
USACE / NAVFAC / AFCEC / NASA UFGS-26 51 00 (May 2016)
Change 1 - 11/16

Preparing Activity: NAVFAC

Superseding
UFGS-26 51 00 (July 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2018

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SECTION 26 51 00

INTERIOR LIGHTING 05/16

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 web sites 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) 'HB-10-LIGHTING HANDBOOK' and 'RP-1-12 - AMERICAN NATIONAL STANDARD PRACTICE FOR OFFICE LIGHTING', NFPA 101 - 'LIFE SAFETY CODE', the DESIGNLIGHTS CONSORTIUM, 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: In recent years, various federal energy conservation legislative requirements have been enacted which are affecting lighting design and

luminaire specifications. The Energy Policy Act (EPACT, 2005), Executive Order 13243 (2007), and the Energy Independence and Security Act (EISA, 2007) are the most applicable examples. Also, the Federal Acquisition Regulations (FAR) Section 23 states that where life cycle cost-effective and available, Energy Star-qualified or FEMP-designated products must be specified and purchased. These energy conserving requirements and industry trends are pushing the lighting industry towards the development and use of more energy efficient technologies like solid state (or LED). While incumbent technologies like fluorescent, induction and HID are all still valid choices, LED has now been included for consideration. The designer must use his or her knowledge of light source applicability and life cycle cost-effectiveness to determine the most suitable luminaire to utilize.

NOTE: TO DOWNLOAD UFGS GRAPHICS

Go to <http://www.wbdg.org/FFC/NAVGRAPH/graphdoc.pdf>

NOTE: This section contains the following sketches (details or plates) and are available in metric (SI) and U.S. Customary (IP) system dimensions. Sketch titles and style numbers are unchanged for both types.

Do not include list of sketches, or sketches themselves, in project specifications. Use luminaire sketches as details on drawings whenever possible. If special features are required for a project, do not modify sketches, 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 sketches, provide additional sketches or details on drawings, but do not label as NL sketch type.

Fixture list is now divided into 2004 sketches and 2016 sketches. Use the 2016 sketches instead of the 2004 when appropriate. Indicate on Fixture Schedule if the fixture is from the 2016 or 2004 list if the same sketch number is used.

<u>2016 SKETCH NUMBER</u>	<u>TITLE</u>
NL-1	DIRECT/INDIRECT LED TROFFER
NL-2	DIRECT/INDIRECT FLUORESCENT TROFFER

<u>2016 SKETCH NUMBER</u>	<u>TITLE</u>
NL-3	PRISMATIC LENS LED TROFFER
NL-4	PRISMATIC LENS FLUORESCENT TROFFER
NL-5	SURFACE LED WRAPAROUND
NL-6	SURFACE FLUORESCENT WRAPAROUND
NL-7	LED INDUSTRIAL STRIP
NL-8	FLUORESCENT INDUSTRIAL STRIP
NL-9	WALL MOUNTED LED
NL-10	WALL MOUNTED FLUORESCENT
NL-11	LED ENCLOSED AND GASKETED
NL-12	FLUORESCENT ENCLOSED AND GASKETED
NL-13	LED LINEAR PENDANT
NL-14	FLUORESCENT LINEAR PENDANT
NL-15	ROUND LED PENDANT
NL-16	ROUND FLUORESCENT PENDANT
NL-17	LED LINEAR WALL WASH
NL-18	FLUORESCENT LINEAR WALL WASH
NL-19	LED RECESSED DOWNLIGHT
NL-20	COMPACT FLUORESCENT RECESSED DOWNLIGHT
NL-21	LED HIGH-BAY INDUSTRIAL
NL-22	FLUORESCENT HIGH-BAY INDUSTRIAL
NL-23	HID HIGH-BAY INDUSTRIAL
NL-24	LED LOW-BAY INDUSTRIAL
NL-25	HID LOW-BAY INDUSTRIAL
NL-26	INDUCTION LOW-BAY INDUSTRIAL
NL-27	RESERVED
NL-28	RESERVED
NL-29	RESERVED
NL-30	RESERVED
NL-31	RESERVED
NL-32	RESERVED
NL-33	RESERVED
NL-34	RESERVED
NL-35	RESERVED
NL-36	RESERVED
NL-37	RESERVED
NL-38	RESERVED
NL-39	RESERVED
NL-40	RESERVED
NL-41	RESERVED
NL-42	RESERVED

<u>2016 SKETCH NUMBER</u>	<u>TITLE</u>
NL-43	RESERVED
NL-44	RESERVED
NL-45	RESERVED
NL-46	RESERVED
NL-47	RESERVED
NL-48	RESERVED
NL-49	RESERVED
NL-50	RESERVED
NL-51	RESERVED
NL-52	RESERVED
NL-53	RESERVED
NL-54	RESERVED
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NL-61	RESERVED
NL-62	RESERVED
NL-63	RESERVED
NL-64	RESERVED
NL-65	RESERVED
NL-66	RESERVED
NL-67	RESERVED
NL-68	RESERVED
NL-69	RESERVED
NL-70	RESERVED
NL-99	RESERVED
NOTE: Do not include this index in project specification.	

<u>2004 SKETCH NUMBER</u>	<u>TITLE</u>
NL-1	PRISMATIC LENS RECESSED 600mm X 1200mm 2' X 4' FLUORESCENT TROFFER
NL-2	PRISMATIC LENS RECESSED 300mm X 1200mm 1' X 4' FLUORESCENT TROFFER
NL-3	PRISMATIC LENS RECESSED 600mm X 600mm 2' X 2' FLUORESCENT TROFFER
NL-4	PARABOLIC RECESSED 600mm X 1200mm 2' X 4' FLUORESCENT TROFFER

<u>2004 SKETCH NUMBER</u>	<u>TITLE</u>
NL-5	PARABOLIC RECESSED 300mm X 1200mm 1' X 4' FLUORESCENT TROFFER
NL-6	PARABOLIC RECESSED 600mm X 600mm 2' X 2' FLUORESCENT TROFFER
NL-7	RECESSED FLUORESCENT TROFFER OPTIONS
NL-8	DIRECT/INDIRECT RECESSED 600mm X 1200mm 2' X 4' FLUORESCENT
NL-9	DIRECT/INDIRECT RECESSED 600mm X 600mm 2' X 2' FLUORESCENT
NL-10	FLUORESCENT WRAPAROUND - OFFICE/CLASSROOM AREAS
NL-11	FLUORESCENT WRAPAROUND - UTILITY
NL-12	LINEAR FLUORESCENT WALL WASH
NL-13	INDUSTRIAL FLUORESCENT
NL-14	STRIP FLUORESCENT
NL-15	STAGGERED-STRIP FLUORESCENT
NL-16	PENDENT-MOUNTED DIRECT/INDIRECT LINEAR FLUORESCENT
NL-17	PENDENT-MOUNTED INDIRECT/OPEN LINEAR FLUORESCENT
NL-18	PENDENT-MOUNTED SEMI-INDIRECT LUMINOUS BOWL
NL-19	FIBERGLASS HOUSING DAMP/WET LOCATION FLUORESCENT
NL-20	STEEL-SIDED SURFACE-MOUNTED FLUORESCENT
NL-21	WALL-MOUNTED FLUORESCENT
NL-22	INDIRECT WALL-MOUNTED FLUORESCENT
NL-23	FLUORESCENT COVE LIGHT
NL-24	FLUORESCENT VANITY LIGHT
NL-25	FLUORESCENT UNDER-CABINET TASK LIGHT
NL-26	OPAL ACRYLIC CEILING-MOUNTED COMPACT FLUORESCENT
NL-27	OPAL ACRYLIC CEILING-MOUNTED FLUORESCENT
NL-28	HAZARDOUS LOCATION INDUSTRIAL FLUORESCENT
NL-29	LOUVERED FLUORESCENT HIGH-BAY
NL-30	ENCLOSED FLUORESCENT HIGH BAY
NL-31	RECESSED COMPACT FLUORESCENT DOWNLIGHT
NL-32	LOW-VOLTAGE RECESSED DOWNLIGHT
NL-33	RECESSED LENSED COMPACT FLUORESCENT DOWNLIGHT
NL-34	RECESSED HIGH-WATTAGE COMPACT FLUORESCENT DOWNLIGHT
NL-35	RECESSED CROSS-BAFFLE COMPACT FLUORESCENT DOWNLIGHT
NL-36	RECESSED METAL HALIDE DOWNLIGHT
NL-37	RETRACTABLE INCANDESCENT/METAL HALIDE DOWNLIGHT
NL-38	RECESSED COMPACT FLUORESCENT SHOWER LIGHT
NL-39	STEP/NIGHT LIGHT
NL-40	SURFACE/CEILING CROSS-BAFFLE PARABOLIC DOWNLIGHT
NL-41	SURFACE/PENDANT/WALL COMPACT FLUORESCENT CYLINDER
NL-42	SURFACE-MOUNTED TRACK LIGHTING
NL-43	TYPICAL TRACK LIGHTING FIXTURES
NL-44	SURFACE-MOUNTED INDIRECT ASYMMETRICAL INDIRECT FIXTURE
NL-45	INDUSTRIAL TASK/DOCK LIGHT
NL-46	COMPACT FLUORESCENT WALL SCONCE
NL-47	RESIDENTIAL TYPE ENTRANCE FIXTURE

<u>2004 SKETCH NUMBER</u>	<u>TITLE</u>
NL-48	WALL-MOUNTED HIGH ABUSE FIXTURE
NL-49	SEMI-FLUSH HIGH ABUSE FIXTURE
NL-50	HIGH-BAY INDUSTRIAL HID FIXTURE
NL-51	LOW-BAY INDUSTRIAL HID FIXTURE
NL-52	WAREHOUSE AISLE HID FIXTURE
NL-53	PENDENT-MOUNTED INDIRECT HID FIXTURE
NL-54	SURFACE-MOUNTED HID FIXTURE
NL-55	RECESSED HID FIXTURE
NL-56	WALL-MOUNTED HID/COMPACT FLUORESCENT
NL-57	WALL-MOUNTED HALF-SHIELDED CUTOFF FIXTURE
NL-58	DECORATIVE HID/COMPACT FLUORESCENT
NL-59	RECESSED LOW LEVEL FLOODLIGHT
NL-60	HIGH ABUSE WALL-MOUNTED EYELID
NL-61	EXTERIOR CYLINDER
NL-62	DECORATIVE EXTERIOR WALL-MOUNTED FIXTURE
NL-63	LED EXIT SIGN
NL-64	EDGE-LIT EXIT SIGN
NL-65	INDUSTRIAL EMERGENCY LIGHTING UNIT
NL-66	REMOTE-MOUNTED FIXTURES FOR EMERGENCY LIGHTING UNIT
NL-67	DECORATIVE EMERGENCY LIGHTING UNIT
NL-68	PRISMATIC LENS EMERGENCY LIGHTING UNIT
NL-69	HAZARDOUS LOCATION FIXTURE
NL-70	OBSTRUCTION LIGHT
NL-99	SAMPLE LIGHTING FIXTURE SCHEDULE

NOTE: Do not include this index in project specification.

NOTE: Include the following information on the project drawings:

1. Luminaire schedule indicating luminaire symbol (type), NL plate and type designation, light source type and quantity, voltage, input watts, output lumens, efficacy or efficiency, BUG rating if applicable, mounting type and height, and any applicable options or notes.
2. Location and mounting height of normal lighting and emergency lighting luminaires and lighting controls for each given area or room.
3. Control strategy description for each given area or room.
4. Referenced NL plate or detail (if no NL plate is available) for each luminaire type provided.

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

6. Where wire for humid areas, rods, or straps are used (if more than one type of hanger is used).

7. EMI filters, surge suppression or shielding required.

8. Occupancy, vacancy or daylight sensor locations, mounting, and sensor technology type used.

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 in the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 189.1

(2014; ERTA 1-2 2015; ERTA 3-4 2017)
Standard for the Design of
High-Performance Green Buildings Except
Low-Rise Residential Buildings

ASHRAE 90.1 - IP (2016; ERTA 1-8 2017; INT 1-5 2017) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M (2016) 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 A580/A580M (2016) Standard Specification for Stainless Steel Wire

ASTM A641/A641M (2009a; R 2014) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

ASTM A653/A653M (2017) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM B164 (2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire

ASTM B633 (2015) 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 24 (2016) Building Energy Efficiency Standards For Residential and Nonresidential Buildings

ILLUMINATING ENGINEERING SOCIETY (IES)

IES HB-10 (2011; Errata 2015) IES Lighting Handbook

IES LM-79 (2008) Electrical and Photometric Measurements of Solid-State Lighting Products

IES LM-80 (2015) Measuring Lumen Maintenance of LED Light Sources

IES RP-16 (2010; Addendum A 2008; Addenda B 2009; Addendum C 2016) Nomenclature and Definitions for Illuminating Engineering

IES TM-21 (2011; Addendum B 2015) Projecting Long Term Lumen Maintenance of LED Light Sources

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
IEEE C62.41.1	(2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
IEEE C62.41.2	(2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI ANSLG C78.43	(2013) Electric lamps: Single-Ended Metal Halide Lamps
ANSI C78.389	(2004; R 2009) American National Standard for Electric Lamps - High Intensity Discharge (HID) - Methods of Measuring Characteristics
ANSI C78.901	(2016) Electric Lamps - Single Base Fluorescent Lamps--Dimensional and Electrical Characteristics
ANSI C82.2	(2002) American National Standard for Lamp Ballasts--Methods of Measurement of Fluorescent Lamp Ballasts
ANSI C82.4	(2017) Lamp Ballasts - Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps
ANSI/NEMA C78.LL 1256	(2003; R 2015) Procedures for Fluorescent Lamp Sample Preparation and the Toxicity Characteristic Leaching Procedure (TCLP)
NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ANSLG C78.377	(2017) Electric Lamps- Specifications for the Chromaticity of Solid State Lighting Products
NEMA ANSLG C78.81	(2016) American National Standard for Electric Lamps--Double-Capped Fluorescent Lamps--Dimensional and Electrical Characteristics

NEMA ANSLG C82.11	(2017) Lamp Ballasts - High-Frequency Fluorescent Lamp Ballasts
NEMA ANSLG C82.14	(2016) Lamp Ballasts Low-Frequency Square Wave Electronic Ballasts -- for Metal Halide Lamps
NEMA ANSLG C82.9	(2010) American National Standard for Lamp Ballasts- High-Intensity Discharge and Low-Pressure Sodium Lamps- Definitions
NEMA C78.376	(2014) Electric Lamps - Specifications for the Chromaticity of Fluorescent Lamps
NEMA C78.LL 3	(2003; R 2015) Electric Lamps - Procedures for High Intensity Discharge Lamp Sample Preparation and the Toxicity Characteristic Leaching Procedure
NEMA C82.77	(2002) Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment
NEMA ICS 2	(2000; R 2005; Errata 2008) 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	(2010) 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 2015) Standard for General Color Requirements for Wiring Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2018; TIA 18-1) Life Safety Code
NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2; TIA 17-3; TIA 17-4; TIA 17-5; TIA 17-6; TIA 17-7; TIA 17-8; TIA 17-9; TIA 17-10; TIA 17-11; TIA 17-12; TIA 17-13; TIA 17-14) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 8500.01	(2014) Cybersecurity
DOD 8510.01	(2014; Change 1-2016; Change 2-2017) Risk Management Framework (RMF) for DoD Information Technology (IT)

UNDERWRITERS LABORATORIES (UL)

UL 1029	(1994; Reprint May 2017) UL Standard for Safety High-Intensity-Discharge Lamp Ballasts
UL 1472	(2015) UL Standard for Safety Solid-State Dimming Controls
UL 1598	(2008; Reprint Oct 2012) Luminaires
UL 20	(2010; Reprint Feb 2012) General-Use Snap Switches
UL 2043	(2013) Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
UL 508	(1999; Reprint Oct 2013) Industrial Control Equipment
UL 844	(2012; Reprint Mar 2016) UL Standard for Safety Luminaires for Use in Hazardous (Classified) Locations
UL 8750	(2015; Reprint Aug 2017) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products
UL 916	(2007; Reprint Aug 2014) Standard for Energy Management Equipment
UL 917	(2006; Reprint Aug 2013) UL Standard for Safety Clock-Operated Switches
UL 924	(2016; Reprint Nov 2017) UL Standard for Safety Emergency Lighting and Power Equipment
UL 935	(2001; Reprint Aug 2014) Standard for Fluorescent-Lamp Ballasts
UL 94	(2013; Reprint Sep 2017) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.2 RELATED REQUIREMENTS

Materials not considered to be luminaires or luminaire accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Luminaires and accessories mounted on exterior surfaces of buildings are specified in Section 26 56 00 EXTERIOR 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 IES RP-16.

- b. For fluorescent, HID and induction luminaire light sources, "Average Rated Life" is the time after which 50 percent of a large group of light sources will have failed and 50 percent will have survived under normal conditions.
- c. 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 know as 70 percent "Rated Lumen Maintenance Life" as defined in IES LM-80.
- d. For fluorescent, HID and induction luminaires, "Luminaire Efficacy Rating" (LER) is the appropriate measure of energy efficiency, measured in lumens/watt. Specifically it is the luminaire's efficiency multiplied by the total rated light source lumens and the ballast factor, divided by the luminaire input watts.
- e. 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.
- f. 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 to reflect only the submittals required for the project.

The Guide Specification technical editors have designated 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 submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

Use the "S" classification only in SD-11 Closeout Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

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

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Data, drawings, and reports must employ the terminology, classifications and methods prescribed by the IES HB-10 as applicable, for the lighting system specified. 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[, [____]]

SD-03 Product Data

Luminaires; G[, [____]]

Light Sources; G[, [____]]

NOTE: Choose "Power Supplies (Drivers)" for LED, "Ballasts" for fluorescent and HID, and "Generators" for induction luminaire applications.

Drivers, Ballasts and Generators; G[, [____]]

LED Luminaire Warranty; G[, [____]]

Luminaire Design Data; G[, [____]]

Vacancy Sensors; G[, [____]]

Dimming Controllers (Dimmers); G[, [____]]

Lighting Contactor; G[, [____]]

Timeswitch; G[, [____]]

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

Exit Signs; G[, [____]]

Emergency Lighting Unit (EBU); G[, [_____]]

LED Emergency Drivers; G[, [_____]]

Fluorescent Emergency Ballasts; G[, [_____]]

Occupancy Sensors; G[, [_____]]

Ambient Light Level Sensor ; G[, [_____]]

Bi-Level HID Controller; G[, [_____]]

Lighting Control Panel; G[, [_____]]

SD-06 Test Reports

LED Luminaire - IES LM-79 Test Report; G[, [_____]]

LED Light Source - IES LM-80 Test Report; G[, [_____]]

LED Light Source - IES TM-21 Test Report; G[, [_____]]

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

Energy Efficiency; G[, [_____]]

SD-07 Certificates

Luminaire Useful Life Certificate; G[, [_____]]

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

1.5 QUALITY CONTROL

1.5.1 Luminaire Drawings

Include dimensions, accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and computerized candlepower distribution data must accompany shop drawings.

1.5.2 Occupancy/Vacancy Sensor Coverage Layout

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

1.5.3 LED Driver and Dimming Switch Compatibility Certificate

Submit certification from the luminaire, driver, or dimmer switch manufacturer that ensures compatibility and operability between devices.

1.5.4 Luminaire Design Data

- a. Provide safety certification and file number for the luminaire family that must be listed, labeled, or identified per the NFPA 70 (NEC). 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 IES TM-21. Data used for projections must be obtained from testing in accordance with IES LM-80.

1.5.5 LED Luminaire - IES LM-79 Test Report

Submit test report on manufacturer's standard production model luminaire. Include all applicable and required data as outlined under "14.0 Test Report" in IES LM-79.

1.5.6 LED Light Source - IES LM-80 Test Report

Submit report on manufacturer's standard production LED light source (package, array, or module). Include all applicable and required data as outlined under "8.0 Test Report" in IES LM-80.

1.5.7 LED Light Source - IES TM-21 Test Report

Submit test report on manufacturer's standard production LED light source (package, array or module). Include all applicable and required data, as well as required interpolation information as outlined under "7.0 Report" in IES TM-21.

1.5.8 Occupancy/Vacancy Sensor Verification Tests

Submit test report outlining post-installation coverage and operation of sensors.

1.5.9 Test Laboratories

Test laboratories for the IES LM-79 and 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 at for LM-79 testing.
- c. One of the EPA-Recognized Laboratories listed at for LM-80 testing.

1.5.10 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "must" 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 must be in accordance with the mandatory and advisory provisions of NFPA 70, unless more stringent requirements are specified or indicated.

1.5.11 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 two years prior to bid opening. The two-year 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 two-year 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.

1.5.11.1 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.

1.5.11.2 Material and Equipment Manufacturing Date

Products manufactured more than six months prior to date of delivery to site must not be used, unless specified otherwise.

1.5.11.3 Energy Efficiency

**NOTE: Meet Energy Star requirements for all
lighting per EO 13123.**

**NOTE: The Energy Policy Act of 2005 requires new
buildings to use 30 percent less energy than the
2007 ASHRAE 90.1 baseline level, or 12 percent less
energy than the 2010 ASHRAE 90.1 baseline level.
Efficient lighting equipment contributes to the
following LEED credits: EA Prerequisite 2; EA1.**

Submit data indicating lumens per watt efficacy and color rendering index of light source.

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 LED Luminaire Warranty

- a. Provide a written 5 year on-site replacement warranty for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.

(1) Include finish warranty to include failure and substantial

deterioration such as blistering, cracking, peeling, chalking, or fading.

(2) Material warranty must include:

(a) All drivers.

(b) Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.

b. Warranty period must begin on date of beneficial occupancy. Provide the Contracting Officer with signed warranty certificates prior to final payment.

1.6.1.1 Provide Luminaire Useful Life Certificate

Submit certification from the manufacturer indicating the expected useful life of the luminaires provided. The useful life must be directly correlated from the IES LM-80 test data using procedures outlined in IES TM-21. Thermal properties of the specific luminaire and local ambient operating temperature and conditions must be taken into consideration.

PART 2 PRODUCTS

2.1 PRODUCT COORDINATION

NOTE: For the purpose of this document, interior luminaires only include those in the interior portion of buildings or facilities. Those luminaires intended to illuminate exterior areas, including those mounted on exterior walls of buildings and facilities are considered to be exterior luminaires.

Products and materials not considered to be luminaires, luminaire controls, or associated equipment are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Luminaires, luminaire controls, and associated equipment for exterior applications are specified in Section 26 56 00 EXTERIOR LIGHTING.

2.2 LUMINAIRES

UL 1598, NEMA C82.77, and UL 8750. Provide luminaires as indicated in luminaire schedule and NL plates or details on project plans. Provide luminaires complete with light sources of quantity, type, and wattage indicated. Provide all luminaires of the same type by the same manufacturer. Luminaires must be specifically designed for use with the driver, ballast or generator and light source provided.

2.2.1 LED Luminaires

NOTE: Minimum performance requirements for LED luminaires meet or exceed data taken from Energy Star Program Requirements and Designlights Consortium Product Qualification Criteria.

Provide luminaires complete with power supplies (drivers) and light sources. Provide design information including lumen output and design life in luminaire schedule on project plans for LED luminaires. LED luminaires must meet the minimum requirements in the following table:

<u>LUMINAIRE TYPE</u>	<u>MINIMUM LUMINAIRE EFFICACY (LE)</u>	<u>MINIMUM COLOR RENDERING INDEX (CRI)</u>
LED TROFFER - 1 x 4300 x 1200 2 x 2600 x 600 2 x 4600 x 1200	90 LPW	80
LED Downlight	50 LPW	90
LED Track or Accent	40 LPW	80
LED Low Bay/High Bay	80 LPW	70
LED Linear Ambient	80 LPW	80

LED luminaires must also meet the following minimum requirements:

- a. Luminaires must have a minimum 5 year manufacturer's warranty.

NOTE: Typically, utilize defaults of L70 and 50k hours for performance unless higher specific parameters are desired.

- b. Luminaires must have a minimum L70[_____] lumen maintenance value of 50,000[_____] hours as calculated by IES TM-21, with data obtained per IES LM-80 requirements.
- c. Luminaire drive current value must be identical to that provided by test data for luminaire in question.
- d. Luminaires must be tested to IES LM-79 and IES LM-80 standards, with the results provided as required in the Submittals paragraph of this specification.
- e. Luminaires must be listed with the DesignLights Consortium 'Qualified Products List' when falling into category of "General Application" luminaires, i.e. Interior Directional, Display Case, Troffer, Linear Ambient, or Low/High Bay. Requirements are shown in the Designlights Consortium "Technical Requirements Table" at <https://data.energystar.gov/dataset/EPA-Recognized-Laboratories-For-Lighting-Products/jgwf-7qrr>.
- f. Provide Department of Energy 'Lighting Facts' label for each luminaire.

2.2.2 Fluorescent Luminaires

UL 1598. Provide linear and compact fluorescent luminaires complete with housing, ballast and light source. All fluorescent luminaires must be equipped with electronic ballasts.

2.2.3 High Intensity Discharge (HID) Luminaires

UL 1598. Provide HID luminaires complete with housing, ballast and light source.

2.2.4 Induction Luminaires

UL 1598. Provide induction luminaires complete with housing, generator and light source.

2.2.5 Luminaires for Hazardous Locations

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

2.3 DRIVERS, BALLASTS and GENERATORS

**NOTE: Choose "drivers for LED, "ballasts" for
fluorescent and HID, and "generators" for induction
luminaire applications.**

2.3.1 LED Drivers

NEMA SSL 1, UL 8750. LED drivers must be electronic, UL Class 1, constant-current type and comply with the following requirements:

- a. Output power (watts) and luminous flux (lumens) as shown in luminaire schedule for each luminaire type to meet minimum luminaire efficacy (LE) value provided.
- b. Power Factor (PF) greater than or equal to 0.9 over the full dimming range when provided.
- c. Current draw Total Harmonic Distortion (THD) of less than 20 percent.
- d. Class A sound rating.
- e. Operable at input voltage of 120-277 volts at 60 hertz.
- f. Minimum 5 year manufacturer's warranty.
- g. RoHS compliant.
- h. Integral thermal protection that reduces or eliminates the output power if case temperature exceeds a value detrimental to the driver.
- i. UL listed for dry or damp locations typical of interior installations.
- j. [Non-dimmable], [step-dimmable to 50 percent output], or fully-dimmable using 0-10V control as indicated in luminaire schedule.

**NOTE: Dimmable LED drivers should usually be
specified unless specifically providing a luminaire
for step-dimming only, such as in hallways or**

corridors. Only specify non-dimmable drivers when luminaire will be installed in an area that is specifically not going to be dimmed, such as an electrical or telecommunications room.

2.3.2 Fluorescent Electronic Ballasts

NEMA ANSLG C82.11, UL 935, CEC Title 24. Fluorescent ballasts must not contain any magnetic core and coil components, and must meet the following requirements:

- a. Provide with transient protection as recommended by IEEE C62.41.1 and IEEE C62.41.2.
- b. Provide UL listed Class P, "A" sound rating, with minimum power factor rating of 0.98 and minimum ballast factor rating of 0.95.
- c. Be designed for the wattage and type of light source provided in the luminaire specified, and have circuit diagrams and light source connection information printed on the exterior of the ballast housing.
- d. Contain no PCB's and be RoHS compliant.
- e. Be manufactured in an ISO 9001 certified facility.
- f. Operate at a frequency greater than 20 kHz, and have a Lamp Current Crest Factor less than 1.7.
- g. Have a light regulation of plus or minus 10 percent of lumen output when operating within a plus or minus 10 percent range of input voltage.
- h. Have a full replacement warranty of five years from date of manufacture.
- [i. Provide all fluorescent ballasts as NEMA Premium type.

]

NOTE: NEMA Premium ballasts should be specified when the highest-efficiency ballast is desired, and the increased cost to the project is not an issue. Initial cost increase is approximately \$0.05 per square foot. These type ballasts are only available for F32/T8 light sources.

2.3.2.1 T8 Programmed[Instant]-Start Fluorescent Ballasts

NOTE: Typically, programmed-start ballasts are preferred for their longer life when switching on and off frequently compared to instant-start type. Specify instant-start type only when specifically desired by the designer

Provide programmed[instant]-start T8 electronic fluorescent ballasts with the following characteristics:

NOTE: Total harmonic distortion of 20 percent is acceptable for most applications.

a. Total harmonic distortion (THD): Must be [20 percent][_____ percent] (maximum).

b. Input wattage at 120/277 volts.

- [(1) 29/28 watts (maximum) when operating one F32T8 light source
-][(2) 55/54 watts (maximum) when operating two F32T8 light sources
-][(3) 84/82 watts (maximum) when operating three F32T8 light sources
-][(4) 109/107 watts (maximum) when operating four F32T8 light sources
-]

NOTE: Multilevel switching for light control is recommended for locations such as classrooms and conference rooms where multiple lighting levels are desired.

- [d. Where indicated on project drawings, provide multi-light source luminaires with two or more ballasts to accomplish the switching scenario indicated.
-]

NOTE: To avoid potential maintenance problems, use following bracketed option only when requested by the activity.

- [e. A single ballast may be used to serve multiple luminaires if they are continuously mounted and factory manufactured for that installation with an integral wireway.

12.3.2.2 T5 (long twin tube) and T5HO Fluorescent Ballasts

a. Total harmonic distortion (THD): Not greater than[25 percent when operating one light source,][15 percent when operating two light sources,][and][20 percent when operating three light sources].

b. Input wattage:

- [(1) 45 watts (maximum) when operating one F40 T-5 light source
-][(2) 74 watts (maximum) when operating two F40 T-5 light sources
-][(3) 105 watts (maximum) when operating three F40 T-5 light sources
-]

NOTE: Multilevel switching for light control is recommended for some locations such as classrooms and conference rooms where multiple lighting levels are desired.

- [c. Provide three[and four] light source luminaires with two ballasts per luminaire where multilevel switching is indicated.

NOTE: To avoid potential maintenance problems, use following bracketed option only when requested by the activity. Also, serving multiple luminaires from a single ballast may alter the minimum starting and operating temperature for the luminaire. Design accordingly.

- [d. A single ballast may be used to serve multiple fixtures if they are continuously mounted and factory manufactured for that installation with an integral wireway.

]2.3.2.3 Compact Fluorescent Ballasts

Provide programmed-start ballasts for compact fluorescent luminaires.

2.3.2.4 Fluorescent Electronic Dimming Ballasts

NOTE: When possible, lighting designer should consider LED solid state lighting when dimming is desired. Overall cost and performance of LED dimming has become favorable over fluorescent in recent years.

Electronic dimming ballast may have the same system compatibility problems as normal light output electronic ballast when installed in certain environments. The problems mainly concern the radiated and conducted EMI due to the relatively high switching frequencies inherent in electronic ballast and possibly due to utilization of the same power source for lighting and other equipment. Environments where electronic ballasts have the potential for EMI are listed in the criteria note for electronic ballasts.

Electronic dimming ballasts as specified in the following paragraph, are for general workplace dimming and daylight harvesting for energy conservation. For architectural dimming applications with very low light levels, 100 percent to 1 percent, the specifier must review all parameters of this paragraph and ensure competitive sources.

Electronic dimming ballasts can be controlled by a number of devices: manual dimmers, occupancy sensors, light level sensor, photosensors, and timers, or with energy management systems. All control types are not specified here and the specifier must ensure system compatibility between ballast and controls.

If dimming ballast and non-dimming ballast are used

**in the same area, designer and specifier may need to
coordinate the ballast factors at full light output.**

Provide fluorescent electronic dimming ballasts with the following characteristics:

- a. Comply with NEMA ANSLG C82.11, UL 935, and NFPA 70, unless specified otherwise. Provide ballast with transient immunity as recommended by IEEE C62.41.1 and IEEE C62.41.2. Provide dimming capability range from 100 to 5 percent (minimum range) of light output, flicker free. Ballast must start lamp at any preset light output setting without first having to go to full light output. Provide ballasts designed for the wattage of the light sources used in the indicated application. Provide ballasts designed to operate on the voltage system to which they are connected.
- b. Provide power factor of 0.95 (minimum) at full light output, and 0.90 (minimum) over the entire dimming range.
- c. Provide ballasts designed to operate at a frequency of 20,000 Hertz (minimum). Ballast must be compatible with and not cause interference with the operation of occupancy sensors or other infrared control systems. When available, provide higher operating frequency of 40,000 hertz or above.
- d. Ballast factor at full light output must be between 0.85 (minimum) and 1.00 (maximum). Current crest factor must be a maximum of 1.7.
- e. Provide ballast with Class P UL listing and with a sound rating of "A".
- f. Provide ballast with circuit diagrams displayed on the ballast exterior.
- g. Provide programmed-start ballast. Ballast may operate light sources in a series circuit configuration. Provide series/parallel wiring for programmed-start ballasts where available.

**NOTE: A source of light other than fluorescent is
recommended for areas subject to temperatures below
minus 17 degrees C 0 degrees F.**

- h. Ballast must be capable of starting and maintaining operation at a minimum of minus 17 degrees C 0 degrees F unless otherwise indicated.
- i. Provide ballast with total harmonic distortion (THD) of 20 percent (maximum) over the entire dimming range.
- j. Ballasts for T-5 and smaller light sources must have end-of-life protection circuits as required by NEMA ANSLG C78.81 and ANSI C78.901 as applicable.

2.3.2.4.1 T-8 Lamp Ballast

Input wattage:

- a. 35 watts (maximum) when operating one F32T8 light source.

- b. 70 watts (maximum) when operating two F32T8 light sources.
- c. 104 watts (maximum) when operating three F32T8 light sources.

2.3.3 HID Ballasts

UL 1029, NEMA ANSLG C82.9, and ANSI C82.2. Provide ballast to serve one single light source.

2.3.3.1 Metal Halide Ballasts

NOTE: Provide electronic metal halide ballasts when available. Otherwise, specify constant wattage autotransformer (CWA) or high reactance/high power factor (HX/HPF), pulse-start magnetic type.

Provide ballasts designed to operate on the voltage system they are connected and in a normal ambient temperature of 40 [_____] degrees C.

2.3.3.1.1 Electronic Metal Halide Ballasts

NEMA ANSLG C82.14. Electronic metal halide ballasts must meet the following minimum requirements:

- a. Power factor greater than 90 percent.
- b. Input voltage of 120-277 volts, plus or minus 10 percent.
- c. Provide end-of-life circuitry to prevent ballast from operating if light source is inoperable, and thermal protection to prevent overheating.
- d. Sound rating of A, with lamp current crest factor less than 1.5.
- e. Input current total harmonic distortion less than 15 percent.
- f. Minimum starting temperature of minus 22 degrees F.
- g. UL listed and Restriction of Hazardous Substances Directive (RoHS) compliant.

2.3.3.1.2 Magnetic Metal Halide Ballasts

ANSI C82.4. Pulse-start constant wattage autotransformer (CWA) type must be used when available. Probe-start CWA, high reactance/high power factor (HX/HPF) or regulator type must be used when pulse-start is not available. Ballasts must meet the following minimum requirements:

- a. Class H insulation rating.
- b. Designed for 60,000 hours of operation at maximum rated temperature.
- c. Minimum starting temperature of minus 22 degrees F.
- d. Nominal ballast factor of 1.0.
- e. Capacitors must have self-contained bleeder resistor as required by

UL 1029.

- f. House oil-filled capacitors in an aluminum or corrosion-resistant steel can and provide with quick disconnect terminals.
- g. Capacitor maximum case temperature must be 194 degrees F for oil-filled and 221 degrees F for dry film type.
- h. Starter/igniter must provide six months of light source open circuit operation without failure and be designed to withstand 10,000 hours of continuous pulsing.

2.3.4 Induction Generators

Generator must be connected, and operate in conjunction with an inductive power coupler or coil(s). Provide solid-state, high-frequency (200 kHz - 2.67 MHz) type, with power factor greater than 0.95, Class A sound rating, maximum input current THD of 15 percent, operating voltage of 120-277V, and a minimum starting temperature of minus 30 degrees F. Provide generator dimmable to a minimum of 50 percent light output.

2.4 LIGHT SOURCES

**NOTE: The term 'light sources' is now used in place
of the previously used term 'lamps' in this
specification.**

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

2.4.1 LED Light Sources

**NOTE: A color temperature of 3500 K is standard for
most applications. Make cooler or warmer selection
only when specifically desired by the designer.**

- a. Correlated Color Temperature (CCT) of [3000]3500[4000][_____] degrees K.
- b. Minimum Color Rendering Index (CRI) R9 value of 80.

**NOTE: Red, green, and blue (RGB) LED technology
produces an even higher CRI value than phosphor
conversion (PC), and is typically more expensive.**

- c. High power, white light output utilizing phosphor conversion (PC) process[or mixed system of colored LEDs, typically red, green and blue (RGB)].
- d. RoHS compliant.
- e. Provide light source color consistency by utilizing a binning tolerance within a 4[_____] step McAdam ellipse.

[2.4.1.1 LED Retrofit T8 Tubes

NOTE: Lighting designer must verify that ballasts in existing luminaires are either instant-start or programmed-start and that they will be compatible with replacement LED light sources being specified.

Provide linear T8 tubular LED light sources to replace fluorescent light sources in renovation or energy conservation projects. Provide only where entire luminaires are not being replaced. Light sources must be compatible with existing instant-start or programmed-start ballasts and have the following requirements:

- a. Correlated Color Temperature (CCT) of [3000]3500[4000] degrees K.
- b. Total Harmonic Distortion (THD) less than 20 percent, with Power Factor (PF) greater than 90 percent.
- c. Minimum lumen per watt efficacy greater than 120.
- d. Minimum beam angle of 180 degrees.
- e. Minimum 5 year warranty.
- f. Minimum Color Rendering Index (CRI) of 80.

]2.4.2 Fluorescent Light Sources

NOTE: For linear luminaires, T8 light sources with CRI of 85 and CCT of 3500 degrees K are recommended for most applications.

NEMA C78.376. Fluorescent light sources must be low-mercury, energy-savings type and be compliant with the most current TCLP test procedure per ANSI/NEMA C78.LL 1256 at the time of manufacture.

2.4.2.1 Linear Fluorescent Light Sources

NEMA ANSLG C78.81. Provide linear fluorescent light sources with minimum CRI of 85[_____] and CCT of 3500[_____] degrees K.

2.4.2.1.1 T8 Linear Fluorescent Light Sources

Provide T8 light sources with medium bi-pin base, rated [17][25][32][_____] watts (maximum), [1450][2250][3100][_____] initial lumens (minimum), and with an average rated life of 30,000[_____] hours using a average three hour burn time and programmed-start ballast.

2.4.2.1.2 T5HO (High-Output) Linear Fluorescent Light Sources

Provide T5HO light sources with miniature bi-pin base, rated [24][39][54][_____] watts (maximum), [2000][3500][5000][_____] initial lumens (minimum), and with an average rated life of 30,000[_____] hours using a average three hour burn time and programmed start ballast.

2.4.2.2 Compact Fluorescent (CFL) Light Sources

ANSI C78.901. Provide compact fluorescent (CFL) light sources with minimum CRI of 82[_____] and CCT of 3500[_____] degrees K.

2.4.2.2.1 T5 Long Twin Tube CFL Light Source

Provide T5 Long Twin Tube CFL light sources with four pin, 2G11 base, rated [40][55][_____] watts (maximum), [3150][4000][_____] initial lumens (minimum), and with an average rated life of 20,000 [_____] hours.

2.4.2.2.2 T4 Twin Tube CFL Light Source

Provide T4 Twin Tube CFL light sources with four pin, G24q base, rated [18][26][_____] watts (maximum), [1250][1800][_____] initial lumens (minimum), and with an average rated life of 17,000 [_____] hours.

2.4.2.2.3 T4 Triple Tube CFL Light Source

Provide T4 Triple Tube CFL light sources with four pin, GX24q base, rated [32][42][_____] watts (maximum), [2400][3200][_____] initial lumens (minimum), and with an average rated life of 17,000 [_____] hours.

2.4.2.2.4 T4 Quad Tube CFL Light Source

Provide T4 Quad Tube CFL light sources with four pin, GX24q base, rated [57][70][_____] watts (maximum), [4300][5200][_____] initial lumens (minimum), and with an average rated life of 17,000 [_____] hours.

2.4.3 HID Light Sources

ANSI C78.389. Light sources must be compliant with the most current TCLP test procedure per NEMA C78.LL 3 at the time of manufacture.

2.4.3.1 Metal Halide Light Sources

NOTE: Metal halide light sources are available in a wide variety of configurations and wattages. Pulse start technology now covers most interior applications. Utilize ceramic light sources when available and when better color rendering is critical. Be aware that some sources are rated for only enclosed luminaires, and rated for horizontal or vertical use only. Consider re-strike time as a factor, especially when considering life safety requirements. PAR envelopes are an efficient choice for lower wattage applications, but must be specified with beam type and angle. Only the most common, higher wattage sources for interior applications are included in this specification.

NOTE: The Energy Independence and Security Act (EISA) of 2007, Title III, Subtitle B, Section 3241 limits the use of certain metal halide light sources and ballasts. Do not specify any of those devices in this specification.

ANSI ANSLG C78.43. Utilize only protected type light sources in open luminaires. Light sources must be specifically suited to operate in the burning position which they are installed, and have the following requirements:

- a. Pulse-start, quartz metal halide light sources utilizing an [ED17][ED28][ED37][_____] type, clear glass envelope; [E26 medium][E39 mogul][_____] base; rated at [175][250][350][400][_____] watts; minimum initial lumen value of [16,000][23,7000][36,000][40,000][_____] lumens; minimum CRI of 62[_____] ; CCT of 3500[4000][_____] degrees K; with a minimum average rated life of 15,000[20,000][_____] hours.
- b. Pulse-start, ceramic metal halide light sources utilizing a (an) [ED17][ED23.5][_____] type, clear[coated] glass envelope; [E26][E39][_____] base; rated at [70][100][150][_____] watts; minimum initial lumen value of [6100][10,000][12,000][_____] ; minimum CRI of 80[90][_____] ; CCT of 3000[4000][_____] degrees K; with minimum rated life of [12,000][10,000][12,000][15,000][24,00][_____] hours.

2.4.4 Induction Light Sources

Provide induction light sources consisting of an electrodeless, inductively-coupled, phosphor-coated fluorescent envelope, with an average rated life of 100,000 hours minimum rated using three hours operation per start. Light sources must be compliant with the most current TCLP test procedure per ANSI/NEMA C78.LL 1256 at the time of manufacture.

2.4.4.1 Circular or Rectangular Tube Style Induction Light Sources

Rated at [40][70][100][150][200]watts, with a CCT of 3500 [4100] degrees K, a minimum CRI of 80, and an initial output at 25 degrees C of [2800][6800][8600][13,000][15400] lumens.

2.4.4.2 Globe or 'A' Lamp Style Induction Light Sources

Rated at [55][85][165]watts, with a CCT of [2700]3000[4000] degrees K, a minimum CRI of 80, and a Luminous Lamp Efficacy (LLE) of 78[86] lumens per watt for 3000 degrees K source.

2.5 LIGHTING CONTROLS

ASHRAE 90.1 - IP ASHRAE 189.1. Provide network certification for all networked lighting control systems and devices per requirements of DOD 8500.01 and DOD 8510.01.

2.5.1 Toggle Switches

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

2.5.2 Dimming Controllers (Dimmers)

NOTE: The majority of dimmers use either pulse width modulation (PWM) or constant current reduction (CCR) technology to dim light sources. PWM type dimmers are a better choice when levels lower than

40 percent are needed, because of the more precise color control. CCR type dimmers are more applicable when used with luminaires requiring UL Class 2 rated output and when stricter EMI emission requirements are required. Specify 0-10V dimming switches only when using 0-10V fluorescent ballasts and LED drivers specifically designed for, and compatible with their use. .

UL 1472, UL 20, IEEE C62.41, NEMA SSL 7A. 120/277 V[0-10 V] dimmers must provide flicker-free, continuously variable light output throughout the dimming range. Provide radio frequency interference suppression integral to device. Provide dimmers utilizing [pulse width modulation (PWM)][constant current reduction (CCR) technology]. Provide device with a vertical slider, paddle, rotary button, or toggle (with adjacent vertical slider) type control, with finish to match switches and outlets in same area. Provide back box in wall with sufficient depth to accommodate body of switch and wiring. 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. Dimmers must be capable of controlling [two-wire][three-wire][0-10 volt] fluorescent ballasts or LED drivers. Ensure compatibility of dimmer with separate power packs when utilized for lighting control. Dimmers and the ballasts or drivers they control, must be provided from the same manufacturer, or tested and certified as compatible for use together. Provide NEMA SSL 7A-compliant devices.

2.5.3 Sensors for Lighting Control

NOTE: Utilize occupancy sensors when automatic turn-on and turn-off is desired. Vacancy sensors require human activation to turn on, and turn off automatically. Occupancy sensors turn on automatically when sensing movement or noise, and also turn off automatically. In general, use wallbox or ceiling-mounted sensors for most interior applications. Keep in mind wallbox mounted sensors may be ineffective when obstructions such as partitioned workstations and storage shelving exist. Use wall-mounted sensors for areas with ceilings higher than 3.6 meters 12 feet. Use high-bay sensors for areas with ceilings higher than 3.6 meters 12 feet. Where ceiling-mounted sensors are utilized, mount no closer than 1.8 meters 6 feet to the nearest HVAC supply or return diffuser. Dual technology sensors are a better choice for most applications, with PIR sensors used in small, line-of-sight spaces such as single toilets, and ultrasonic sensors used in multi-person toilets and corridors.

IEEE C62.41, NEMA WD 1, UL 94, UL 916, UL 508, ASTM D4674 REV A.

2.5.3.1 Occupancy Sensors

Provide occupancy sensors with coverage patterns as indicated on project

plans. Provide no less quantity of sensors as shown on plans, but add additional sensors when required to fulfill coverage requirement for the specific model sensor provided. Sensor must be provided with an adaptive learning function that automatically sets sensor in optimum calibration in a set period of time after installation and a non-volatile memory that saves settings after a power outage. Provide sensors designed for ceiling, wall or wall-box installation as indicated. Operating voltage must be 120[277] volts.[Operating voltage must be 24V in conjunction with a control system or separate power pack which interacts with luminaire being controlled.] Provide housing of high-impact, injection-molded thermoplastic with a multi-segmented lens for PIR and dual technology sensors. Sensor operation requires movement to activate luminaires controlled, and turns luminaires off after a set time of inactivity.[Provide integral photocell mounted in occupancy sensor housing when indicated.]

2.5.3.1.1 Passive Infrared (PIR) Sensors

Provide ceiling or wall-mounted PIR sensors meeting the following requirements:

- a. Temperature compensated, dual element sensor and a multi-element fresnel lens (Poly IR4 material).
- b. Technology to optimize automatic time delay to fit occupant usage patterns.
- c. No minimum load requirement for line voltage sensors and be capable of switching from zero to 800 W at 120 VAC, 50/60 Hz and from zero to 1200 W at 277 VAC, 50/60 Hz. Control voltage sensors must not exceed a maximum load requirement of 20 mA at 24VDC.
- d. Time delay of five to 30 minutes in increments of five minutes with a walk through and test mode set by DIP switch.
- e. LED indicator that remains active during occupancy.
- f. Built-in light level sensor that is operational from 0.8 to 18 lux 8 to 180 foot-candles.
- g. Coverage pattern tested to NEMA WD 7 standards.
- h. Standard five year warranty and be UL listed
- i. No leakage current to load when in the off mode.

2.5.3.1.2 Ultrasonic Sensors

Provide ceiling-mounted ultrasonic sensors meeting the following requirements:

- a. Operate at an ultrasonic frequency of 25 kHz[40 kHz][_____].
- b. LED on exterior of device to indicate occupant detection.
- c. Adjustable time delay period of 15 seconds to 15 minutes [_____].
- d. UL listed with minimum five year warranty.

- [e. Provide with isolated relay for integrating control of HVAC or other automated systems.

]2.5.3.1.3 Dual Technology Sensors

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

2.5.3.1.4 High/Low-Bay Sensors

Provide occupancy sensors specifically designed for high/low-bay mounting application using passive infrared (PIR) technology, with the following characteristics:

- a. Input voltage of 120/277 volts, at 50/60 hertz.
- b. High-impact, injection-molded thermoplastic housing with interchangeable lenses for 360 degree open area coverage or narrow rectangular, warehouse aisle coverage.
- c. Utilize zero-crossing circuitry to prevent damage from high inrush current and to promote long life operation.
- d. Be designed to mount directly to or adjacent to high or low-bay luminaires.
- e. UL listed, CEC Title 24 and ASHRAE 90.1 - IP compliant.

2.5.3.1.5 Power Packs for Sensors

UL 2043, CEC Title 24, ASHRAE 90.1 - IP. Power packs used to provide power to one or more lighting control sensors must meet the following requirements:

- a. Input voltage - 120-277 VAC; output voltage - 24 VDC at 225 mA.
- b. 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. RoHS compliant.

2.5.3.2 Vacancy Sensors

Provide vacancy sensors as indicated above under paragraph OCCUPANCY SENSORS, but with requirement of a manual operation to activate luminaires controlled. Provide automatic operation to turn luminaires off after a set period of inactivity.

2.5.4 [Lighting Contactor

NEMA ICS 2. Provide an electrically[mechanically]-held lighting contactor housed in a NEMA 1[12][3R][4][4X][_____] enclosure conforming to NEMA ICS 6. 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.]

2.5.5 Timeswitch

UL 917. [Provide electromechanical type timeswitch with a [24 hour][7 day][astronomic] dial [that changes on/off settings according to seasonal variations of sunset and sunrise]. Provide power to switch from integral synchronous motor with a maximum three watt rating. Rate contacts at 40 amps at 120-277 volts for general purpose loads. Provide contacts in a SPST[DPST][SPDT], [normally-open (NO)][normally-closed (NC)] configuration. [Provide switch with an automatic spring mechanism to maintain accurate time for up to 16 hours.] [Provide switch with function that allows automatic control to be skipped on certain selected days of the week.][Provide switch with manual bypass[remote override] control function.]]

[Provide electronic type timeswitch with a [24 hour][7 day][astronomic] programming function [that changes on/off settings according to seasonal variations of sunset and sunrise], providing a total of 56[_____] on/off set points. Provide [12 hour AM/PM][24 hour] type digital clock display format. Provide power outage back-up for switch for a minimum of [seven][_____] days. Provide switch capable of controlling a minimum of [1][2][4][_____] channels or loads. Rate contacts at [30][_____] amps at 120/277 volts for general purpose loads. Provide contacts in a SPST[DPST][SPDT], [normally-open (NO)][normally-closed (NC)] configuration. [Provide switch with [function that allows automatic control to be skipped on certain selected days of the week][manual bypass or remote override control][daylight savings time adjustment][additional memory module][momentary function for output contacts][ability for photosensor input].]]

House timeswitch in a surface-mounted, lockable, NEMA 1[3R] enclosure constructed of painted steel or plastic polymer conforming to NEMA ICS 6.

2.5.6 Bi-Level HID Controller

UL 1598. Provide device to switch full lumen output of HID luminaires to 50 percent output upon receiving 24 VDC signal from motion sensor, photocell, or control system circuit. Provide device compatible with constant wattage autotransformer (CWA) ballasts and have maximum load rating of 1000[_____] watts. Provide controller in a NEMA 1 enclosure and mount to luminaire or adjacent ceiling structure.

2.5.7 Lighting Control Panel

NOTE: 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.

Provide an electronic, programmable lighting control panel, capable of providing lighting control with input from internal programming, digital switches, time clocks, and other low-voltage control devices.

Enclose panel hardware in a surface[flush]-mounted, NEMA 1[3R], painted,

steel enclosure, with hinged, 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.]

Input voltage - 120/277 V, 60 Hz, with internal 24 VDC power supply.

Provide 8[16][32][_____] single-pole latching[return to close] relays rated at [20][30] amps, [120][277] volts.[Provide provision for relays to close upon power failure that meets UL 924.]

Relay control module must operate at 24 VDC and be rated to control a minimum of 8[16][32][_____] relays.

2.5.8 Local Area Lighting Controller

CEC Title 24 and ASHRAE 90.1 - IP compliant. Provide controller designed for single area or room with the following requirements:

- a. [120][277] volt input, designed for fluorescent or LED lighting loads.
- b. 2[_____] zone, with 1[2][_____] relay[s] rated 20 amps[each].
- c. Provide daylight harvesting capability with full-range dimming control.
- d. Inputs for occupancy sensor, photocell, and low-voltage wall switch.
- [e. Provide capability for receptacle load control.
-]f. Provide full 'OFF' function with input from external time clock input.

2.6 EXIT AND EMERGENCY LIGHTING EQUIPMENT

UL 924, NFPA 101, and NFPA 70 compliant.

2.6.1 Exit Signs

NOTE: For NAVFAC projects, provide LED type self-powered exit signs (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.

Provide exit signs consuming a maximum of five watts total.

2.6.1.1 LED Self-Powered Exit Signs

Provide in [UV-stable, thermo-plastic][painted, die-cast aluminum][painted steel] housing with [UL damp label][UL wet label][using clear polycarbonate housing], configured for ceiling[wall][end] mounting. [Provide edge-lit type with clear acrylic, edge-lit face and aluminum trim having clear

aluminum[white][chrome][brass][_____] finish.] Provide 150 mm 6 inch high, 19 mm 3/4 inch stroke red[green][_____] lettering on face of sign. Provide chevrons on either side of lettering to indicate direction. Provide single[double] face. 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.]

2.6.1.2 LED Remote-Powered Exit Signs

Provide as indicated above for self-powered type, but without battery and charger. Exit sign must contain provision for 120/277 VAC or 6-48 VDC input from remote source.

2.6.2 Emergency Lighting Unit (EBU)

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 lamps 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, MR-16[_____] type 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 1 1/2 hours. 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.

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 Fluorescent Emergency Ballasts

Provide each 'system' with an automatic power failure device, test switch operable from the exterior of the luminaire (or remotely), a pilot light visible from the exterior of the luminaire, and fully automatic solid-state charger, battery, and inverter integral to a self-contained housing.

[Provide self-diagnostic function integral to emergency ballast.] Integral [nickel-cadmium][lead-calcium][_____] battery is required to supply a minimum of 90 minutes of emergency power to one[two][_____] light source[s] within luminaire at a minimum of [500][700][1200][_____] lumens output[each]. Provide open-circuit protection and time-delay function to counteract 'end-of-life' circuitry in normal power ballast from interfering with emergency ballast operation. Ballast must be RoHS compliant, rated for installation in plenum-rated spaces and damp locations, and be warranted for a minimum of five years.

2.6.5 Self-Diagnostic Circuitry for LED and Fluorescent Emergency Drivers/Ballasts

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.

2.6.6 Central Emergency Lighting System

NOTE: Show clearly on project drawings extent and zoning of central emergency system.

Provide integrally-housed emergency system rated at [_____] VA/watts, 120[277] volts (input and output), for a minimum period of 90 minutes. Output frequency must be a pure sine wave at 60 hertz, with maximum 5 percent total harmonic distortion. Provide system with minimum short circuit rating required for protection against available fault current.

2.6.6.1 System Operation

During normal power operation, system charges batteries as needed and allows normal power to pass through to load. Upon loss of normal power, system automatically transfers to emergency mode without interruption of connected loads. Internal batteries provide a minimum of 90 minutes of emergency power at this time. Upon normal power being restored, system switches back to normal power mode and fully charges batteries within UL-approved time period.

2.6.6.2 Battery Charger

Solid state, monitored, three step float charging type, keeping batteries in a fully charged state. Provide circuitry to prevent deep discharge of batteries in prolonged power outage conditions.

2.6.6.3 Batteries

Provide sealed, lead calcium type, designed to operated unattended without maintenance, for a minimum of 10 years.

2.6.6.4 Enclosure

Provide system in NEMA 1[3R] painted steel[aluminum] enclosure with exterior-mounted "push-to-test" button and LED indicator.

2.6.6.5 Accessories

Provide [_____] single pole, [_____] ampere output circuit breakers.
[Voltmeter and ammmeter for battery[load].]

2.7 LUMINAIRE SUPPORT HARDWARE

2.7.1 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.

2.7.2 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, dishwashing areas, etc. Use nickel copper alloy when hangars are used in indoor pool environments. When spacing of hangar wires exceeds 1200 mm 4 feetor 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 Threaded Rods

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

2.7.4 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.

2.8 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. Fixture 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.

2.9 EQUIPMENT IDENTIFICATION

2.9.1 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.

2.9.2 Labels

NOTE: Labeling of lighting components is an inexpensive and effective method for helping facilities personnel properly operate and maintain the lighting systems. 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.

Provide labeled luminaires in accordance with UL 1598 requirements. All luminaires must be clearly marked for operation of specific light sources and ballasts, generators or drivers. Note the following light source characteristics in the format "Use Only _____":

- a. Light source diameter code (T-4, T-5, T-8), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
- b. Light source type, wattage, envelope type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
- c. Start type (programmed 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 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. Ballasts, generators or drivers must have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.10 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.

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

2.11 RECESS- AND FLUSH-MOUNTED LUMINAIRES

Provide access to lamp and ballast from bottom of luminaire. Provide trim [and lenses] for the exposed surface of flush-mounted luminaires as indicated on project drawings and specifications.

2.12 SUSPENDED LUMINAIRES

NOTE: Coordinate pendant sway bracing details with the architect. The architect may prefer to provide pendant sway bracing details in locations where appearance is important. Specify shock absorbing hangers for luminaires in certain hazardous locations if indicated. Specify swivel hangers to satisfy antiterrorist/force protection requirements.

Provide hangers capable of supporting twice the combined weight of luminaires supported by hangers. Provide with swivel hangers to ensure a plumb installation. Provide cadmium-plated steel with a swivel-ball tapped for the conduit size indicated. Hangers must allow fixtures to swing within an angle of 0.79 rad 45 degrees. Brace pendants 1219 mm 4 feet or longer to limit swinging. Single-unit suspended luminaires must have twin-stem hangers. Multiple-unit or continuous row luminaires 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. Provide rods in minimum 4.57 mm 0.18 inch diameter.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations must conform to IEEE C2, NFPA 70, and to the requirements specified herein. Install luminaires and lighting controls to meet the requirements of ASHRAE 90.1 - IP and ASHRAE 189.1. To encourage consistency and uniformity, install luminaires of the same manufacture and model number when residing in the same facility or building.

3.1.1 Light Sources

NOTE: Indicate all light source descriptive information in the luminaire schedule on the project drawings.

When light sources are not provided as an integral part of the luminaire, deliver light sources of the type, wattage, lumen output, color temperature, color rendering index, 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, "General Building Requirements, with Change 1" and UFC 3-310-04, "Seismic Design for Buildings".

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. Installation must meet requirements of NFPA 70. Mounting heights specified or indicated must be to the bottom of the luminaire for ceiling-mounted luminaires and to center of luminaire for wall-mounted luminaires. Obtain 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. Recessed and semi-recessed luminaires must be independently supported from the building structure by a minimum of four wires, straps or rods per luminaire and located near each corner of the luminaire. Ceiling grid clips are not allowed as an alternative to independently supported luminaires. Round luminaires or luminaires smaller in size than the ceiling grid must be independently supported from the building structure by a minimum of four wires, straps or rods per luminaire, spaced approximately equidistant around. Do not support luminaires by acoustical tile ceiling panels. 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. Provide wires, straps, or rods for luminaire support in this section. Luminaires installed in suspended ceilings must also comply with the requirements of Section 09 51 00 ACOUSTICAL CEILINGS.

3.1.3 Suspended Luminaires

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

Provide suspended luminaires with 0.79 rad 45 degree swivel hangers so that they hang plumb and level. Locate so that there are no obstructions within the 0.79 rad 45 degree range in all directions. The stem, canopy and luminaire must be capable of 0.79 rad 45 degree swing. Pendants, rods, or chains 1.2 meters 4 feet or longer excluding luminaire must be braced to prevent swaying using three cables at 2.09 rad 120 degree separation. 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. Utilize aligning splines on extruded aluminum luminaires to assure minimal hairline joints. Support steel luminaires to prevent "oil-canning" effects. Luminaire finishes must be free of scratches, nicks, dents, and warps, and must match the color and gloss specified. Match supporting pendants with supported luminaire. Aircraft cable must be stainless steel. Canopies must be finished to match the ceiling and must be low profile unless otherwise shown. Maximum distance between suspension points must be 3.1 meters 10 feet or as recommended by the manufacturer, whichever is less.

3.1.4 Ballasts, Generators and Power Supplies

Typically, provide ballasts, generators, and power supplies (drivers) integral to luminaire as constructed by the manufacturer.

3.1.5 Exit Signs and Emergency Lighting Units

NOTE: Use this paragraph for most projects.

The bracketed subparagraphs must only be used in special cases such as where energy monitoring systems are used, where facilities use breakers as switches, and where central emergency systems are used. In these cases emergency lighting may have to be on separate circuits rather than connected ahead of the local switching.

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

[3.1.5.1 Exit Signs

NOTE: Use this subparagraph only in special cases and as indicated in the above referenced note.

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.

]3.1.5.2 Emergency Lighting from Central Emergency System

NOTE: Use this subparagraph only for projects utilizing a central emergency system. Include zone control details of emergency system on project drawings when used.

Connect emergency lighting from a central emergency system as indicated on the project drawings.

]3.1.6 Photocell Switch Aiming

Aim switch according to manufacturer's recommendations.

3.1.7 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.

Provide testing of sensor coverage in all spaces where sensors are placed. This should be done only after all furnishings (carpet, furniture, workstations, etc.) have been installed. 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. 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.

3.1.8 Daylight or Ambient Light Level Sensor

Locate sensor as indicated and in accordance with the manufacturer's recommendations. Adjust sensor for 300 lux 30 foot-candles or for the indicated light level measured at the work plane for that particular area.

3.2 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.

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.

-- End of Section --