
USACE / NAVFAC / AFCEA UFGS-16510 (August 2004)

Preparing Activity: NAVFAC Superseding
UFGS-16510N (August 2003)
UFGS-16415A (June 2002)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 23 June 2005

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DIVISION 16 - ELECTRICAL

SECTION 16510

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SECTION 16510

INTERIOR LIGHTING 08/04

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.

Comments and suggestion on this specification are welcome and should be directed to the technical proponent of the specification. A listing of the technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

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 | (1998) How to Buy Energy-Efficient Fluorescent Ballasts |
| FEMP LT-3 | (1998) How to Buy Energy-Efficient Fluorescent Luminaires |
| FEMP LT-4 | (1998) How to Buy Energy-Efficient Exit Signs |
| FEMP LT-5 | (1999) How to Buy Energy-Efficient Compact Fluorescent Light Bulbs |
| FEMP LT-6 | (1999) How to Buy Energy-Efficient Industrial HID Luminaires |
| FEMP LT-7 | (2000) How to Buy Energy-Efficient Commercial Downlight Luminaires |
| FEMP LT-8 | (2000; Draft) How to Select Lighting Controls For Offices and Public Buildings |

Be aware that PEER is based on certain cost-effectiveness assumptions. Where energy prices and hours of use differ from those assumed in the PEER, recalculate cost effectiveness using the ratios given in the PEER.

For additional information on PEER, contact FEMP at 800-363-3732. To view the latest information about buying energy efficient products on-line go to the FEMP home page at:
<http://www.eren.doe.gov/femp/procurements>.

NOTE: TO DOWNLOAD UFGS GRAPHICS

Go to <http://www.ccb.org/docs/ufgshome/graphtoc.pdf>.

NOTE: This section contains the following 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.

SKETCH NUMBERTITLE

| | |
|---------------|---|
| NL-1 | Surface Mounted Wrap-Around Luminaire for Premium Office/Classroom Type Spaces |
| NL-2 | Surface Mounted Wrap-Around Luminaire for Standard Office Type Spaces and Other Type Spaces |
| NL-3 | Fluorescent Troffer Luminaire Lens Type |
| NL-4 | Wall-Mounted Fluorescent |
| NL-5 | Wall-Mounted Indirect Fluorescent With Wood Shielding |
| NL-6 | Industrial Fluorescent |
| NL-7 | Strip Fluorescent |
| NL-8 | Wet/Damp Location Luminaries |
| NL-9 | Parabolic Troffers - 610 mm x 610 mm and 610 mm x 1220 mm 2 x 2 and 2 x 4 |
| NL-10 | Parabolic Troffer - 305 mm x 1220 mm 1 x 4 |
| NL-11 | Surface, Pendant or Bracket-Mounted Parabolic Luminaire |
| NL-12 | Steel Sided Surface Fluorescent |
| NL-13 | Round Surface Fluorescent |
| NL-14 | Surface Mounted 1-Lamp Vandal Resistant Luminaire |
| NL-15 | Arm Mounted Outdoor Sign Luminaire |
| NL-16 | Decorative/Specialty 1-Lamp Luminaire |
| NL-17 | Recessed Round, Lens Type Compact Fluorescent |
| NL-18 | Recessed Round, Open Bottom Multigroove Compact Fluorescent |
| NL-19 | Recessed Round, Open Bottom Compact Fluorescent |
| NL-20 | Round-Surface, Pendant, or Wall Mount Compact Fluorescent - Interior/Exterior |
| NL-21 | Fluorescent Troffer With Plastic Parabolic Cube Louvers |
| NL-22 | High Bay Open/Enclosed Industrial HID |
| NL-23 | Low Bay Industrial HID |
| NL-24 | Pendant/Wall Mount - Indirect HID |
| NL-25 | Exterior Commercial Wall Mount HID |
| NL-26 | Exterior Compact Fluorescent and Low Pressure Sodium-Wall Mount |
| NL-27 | Recessed Round Regressed Lens Type HID |
| NL-28 | Handball and Racquetball Court Luminaire |
| NL-29 | Architectural Style Security/Area Luminaire |
| NL-30 | Warehouse HID Aisle Luminaire |
| NL-31 | Surface Mounted Commercial HID |
| NL-32 | Recessed Commercial HID |
| NL-33 thru 39 | Reserved for Future HID Luminaries |
| NL-40 | Step Light/Night Light |
| NL-41 | Adjustable Incandescent Interior Spotlight |
| NL-42 | Semi-Recessed Baffle Downlight |
| NL-43 | Open Recessed Baffle Downlight |
| NL-44 | Adjustable Semi-Recessed Spotlight |
| NL-45 | Exterior Luminaries |
| NL-46 | Ceiling-Mounted Vandal-Resistant Luminaire |
| NL-47 | Wall-Mounted Vandal-Resistant Luminaire |
| NL-48 | Fluorescent Exit Sign |
| NL-49 | Explosion-Proof Luminaire |
| NL-50 | Obstruction Light |
| NL-51 | Emergency Lighting Unit |
| NL-52 | Lens Type Emergency Lighting Unit |
| NL-53 | Cylinder Type Emergency Lighting Unit |
| NL-54 | Remote Fixtures for Use With Battery Unit |

SKETCH NUMBER

TITLE

| | |
|---------------|---|
| NL-55 | Not Used |
| NL-56 | Recessed Shower Light |
| NL-57 | Recessed Downlight - Incandescent/Fluorescent |
| NL-58 and 59 | Reserved for Future Luminaires |
| NL-60 | Industrial Fluorescent - Hazardous Location |
| NL-61 | Light Emitting Diode Exit Sign |
| NL-62 thru 98 | Reserved for Future Luminaires |
| NL-99 | Sample Lighting Fixture Schedule |

NOTE: Do not include this index in project specification.

NOTE: The following information shall be shown 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 will require the use of Section 13286N HANDLING OF LIGHTING BALLASTS AND LAMPS CONTAINING PCBs AND MERCURY.

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---------------------|---|
| ASTM A 1008/A 1008M | (2004b) Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability |
| ASTM A 580/A 580M | (1998; R 2004) Stainless Steel Wire |
| ASTM A 641/A 641M | (2003) Zinc-Coated (Galvanized) Carbon Steel Wire |
| ASTM A 653/A 653M | (2004a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM B 164 | (2003) Nickel-Copper Alloy Rod, Bar, and Wire |
| ASTM B 633 | (1998e1) Electrodeposited Coatings of Zinc on Iron and Steel |

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

| | |
|------------|--------------------------|
| IESNA HB-9 | (2000) Lighting Handbook |
|------------|--------------------------|

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|--------------|--|
| IEEE C136.10 | (1996) Roadway Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacle - Physical and Electrical Interchangeability and Testing |
| IEEE C2 | (2002) National Electrical Safety Code |
| IEEE C62.41 | (1991; R 1995) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits |
| IEEE Std 100 | (2000) The Authoritative Dictionary of IEEE Standards Terms |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---------------|---|
| NEMA 250 | (2003) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA C78.1381 | (1998) Electric Lamps - 250-Watt, 70 Watt, M85 Metal-Halide Lamps |
| NEMA C78.41 | (2001) Guidelines for Low-Pressure Sodium |

Lamps

| | |
|--------------|--|
| NEMA C78.42 | (2004) Electric Lamps - High-Pressure Sodium Lamps |
| NEMA C78.43 | (2004) Electric Lamps - Single-Ended Metal-Halide Lamps |
| NEMA C78.81 | (2003) Electric Lamps - Double-capped Fluorescent Lamps Dimensional and Electrical Characteristics |
| NEMA C78.901 | (2001) Electric Lamps - Single Base Fluorescent Lamps Dimensional and Electrical Characteristics |
| NEMA C82.1 | (1997; R 1998) Electric Lamp Ballasts - Line Frequency Fluorescent Lamp Ballasts |
| NEMA C82.11 | (2002) High-Frequency Fluorescent Lamp Ballasts |
| NEMA C82.2 | (1984; R 1995) Methods of Measurement of Fluorescent Lamp Ballasts |
| NEMA C82.4 | (1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type) |
| NEMA ICS 2 | (2000; R 2004) Industrial Controls and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC |
| NEMA ICS 6 | (1993; R 2001) Industrial Control and Systems: Enclosures |
| NEMA LL 1 | (1997; R 2002) Procedures for Linear Fluorescent Lamp Sample Preparation and the TCLP |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|----------|---|
| NFPA 101 | (2003) Life Safety Code |
| NFPA 70 | (2005) National Electrical Code |
| NFPA 90A | (2002) Installation of Air Conditioning and Ventilating Systems |

UNDERWRITERS LABORATORIES (UL)

| | |
|---------|---|
| UL 1029 | (1994; Rev thru Feb 2001) High-Intensity-Discharge Lamp Ballasts |
| UL 1598 | (2004) Luminaires |
| UL 20 | (2000; Rev thru Jun 2002) General-Use Snap Switches |

| | |
|---------|--|
| UL 595 | (1985) Marine-Type Electric Lighting Fixtures |
| UL 773 | (1995; Rev thru Mar 2002) Plug-In Locking Type Photocontrols for Use with Area Lighting |
| UL 773A | (1995; Rev thru Jul 2003) Nonindustrial Photoelectric Switches for Lighting Control |
| UL 844 | (1995; Rev thru Mar 1999) Electric Lighting Fixtures for Use in Hazardous (Classified) Locations |
| UL 924 | (1995; Rev thru Jul 2001) Emergency Lighting and Power Equipment |
| UL 935 | (2001) Fluorescent-Lamp Ballasts |

1.2 RELATED REQUIREMENTS

Materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 16402 INTERIOR DISTRIBUTION SYSTEM. Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in this section.

1.3 DEFINITIONS

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

1.4 SYSTEM DESCRIPTION

1.4.1 Lighting Control System

NOTE: Edit this paragraph to provide additional requirements as required to supplement the information contained on the drawings. Delete components that are not included in the project.

Provide lighting control system as indicated. Lighting control equipment shall include, if indicated: control modules, power packs, dimming ballasts, occupancy sensors, and light level sensors.

1.5 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an

item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" 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. Recommended codes for Army projects are "RE" for Resident Engineer approval, "ED" for Engineering approval, and "AE" for Architect-Engineer approval. Codes following the "G" typically are not used for Navy projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy 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. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

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

SD-03 Product Data

Fluorescent lighting fixtures; G, [_____]

Fluorescent electronic ballasts; G, [_____]

Fluorescent 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, [____]

Dimmer switch; G, [____]

Lighting contactor; G, [____]

Time switch; G, [____]

Photocell switch; G, [____]

Power hook fixture hangers; G, [____]

Exit signs; G, [____]

Emergency lighting equipment; G, [____]

Central emergency system; G, [____]

Occupancy sensors; G, [____]

Electronic dimming ballast; G, [____]

Dimming ballast controls; G, [____]

Light Level Sensor ; 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, complete with lamps and ballasts; G, [____]

SD-06 Test Reports

Operating test

Submit test results as stated in paragraph entitled "Field Quality Control."

SD-10 Operation and Maintenance Data

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.

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

Submit operation and maintenance data in accordance with Section

01781 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.

1.6 QUALITY ASSURANCE

1.6.1 Fluorescent Electronic Ballasts

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

1.6.2 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 fixture type[indicated] for inspection, review, and approval. The sample shall be retained 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: [_____].]

1.6.3 Regulatory Requirements

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

1.6.4 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on

the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.4.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.4.2 Material and Equipment Manufacturing Date

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

1.7 WARRANTY

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

1.7.1 Electronic Ballast Warranty

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

PART 2 PRODUCTS

2.1 FLUORESCENT LIGHTING FIXTURES

NOTE: For projects within the United States and its possessions, do not specify hard metric recessed lighting fixtures as the only option.

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

2.1.1.1 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. 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.

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

- a. Ballast shall comply with UL 935, NEMA C82.11, and NFPA 70 unless specified otherwise. Ballast shall be 100% electronic high frequency type with no magnetic core and coil components. Ballast shall provide transient immunity as recommended by IEEE C62.41. Ballast shall be designed for the wattage of the lamps used in the indicated application. Ballasts shall be designed to operate on the voltage system to which they are connected.
- b. Power factor shall be 0.95 (minimum).
- c. Ballast shall operate at a frequency of 20,000 Hertz (minimum).

Ballast shall be compatible with and not cause interference with the operation of occupancy sensors or other infrared control systems. Provide ballasts operating at or above 40,000 Hertz where available.

- d. Ballast shall have light regulation of plus or minus 10 percent lumen output with a plus or minus 10 percent input voltage regulation. Ballast shall have 10 percent flicker (maximum) using any compatible lamp.
- e. Ballast factor shall be between 0.85 (minimum) and 1.00 (maximum). Current crest factor shall be 1.7 (maximum).
- f. Ballast shall be UL listed Class P with a sound rating of "A."
- g. Ballast shall have circuit diagrams and lamp connections displayed on the ballast.

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. [Ballasts shall be instant start unless otherwise indicated. Ballasts shall be programmed start where indicated. Instant start ballasts shall operate lamps in a parallel circuit configuration that permits the operation of remaining lamps if one or more lamps fail or are removed.] [Ballasts shall be programmed start unless otherwise indicated.] Programmed start ballasts may operate lamps in a series circuit configuration. Provide series/parallel wiring for programmed start ballasts where available.
- i. Ballasts for compact fluorescent fixtures shall be programmed start.
- j. Ballasts for T-5 and smaller lamps shall have end-of-life protection circuits as required by NEMA C78.81 and NEMA C78.901 as applicable.

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

- k. Ballast shall be capable of starting and maintaining operation at a minimum of -17 degrees C 0 degrees F unless otherwise indicated.
- l. Electronic ballast shall have a full replacement warranty of 5 years from date of manufacture as specified in paragraph entitled "Electronic Ballast Warranty" herein.

2.1.1.1 T-8 Lamp Ballast

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

- a. Total harmonic distortion (THD): Shall be [20 percent] [____ percent] (maximum).
- b. Input wattage:
 - [1. 32 watts (maximum) when operating one F32T8 lamp]
 - [2. 62 watts (maximum) when operating two F32T8 lamps]
 - [3. 92 watts (maximum) when operating three F32T8 lamps]
 - [4. 114 watts (maximum) when operating four F32T8 lamps]

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

- [c. 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.

- [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.]

2.1.1.2 F17T8 Lamp Ballast

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

2.1.1.3 T-5 Long Twin Tube Lamp Ballast

- a. Total harmonic distortion (THD): Shall not be greater than[25 percent when operating one lamp,] [15 percent when operating two lamps,] [and] [20 percent when operating three lamps].
- b. Input wattage:
 - [1. 45 watts (maximum) when operating one F40 T-5 lamps]
 - [2. 74 watts (maximum) when operating two F40 T-5 lamps]

[3. 105 watts (maximum) when operating three F40 T-5 lamps]

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

[c. 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. Also, serving multiple fixtures from a single ballast may alter the minimum starting and operating temperature for the fixture. 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.]

2.1.1.4 F96T12 Lamp Ballast

a. Total harmonic distortion (THD): Shall not be greater than[30 percent when operating one lamp] [and] [20 percent when operating two lamps].

b. Input wattage:

[1. 70 watts (maximum) when operating one F96T12 lamps]

[2. 113 watts (maximum) when operating two F96T12 lamps]

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

[c. 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.]

2.1.2 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% to 1%, 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.

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

- a. Ballast shall comply with NEMA C82.11, UL 935, and NFPA 70, unless specified otherwise. Ballast shall provide transient immunity as recommended by IEEE C62.41. Ballast dimming capability range shall be from 100 to 5 percent (minimum range) of light output, flicker free. Ballast shall start lamp at any preset light output setting without first having to go to full light output. Ballast shall be designed for the wattage of the lamps used in the indicated application. Ballasts shall be designed to operate on the voltage system to which they are connected.
- b. Power factor shall be 0.95 (minimum) at full light output, and 0.90 (minimum) over the entire dimming range.
- c. Ballast shall operate at a frequency of 20,000 Hertz (minimum). Ballast shall be compatible with and not cause interference with the operation of occupancy sensors or other infrared control systems. Provide ballasts operating at or above 40,000 Hertz where available.
- d. Ballast factor at full light output shall be between 0.85 (minimum) and 1.00 (maximum). Current crest factor shall be 1.7 (maximum).
- e. Ballast shall be UL listed Class P with a sound rating of "A".
- f. Ballast shall have circuit diagrams and lamp connections displayed on the ballast.
- g. Ballast shall be programmed start. Ballast may operate lamps in a series circuit configuration. Provide series/parallel wiring for programmed start ballasts where available.

h. Ballasts for compact fluorescent fixtures shall be programmed start.

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

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

2.1.2.1 T-8 Lamp Ballast

Input wattage, for indicated lamp quantity shall be:

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

2.1.3 Dimming Ballast Controls

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

2.1.4 Light Level Sensor

UL listed. Light level sensor shall be capable of detecting changes in ambient lighting levels, shall provide a dimming range of 20 percent to 100 percent, minimum, and shall be designed for use with dimming ballast and voltage system to which they are connected. Sensor shall be capable of controlling 40 electronic dimming ballast, minimum. Sensor light level shall be adjustable and have a set level range from 10 to 100 footcandles 100 to 1000 lux, minimum. Sensor shall have a bypass function to electrically override sensor control.

[2.1.5 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.

UL 935. Ballasts shall be high power factor type (0.9 minimum), [unless indicated otherwise] and shall be designed to operate on the voltage system

to which they are connected. Ballasts shall be Class P and shall have sound rating "A"[unless otherwise noted]. Fixtures and ballasts shall be designed and constructed to limit the ballast case temperature to 90 degrees C when installed in an ambient temperature of [40][_____] degrees C. Electromagnetic ballasts for T-8 and T-12 lamps shall be energy saving. Provide three lamp fixtures with two ballasts per fixture.

2.1.5.1 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.

NEMA C82.1. Provide energy-saving fluorescent ballasts of the CBM certified full light output type[except where fixtures are provided with low temperature ballasts]. Ballasts shall have 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][[136][123] or less when operating two 60-watt F96T12 lamps][[_____] or less when operating [_____] lamps] tested in accordance with NEMA C82.2 methods.[Provide ballasts which are compatible with energy-saving lamps.]

2.1.5.2 Electromagnetic Ballasts for Compact Fluorescent Lamps

Provide electromagnetic ballasts for compact fluorescent lamps.

2.1.5.3 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 NEMA 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 milliampere, high output (HO) lamps in fixtures mounted[in cold rooms,][outdoors,][in unheated buildings,][and as indicated].

[2.1.5.4 Electromagnetic Ballasts for T-5 Long Twin Tube Lamps

Provide electromagnetic ballasts with an average input wattage of[49 or less when operating one][86 or less when operating two] 40-watt T-5 long twin tube lamps.

]2.1.6 Fluorescent Lamps

NOTE: T-8 lamps with CRI of 75 and color temperature of 3500 K are recommended for most applications.

Low mercury lamps must be specified on projects that use 1220 mm (4 foot) 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. T-8 rapid start[low mercury] lamps shall be rated 32 watts (maximum), 2800 initial lumens (minimum), CRI of 75 (minimum), color temperature of [3500 K][____], and an average rated life of 20,000 hours.[Low mercury lamps shall have passed the EPA Toxicity Characteristic Leachate Procedure (TCLP) for mercury by using the lamp sample preparation procedure described in NEMA LL 1.]
- [b. T-8 rapid start lamp, 17 watt (maximum), nominal length of 610 mm (24 inches) 24 inches, 1300 initial lumens, CRI of 75 (minimum), color temperature of [3500 K][____], and an average rated life of 20,000 hours.]
- [c. T-8 instant start lamp, 59 watts (maximum), nominal length of 2438 mm (96 inches) 96 inches, minimum CRI of 75, 5700 initial lumens, color temperature of [3500 K][____], and average rated life of 15,000 hours.]
- [d. T-12 slim line lamps shall be rated 60 watts (maximum), 5750 initial lumens (minimum), 12,000 hours average rated life.]
- [e. T-5, long twin tube fluorescent lamp, 40 watts (maximum), [3500 K][____], 574 mm(22.6 inches) 22.6 inches maximum length, 20,000 hours average rated life, 3150 initial lumens, CRI of 80 (minimum), 2G11 Type base.]
- [f. T-8, U shaped fluorescent lamp, 31 watts maximum, 2600 initial lumens (minimum), [3500 K][____], 75 CRI (minimum), 20,000 hours average rated life, [41.29 mm (1.625 inch)][[____] mm ([____] inch)][1.625][____] inch leg spacing.]
- [g. Compact fluorescent lamps shall be: CRI 80, minimum, [3500 K][____], 10,000 hours average rated life, and as follows:
 - 1. T-4, twin tube, rated[5 watt, 250 initial lumens (minimum)][7 watts, 400 initial lumens (minimum),][9 watts, 600 initial lumens (minimum),][and][13 watts, 825 initial lumens (minimum),][as indicated].
 - 2. T-4, double twin tube, rated[13 watts, 900 initial lumens (minimum),][18 watts, 1200 initial lumens (minimum),][and][26

watts, 1800 initial lumens (minimum),][as indicated].]

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

2.1.7 Compact Fluorescent Fixtures

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

2.1.8 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) 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. The sleeve
shall be rated to withstand the thermal profile of the lamp and ballast.]

2.1.9 Air Handling Fixtures

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

[2.1.10 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 in each fluorescent fixture mounted[in shielded enclosures][where
indicated].[Filters shall be integral to the fixture assembly with one
filter per ballast and shall suppress electromagnetic interference in the
AM radio band from 500 to 1700 kHz.][Filters shall be in the circuit
serving the lighting fixtures mounted where indicated and shall conform to
requirements of Section 16280N RADIO FREQUENCY INTERFERENCE POWER LINE
FILTERS.]

]2.2 HIGH-INTENSITY-DISCHARGE (HID) LIGHTING FIXTURES

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

2.2.1 HID Ballasts

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

shall be:

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

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

2.2.2 High-Pressure Sodium (HPS) Lamps

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

[2.2.2.1 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.

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

]2.2.3 Low-Pressure Sodium Lamps

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

NEMA C78.41.

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 shall include weekly turnoff
instructions when continuously operated, 24 hours
per day, 7 days per week. These instructions shall
be detailed 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.

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

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

2.3 INCANDESCENT LIGHTING FIXTURES

UL 1598.

2.3.1 Incandescent Lamps

Provide the number, type, and wattage indicated.

2.4 RECESS- AND FLUSH-MOUNTED FIXTURES

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

2.5 SUSPENDED FIXTURES

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.

Provide hangers capable of supporting twice the combined weight of fixtures supported by hangers. Provide with swivel hangers to ensure a plumb installation. Hangers shall be cadmium-plated steel with a swivel-ball tapped for the conduit size indicated.[Hangers shall be shock-absorbing type where indicated.] Hangers shall 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. Single-unit suspended[fluorescent] fixtures shall have twin-stem hangers. Multiple-unit or continuous row fluorescent fixtures shall have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end. Rods shall be a minimum 4.57 mm 0.18 inch diameter.

2.6 FIXTURES FOR HAZARDOUS LOCATIONS

In addition to requirements stated herein, 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.[Fixture shall also conform to UL 595 for marine environments as indicated.]

2.7 SWITCHES

2.7.1 Toggle Switches

Provide toggle switches as specified in Section 16402 INTERIOR DISTRIBUTION SYSTEM.

2.7.2 Incandescent Dimmer Switch

NOTE: Do not specify central dimming systems with
this specification.

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

2.8 LIGHTING CONTACTOR

NEMA ICS 2, [electrically][mechanically] held contactor.[Contacts shall
be rated [_____] volts, [_____] amperes, and [_____] poles. Coils shall be
rated [_____] volts.][Rate contactor as indicated.] Provide in NEMA
[1][4][_____] enclosure conforming to NEMA ICS 6. Contactor shall have
silver alloy double-break contacts[and coil clearing contacts for
mechanically held contactor].[Provide contactor with[
hand-off-automatic][on-off] selector switch.]

2.9 TIME SWITCH

NOTE: Photocells and time switches should not
always be used together. Use the following
information as a guide:

1. Lights on/lights off by photocell: Street
parking lots. Any facility or street that requires
lighting after dark.

2. Lights on by photocell; lights off by time
switch: Most administration facilities,
commissaries, hobby shops, or clubs. Any facility
that does not stay open all night.

3. Lights on/lights off by time switch: Service
stations, snack bars, barracks, or officers'
quarters. Facilities that will be open to the
public, or have personnel that must report before
daylight and after dark, but not continually through
the night.

Other considerations: Time switches with a
skip-a-day feature may be useful for facilities with
a 5-day work week. (Program time switch to skip
Saturday and Sunday.) For facilities that do not
stay open all night, it may be desirable to have
lighting at night for security. Consult area
Engineering Field Division for local station policy
and exceptions to these procedures.

Astronomic dial type or electronic type, arranged to turn "ON" at sunset
and turn "OFF" at predetermined time between 8:30 p.m. and 2:30 a.m. or
sunrise, automatically changing the settings each day in accordance with
seasonal changes of sunset and sunrise. Provide switch rated [_____]
volts, having automatically wound spring mechanism or capacitor, to
maintain accurate time for a minimum of 15 hours following power failure.

Provide time switch with a manual on-off bypass switch. Housing for the time switch shall be[surface][flush]-mounted, NEMA [1][3][_____] enclosure conforming to NEMA ICS 6.

2.10 PHOTOCCELL SWITCH

NOTE: Silicon diode type photocells are solid state devices and have limited sources. Therefore, cadmium-sulfide type cells cannot be deleted from the specification.

UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell rated [_____] volts ac, 60 Hz with[single-throw contacts][single pole double-throw (SPDT) contacts for control of mechanically held contactors, rated 1000 W]. Switch shall turn on at or below 32 lux 3 footcandles and off at 22 to 107 lux 2 to 10 footcandles. A time delay shall prevent accidental switching from transient light sources. Provide switch:

- [a. Integral to the luminaire, rated 1000W minimum.[Provide a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition.]]
- [b. In a U.V. stabilized polycarbonate housing with swivel arm and adjustable window slide, rated 1800 VA, minimum.]
- [c. In a high-impact-resistant, noncorroding and nonconductive molded plastic housing with a locking-type receptacle conforming to IEEE C136.10, rated 1800 VA, minimum.]
- [d. In a cast weatherproof aluminum housing with adjustable window slide, rated 1800 VA, minimum.]

2.11 POWER HOOK FIXTURE HANGERS

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

2.12 EXIT SIGNS

NOTE: For LANTNAVFACENGCOM projects, provide LED type self-powered exit signs (battery backup) unless specifically instructed otherwise. Normal mode of power to these signs shall be the branch circuit serving normal lighting in the area connected ahead of any local switches; emergency mode of power shall be the unit's self-contained power/battery pack. Luminous exit signs contain radiation emitting sources and are not permitted because of potential radioactive hazards and disposal problems.

UL 924, NFPA 70, and NFPA 101. Exit signs shall be[self-powered][remote-powered] type.

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

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

2.12.2 Remote-Powered Exit Signs

Provide remote ac/dc exit signs with provisions for wiring to external ac and dc power sources. Provide signs with a minimum of two ac lamps for normal illumination and a minimum of two dc lamps for emergency lighting.

2.13 EMERGENCY LIGHTING EQUIPMENT

NOTE: Lamp wattage shall be properly specified to provide the required illumination per NFPA. In lieu of an installation involving many individual emergency lighting units, consider several emergency lighting units with remote heads or central system with zone control. Remote heads shall be shown on the drawings. Circuit shall be hard wired to normal power system. A variety of battery types exists. Each has differing life expectancies and maintenance requirements. Choose the battery type which best suits the application.

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

2.13.1 Emergency Lighting Unit

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

2.13.2 Fluorescent Emergency System

NOTE: Designer shall decide on number of lamps and minimum lumens required to meet criteria.

Each system shall consist of an automatic power failure device, test switch operable from outside of the fixture, pilot light visible from outside the

fixture, and fully automatic solid-state charger in a self-contained power pack.[Provide self-testing module[mounted adjacent][integral] to the fixture.] Charger shall be either trickle, float, constant current or constant potential type, or a combination of these. Battery shall be sealed electrolyte type with capacity as required to supply power to[_____] lamps[the number of lamps shown for each system] for 90 minutes at a minimum of [600][1100][400][_____] lumens per lamp output. Battery shall operate unattended and require no maintenance, including no additional water, for a period of not less than 5 years. Emergency ballasts provided with fixtures containing solid-state ballasts shall be fully compatible with the solid-state ballasts.

[2.14 SELF-TESTING MODULE

NOTE: Activity and designer shall decide on appropriate usage of self-testing module. The self-testing module can significantly increase emergency lighting and exit fixture pricing. If self-testing module is not used, coordinate with options in paragraphs entitled "Exit Signs" and "Emergency Lighting Equipment."

Self-testing module for exit signs and emergency lighting equipment shall perform the following functions:

- a. Continuous monitoring of charger operation and battery voltage with visual indication of normal operation and of malfunction.
- b. Monthly discharge cycling of battery with monitoring of transfer circuit function, battery capacity and emergency lamp operation with visual indication of malfunction. The battery capacity test may be conducted by using a synthetic load.
- c. Manual test switch to simulate a discharge test cycle.
- d. Module shall have low voltage battery disconnect (LVD) and brown-out protection circuit.

]2.15 CENTRAL EMERGENCY SYSTEM

NOTE: Clearly show on plans how system is zoned.

Each system shall supply [_____] watts of emergency power at[[277][120][_____] volts, 60 Hz sine wave ac][[32][_____] volts dc] for a minimum period of [90][_____] minutes.[Sine wave ac system shall have an inverter output distortion of not more than 10 percent at unity power factor.] The system shall be designed to handle surges during loss and recovery of power.

2.15.1 Operation

With normal power applied, batteries shall be automatically charged. Upon loss of normal power, system shall automatically disengage from the normal input line and switch to a self-contained inverter within[1 second when serving incandescent and fluorescent lamps][2 milliseconds when serving

HID lamps]. Inverter shall have built-in protection when output is shorted or overloaded. When normal power resumes, the emergency system shall automatically switch back to normal operation before the power loss. Size transfer switch for this function to handle 125 percent of full load.

2.15.2 Battery Charger

[Provide two-rate charger for lead-calcium batteries.] [Provide three-rate charger for nickel-cadmium batteries .] The charger shall be solid-state, completely automatic, maintaining the batteries in a fully charged condition, and recharging the batteries to full capacity as specified in UL 924.

2.15.3 Batteries

Batteries shall be [sealed lead-calcium] [nickel-cadmium] type, shall operate unattended, and shall require no maintenance, including no additional water, for a period of not less than [10] [5] years.

2.15.4 Accessories

NOTE: Electrolyte level detector is not applicable to sealed batteries.

Provide visual indicators to indicate normal power, inverter power, and battery charger operation. Provide test switch to simulate power failure by interrupting the input line, [battery voltage meter,] [load ammeter,] [automatic brown-out circuitry to switch to emergency power when input line voltage drops below 75 percent of normal value,] [electrolyte level detector that will activate a visual or audio alarm in the event of a low water condition,] [time delay feature for areas with HID lighting,] [and] [low voltage cutoff (LVD) to disconnect inverter when battery voltage drops to approximately 80 percent of nominal voltage].

2.15.5 Enclosure

Provide a free-standing cabinet with floor stand. Cabinet construction shall be of 14 gage sheet steel with baked-on enamel finish and locking type latch.

2.16 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.

UL listed, automatically switched instant-on [_____] [150] [250] watt [quartz] [compact fluorescent] lamp. [Quartz] [Compact fluorescent] lamp shall come on when luminaire is initially energized and following a momentary power outage and shall remain on until HID lamp reaches approximately 60 percent light output. Wiring for [quartz] [compact fluorescent] lamp shall be internal to the ballast and shall be 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.]

2.17 OCCUPANCY SENSORS

NOTE: Occupancy sensors are useful in lighting control applications for restrooms, conference rooms, utility areas, warehouses, and corridors. Additional design guidance can be found at the NAVFAC Criteria Office's website at:
"www.efdlant.navfac.navy.mil/criteria/documents/ITG/ITGLIST.asp".
Go to the "Interim Technical Guidance (ITG)"
Article on Occupant Sensors (1 JUL 96).

Also, most occupancy sensor manufacturers offer design services for their products.

NOTE: Typical sensor applications are:
Ultrasonic - Restrooms, Hallways
Infrared - Warehouses, Open Offices
Combination Sensor - Classrooms, Conference Rooms

UL listed. Occupancy sensors and power packs shall be designed to operate on the voltage indicated. Sensors and power packs shall have circuitry that only allows load switching at or near zero current crossing of supply voltage. Occupancy sensor mounting as indicated. Sensor shall have an LED occupant detection indicator. Sensor shall have adjustable sensitivity and adjustable delayed-off time range of 5 minutes to 15 minutes, minimum. Wall mounted sensors shall[be ivory][be white][match the color of adjacent wall plates as specified in Section 16402 INTERIOR DISTRIBUTION SYSTEM], ceiling mounted sensors shall be white. Ceiling mounted sensors shall have 6.28 rad 360 degree coverage unless otherwise indicated.

- [a. Ultrasonic sensor shall be crystal controlled and shall not cause detection interference between adjacent sensors.]
- [b. Infrared sensors shall have a daylight filter. Sensor shall have a fresnel lens that is applicable for indicated usage.]
- [c. Ultrasonic/Infrared Combination Sensor

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

2.18 SUPPORT HANGERS FOR LIGHTING FIXTURES IN SUSPENDED CEILINGS

2.18.1 Wires

NOTE: Select zinc-coated steel wire for all

locations except those listed in the note in the paragraph entitled "Wires, for Humid Spaces," below. 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.

ASTM A 641/A 641M, galvanized regular coating, soft temper, [2.68 mm (0.1055 inches)][[] mm ([] inches)] [0.1055][] inches in diameter ([12][] gage).

[2.18.2 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.

[ASTM A 580/A 580M, composition 302 or 304, annealed stainless steel [2.68 mm (0.1055 inches)][[] mm ([] inches)] [0.1055][] inches in diameter ([12][] gage).]

[ASTM B 164, UNS NO4400, annealed nickel-copper alloy [2.68 mm (0.1055 inches)][[] mm ([] inches)] [0.1055][] inches in diameter ([12][] gage).]

] [2.18.3 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.

Galvanized steel, 25 by 4.76 mm (one by 3/16 inch) one by 3/16 inch, conforming to ASTM A 653/A 653M, with a light commercial zinc coating or ASTM A 1008/A 1008M with an electrodeposited zinc coating conforming to ASTM B 633, Type RS.

] [2.18.4 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.

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

]2.19 MANUFACTURER'S NAMEPLATE

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

2.20 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.

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

PART 3 EXECUTION

3.1 INSTALLATION

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

3.1.1 Lamps

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

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

3.1.2 Lighting Fixtures

NOTE: The electrical designer shall 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 09510 ACOUSTICAL CEILINGS by referencing ASTM E 580 seismic requirements in that section.

Lighting fixtures for facilities located in earthquake zones shall have 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, and secure in accordance with manufacturers' directions and approved drawings. Installation shall meet requirements of NFPA 70. Mounting heights specified or indicated shall be to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures. Obtain approval of the exact mounting for lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Recessed and semi-recessed fixtures shall be independently supported from the building structure by a minimum of four wires[or straps][or rods] per fixture and located near each corner of each fixture. Ceiling grid clips are not allowed as an alternative to independently supported light fixtures. Round fixtures or fixtures smaller in size than the ceiling grid shall be independently supported from the building structure by a minimum of four wires[or 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) 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 shall also comply with the requirements of Section 09510 ACOUSTICAL CEILINGS.

3.1.3 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.

Suspended fixtures shall be provided with 0.79 rad 45 degree swivel hangers so that they hang plumb and shall be located with no obstructions within the 0.79 rad 45 degree range in all directions. The stem, canopy and fixture shall be capable of 0.79 rad 45 degree swing. Pendants, rods, or chains 1.2 meters 4 feet or longer excluding fixture shall be braced to prevent swaying using three cables at 2.09 rad 120 degree separation. Suspended fixtures in continuous rows shall have internal wireway systems for end to end wiring and shall be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Aligning splines shall be used on extruded aluminum fixtures to assure hairline joints. Steel fixtures shall be supported to prevent "oil-canning" effects. Fixture finishes shall be free of scratches, nicks, dents, and warps, and shall match the color and gloss specified. Pendants shall be finished to match fixtures. Aircraft cable shall be stainless steel. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown. Maximum distance between suspension points shall be 3.1 meters 10 feet or as recommended by the manufacturer, whichever is less.

[3.1.4 Ballasts

[3.1.4.1 Remote Ballasts

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

] [3.1.4.2 Electronic Dimming Ballasts

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

]] 3.1.5 Exit Signs and Emergency Lighting Units

NOTE: Use this paragraph for most projects.

The bracketed subparagraphs should 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 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 note.

Wire exit signs on separate circuits and serve from[an emergency panel][a separate breaker][a fused disconnect switch]. Signs shall have only one control, which shall be[the circuit breaker in the emergency panel][the separate breaker][the disconnect switch]. Paint control device red and provide lockout.

] [3.1.5.2 Emergency Lighting from Central Emergency System

NOTE: Use this subparagraph only for projects utilizing a central emergency system. Central emergency system details including zone control must be included on the drawings.

Wire emergency lighting powered from a central emergency system as indicated on the drawings.

] 3.1.6 Photocell Switch Aiming

Aim switch according to manufacturer's recommendations.[Set adjustable window slide for [_____] [minimum] lux [_____] [minimum] footcandles

photocell turn-on.]

3.1.7 Occupancy Sensor

NOTE: Before selecting locations for occupancy sensors, consult the Interim Technical Guidance (ITG) on Occupant Sensors, dated 1 Jul 96. This ITG is available from the NAVFAC Criteria website at "www.efdlant.navy.mil/criteria/documents/ITG/ITGLIST.asp".

Edit last sentence for desired "on" duration.

Provide quantity of sensor units indicated as a minimum. Provide additional units to give full coverage over controlled area. Full coverage shall provide hand and arm motion detection for office and administration type areas and walking motion for industrial areas, warehouses, storage rooms and hallways. Locate the sensor(s) as indicated and in accordance with the manufacturer's recommendations to maximize energy savings and to avoid nuisance activation and deactivation due to sudden temperature or airflow changes and usage. Set sensor "on" duration to [10] [15] [_____] minutes.

3.1.8 Light Level Sensor

Locate light level sensor as indicated and in accordance with the manufacturer's recommendations. Adjust sensor for 50 footcandles 500 lux or for the indicated light level at the typical work plane for that area.

3.2 FIELD APPLIED PAINTING

NOTE: Use and coordinate paint and coating requirements with Section 09900 PAINTS AND COATINGS when provided in the job. If Section 09900 is not provided or when requirements are beyond what is specified in Section 09900, 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. Painting shall be as specified in Section 09900 PAINTS AND COATINGS.

3.3 FIELD QUALITY CONTROL

Upon completion of installation, 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.

3.3.2 Occupancy Sensor

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

-- End of Section --