- and 3-pole branch devices, HID ratings, and HACR ratings.
3. Handle operator that shall mechanically open the power

switching device contacts when moved to the OFF position and disable the contacts from being remotely closed.

4. Manual override switch to enable or disable the remote operation of the device and allow breaker handle to fully control the On/Off state of the breaker.

5. Visible flag that clearly indicates the status of the circuit breaker contacts with the panel trim installed.

6. Switching endurance rating of 200,000 open/close/open remote operations.

c. Lighting Control Electronics-Master Panelboards:

1. Panels identified on the panel schedule as master panels shall contain both a power supply module and controller in the indicated spaces. Master panels provide power and control for operating and monitoring remotely operated branch circuit breakers connected to control busses located in master and slave panelboards. One power supply module and controller shall support up to eight (8) control busses.

2. Master panels shall contain a nameplate label, located on the panel trim indicating its designation, automation level network address, and the designations and addresses of all associated slave panels.

3. A power supply module shall be furnished to provide control power for the operation of the remotely operated circuit breakers, controller, bus system and low voltage inputs. Power module(s) shall connect directly to the panel interior and receive line voltage from the panel bus. Power module(s) shall be internally self-protected and operate within a range of -15% to +10% of its nominal line voltage rating.

4. The controller shall be as shown on the Drawings.

d. Keypads - Neo Style:

1. Provide wall mount programmable keypads as designated on the drawings. Keypads shall be designed to control lighting applications. The units shall be able to control any system output device including remotely operated circuit breakers, relays, dimmers, and analogue outputs.

2. Keypad functions shall be configurable before, during, or after installation. Each key shall be capable of being programmed to achieve various control functions including, setting a scene, toggle switch, dimmer control, timer or pre-set. All control information for the keypad shall be held in non-volatile memory on the unit itself. In the event of power failure, the non-volatile memory shall retain all programmed information relating to the unit's operation.

3. There shall be an option for an identification window for each switch to allow a label to easily identify each switch. These optional identification windows shall be backlit via individual LED's

4. Keypads shall communicate with all other system units and obtain power via the UTP communication cable.

e. Light Level Sensor:

1. Provide light level sensor as shown on the drawings.

2. Light level sensors shall communicate with all other system units and obtain power via the UTP communication cable.

3. Light level sensors shall be capable of measuring ambient light levels in the range of 0 to 300 footcandles.

4. Light level sensor shall measure the ambient light level and output devices (such as Dimmer Units) shall be controlled to maintain constant illuminance in a given area, under varying conditions.

5. Light level sensors shall incorporate filtering and hysteresis functions to suppress noise and compensate for rapid light intensity fluctuations.

6. If the natural ambient illuminance level is such that extra illumination is not necessary, an Off command shall be transmitted by the Light Level Sensor to the designated output devices.

7. The field of View of the light level sensor shall be 180 degrees.

2.18.3 Networks

a. Sub-net

1. Provide sub-net wiring between master and slave panels as indicated on the drawings. Sub-net wiring shall permit slave panels to receive power and control data from the master panelboard. Each master/slave system may consist of a maximum of 8 panels total.

2. Sub-net communications shall follow Class 1 wiring practices. Communications conductors shall be Belden 27326 or equal having the same voltage rating as the branch circuit conductors. Wiring distances shall not exceed the manufacturer's recommendations.

2.18.4 Configuration Software

a. Configuration software shall be designed specifically for the lighting control system and supported by the manufacturer. Software shall support system configuration, printing of configuration records, and monitoring and control functions in a Windows environment.

b. For basic setup and control, the software shall serve as a configuration and diagnostic utility. Basic features shall include support for configuring inputs, zones, circuit breaker actions, and time schedules. Software shall be able to monitor the status of the system and provide visual indication of input status, circuit breaker status, and operational parameters. Software shall be able to establish connections to the system through a controller front port, RS232 port,

RS485 port, and Ethernet port. Support for remote system dial-up shall be incorporated into the software package.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.1.1 Lamps

Lamps of the type, wattage, and voltage rating indicated shall be delivered to the project in the original cartons and installed just prior to project completion. Lamps installed and used for working light during construction shall be replaced prior to turnover to the Government if more than 15 percent of their rated life has been used. Lamps shall be tested for proper operation prior to turn-over and shall be replaced if necessary with new lamps from the original manufacturer. Provide 10 percent spare lamps of each type from the original manufacturer.

3.1.2 Lighting Fixtures

Set lighting fixtures plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures, and secure in accordance with manufacturers' directions and approved drawings. Installation shall meet requirements of NFPA 70. Mounting heights specified or indicated shall be to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures. Obtain approval of the exact mounting for lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Recessed and semi-recessed fixtures shall be independently supported from the building structure by a minimum of four wires or rods per fixture and located near each corner of each fixture. Ceiling grid clips are not allowed as an alternative to independently supported light fixtures. Round fixtures or fixtures smaller in size than the ceiling grid shall be independently supported from the building structure by a minimum of four wires or rods per fixture spaced approximately equidistant around the fixture. Do not support fixtures by ceiling acoustical panels. Where fixtures of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support such fixtures independently and provide at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture. Provide wires or rods for lighting fixture support in this section. Lighting fixtures installed in suspended ceilings shall also comply with the requirements of Section 09 51 00 ACOUSTICAL CEILINGS.

3.1.3 Suspended Fixtures

Suspended fixtures shall be provided with 45 degree swivel hangers so that they hang plumb and shall be located with no obstructions within the 45 degree range in all directions. The stem, canopy and fixture shall be capable of 45 degree swing. Pendants, rods, or chains 4 feet or longer excluding fixture shall be braced to prevent swaying using three cables at 120 degree separation. Suspended fixtures in continuous rows shall have internal wireway systems for end to end wiring and shall be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Aligning splines shall be used on extruded aluminum fixtures to assure hairline joints. Steel fixtures shall be

supported to prevent "oil-canning" effects. Fixture finishes shall be free of scratches, nicks, dents, and warps, and shall match the color and gloss specified. Pendants shall be finished to match fixtures. Aircraft cable shall be stainless steel. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown. Maximum distance between suspension points shall be 10 feet or as recommended by the manufacturer, whichever is less.

3.1.4 Ballasts

3.1.4.1 Remote Ballasts

Remote type ballasts or transformers, where indicated, shall be mounted in a well ventilated, easily accessible location, within the maximum operating distance from the lamp, as designated by the manufacturer.

3.1.4.2 Electronic Dimming Ballasts

All electronic dimming ballasts controlled by the same controller shall be of the same manufacturer. All fluorescent lamps on electronic dimming ballast control shall be seasoned or burned in at full light output for 100 hours before dimming.

3.1.5 Exit Signs and Emergency Lighting Units

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

3.1.6 Photocell Switch Aiming

Aim switch according to manufacturer's recommendations. Set adjustable window slide for 2 footcandles photocell turn-on.

3.1.7 Occupancy Sensor

Provide quantity of sensor units indicated as a minimum. Provide additional units to give full coverage over controlled area. Full coverage shall provide hand and arm motion detection for office and administration type areas and walking motion for industrial areas, warehouses, storage rooms and hallways. Locate the sensor(s) as indicated and in accordance with the manufacturer's recommendations to maximize energy savings and to avoid nuisance activation and deactivation due to sudden temperature or airflow changes and usage. Set sensor "on" duration to 15 minutes.

3.1.8 Light Level Sensor

Locate light level sensor as indicated and in accordance with the manufacturer's recommendations. Adjust sensor for 50 footcandles or for the indicated light level at the typical work plane for that area.

3.2 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00.00 40 PAINTING AND COATING.

3.3 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly

installed, connected, and adjusted. Conduct an operating test to show that equipment operates in accordance with requirements of this section. Coordinate lighting and controls installation and testing with commissioning of facilities.

3.3.1 Electronic Dimming Ballast

Test for full range of dimming capability. Observe for visually detectable flicker over full dimming range.

3.3.2 Occupancy Sensor

Test sensors for proper operation. Observe for light control over entire area being covered.

3.3.3 [Operational Service](#)

Submit required information and recycling procedures.

3.4 Customization

a. Manufacturer shall provide any custom hardware or communication devices necessary to make the system perform as specified above.

b. Manufacturer shall provide PC user interface custom screens. Rough layouts of the screens shall be provided by the manufacturer no less than 30 days before scheduled system start-up.

3.5 Start-up

a. Manufacturer shall provide on site services to confirm correct communications wiring in the field, initiate communications between panels, and program the lighting control system. The electrical contractor shall provide zone configuration schedules, time-of-day schedules, and input override assignments to be used in programming to the manufacturer no less than 14 days before planned system start-up.

b. Manufacturer shall provide 2 days of on-site training during the start up period.

-- End of Section --