
USACE / NAVFAC / AFCEC / NASA UFGS-26 51 00.00 40 (February 2013)
Change 1 - 11/14

Preparing Activity: NASA Superseding
 UFGS-26 51 00.00 40 (February 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2017

SECTION TABLE OF CONTENTS

DIVISION 26 - ELECTRICAL

SECTION 26 51 00.00 40

INTERIOR LIGHTING

02/13

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 DEFINITIONS
- 1.3 ADMINISTRATIVE REQUIREMENTS
 - 1.3.1 Pre-Installation Meetings
- 1.4 SUBMITTALS
- 1.5 QUALITY ASSURANCE
 - 1.5.1 Lighting Fixtures, Complete with Lamps and Ballasts
 - 1.5.2 Regulatory Requirements
 - 1.5.3 Standard Products
 - 1.5.3.1 Alternative Qualifications
 - 1.5.3.2 Material and Equipment Manufacturing Date
 - 1.5.4 Sustainable Design Requirements
 - 1.5.4.1 Local/Regional Materials Documentation
 - 1.5.4.2 Environmental Data
 - 1.5.5 Energy Efficiency Data
- 1.6 WARRANTY
 - 1.6.1 Electronic Ballast Warranty

PART 2 PRODUCTS

- 2.1 DESIGN REQUIREMENTS
- 2.2 COMPONENTS
 - 2.2.1 Fluorescent Lighting Fixtures
 - 2.2.1.1 Fluorescent Lamp Electronic Ballasts
 - 2.2.1.2 Fluorescent Lamp Electronic Dimming Ballast
 - 2.2.1.3 Fluorescent Electromagnetic Ballasts
 - 2.2.1.4 Fluorescent Lamps
 - 2.2.1.5 Compact Fluorescent Fixtures
 - 2.2.1.6 Open-Tube Fluorescent Fixtures
 - 2.2.1.7 Air Handling Fixtures
 - 2.2.1.8 Electromagnetic Interference Filters
 - 2.2.2 High-Intensity-Discharge (Hid) Lighting Fixtures
 - 2.2.2.1 HID Ballasts

- 2.2.2.2 High-Pressure Sodium (HPS) Lamps
- 2.2.2.3 Low-Pressure Sodium Lamps
- 2.2.2.4 Metal-Halide Lamps
- 2.2.3 Incandescent Lighting Fixtures
 - 2.2.3.1 Incandescent Lamps
- 2.2.4 Commercial Incandescent Lighting Fixtures
 - 2.2.4.1 Surface-Mounted Fixtures
 - 2.2.4.2 Recessed Fixtures
 - 2.2.4.3 Pendant-Mounted Fixtures
- 2.2.5 Industrial Incandescent Lighting Fixtures
- 2.2.6 Enclosed And Gasketed Vapor-Tight Fixtures
- 2.2.7 Incandescent Lamps
- 2.2.8 Recess- And Flush-Mounted Fixtures
- 2.2.9 Suspended Fixtures
- 2.2.10 Fixtures For Hazardous Locations
- 2.3 EQUIPMENT
 - 2.3.1 Equipment Identification
 - 2.3.1.1 Manufacturer's Nameplate
 - 2.3.1.2 Labels
 - 2.3.2 Power Hook Fixture Hangers
 - 2.3.3 Auxiliary Instant-On System
 - 2.3.4 Support Hangers for Lighting Fixtures in Suspended Ceilings
 - 2.3.4.1 Wires
 - 2.3.4.2 Wires, for Humid Spaces
 - 2.3.4.3 Straps
 - 2.3.4.4 Rods
 - 2.3.5 Factory Applied Finish
- 2.4 ACCESSORIES
 - 2.4.1 Lowering Devices For High-Bay Lighting Fixtures
 - 2.4.1.1 Contact Assembly
 - 2.4.1.2 Lockbox
 - 2.4.1.3 Cable/Chain

PART 3 EXECUTION

- 3.1 PREPARATION
 - 3.1.1 Field Applied Painting
- 3.2 INSTALLATION
 - 3.2.1 Lamps
 - 3.2.2 Lighting Fixtures
 - 3.2.3 Suspended Fixtures
 - 3.2.4 Ballasts
 - 3.2.4.1 Remote Ballasts
 - 3.2.4.2 Electronic Dimming Ballasts
- 3.3 FIELD QUALITY CONTROL
 - 3.3.1 Electronic Dimming Ballast
- 3.4 FIELD TESTING
- 3.5 MAINTENANCE
 - 3.5.1 Operational Service

-- End of Section Table of Contents --

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INTERIOR LIGHTING
02/13

NOTE: This guide specification covers requirements for interior lighting installations. Requirements for materials and procedures for special or unusual design should be added as necessary to fit specific projects.

Emergency lighting and exit signs are covered in Section 26 52 00.00 40 EMERGENCY LIGHTING. Lighting control devices are covered in the Section 26 09 23.00 40 LIGHTING CONTROL DEVICES.

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 items(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 compliance with Executive Order 12902 and FAR section 23.704 which directs federal agencies to purchase products in the upper 25 percent of energy efficiency, the following products specified in this section meet or exceed the U.S. Department of Energy, Federal Energy Management Program (DOE/FEMP) Product Energy Efficiency Recommendations (PEER) for the Recommended energy efficiency levels.

This specification contains products recommended by

FEMP. The following recommendations are currently on the FEMP site on the internet. Additional recommendations may be added or existing recommendations updated at any time.

FEMP LT-1 (1998) How to Buy Energy Efficient Fluorescent Tube Lamps

FEMP LT-2 (2000) How to Buy Energy-Efficient Fluorescent Ballasts

To view the latest on-line information about buying energy efficient products go to the FEMP home page at:

http://www1.eere.energy.gov/femp/technologies/procuring_eeproducts.html

NOTE: TO DOWNLOAD UFGS GRAPHICS

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

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NOTE: This site contains lighting fixture sketches (Graphics) and are available in metric (SI) and U.S. Customary (IP) system dimensions. Sketch titles and style numbers are unchanged for both types. The metric values indicated are a conversion of the IP system dimensions.

Do not include list of sketches, or sketches themselves, in project specifications. Use lighting fixture 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 fixture schedule. The "NL" style numbers and dates should remain on the drawing details.

NOTE: Show the following information on project drawings:

1. Type, style, mounting, and lamp arrangement
2. Location of fixtures
3. Wattage, voltage, and frequency rating required
4. Type of reflector, diffuser required
5. Glass/plastic lens
6. Accessories required, such as photocell, time switches, sensors, and auxiliary lamps

7. Mounting height above floor or grade to bottom of fixture
8. Where wire for humid areas, rods, or straps are used (if more than one type of hanger is used)
9. Reflecting or nonreflecting surface finish
10. Shielding required
11. Referenced sketch
12. NEMA distribution type (when applicable)
13. Occupancy sensor location, mounting, and sensor detection type

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

PART 1 GENERAL

Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in this section.

Materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

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.

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M	(2016) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened
ASTM A123/A123M	(2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A368	(1995; R 2013) Standard Specification for Stainless Steel Wire Strand
ASTM A467/A467M	(2007; R 2012) Standard Specification for Machine Coil Chain
ASTM A47/A47M	(1999; R 2014) Standard Specification for Ferritic Malleable Iron Castings
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	(2015; E 2016) 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 B26/B26M	(2014; E 2015) Standard Specification for Aluminum-Alloy Sand Castings
ASTM B633	(2015) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM E2129	(2010) Standard Practice for Data Collection for Sustainability Assessment of Building Products

CALIFORNIA ENERGY COMMISSION (CEC)

CEC Title 24	(2008; Effective Jan 2010) California's Energy Efficiency Standards for Residential and Nonresidential Buildings
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ILLUMINATING ENGINEERING SOCIETY (IES)

IES HB-10	(2011; Errata 2015) IES Lighting Handbook
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INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2017) National Electrical Safety Code
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
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI ANSLG C78.41	(2006) For Electric Lamps--Guidelines for Low-Pressure Sodium Lamps
ANSI ANSLG C78.42	(2009; R 2016) For Electric Lamps: High-Pressure Sodium Lamps
ANSI C78.1381	(1998) American National Standard for Electric Lamps - 250-Watt, 70 Watt, M85 Metal-Halide Lamps
ANSI C78.901	(2005) American National Standard for Electric Lamps - Single Base Fluorescent Lamps--Dimensional and Electrical Characteristics
ANSI C82.1	(2004; R 2015) American National Standard for Electric Lamp Ballasts - Line Frequency Fluorescent Lamp Ballasts
ANSI C82.2	(2002) American National Standard for Lamp Ballasts--Methods of Measurement of Fluorescent Lamp Ballasts
ANSI C82.4	(2002) American National Standard for Ballasts for High-Intensity-Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)
ANSI/ANSLG C78.43	(2013) American National Standard for Electric Lamps - Single-Ended Metal-Halide 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 C78.81	(2016) American National Standard for Electric Lamps--Double-Capped Fluorescent Lamps--Dimensional and Electrical

Characteristics

NEMA ANSLG C82.11

(2011) Lamp Ballasts - High-Frequency
Fluorescent Lamp Ballasts

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70

(2017) National Electrical Code

NFPA 90A

(2015) Standard for the Installation of
Air Conditioning and Ventilating Systems

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star

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

UNDERWRITERS LABORATORIES (UL)

UL 1029

(1994; Reprint Dec 2013)
High-Intensity-Discharge Lamp Ballasts

UL 1598

(2008; Reprint Oct 2012) Luminaires

UL 844

(2012; Reprint Mar 2016) UL Standard for
Safety Luminaires for Use in Hazardous
(Classified) Locations

UL 935

(2001; Reprint Aug 2014) Standard for
Fluorescent-Lamp Ballasts

1.2 DEFINITIONS

- a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.
- b. Average life is the time after which 50 percent has failed and 50 percent has 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.

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Meetings

Within [30] [_____] days of Contract Award, the Contracting Officer may schedule a Pre-Installation meeting. Submit the following for review and approval:

- a. Local/Regional Materials Documentation
- b. Environmental Data
- c. Energy Efficiency Data
- d. 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.

1.4 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. An "S" following a submittal item indicates that the submittal is required for the Sustainability Notebook 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 information only or as otherwise designated. 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 Notebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Employ the terminology, classifications, and methods prescribed by the IES HB-10, as applicable, for the lighting system specified in data, drawings, and reports.

SD-02 Shop Drawings

Commercial Incandescent Lighting Fixtures[; G[, [____]]]
Industrial Incandescent Lighting Fixtures[; G[, [____]]]
Enclosed and Gasketed Vapor-Tight Fixtures[; G[, [____]]]
Lowering Devices[; G[, [____]]]

SD-03 Product Data

Fluorescent Lighting Fixtures[; G[, [____]]]
Fluorescent Electronic Ballasts[; G[, [____]]]
Fluorescent Electromagnetic Ballasts[; G[, [____]]]
Fluorescent Lamps[; G[, [____]]]
High-Intensity-Discharge (Hid) Lighting Fixtures[; G[, [____]]]
HID Ballasts[; G[, [____]]]
High-Pressure Sodium (HPS) Lamps[; G[, [____]]]
Low-Pressure Sodium Lamps[; G[, [____]]]
Metal-Halide Lamps[; G[, [____]]]
Incandescent Lighting Fixtures[; G[, [____]]]
Incandescent Lamps[; G[, [____]]]
Power Hook Fixture Hangers[; G[, [____]]]
Electronic Dimming Ballast[; G[, [____]]]
[Local/Regional Materials Documentation[; G[, [____]]]
][Environmental Data[; G[, [____]]]
Energy Efficiency Data[; G[, [____]]]
Commercial Incandescent Lighting Fixtures[; G[, [____]]]
Industrial Incandescent Lighting Fixtures[; G[, [____]]]
Enclosed and Gasketed Vapor-Tight Fixtures[; G[, [____]]]
Lowering Devices[; G[, [____]]]

SD-04 Samples

**NOTE: Samples involve additional shipping cost.
Use only for special fixtures on a project. If
samples are not essential to the specific**

application, delete them.

Lighting Fixtures[; G[, [____]]]

SD-07 Certificates

Energy Star Documentation[; G[, [____]]]

SD-10 Operation and Maintenance Data

Operational Service[; G[, [____]]]

1.5 QUALITY ASSURANCE

[1.5.1 Lighting Fixtures, Complete with Lamps and Ballasts

NOTE: Delete this paragraph if samples are not required.

Delete bracketed options if samples are required for all fixture types. Choose bracketed options only if samples of some fixtures are required. Indicate in the fixture schedule on the drawings which fixture types require samples or specify using the last bracketed sentence.

Submit one sample of each[indicated] fixture type[complete with lamps and ballast,] for inspection, review, and approval. Retain the sample for comparison against the remainder of the fixtures. The sample may be used in the final fixture installation.[Provide samples for the following fixture types indicated on the drawings: [____].]

[1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory 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. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.3 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, which have been in satisfactory commercial or industrial use for 2-years prior to bid opening. The 2-year period includes applications of equipment and materials under similar circumstances and of similar size, 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, provide 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.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record are 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.

1.5.3.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than 3-years prior to date of delivery to site, unless specified otherwise.

1.5.4 Sustainable Design Requirements

[1.5.4.1 Local/Regional Materials Documentation

NOTE: Using local materials can help minimize transportation impacts, including fossil fuel consumption, air pollution, and labor.

This is optional for Army projects.

[Use materials or products extracted, harvested, or recovered, as well as manufactured, within a [800][_____] kilometer [500][_____] mile radius from the project site, if available from a minimum of three sources.

] Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

]1.5.4.2 Environmental Data

NOTE: ASTM E2129 provides for detailed documentation of the sustainability aspects of products used in the project. This level of detail may be useful to the Contractor, Government, building occupants, or the public in assessing the sustainability of these products.

This is optional for Army projects.

Submit Table 1 of ASTM E2129 for the following products: [_____].

]1.5.5 Energy Efficiency Data

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 ASHRAE 90.1 level. Efficient lighting equipment

contributes to the following LEED credits: EA
Prerequisite 2; EA1.

Comply with National Energy Policy Act and Energy Star requirements for lighting products. [Submit Energy Star documentation for qualifying equipment.]Include data indicating lumens per watt efficiency and color rendition index of light source.

Ensure lighting designs utilize Spectrally Enhanced Lighting (SEL) in designs for application in which the IES Illuminance Category is P or Higher. In this application the lamp color is a minimum 82 CRI and 5000K CCT for fluorescent lamps. For the purpose of these calculations, the reference S/P value is 1.4. Submit a sample calculation utilizing the S/P value for the specified lamps to provide a factor for lighting reduction below IES recommendations. Light levels can not go below the IES recommended levels.

Submit equipment and performance data for incandescent lighting fixtures.

1.6 WARRANTY

Support the equipment items with 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 Electronic Ballast Warranty

NOTE: The warranty clause in this section has been approved by a Level 1 Contracting Officer, and may be used without further approval or request for waiver.

Furnish the electronic ballast manufacturer's warranty, for not less than 5-years from the date of manufacture of the electronic ballast. Ballast assembly in the lighting fixture, transportation, and on-site storage is not to exceed 12-months, thereby permitting 4-years of the ballast 5-year warranty to be in service and energized. State in the warranty that the manufacturer agrees to exchange a malfunctioning ballast and promptly ship the replacement to the using Government facility, said replacement ballast being identical to, or an improvement upon, the original design of the malfunctioning ballast.

PART 2 PRODUCTS

2.1 DESIGN REQUIREMENTS

Furnish lighting fixtures completely assembled with wiring and mounting devices and ready for installation at the locations noted. Design and equip recessed fixtures in suspended ceilings for installation in the type of ceiling in which the fixture is installed. Design fixtures to be supported independent of the ceiling. Equip fixtures with the lamps required.

Ensure lighting fixtures conform to UL 1598. Ensure fixtures in hazardous areas conform to UL 844.

2.2 COMPONENTS

2.2.1 Fluorescent Lighting Fixtures

2.2.1.1 Fluorescent Lamp Electronic Ballasts

NOTE: Electronic ballasts may have system compatibility problems when installed in certain environments. The problems mainly concern the radiated and conducted EMI due to the relatively high switching frequencies inherent in electronic ballasts and possibly due to utilization of the same power source for lighting and other equipment. Shielding technologies today can prevent interference with surroundings, and therefore this is rarely an issue. Environments where electronic ballasts have the potential for EMI are:

1. Libraries or other facilities which utilize magnetic detectors to prevent theft or inventory control. However, it has been reported that electronic ballasts have no impact on the magnetic detectors if the separation distance is greater than 3050 to 4575 mm 10 to 15 feet. This includes distances in all directions through floors, ceilings, and walls.

2. Facilities using high frequency power line carrier (PLC) control systems, such as a central clock system. These PLC systems usually have a 50,000 Hz to 200 kHz carrier frequency which may be affected by the harmonics generated by the electronic ballasts.

3. Areas where sensitive electronic equipment is installed such as hospital critical care units, other areas utilizing sensitive electronic equipment based life support systems, and electronic testing facilities.

With proper design considerations, electronic ballasts should provide satisfactory performance even in these and other sensitive areas. The designer must consider fixture location, fixture performance characteristics, manufacturers' recommendations, environmental constraints, etc. in the lighting design. Edit this specification as required to solve specific design problems.

Submit fluorescent electronic ballasts catalog data. As an option, submit the fluorescent fixture manufacturer's electronic ballast specification information in lieu of the actual ballast manufacturer's catalog data. Include published specifications and sketches. This information may be supplemented by catalog data if required, containing a list of vendors with vendor part numbers.

Provide electronic ballasts, meeting as a minimum, the following characteristics:

- a. Provide ballasts complying with UL 935, NEMA ANSLG C82.11, NFPA 70, and CEC Title 24 unless specified otherwise. Ensure transient immunity as recommended by IEEE C62.41.1 and IEEE C62.41.2 by providing 100 percent electronic high frequency type ballasts with no magnetic core and coil components. Design ballast for the wattage of the lamps used in the indicated application. Design ballasts to operate on the voltage system to which they are connected.
- b. A power factor of 0.95 (minimum).
- c. Operates at a frequency of 20,000 Hertz (minimum), and is 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. Light regulation of plus or minus 10 percent lumen output with a plus or minus 10 percent input voltage regulation. Ensure ballasts have 10 percent flicker (maximum) using any compatible lamp.
- e. A ballast factor between 0.77 (minimum) and 1.00 (maximum). Current crest factor - 1.7 (maximum).
- f. UL listed Class P with a sound rating of "A."
- g. Include circuit diagrams and lamp connections displayed on the ballast.

NOTE: Choose the bracketed option and require programmed start ballasts for Army and Air Force projects.

For Navy projects, provide instant start ballasts for areas not subject to frequent switching (i.e., more than once every three hours). Provide programmed start ballasts for areas subject to frequent switching, including all areas controlled by occupancy sensors. Identify fixtures requiring each type on the drawings.

- [h. Provide instant start ballasts unless otherwise indicated, with programmed start where indicated. Provide instant start ballasts which operate lamps in a parallel circuit configuration that permits the operation of remaining lamps if one or more lamps fail or are removed.][Provide programmed start ballast 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. Provide programmed start ballasts for compact fluorescent fixtures.
- j. Provide ballasts for T-5 and smaller lamps with end-of-life protection circuits as required by NEMA ANSLG C78.81 and ANSI C78.901 as applicable.

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

- k. Provide ballasts capable of starting and maintaining operation at a minimum of -17 degrees C 0 degrees F unless otherwise indicated.
- l. Provide electronic ballasts with a full replacement warranty of 5 years from date of manufacture as specified in paragraph ELECTRONIC BALLAST WARRANTY," of this section.

Provide T-8 Lamp Ballast with the following characteristics:

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

- a. Provide T-8 electronic ballasts compatible with the specific amp wattages being driven.
- b. For T-8 lamps with 30 watts or lower, provide ballasts with anti-striation technology.
- c. Total harmonic distortion (THD): [20 percent][____] percent]
(maximum).
- d. 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
 -]

NOTE: Multilevel switching for light control is recommended for some locations, such as classrooms and conference rooms where multilevel switching is desired.

- e. 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
 -][f. Provide three[and four] lamp fixtures with two ballasts per fixture where multilevel switching is indicated.
 -]

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

- [g. 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.

-] Provide F17T8 Lamp Ballast with a total harmonic distortion (THD) of 25 percent (maximum).

Provide T-5 and T-5 HO Ballast compatible with the specific amp wattages being driven. Ensure total harmonic distortion (THD) is 15 percent (maximum).

a. 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

]2.2.1.2 Fluorescent Lamp Electronic Dimming Ballast

NOTE: 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 ballast have the potential for EMI are listed in the criteria note for electronic ballast.

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, 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; 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 electronic ballasts meeting the following minimum characteristics:

- a. Ensure compliance with NEMA ANSLG C82.11, UL 935, and NFPA 70, unless specified otherwise. Provide transient immunity as recommended by IEEE C62.41.1 and IEEE C62.41.2. Ballast dimming capability range - from 100 to 5 percent (minimum range) of light output, flicker free, and starts lamp at any preset light output setting without first having to go to full light output. Design ballast for the wattage of the lamps used in the indicated application. Design ballasts to operate on the voltage system to which they are connected.
- b. Power factor of 0.95 (minimum) at full light output, and 0.90 (minimum) over the entire dimming range.
- c. Ballast operates at a frequency of 20,000 Hertz (minimum). Ballast is 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 is between 0.85 (minimum) and 1.00 (maximum). Current crest factor is 1.7 (maximum).
- e. UL listed Class P with a sound rating of "A".
- f. Display circuit diagrams and lamp connections on the ballast.
- g. Provide dimming ballast compatible with specified lighting control system.

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

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

For T-8 Lamp Ballast, the input wattage for the indicated lamp quantity is:

- 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.

[2.2.1.3 Fluorescent Electromagnetic Ballasts

NOTE: Generally, electromagnetic ballasts should not be specified. Include this paragraph only for specific project requirements. Include this

paragraph if any of the optional subparagraphs are used. Delete last two sentences when only compact fluorescent fixtures paragraph is used.

Ensure ballasts conform to UL 935. Provide high power factor type ballasts (0.9 minimum),[unless indicated otherwise,] designed to operate on the voltage system to which they are connected. Ensure ballasts are Class P and have sound rating "A"[unless otherwise noted]. Design and construct fixtures and ballasts to limit the ballast case temperature to 90 degrees C 195 degrees F when installed in an ambient temperature of [40][_____] degrees C [105][_____] degrees F. Provide energy saving electromagnetic ballasts for T-8 and T-12 lamps. Provide three lamp fixtures with two ballasts per fixture.

a. Electromagnetic Energy-Saving Ballasts

NOTE: Energy-saving ballasts are generally not available for low temperature applications (below 10 degrees C 50 degrees F). Additionally, the combination of energy-saving ballasts and energy-saving lamps are not recommended below 15 degrees C 60 degrees F.

NOTE: Include last bracketed sentence and use 123 input wattage in lieu of 136, when required by the Post or Base or Activity involved.

Ensure ballasts conform to ANSI C82.1. Provide energy-saving fluorescent ballasts of the CBM certified full light output type[except where fixtures are provided with low temperature ballasts], with an average input wattage of[40 or less when operating one 32-watt F32T8 lamp][45 or less when operating two 17 watt F17T8 lamps][72 or less when operating two 32 watt F32T8 lamps][109 or less when operating two 59-watt F96T8 lamps][[_____] or less when operating [_____] lamps] tested in accordance with ANSI C82.2 methods.[Provide ballasts which are compatible with energy-saving lamps.]

b. Provide electromagnetic ballasts for compact fluorescent lamps.

c. Electromagnetic Low Temperature Ballasts

NOTE: A source of light other than fluorescent is recommended for areas subject to temperatures below -17 degrees C, 0 degrees F. If fluorescent fixtures are required, low temperature ballasts should be indicated and specified where ambient temperatures may normally drop below 10 degrees C 50 degrees F if required by the design. Low temperature ballasts are not CBM certified and do not conform to ANSI C82.1.

Provide fluorescent ballasts having a minimum starting temperature of[minus 17 degrees C][minus 28 degrees C][zero degrees F][minus 20 degrees

F] for 800 milliamperere, high output (HO) lamps in fixtures mounted[in cold rooms,][outdoors,][in unheated buildings,][and as indicated].

]2.2.1.4 Fluorescent Lamps

NOTE: Fluorescent lamps with minimum CRI of 82 and correlated color temperature of 5000 K are recommended for most applications.

Low mercury lamps must be specified on projects that use 1220 mm 4-foot lamps and are located in the continental United States. For other locations or lamp types, the specifier must ensure availability of the low mercury lamps.

- [a. Provide T-8 rapid start[low mercury] lamps rated 32 watts (maximum), 2800 initial lumens (minimum), CRI of 82 (minimum), correlated color temperature of [5000 K][____], with an average rated life of 20,000 hours.[Provide low mercury lamps which have passed the EPA Toxicity Characteristic Leachate Procedure (TCLP) for mercury by using the lamp sample preparation procedure described in ANSI/NEMA C78.LL 1256.]
-]b. Provide T-8 rapid start lamp, 17 watt (maximum), nominal length of 610 mm 24 inches, 1300 initial lumens, CRI of 82 (minimum), correlated color temperature of [5000 K][____], and an average rated life of 20,000 hours.
-]c. Provide T-8 instant start lamp, 59 watts (maximum), nominal length of 2438 mm 96 inches, minimum CRI of 82, 5700 initial lumens, correlated color temperature of [5000 K][____], and average rated life of 15,000 hours.
-]d. Provide T-12 slim line lamps rated 60 watts (maximum), 5750 initial lumens (minimum), 12,000 hours average rated life.
-]e. Provide T-8, U shaped fluorescent lamp, 31 watts maximum, 2600 initial lumens (minimum), [5000 K][____], 82 CRI (minimum), 20,000 hours average rated life,[41.29 mm][____] mm ([____] inch)[1.625][____] inch leg spacing.
-]f. Provide compact fluorescent lamps: CRI 82, minimum, [5000 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.

2.2.1.5 Compact Fluorescent Fixtures

Provide compact fluorescent fixtures 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. Provide fixtures using lamps as indicated, with a minimum CRI of 80.

a. Bare Bulb Retrofits

Replace 40-watt incandescent bulbs (495 plus lumens) with 11- to 14-watt compact fluorescent bulbs (45 plus lumens per watt). Replace 60-watt incandescent bulbs (900 plus lumens) with 15- to 19-watt compact fluorescent bulbs (60 plus lumens per watt). Replace 75-watt incandescent bulbs (1200 plus lumens) with 20- to 25-watt compact fluorescent bulbs (60 plus lumens per watt). Replace 100-watt incandescent bulbs (1750 plus lumens) with 29-watt or greater compact fluorescent bulbs (60 plus lumens per watt).

b. Reflector Type Bulb Retrofits

Replace 50-watt incandescent bulbs (550 plus lumens) with 17- to 19-watt compact fluorescent bulbs (33 plus lumens per watt). Replace 60-watt incandescent bulbs (675 plus lumens) with 20- to 21-watt compact fluorescent bulbs (40 plus lumens per watt). Replace 75-watt incandescent bulbs (875 plus lumens) with 22-watt or greater compact fluorescent bulbs (40 plus lumens per watt).

2.2.1.6 Open-Tube Fluorescent Fixtures

NOTE: Select one of bracketed options where lamp breakage is detrimental, such as above food counters.

Provide with self-locking sockets, or lamp retainers (two per lamp).[Provide lamps with shatter resistant coating, non-yellowing, nominal thickness of 0.38 mm 15-mils, and with 97 percent (minimum) light transmission.][Provide a clear polycarbonate protective sleeve with end caps, over lamp, with 95 percent (minimum) light transmission. Rate the sleeve to withstand the thermal profile of the lamp and ballast.]

2.2.1.7 Air Handling Fixtures

Provide fixtures used as air handling registers conforming to the requirements of NFPA 90A. Ensure that T8 lamps used in air handling fixtures are a minimum of 32 watts.

[2.2.1.8 Electromagnetic Interference Filters

NOTE: Use filters only when specifically required by activity. Filters available for mounting within lighting fixtures provide only basic interference suppression. For shielded enclosures and secure facilities, provide power line filters in the circuits serving the lighting.

Provide filters in each fluorescent fixture mounted[in shielded enclosures][where indicated].[Provide filters integral to the fixture assembly with one filter per ballast and suppress electromagnetic

interference in the AM radio band from 500 to 1700 kHz.][Install filters in the circuit serving the lighting fixtures mounted where indicated.]

]2.2.2 High-Intensity-Discharge (Hid) Lighting Fixtures

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

2.2.2.1 HID Ballasts

Provide HID ballasts conforming to UL 1029 and ANSI C82.4, with a constant wattage autotransformer (CWA) or regulator, high power factor type (minimum 90 percent). Provide single-lamp ballasts which have a minimum starting temperature of minus 30 degrees C minus 22 degrees F. Provide ballasts:

- 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 [105][_____] degrees F.
- c. Constructed so that open circuit operation does not reduce the average life.

Provide high-pressure sodium (HPS) ballasts with a solid-state igniter/starter with an average life in the pulsing mode of 3500 hours at the intended ambient temperature. Igniter case temperature is not to exceed 90 degrees C 195 degrees F in any mode.

2.2.2.2 High-Pressure Sodium (HPS) Lamps

ANSI ANSLG C78.42 wattage as indicated. 150 watt lamps, if required, are 55 volt type.

[a. Standby HPS Lamps

NOTE: Dual ARC tube HPS Lamps may, under certain conditions be used as auxiliary stand-by lighting when momentary power interruptions are anticipated.

Provide standby HPS lamps with two arc tubes and an average rated life of 40,000 hours (minimum), and hot restart instant lumen output of 8 percent, minimum, of total light output.

] b. Luminaire Efficiency Rating (LER)

(1) Upward efficiency of 0 percent

[(a) 150-399 watts: Minimum 58 LER for closed fixture; minimum 68 for open fixture

][(b) 400-999 watts: Minimum 63 LER for closed fixture; minimum 84 for open fixture

] (2) Upward efficiency of 1 percent-10 percent

[(a) 150-399 watts: Minimum 64 LER for closed fixture; minimum 63 for open fixture

-][(b) 400-999 watts: Minimum 82 LER for closed fixture; minimum 89 for open fixture
-][(c) 1000 plus watts: Minimum 109 LER for open fixture
-] (3) Upward efficiency of 11 percent to 20 percent
 - [(a) 150-399 watts: Minimum 78 LER for open fixture
 -][(b) 400-999 watts: Minimum 94 LER for open fixture
-] (4) Upward efficiency greater than 20 percent
 - [(a) 150-399 watts: Minimum 75 LER for closed fixture; minimum 77 for open fixture

2.2.2.3 Low-Pressure Sodium Lamps

NOTE: Use low-pressure sodium where color rendition is not a factor, but high lamp efficiency is.

Ensure LPS lamps conform to ANSI ANSLG C78.41.

2.2.2.4 Metal-Halide Lamps

NOTE: Metal-halide lamp safe operation requires lamps to be turned off at least 15 minutes per week or lamp may rupture near the end of its expected life. Lamp rupture may discharge glass and extremely hot quartz (greater than 900 degrees C) into the surrounding area. Therefore, designs for metal-halide lamps include weekly turnoff instructions when continuously operated, 24 hours per day, 7 days per week. Detail these instructions on the drawings for posting at the control locations. For indoor use, color rendition index (CRI) and color temperature (CCT) may need to be specified.

- [Provide double-ended, 70 watt lamps, conforming to ANSI C78.1381.
-][Provide single-ended, wattage as indicated, conforming to ANSI/ANSLG C78.43.
-] Provide lamps with a Luminaire Efficiency Rating (LER):
 - a. Upward efficiency of 0 percent
 - [(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 plus watts: Minimum 77 LER for closed fixture

] b. Upward efficiency of 1 percent-10 percent

[(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 plus watts: Minimum 88 LER for open fixture

] c. Upward efficiency greater than 20 percent

[(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

]2.2.3 Incandescent Lighting Fixtures

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

2.2.3.1 Incandescent Lamps

Provide the number, type, and wattage indicated.

2.2.4 Commercial Incandescent Lighting Fixtures

Submit manufacturer's catalog data for commercial incandescent lighting fixtures.

Commercial incandescent lighting fixtures include recessed, surface mounted, and pendant-mounted luminaires.

Provide [corrosion-resistant nonferrous metal] [sheet steel with corrosion-resistant finish] metal parts of fixtures. Do not use solder or self-threading sheet metal screws in the construction of the fixture enclosure.

Equip fixtures rated up to and including 300 watts with medium screw-base lampholders. Equip fixtures rated in excess of 300 watts but not more than 1,500 watts with mogul screw-base lampholders. Provide screw shells of lampholders, which are electrically connected to the metal part of lighting fixtures, or equipment grounding-circuit conductor.

2.2.4.1 Surface-Mounted Fixtures

Design the surface-mounted fixtures to be fastened to wall or ceiling flush-mounted outlet boxes. Do not subject combustible ceiling materials to temperatures in excess of 90 degrees C 195 degrees F.

2.2.4.2 Recessed Fixtures

Design recessed fixtures in suspended ceilings for the type of ceiling construction in which the fixture is installed. Do not subject combustible ceiling materials to temperatures in excess of 90 degrees C 195 degrees F. Where recessed fixtures are supported on suspended ceilings, provide a minimum of four support rods per fixture with no support further than [150] [_____] millimeter [6] [_____] inches from the edge of the fixture. Do not support fixtures by acoustic panels.

2.2.4.3 Pendant-Mounted Fixtures

Equip pendant-mounted fixtures with stems and swivel ball-and-socket self-aligning hangers. Allow a minimum of a [20] [_____] -degree angle swing for all ceiling canopies, and fixture-hanging devices, made of seamless brass, aluminum, steel, corrosion-resistant steel tubing, or steel conduit not less than [15] [_____] millimeter [1/2] [_____] inch in diameter. Stem length, material, and finish are as noted.

2.2.5 Industrial Incandescent Lighting Fixtures

Submit manufacturer's catalog data for industrial incandescent lighting fixtures.

Provide industrial incandescent lighting fixtures with industrial porcelain-enameled seamless dome reflectors. Use ventilated necks and hoods tapped for 15 millimeter 1/2 inch conduit for swivel suspension pendant mounting. Provide lampholders with medium or mogul bases as applicable, furnished with incandescent lamps having the wattage rating indicated. Ensure lampholders meet the requirements of UL 1598. Provide reflectors and sockets as a unit, that are detachable without the use of tools, but arranged so that they cannot inadvertently come loose.

2.2.6 Enclosed And Gasketed Vapor-Tight Fixtures

Submit manufacturer's catalog data for enclosed and gasketed vapor-tight fixtures.

Provide enclosed and gasketed vapor-tight fixtures suitable for wet or damp locations consisting of a cast-aluminum body, cap or matching outlet box, porcelain lampholder, glass enclosing globe, cork gaskets, and cast-aluminum guards for wall, ceiling, or pendant mounting in accordance with UL 1598 and NFPA 70.

Furnish exposed cast aluminum outlet boxes for wall- and ceiling-mounted fixtures with four tapped hubs, 90 degrees apart circumferentially, with three cast-aluminum threaded pipe plugs to fit the tapped holes. Provide boxes with ears or lugs for surface mounting to wall or ceiling. Provide body with mounting screws and gasket to ensure a vapor-tight joint between the body and outlet box.

Concealed outlet boxes for wall- and ceiling-mounted fixtures may be standard sheet metal boxes. Provide fixture body with mounting screws and gasket to ensure a vapor-tight joint between the body and outlet box.

Seal body and cap for pendant-mounted fixtures with a gasket at the joint. Provide cast aluminum cap with top hub tapped for 15 millimeter 1/2-inch tapered iron pipe threads.

Furnish cast aluminum exposed outlet boxes for pendant-mounted fixtures with the fixtures with four tapped hubs, 90 degrees apart circumferentially, with three cast-aluminum threaded pipe plugs to fit the tapped holes. Supply boxes with ears or lugs for surface mounting to the ceiling. Provide cast aluminum outlet-box covers for concealed and exposed outlet boxes with the center hub tapped for 15 millimeter 1/2-inch tapered iron pipe threads. Provide cover and outlet box with mounting screws and gasket to ensure a vapor-tight joint between the cover and outlet box. Provide 15 millimeter 1/2-inch galvanized rigid steel conduit stem.

Provide clear nondiffusing heat-resistant glass enclosing globe, molded in one piece into a cylindrical shape, with a closed bowl-shaped bottom and an open molded top bead or thread. Make edges of the open end either ground or molded to a smooth, true surface that ensures a vapor-tight joint when the globe is fastened to the gasketed body.

Provide a cast-aluminum guard of the same shape as the glass enclosing globe which is affixed to the fixture body with threads or setscrews.

2.2.7 Incandescent Lamps

Submit manufacturer's catalog data for incandescent lamps.

Provide [clear] [frosted inside] general-purpose lamps. Provide lamps with wattage ratings up to and including 300 watts with medium brass screw bases. Provide lamps with wattage ratings in excess of 300 watts with mogul brass screw bases.

Special-purpose lamps include PAR and R lamps. Provide PAR lamps with clear, molded, heat-resistant, hard-glass bulbs with a parabolic, aluminized, inner-bulb wall reflector for spot- or flood-lighting applications. Provide R lamps with clear, soft, blown-glass bulbs with silver-deposited, inner-bulb wall reflector for spot or floodlighting applications. Design lamps for operation on 120 volts.

2.2.8 Recess- And Flush-Mounted Fixtures

Provide type that can be relamped from the bottom, with access to ballast from the bottom, with trim for the exposed surface of flush-mounted fixtures as indicated.

2.2.9 Suspended Fixtures

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 fixtures in certain hazardous locations if indicated. Specify swivel hangers to satisfy antiterrorist/force protection requirements.

Install hangers capable of supporting twice the combined weight of fixtures supported by hangers. Provide with swivel hangers to ensure a plumb installation. Use cadmium-plated steel hangers with a swivel-ball tapped for the conduit size indicated.[Provide shock-absorbing type hangers where indicated.] Provide hangers which allow fixtures to swing within an angle of 0.79 rad 45 degrees. Brace pendants 1219 mm 4-feet or longer[provided in shops or hangers] to limit swinging. Provide single-unit suspended[fluorescent] fixtures with twin-stem hangers. Provide multiple-unit or continuous row fluorescent fixtures with 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 with a minimum 4.57 mm 0.18-inch diameter.

[2.2.10 Fixtures For Hazardous Locations

Provide[fluorescent][HID][incandescent] fixtures for hazardous locations which conform to UL 844 or which have Factory Mutual certification for the class and division indicated.[Ensure fixtures conform to UL 1598 for marine environments as indicated.]

]2.3 EQUIPMENT

2.3.1 Equipment Identification

2.3.1.1 Manufacturer's Nameplate

Provide each item of equipment with 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 is not acceptable.

2.3.1.2 Labels

NOTE: Labeling of lighting components is an inexpensive and effective method for helping facilities personnel properly operate and maintain the lighting systems. Provide easily readable labels when standing next to the equipment, and durable to match the life of the equipment to which they are attached. Refer to the FEMP guidelines for lighting at http://www1.eere.energy.gov/femp/regulations/notices_rules.html

Provide labeled luminaires in accordance with UL 1598 requirements. Clearly mark all luminaires for operation of specific lamps and ballasts according to proper lamp type. Note the following lamp characteristics 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.

Ensure all markings related to lamp type are clear and located where they are readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Clearly mark ballasts indicating multi-level outputs and indicate proper terminals for the various outputs.

2.3.2 Power Hook Fixture Hangers

Provide UL listed assembly including through-wired power hook housing, interlocking plug and receptacle, power cord, and fixture support loop. Provide power hook housing of cast aluminum having two 19 mm 3/4-inch threaded hubs, including support hook with safety screw. Provide fixture support loop of cast aluminum with provisions for accepting 19 mm 3/4-inch threaded fixture stems. Include with a power cord 410 mm 16-inches of 3 conductor No. 16 Type SO cord. Provide complete assembly rated[120 volts or 277 volts, 15 amperes][480 volts, 20 amperes].

2.3.3 Auxiliary Instant-On System

NOTE: Specify auxiliary quartz or compact fluorescent system for luminaries where extinguishing of HID lamps caused by momentary power interruptions is unacceptable for safety or security reasons, and inclusion of a central emergency system is beyond the project scope.

Provide an UL listed, automatically switched, instant-on [____][150][250] watt[quartz][compact fluorescent] lamp. [Quartz][Compact fluorescent] lamp is to come on when the luminaire is initially energized and following a momentary power outage. The lamp is to remain on until the HID lamp reaches approximately 60 percent light output. Design wiring for[quartz][compact fluorescent] lamp internal to the ballast and independent of the incoming line voltage to the ballast.[Provide instant-on[quartz][compact fluorescent] system for each HID fixture.][Provide instant-on[quartz][compact fluorescent] system as indicated.]

2.3.4 Support Hangers for Lighting Fixtures in Suspended Ceilings

2.3.4.1 Wires

NOTE: Select zinc-coated steel wire for all locations except those listed in the note in paragraph WIRES, FOR HUMID SPACES. When spacing of hanger wires exceeds 1219 mm 4 feet or when heavy lighting fixtures are supported, 8 or 10 gage wire should be specified.

Use wires that are: galvanized regular coating, soft temper, [2.68 mm][[____] mm ([____] inches)] [0.1055][____]-inches in diameter ([12][____] gage). Ensure wires conform to ASTM A641/A641M.

[2.3.4.2 Wires, 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. Select nickel copper alloy when hangers are used in an indoor pool environment. When spacing of hanger wires exceeds 1219 mm 4 feet or when heavy lighting fixtures are supported, 8 or 10

gage wire should be specified.

[Ensure wires conform to ASTM A580/A580M, with composition 302 or 304 steel, and annealed stainless steel [2.68 mm][_____] mm] [0.1055][_____] -inches in diameter ([12][_____] gage).

] [Ensure wires conform to ASTM B164, with UNS NO4400, annealed nickel-copper alloy [2.68 mm][_____] mm] [0.1055][_____] -inches in diameter ([12][_____] gage).

]] [2.3.4.3 Straps

NOTE: Normally wire hangers should be used. If the project is in an area subject to violent storms, steel strap or rod hangers should be specified. Check with area Engineering Office to determine if straps or rods are needed.

Provide galvanized steel, 25 by 4.76 mm 1 X 3/16-inch straps, conforming to ASTM A653/A653M, with a light commercial zinc coating, or conform to ASTM A1008/A1008M with an electrodeposited zinc coating conforming to ASTM B633, Type RS.

] [2.3.4.4 Rods

NOTE: Normally wire hangers should be used. If the project is in an area subject to violent storms, steel straps or rod hangers should be specified. Check with area Engineering Office to determine if straps or rods are needed.

Provide zinc or cadmium coated, threaded, steel rods, 4.76 mm 3/16-inch diameter.

] 2.3.5 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 electrical equipment with factory-applied painting systems which, as a minimum, meet the requirements of the NEMA 250 corrosion-resistance test.

2.4 ACCESSORIES

2.4.1 Lowering Devices For High-Bay Lighting Fixtures

Submit manufacturer's catalog data for lowering devices for high-bay lighting fixtures.

Provide lowering devices for high-bay lighting fixtures consisting of a hand-operated mechanism that connects, disconnects, raises and lowers the lighting fixture to permit the servicing and maintenance of fixtures and equipment at floor level. Include with the lowering device: hangers, pulleys, beam clamps or suspension fittings, operating cable, hand chain, and cable and chain fittings.

Provide open face pulleys with cast-aluminum alloy housings and deep-grooved pulley wheels closely shrouded to prevent lines from becoming wedged between wheel and housing. Design pulleys to be straight through for top and bottom mounted operating cables and corner type as required. Hinge top mounted pulleys with mounting lugs. Provide fixed bottom mounted pulleys with mounting lugs. Bolt all pulleys to the supporting structure. Support horizontal runs of operating cable with pulleys located not more than [10700] [_____] millimeter [35] [_____] -feet apart.

Provide cast-aluminum-alloy housings conforming to ASTM B26/B26M.

Provide malleable-iron fittings conforming to ASTM A47/A47M, and hot-dip galvanized coatings conforming to ASTM A123/A123M.

2.4.1.1 Contact Assembly

Provide hangers consisting of a two-piece latching spring-loaded mechanism with an upper and lower separable contact assembly and stem and guide assembly, with cast-aluminum protective housings. Provide contacts for two-pole, single 2-wire circuits, and four-pole for 3- and 4-wire circuits rated 15 amperes at 600 volts and 30 amperes at 250 volts ac.

Include with upper contact assembly an integrally mounted corner pulley with threaded hub for electrical-conduit connections and a top flange with [lugs] [ears] for mounting.

Include with lower contact assembly fixture adapters and swivel end fittings for anchoring operating cable in the stem of the hanger, with adapters of hot-dip galvanized malleable iron.

2.4.1.2 Lockbox

Include with terminal fittings an enclosed lockbox with hub, tapped for 20 millimeter 3/4-inch conduit, flared conduit end fitting, pulley wheel, locking hooks, and hinged cover with provisions for padlocking.

Provide cast-aluminum alloy lockbox and cover, with the flared conduit end fitting of hot-dip galvanized malleable iron.

Mount wall mounted lockbox not less than [1100] [_____] millimeter and not more than [1370] [_____] millimeter [43] [_____] -inches and not more than [54] [_____] -inches above the floor at the operating level. Provide pulley designed to allow horizontal pull operation of the lowering device at the operating level.

2.4.1.3 Cable/Chain

Provide 3 millimeter 1/8-inch diameter operating cable, 7 by 19 stranded, heat- and corrosion-resistant steel aircraft cable with link, cable loops, and serving sleeves. Preform cable with detachable fittings designed for connection to the terminal fittings. Ensure cable conforms to ASTM A368.

Provide hand chains which are separate detachable hand lines to provide means for disconnecting, lowering, raising, and reconnecting fixtures. Provide hand chain equal in length to the mounting height of the fixture and equipped with a snap hook for connection to the terminal end of the operating cable, size 4, hot-dip galvanized steel, conforming to ASTM A467/A467M, Class MS machine, straight link, steel chain.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 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 electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Specify painting in Section 09 90 00 PAINTS AND COATINGS.

3.2 INSTALLATION

Ensure all electrical installations conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2.1 Lamps

NOTE: Indicate all lamp types and colors on the lighting fixture schedule.

Deliver lamps to the project in the original cartons. Install just prior to project completion. Replace lamps installed and used for working light during construction prior to turnover to the Government if more than 15 percent of their rated life has been used. Test the lamps for proper operation prior to turn-over and replace if necessary with new lamps from the original manufacturer. Provide 10 percent spare lamps of each type from the original manufacturer.

3.2.2 Lighting Fixtures

NOTE: Coordinate these requirements with architectural plans and specifications. Ensure requirements for antiterrorism/force protection for fixtures in suspended ceilings are included in and coordinated with Section 09 51 00 ACOUSTICAL CEILINGS by referencing ASTM E580/E580M seismic requirements in that section.

Design lighting fixtures for facilities located in

**earthquake zones with additional supports and
restraining devices as described in Army TI809-04,
"Seismic Design for Buildings."**

Set lighting fixtures plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures. Secure fixtures in accordance with manufacturers' directions and approved drawings, in conformance with the requirements of NFPA 70. Mounting heights specified or indicated are 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. Independently support recessed and semi-recessed fixtures from the building structure by a minimum of four wires[or straps][or rods] per fixture and locate near each corner of each fixture. Ceiling grid clips are not allowed as an alternative to independently supported light fixtures. Independently support round fixtures smaller in size than the ceiling grid from the building structure by a minimum of four wires[or straps][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 19 mm 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture. Provide wires[or straps][or rods] for lighting fixture support in this section. Lighting fixtures installed in suspended ceilings are to comply with the requirements of Section 09 51 00 ACOUSTICAL CEILINGS.

3.2.3 Suspended Fixtures

**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 fixtures with 0.79 rad 45 degree swivel hangers so that they hang plumb and locate with no obstructions within the 0.79 rad 45 degree range in all directions. Provide the stem, canopy and fixture capable of a 0.79 rad 45 degree swing. Brace pendants, rods, or chains 1.2 meters 4-feet or longer excluding fixture, to prevent swaying, using three cables at 2.09 rad 120 degree separation. Provide suspended fixtures in continuous rows with internal wireway systems for end to end wiring and properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Use aligning splines on extruded aluminum fixtures to assure hairline joints. Support steel fixtures to prevent "oil-canning" effects. Ensure fixture finishes are free of scratches, nicks, dents, and warps, and matching the color and gloss specified. Finish pendants to match furniture. Select aircraft cable made from stainless steel. Install canopies finished to match the ceiling and are low profile unless otherwise shown. Ensure maximum distance between suspension points is 3.1 meters 10-feet or as recommended by the manufacturer, whichever is less.

[3.2.4 Ballasts

[3.2.4.1 Remote Ballasts

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

]3.2.4.2 Electronic Dimming Ballasts

Provide all electronic dimming ballasts, controlled by the same controller, from the same manufacturer. Season or burn in all fluorescent lamps on electronic dimming ballast control at full light output for 100 hours before dimming.

]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.

3.3.1 Electronic Dimming Ballast

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

3.4 FIELD TESTING

Demonstrate that all incandescent lighting fixtures and their accessories, including lowering devices, operate satisfactorily in the presence of the Contracting Officer.

Perform operational tests in the presence of the Contracting Officer and in accordance with referenced standards in this section.

3.5 MAINTENANCE

NOTE: Require O&M manuals for lighting control systems that use low voltage control circuits.
Example: Light level sensors used with dimming ballast, or occupancy sensors used with power packs.

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.

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.

3.5.1 Operational Service

NOTE: Maintenance agreements are standard practice in the building industry. Take-back programs refer to programs in which the product manufacturer

"takes-back" scrap material and/or packaging associated with its product. Under a green lease, when the customer no longer requires the use of the particular product or requires an updated model, the manufacturer is obligated to reclaim it and refurbish it or disassemble it for recycling as appropriate. Using one of these manufacturer's services contributes to the following LEED credit: MR2.

Coordinate with manufacturer for [maintenance agreement] [take-back program] for services which reclaim materials for recycling and/or reuse. Collect information from the manufacturer about [maintenance agreement] [green lease] options, and submit to Contracting Officer. Placement into landfills or burning of reclaimed materials is not allowed. Indicate procedures for compliance with regulations governing disposal of mercury. When such a service is not available, seek out local recyclers to reclaim the materials.

-- End of Section --