

SECTION 265000 – LIGHTING

This document is provided as a reference for the design professionals working for the University of Pennsylvania. This document should not be used directly as written project specifications. This document does not define products for maintenance replacement purposes, but rather should be used for renovation and new construction projects.

PART 1 – GENERAL**1.0 Summary**

- A. This Section includes lighting design criteria, interior and exterior luminaires, lamps and ballasts, as well as related installation guidelines.

2.0 Regulatory Agencies

- A. Lighting design should conform to the applicable requirements of the following agencies' most current edition of regulations and standards, unless otherwise stated:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society for Testing Materials (ASTM)
 - 3. Environmental Protection Agency (EPA)
 - 4. Federal Communications Commission (FCC)
 - 5. Illuminating Engineering Society of North America (IESNA)
 - 6. National Electrical Manufacturers Association (NEMA)
 - 7. National Fire Protection Association (NFPA)
 - 8. Underwriter's Laboratories (UL)
 - 9. U.S. Green Building Council (USGBC)
 - 10. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE 90.1)
 - 11. International Building Code (IBC)
 - 12. International Energy Conservation Code (IECC)

3.0 Record Drawings

- A. Refer to 'Penn Instructions to Design Professionals' for information regarding record drawings. In addition, lighting fixture record drawings shall be provided to the University in the form of standard catalog cuts and/or factory assembly drawings, and shall indicate the following:
 - 1. Luminaire type correlated to lighting plans
 - 2. Luminaire and lamp wattage and voltage
 - 3. Complete photometric data
 - 4. Manufacturer's name and catalog number including all fixture options
 - 5. Lamp and ballast types and manufacturer's name
 - 6. Lamps/Fixture and Ballasts/Fixture
 - 7. Warranty information for lamps and ballasts
 - 8. Lamp correlated color temperature (CCT), color rendering index (CRI), and beam spread when applicable
 - 9. Lamp and Ballast Rated Life
- B. Lighting control record drawings shall include the following:
 - 1. Single line diagram showing all control components and associated wiring

2. Load schedule indicating circuit and zone number, light fixture types, lamp source, and load per circuit or zone
 3. Catalog cut sheets of control system components
 4. Lighting control narrative describing control intent for programmable lighting systems
- C. Full size manufacturer's drawings should be provided for custom designed light fixtures.

4.0 Substitutions

- A. Substitutions for light fixtures not specified in the Contract Documents shall be coordinated with the University Engineering Department.
- B. All fixture substitutions must be requested via a product substitution request in accordance with the Division 1 requirements of the contract. If substitutions are requested, the University is under no obligation to accept them.

PART 2 - DESIGN CRITERIA

1.0 Design Guidelines

- A. Penn has developed interior lighting guidelines to direct design professionals toward standard solutions that meet the University of Pennsylvania's performance requirements. These guidelines provide guidance on preferred upgrade and new fixtures solutions including: relamping, retrofitting, retrofitting with kit and new fixtures. For upgrade solutions, a matrix is provided that defines currently installed lighting technologies and the appropriate lighting upgrade solution. For new fixture solutions, a matrix is provided that defines a space functional type (i.e. laboratory) and provides multiple new fixture solutions depending on room architecture, desired technology, general cost category and other performance parameters. These interior lighting guidelines can be accessed at the following link: [Penn Interior Lighting Guidelines for Lamps, Ballasts, Kits & Fixtures](#).

2.0 Illuminance Levels

- A. Penn recognizes the Illuminating Engineering Society of North America (IESNA) Lighting Handbook as a reference for recommended illuminance levels for various spaces. IESNA illuminance criteria for applicable spaces are listed in the tables below.
- B. Lighting design for videoconferencing spaces should follow all guidelines described in the current version of the IESNA Design Guide DG-17 Fundamentals of Lighting for Videoconferencing.
- C. The illuminance levels listed below are average horizontal values unless otherwise noted and shall be calculated at the work plane height appropriate to the space. For instance, the work plane of a Corridor is the floor and an Office work plane is desk height (approximately 30" above floor).
- D. Illuminance levels listed should be calculated as average maintained values, using the appropriate light loss factor (LLF) for the room type, lamp, ballast, cleaning cycle and luminaire type.
- E. Uniformity ratios if not listed below should be calculated to match current IESNA design guidelines for the specific areas. Footcandle levels shall be calculated at ground level.

Exterior Areas	Minimum Horizontal Illuminance Level (Footcandles)	Average Vertical Illuminance Level (Footcandles) ¹	Maximum Uniformity Ratio (Maximum: Minimum)
Pedestrian Paths	0.5 fc	0.5 fc	15:1
Parking Lots	0.5 fc	0.25 fc	15:1
Parking Garages ²	5.0 fc	0.5 fc	10:1

¹ Measured at 5 feet above walking surface

² A higher light level is required at parking garage entrances and stairways.

Academic Building Areas	Illuminance Level (Footcandles)
Art Studio	50 fc
Auditoriums	30 - 50 fc
Circulation and Corridor Areas	10 fc
Classrooms	30 - 50 fc
Whiteboards	5 fc vertical
Chalkboards	50 fc vertical
Computer Lab	30 fc
Conference Rooms	30 - 40 fc ³
Environmental Rooms - Workspace	50 - 60 fc ⁴
Environmental Rooms - Storage	15 fc
File/Mail	30 - 50 fc
Laboratories	50 - 60 fc ⁴
Libraries - General/Stacks	30 fc
Libraries - Reading Rooms	50 fc
Mechanical/Electrical rooms	20 fc
Offices	35 - 50 fc ⁴
Restrooms	15 fc
Storage areas	15 fc
Theaters ⁵	30 fc
Museums ⁶	20 fc

³ Higher values may be required if the space is used for videoconferencing. Refer to Section 2.01.B.

⁴ On work plane, including task lighting.

⁵ On aisle, entrance and exit corridors as well as general work levels on stage. Theatrical lighting will be evaluated separately.

⁶ On aisles, entrance and exit corridors. Exhibit lighting should be evaluated and located based on the needs and type of installation and be designed to meet IESNA recommendations based on the specific use and function of the exhibit.

Residential Building Areas	Illuminance (Footcandles) Level
Hallways	10 fc
Dining Areas	20 fc
Dormitory Rooms - General	10 fc
Dormitory Rooms - Desk	30-50 fc ⁷
Kitchens	50 fc
Laundry Rooms	30 fc
Lounges	30 fc

⁷ Including task lighting

Athletic Facilities	Minimum Illuminance (Footcandles) ⁸	Horizontal Level	Maximum Uniformity Ratio (Maximum: Minimum)
Baseball			
Infield	100		2.5:1
Outfield	70		2.5:1
Basketball (Indoor)	125 fc		1.7:1
Football ⁹	100 fc		1.7:1
Locker rooms	20 fc		N/A
Soccer	150 fc		2.5:1
Tennis	100 fc		2.5:1
Track & Field	50 fc		2.5:1
Training Facilities	50 fc		N/A

⁸ Readings taken at 36" above ground unless otherwise noted.

⁹
Readings taken at grade.

- F. If sports and athletic facilities are required to be used for televised events, the lighting designed in these facilities must meet IESNA and NCAA guidelines based on the type of facility and the broadcast category. Consideration must be given to both horizontal and vertical illumination for all areas intended to be included in the televised event.
- G. Special and High Risk Use Areas such as wood shops, machine shops, work-shops should be designed to allow for both general lighting levels and elevated lighting levels where tasks are performed. Lighting positions should be coordinated with the location of equipment and levels should meet IESNA standards for the specific tasks performed in each area.

3.0 Energy Efficiency & Conservation

- A. Lighting Power Density – All interior spaces should comply with the Lighting Power Density (LPD) defined by the most current edition of IECC. LPD is expressed in terms of watts/square foot. Standards can be evaluated based on the “building method” or the “space-by-space method.”
- B. Building designs and fenestration shall be configured to provide the maximum advantage to daylight harvesting control schemes. Daylight harvesting control schemes shall be employed in all instances where the fenestration area of the room is equal to or exceeds 250 sq. ft.

4.0 Sustainable Design & Energy Conservation

- A. The USGBC Leadership in Energy and Environmental Design (LEED) Building Rating System should be used as a guideline for project lighting design. The Rating System (New Construction, Commercial Interiors, Core & Shell, etc.) most appropriate to the project type should be followed.
 - 1. If the New Construction (NC) rating system is deemed most appropriate, reference in particular the following credit sections; however additional sections may apply.
 - a. Sustainable Sites Credit 8 - Light Pollution
 - b. Energy & Atmosphere Prerequisite 2 – Minimum Energy Performance
 - c. Energy & Atmosphere Credit 1 – Optimize Energy Performance
 - d. Indoor Air Quality Credit 6.1 - Controllability of Systems – Lighting
 - e. Indoor Air Quality Credit 8.1,2 - Daylighting & Views
- B. Projects shall meet energy and control requirements outlined in the most currently adopted version of IECC or referenced in the LEED guidelines as described above.
- C. The application of natural light is encouraged to minimize electric lighting requirements.
 - 1. Appropriate glare control must be provided on all windows and skylights. Automatic daylight harvesting (reducing electric lighting load when available daylight is sufficient for lighting requirements) is encouraged.
 - 2. Daylight harvesting utilizing continuous (i.e. not stepped) dimming should always be used in regularly occupied spaces, such as offices and classrooms, to prevent disruption to occupants. Daylight harvesting utilizing on/off switching is acceptable in transient spaces, such as lobbies, atriums, etc.

- D. A lower general light level is recommended in office or other spaces where undercabinet or desk mounted adjustable task lighting is installed. Such that the net illumination level (as per above tables) is achieved as a result of combined room and task light sources. Task lighting fixtures should be separately controlled from general room lighting fixtures.
- E. High reflectance finishes are recommended for all ceiling and wall surfaces to minimize required energy usage.
- F. Lighting systems should be designed to achieve the above recommended illuminance levels while minimizing energy consumption.
- G. Locate interior and exterior luminaires to minimize light trespass and glare to adjoining properties.
- H. Lighting levels in unoccupied public spaces such as lobbies with exterior views or dorm room corridors must at a minimum meet emergency access and egress levels. Consideration should be given to include the illumination of selected walls and vertical surfaces to provide the appearance of occupancy while maintaining the reduced energy levels.

5.0 Controls

- A. Penn has developed interior lighting control guidelines to direct design professionals toward control solutions that meet Penn performance requirements. For new control solutions, a working spreadsheet is provided with column filters which allow the user to define specific applications and see preferred control solutions. These interior lighting control guidelines can be accessed at the following link: [Penn Interior Lighting Control Guidelines](#) and [Instructions for Use](#).
- B. Penn requires that interior spaces meet the control requirements defined by the currently adopted version of IECC.
- C. Ceiling mounted occupancy sensors are preferred and should be used as a default approach to lighting control. Ceiling mounted sensor(s) should be placed in a space such that detection area(s) cover the entire space. When a corner or wall mounted occupancy sensor(s) is used it should be located on the “door wall” in the corner farthest from the door. Wall mounted occupancy sensors will be considered for small spaces pre-approved by University Engineering Department.
- D. Where applicable, occupancy sensors should be specified with isolated relays for future use by non-lighting systems (i.e. local HVAC VAV).
- E. Occupancy sensors shall be specified as the control method in all private offices, restrooms, classrooms, conference rooms, storage rooms and other enclosed areas of intermittent use.
 - 1. Override wall switches or dimmers should be incorporated in offices, conference rooms, and classrooms.
 - 2. Dual Technology (infrared and ultrasonic/microphonic) sensors should be used in all room applications.
 - 3. Follow manufacturer's recommendations for coverage specification and sensor placement.
 - 4. Wireless sensors are allowed when battery life meets or exceeds a 10-year rated life and provide a low battery indicator.
 - 5. No automatic lighting controls should be used in mechanical spaces with

electrical distribution equipment, motors, pumps, shop equipment or other devices that without appropriate light levels would create a safety hazard.

- F. Provide BAS or relay panel, photocell, or a combination of both for control of all exterior lighting except code-required egress lighting. Locate controls within electrical rooms. In new construction, supply time clock control with current transformers to provide feedback to central monitoring system at Operations Control Center (OCC) that fixtures are illuminated and drawing current.
- G. The location of switch pack relays located above ceilings should be identified with a discrete label on the ceiling tile or access panel directly below the unit.
- H. Where rooms are used for a variety of functions, provide multi-level switching, fixture zoning, or dimming to accommodate light level flexibility for occupants.
- I. MRI room lighting system shall be direct current (DC).
- J. Consider the design of load shedding for lighting controls in larger new construction to provide feedback to central monitoring system at OCC.
- K. Lighting control systems should be tested and calibrated by the Commissioning Agent for all projects.
- L. Interior lighting controlled by relay panels for code required automatic shut-off shall have local override switches located at exits, entrances and accessible to occupants.
- M. Programming of preset lighting control systems shall be coordinated with the University Engineering Department and building occupants. A record of the settings shall be provided to building occupants. Lighting specifications should provide manufacturer training to building facilities.
- N. Acceptable manufacturers shall be by the following manufactures or approved equal by University Engineering Department:
 - 1. Sensor Switch
 - 2. Hubbell
 - 3. Wattstopper
 - 4. Eaton Controls (Cooper)
 - 5. Leviton
 - 6. Lutron

PART 3 – PRODUCTS

1.0 Luminaires

- A. Luminaires should be constructed and installed to allow easy access for luminaire maintenance. Lenses, reflectors, and connectors should be captive to fixture where practical.
- B. Interior Lighting
 - 1. For linear applications, utilize fixtures with extra-long life T8 lamps and program start ballasts. With consideration to energy usage and maintainability, the University has determined that this is currently the most economical solution. While the University Guideline contains LED options, LED technology is only to

be utilized in special applications with approval from the University Engineering Department. Fixture types previously specified with incandescent or compact fluorescent lamp sources (i.e. recessed downlights) should use dimmable LED light source. Penn prefers fixtures manufactured for incandescent lamps paired with LED replacement lamps meeting University standards later defined. In these instances the design professional must insure that the specified dimming control is proven to work with the specific LED replacement lamp utilized and for the quantity designed for a given switch circuit. Consideration should be given if replacement LED lamps are suitable in existing incandescent fixtures. Design professional should consult existing manufacturer for potential heat dissipation and LED lamp life issues. Penn Interior Lighting Guidelines for Lamps, Ballasts, Kits & Fixtures can be accessed at the following link: [Penn Interior Lighting Guidelines for Lamps, Ballasts, Kits & Fixtures](#).

2. Penn will consider acceptance of fixtures manufactured for incandescent lamps paired with LED replacement lamps meeting University standards later defined. In these instances the design professional must insure that the specified dimming control is proven to work with the specific LED lamp utilized and for the quantity designed for a given switch circuit.
3. Acceptable dimming protocols for non-incandescent relamp applications include 0-10V for LED and 3-wire for fluorescent lamps. DALI, DMX or other dimming protocols must be specifically requested or approved by University Engineering Department.
4. Mounting of luminaires above stairs and in locations that are higher than single floor ceiling heights shall be coordinated with the University Engineering Department to confirm access to the fixtures is possible with available maintenance equipment.
5. Luminaires must be hard-wired. Flexible cord (SJO) connectors are not acceptable. MC cable is permitted.
6. Where luminaires from manufacturer's standard product lines do not meet the requirements of the project or application, custom designed fixtures are acceptable with approval by the University provided they meet the following criteria:
 - a. The fixture shall utilize commonly available lamp types, preferably those used elsewhere on the project.
 - b. The entire fixture assembly must be listed by U.L. or other Nationally Recognized Testing Laboratory (NRTL) to U.L. standards.
 - c. The lamp and ballast must be easily accessible for maintenance without major disassembly of the fixture.
7. Where required, luminaires should have low iridescent reflectors, baffles, and louvers.
8. Adjustable luminaires shall be capable of being locked into position with a legible aiming angle for consistency between fixtures. These luminaires should have the ability to maintain focus position during lamp changes.
9. Luminaires shall bear U.L. label or other Nationally Recognized Testing Laboratory (NRTL) tested to U.L. standards.
10. Where luminaires utilize flat lenses, 100% UV stabilized virgin acrylic with minimum 0.125" thickness shall be specified. When lensed fixtures are specified in areas where the fixtures are subject to damage, polycarbonate lenses shall be specified in lieu of acrylic.
11. Luminaires with painted components should be painted after fabrication.
12. Specify luminaires utilizing linear fluorescent lamps. Compact fluorescent lamps are not acceptable.
13. Fixtures using linear fluorescent lamps and electronic ballasts should use lamps and ballasts specified in the lamps and ballasts section of this document.

14. Fixtures using LED technology should have the following performance specifications:
 - a. Consider LED sources based on durability, energy efficiency, and reduced maintenance. The use should be approved by the University Engineering Department prior to specification.
 - b. LED fixtures are to be provided by manufacturers with a minimum (8) years' experience and provide minimum (5) years warranty on all electrical parts.
 - c. LED components and fixtures shall comply with ANSI chromaticity standards, LM79 and IES LM-80 lumen maintenance testing standards.
 - d. Dimmable LEDs will utilize Constant Current Reduction or Pulse Width Modulation controls. The design professional is responsible for ensuring performance compatibility between specific LED fixtures and controls.
 - e. LED lighting systems with unmatched drivers and power supplies will not be considered.
 - f. Lumen packages sufficient to meet space design requirements including: maximum watts/square foot allowed by current energy codes adopted by the University of Pennsylvania, uniformity ratios no greater than 5:1 (excluding non-critical lighting locations) and minimum IESNA light levels for the applicable space type. The assumed Driver mA rating should be indicated when reporting initial delivered lumens of a specified fixture.
 - g. Lumen/watt efficacy performance greater than 80, assuming Lumens are measured as delivered lumens @ 35-degree Celsius multiplied by a 90% Light Loss Depreciation Factor and Watts are the total system watts of the fixture. Lumen/Watt performance meeting or exceeding 100 is the University's goal.
 - h. Rated life of 50,000 when lumens depreciated to 90% of initial rating using IESNA TM-21 testing methodology and data extrapolation. This is commonly referred to L₉₀ rated life.
 - i. DLC certification recommended and preferred.
 - j. Color Rendering Index equal or greater than 80.
 - k. Correlated color temperature of 3,500K.
 - l. Design professionals are required to provide LED fixtures that are compatible with existing or newly specified dimming controls.
 - m. Any exceptions to the above specifications must be approved by University Engineering Department.

C. Exterior Lighting

1. Mission Statement: The University's primary mission for exterior lighting of the campus is to enhance safety. In the process, lighting should improve the appearance of the campus, be energy efficient, utilize long life sources to minimize maintenance and minimize light pollution. Lighting must be adaptable for future campus development and changing technologies and be responsive to input from campus users.
2. All measures should be made to match existing campus standard lighting however LED lighting should be considered as the source for illumination of all new pathway and drive lane lighting.
3. Exterior pathway light poles shall be either of the following existing fixtures. Any deviations must be pre-approved by the University Engineering Department.
 - a. Decorative exterior pole fixture with overall 12' tall dimension, pole with decorative aluminum base cover and traditional style luminaire, both with custom color finish. Post shall be tapered aluminum construction with 3" diameter top and 5" diameter base. Luminaire shall have Lexan diffuser

and injection molded clear closer with specular reflectors. Lamp is 175-watt metal halide.

- (1) Catalog number: Street Lighting Corporation PLV/3-14MH 175 MODIFIED SPECIAL
- (2) Refer to following link for updated specifications: [Penn Exterior Pathway Pole and Fixture Standards](#).

b. Decorative exterior pole fixture with nominal 14' tall pole with decorative tapered base and traditional style luminaire. Post shall be aluminum construction with 4-1/4" diameter shaft with wiring access door within base and 3" by 3" round tenon. Luminaire shall be 18" diameter by 40-1/2" tall with cast aluminum cage, roof, and finial, and clear textured acrylic globe and clear acrylic dome lens, and stainless steel hardware. Lamp is 150-watt metal halide with medium base. Luminaire and pole shall have a custom finish to match Rockwood Shutter Green, SW#2809.

- (1) Catalog number: Antique Street Lamps, Philadelphia Series PX PD18 13-11 S4X FG-S AB4/11 CM PD28 S 150M MED ACT TB CDL L-6355A CM
- (2) Refer to following link for updated specifications: [Penn Exterior Pathway Pole and Fixture Standards](#).

c. All exterior pole fixtures (a. and b., above) shall utilize LED light source as per the following:

- (1) Beacon Products Type V Indirect Retrofit Kit
- (2) Refer to following link for updated specifications: [Penn Exterior Pathway Pole and Fixture Standards](#).

4. Poles shall be spaced a maximum of thirty (30) feet on center.
5. Luminaires should be either located or specified to prevent possible damage from vandalism.
6. Exterior luminaires and poles shall have the ability to withstand wind speeds of 80 miles per hour.
7. Exterior wall packs and garage lighting, both new and replacement units, shall utilize LED lamping. Fixtures shall have superior glare control with lighting directed downward. Fixtures with light distribution above 90 degrees shall not be acceptable.

2.0 LAMPS

A. General

1. Penn has developed Interior Lighting Guidelines which can be accessed at the following link: [Penn Interior Lighting Guidelines for Lamps, Ballasts, Kits & Fixtures](#). Preferred lamps are defined in each section of these guidelines.
2. The selection of luminaires should minimize the quantity of different lamp types utilized to the greatest extent possible.
3. Incandescent lamps should not be used.
4. Mercury vapor, ceramic metal halide and low pressure sodium lamps are not acceptable.
5. T-12 fluorescent lamps are not acceptable.
6. U-shaped fluorescent lamps are not acceptable.
7. For renovation projects, the lamp specification must match that of adjacent areas.

8. All fluorescent lamps should be by:
 - a. Philips
 - b. GE
 - c. Osram Sylvania
9. Energy-saving linear fluorescent (eg Philips Energy Advantage) lamps should not be used in exterior low temperature or dimming applications, unless otherwise approved by ballast manufacturer.

B. Linear Fluorescent Lamps

1. T8 Linear Fluorescent Lamps:

a. 4-foot T8 Lamps:

(1) The following minimum lamp specifications must be met for each project and represented on submitted product specification sheets:

(a) Nominal Watts: 32- or 28-watt acceptable

i. 32-watt lamps should only be used when required for dimming applications

(b) Rated Life: 46,000 hours at 3 hours/start on program start ballast, or greater

(c) Warranty: 36 months or greater

(d) Color Rendering Index: 82 or above

(e) Color Temperature (CCT): 3500K

(f) Initial Lumens: 2,900 lumens (32-watt) or 2,600 lumens (28-watt), or greater

(g) Depreciation Rate: Less than 10% at 40% of rated life

(h) Mercury Content: TCLP compliant

(i) Approved Manufacturers: Philips, Osram Sylvania and GE

b. 3-foot T8 Lamps

(1) The following minimum lamp specifications must be met for each project and represented on submitted product specification sheets:

(a) Nominal Watts: 25-watt or 21-watt

(b) Rated Life: 36,000 hours at 3 hours/start on program start ballast, or greater

(c) Warranty: 24 months or greater

(d) Color Rendering Index: 82 or above

(e) Color Temperature (CCT): 3500K

(f) Initial Lumens: 2,100 lumens (25-watt) or 1,800 lumens (21-watt), or greater

(g) Depreciation Rate: Less than 10% at 40% of rated life

(h) Mercury Content: TCLP compliant

(i) Approved Manufacturers: Philips, Osram Sylvania and GE

- c. 2-foot T8 Lamps
- (1) The following minimum lamp specifications must be met for each project and represented on submitted product specification sheets:
- (a) Nominal Watts: 17-watt or 15-watt
 - (b) Rated Life: 36,000 hours at 3 hours/start on program start ballast, or greater
 - (c) Warranty: 24 months or greater
 - (d) Color Rendering Index: 82 or above
 - (e) Color Temperature (CCT): 3500K
 - (f) Initial Lumens: 1,300 lumens (17-watt) or 1,100 lumens (55-watt), or greater
 - (g) Depreciation Rate: Less than 10% at 40% of rated life
 - (h) Mercury Content: TCLP compliant
 - (i) Approved Manufacturers: Philips, Osram Sylvania and GE
- d. T5 Linear Fluorescent Lamps
- (1) T5 lamps are not preferred by the University. All attempts should be made to utilize fixtures with T8 lamps or LED technology. Fixtures using T5 lamps require approval from University Engineering Office.
- (2) 4-foot T5 Lamps
- (a) The following minimum lamp specifications must be met for each project and represented on submitted product specification sheets:
- i. Nominal Watts: 28-watt or 25-watt
 - ii. Rated Life: 30,000 hours at 3 hours/start on program start ballast, or greater
 - iii. Warranty: 24 months or greater
 - iv. Color Rendering Index: 82 or above
 - v. Color Temperature (CCT): 3500K
 - vi. Initial Lumens: 2,900 lumens (28-watt) or 2,900 lumens (25-watt), or greater
 - vii. Depreciation Rate: Less than 10% at 40% of rated life
 - viii. Mercury Content: TCLP compliant
 - ix. Approved Manufacturers: Philips, Osram Sylvania and GE
- e. 4-foot High Output T5 Lamps
- (1) The following minimum lamp specifications must be met for each project and represented on submitted product specification sheets:
- (a) Nominal Watts: 51-watt or 49-watt
 - (b) Rated Life: 30,000 hours at 3 hours/start on program start ballast, or greater
 - (c) Warranty: 24 months or greater

- (d) Color Rendering Index: 82 or above
- (e) Color Temperature (CCT): 3500K
- (f) Initial Lumens: 5,000 lumens (51-watt) or 5,000 lumens (49-watt), or greater
- (g) Depreciation Rate: Less than 10% at 40% of rated life
- (h) Mercury Content: TCLP compliant
- (i) Approved Manufacturers: Philips, Osram Sylvania and GE

C. LED Replacement Lamps

1. Consider LED sources based on durability, energy efficiency, and reduced maintenance. The use should be approved by the University Engineering Department prior to specification.
2. LED lamps are to be provided by manufacturers with a minimum (8) years' experience and provide minimum (5) years warranty on all electrical parts.
3. LED components and fixtures shall comply with ANSI chromaticity standards, LM79 and IES LM-80 lumen maintenance testing standards.
4. Dimmable LED sources will utilize Constant Current Reduction or Pulse Width Modulation controls.
5. Design professionals are required to provide LED lamps that are compatible with existing or newly specified dimming controls.
6. LED lighting systems with unmatched drivers and power supplies will not be considered.
7. DLC certification recommended and preferred.
8. Design professionals are required to provide LED fixtures that are compatible with existing or newly specified dimming controls.

3.0 BALLASTS

A. General

1. Penn has developed Interior Lighting Guidelines which can be accessed at the following link: [Penn Interior Lighting Guidelines for Lamps, Ballasts, Kits & Fixtures](#). Preferred ballasts are defined in these guidelines.
2. All ballasts should have end-of-life protection.
3. Utilize tandem wiring to avoid single-lamp ballasts.
4. Ballasts used in fixtures mounted in an exterior location shall have a starting temperature of 0°F.

B. Fluorescent

1. NEMA Premium High Efficiency Electronic ballasts shall be specified for all non-dimming fluorescent lamps.
2. Fixed light output ballasts should use program-start technology with lamp sockets wired with parallel circuitry when available.
3. Fluorescent ballasts should be listed UL Class P with a Sound Rating of A and a minimum power factor of 95.
4. Confirm all dimming ballasts are compatible with the control systems operating them.
5. Electronic fluorescent ballasts shall have a warranty for a minimum of five (5) years against defects in material or workmanship.
6. Emergency battery and dimming ballasts for fluorescent lamps shall have a warranty for a minimum of three (3) years, against defects in material or workmanship.
7. Dimming ballasts shall be capable of striking lamps at any light level without first flashing to full output.

8. Ballasts should have total harmonic current distortion of less than 10% unless determined that related inrush current would be detrimental to the control system.
9. Acceptable tubular fluorescent electronic ballasts manufacturers shall be:
 - a. Universal Lighting Technologies
 - b. Advance Transformer Co.
 - c. Osram Sylvania
 - d. General Electric
10. Acceptable tubular fluorescent electronic dimming ballasts shall be:
 - a. Advance Transformer Co.
 - b. Universal Lighting Technologies
 - c. Osram Sylvania
 - d. General Electric
 - e. Lutron

4.0 RETROFIT KITS

A. General

1. Please reference Penn's Interior Lighting Standards (Retrofit Section) at the following link: [Penn Interior Lighting Guidelines for Lamps, Ballasts, Kits & Fixtures](#)
2. All fixtures considered for retrofit must meet the following conditions. Otherwise fixture must be replaced with new.
 - a. Fixture housings and fittings are in good condition free of corrosion, warping, mechanical or electrical defects.
 - b. Finish on fixtures should be in good appearance free of cracks, chips and defects. Exterior fixtures should maintain powder coat or exterior grade criteria with no parts exposed to corrosion.
 - c. Fixtures must maintain U.L. or other Nationally Recognized Testing Laboratory (NRTL) to U.L. standards.
3. Retrofit components and parts must meet the following criteria:
 - a. Retrofitted electrical components must be U.L. listed or other Nationally Recognized Testing Laboratory (NRTL) to U.L. standards.
 - b. Components will be provided by manufacturers with a minimum 8 years' experience in the lighting and retrofit industry with local representation and factory support.
 - c. All components will have minimum 5 years warranty covering all defective parts and labor for installation.

5.0 EMERGENCY LIGHTING

- A. All emergency lighting shall be provided by a dedicated Emergency Lighting Inverter System or Emergency Generator. The use of Emergency Battery Ballasts installed in lighting fixtures should not be considered.
- B. Provide self-contained emergency lighting units in all generator, switchgear, ATS, and UPS rooms, regardless of whether or not generator power is available on the project.
- C. All new exit signs shall utilize LED lamping.

- D. Self-powered exit signs should be provided with sealed maintenance-free batteries and self-diagnostics.
- E. When generator power is unavailable, emergency battery ballasts utilized within general lighting fixtures or self-contained emergency battery units are acceptable for code required egress lighting. Coordinate with the University Engineering Department.
- F. Radioactive self-luminous exit signs are not acceptable. Self-luminous exit signs which are toxin free may be considered on a case by case basis.
- G. Emergency lighting levels shall meet National Fire Protection Association (NFPA) 101 and International Building Code (IBC) requirements.
- H. Identified Egress Paths (i.e. corridors, stairwells & assembly areas) must meet both currently adopted code requirements for minimum illumination levels and sufficient directional signage when normal power is not available.

PART 4 – EXECUTION

- A. Fluorescent lamps, especially those to be dimmed, should be aged/operated 100 hours or as recommended by the lamp manufacturer prior to space occupation by the University.
- B. All luminaires recessed or suspended from the ceiling shall be supported by the structure above the ceiling at a minimum of two locations for every four feet of fixture length.
- C. The Contractor shall provide a list of lamp types used on the project with the associated installation locations noted.
- D. All adjustable interior and exterior light fixtures should be aimed by the Contractor to the satisfaction of the University Engineering Department.
- E. The contractor will be responsible for the coordination for programming of programmable lighting control systems. This includes providing factory trained technicians for programming and commissioning of the systems as well as training of personnel responsible for the upkeep of the systems as well as arranging a time conducive to both client and design team to meet and provide direction to the programmer. Factory technicians shall provide an after occupancy follow-up programming, commissioning and training site visit for up to 12 months after installation.