MINOR REVISION

Modify *Division 26, 26 00 00 Electrical* per the following (deletions are shown struck through and additions are double underlined). Remainder of section is unchanged.

26 00 00 ELECTRICAL

26 09 00 INSTRUMENTATION AND CONTROL FOR ELECTRICAL SYSTEMS

26 09 23 Lighting Control Devices and Systems

.01 General

A. Intent – PSU designs shall strive for simple and effective methods of lighting control that is robust and easy to maintain while meeting all required standards and applicable codes.
B. Approved System Manufacturers
    1. Hardwired Digital and Network Based Systems
        a. Wattstopper
        b. Nlight (Sensorswitch)
        c. Crestron Electronics (where A/V interface is required)
        d. Additional manufacturer's as approved by Engineering Services
    2. Stand-Alone Line-Voltage Devices
        a. Wattstopper
        b. Sensor Switch
        c. Leviton
        d. Lutron
        e. Additional manufacturer's as approved by Engineering Services
    3. Wireless Systems: All wireless systems and devices will be approved on a case-by-case basis based on facility requirements, manufacturer's product offering to meet University standards, manufacturer/vendor field support, and product warranty.
    4. Additional lighting control systems and protocols (DALI/DMX, etc) will be approved by Engineering Services on a case-by-case basis.
    5. All control components and systems shall be UL listed for the purpose.
C. Control Systems Warranty
    1. All lighting control components and systems shall be covered by the manufacturer's product warranty. Warranty period shall be no less than five (5) years from the date of project substantial completion.
D. Control System Deployment Types and Definitions
    1. Line-Voltage Room/Zone Based
        a. Typically consist of wall box control devices connected to the branch circuit line-voltage source (120/277vac) providing switching and/or dimming functions wired direct to the luminaires being controlled. Additional line-voltage control interface devices shall not be limited to line-voltage occupancy sensors, emergency relays, or other control devices as required for the spatial functions.
        b. HVAC Interfacing shall be performed using stand-alone occupancy devices with auxiliary contacts to provide digital status of space occupancy to the building automation system.

    2. Hardwired Digital, Stand-Alone/Room Based

a. Typically consists of low-voltage wall box control devices connected to a local digital room controller via low-voltage cabling providing switching and/or dimming functions through the local room controller. The functions of the room controller shall provide single or multiple switched and/or dimmable zones of control based on the control device function and room zoning. Line-voltage wiring typically interfaces with the room controller for luminaire operation. Low-voltage cabling typically consists of category 5 (or better) terminated cabling, or twisted shielded pair cabling for control device interface. Additional digital control interface devices shall not be limited to low-voltage occupancy sensors, low-voltage daylight harvesting photocells, emergency relays, etc.
b. HVAC Interfacing shall be performed using stand-alone occupancy devices with auxiliary contacts to provide digital status of space occupancy to the building automation system.

3. Hardwired Digital, Building-Wide Integration, Network Based

a. Typically consists of low-voltage wall box control devices connected to a local digital room controller via low-voltage cabling providing switching and/or dimming functions through a room controller. Room controllers are interfaced through network bridges with connections to a master network interface manager device via low-voltage cabling. The functions of the room controller shall provide single or multiple switched and/or dimmable zones of control based on the control device function. Line-voltage wiring typically interfaces with the room controller for luminaire operation. Low-voltage cabling typically consists of category 5 (or higher) terminated cabling, or twisted shielded pair cabling for control device interface. Additional digital control interface devices shall not be limited to low-voltage occupancy sensors, low-voltage daylight harvesting photocells, emergency relays, etc. System shall include a front-end network interface management device which provides direct BACnet IP interfacing. Systems not providing interfacing per PSU standards will not be accepted. nLight deployed systems must utilize the Eclypse IP and Building management interface with native BACnet IP. Networked lighting control systems shall be used exclusively for lighting controls unless otherwise approved by Engineering Services.
b. HVAC Interfacing shall be performed using direct connectivity to the building automation system using direct BACnet interfacing.

4. Hardwired Digital, Building-Wide Integration, A/V Interfacing, Network Based

a. Typically consists of low-voltage wall box control devices connected to a local digital room controller via low-voltage cabling providing switching and/or dimming functions through a room controller. Room controllers are interfaced through network bridges with connections to a master network interface device via low-voltage cabling. The functions of the room controller shall provide single or multiple switched and/or dimmable zones of control based on the control device function. Line-voltage wiring typically interfaces with the room controller for luminaire operation. Low-voltage cabling typically consists of category 5 (or higher) terminated cabling, or twisted shielded pair cabling for control device interface. Additional digital control interface devices shall not be limited to low-voltage occupancy sensors, low-voltage daylight harvesting

photcells, etc. A/v interfacing shall require the connection of various audio/visual devices including but not limited to; window shade/blackout controls, projector and projection screen controls, podium controls, and audio controls for the space(s). A/v interfacing may require the use of a graphical interface display which projects both lighting and a/v control options on a single LCD display. System shall include a front-end network interface management device which provides direct BACnet IP interfacing. Systems not providing interfacing per PSU standards will not be accepted.

b. HVAC Interfacing shall be performed using direct connectivity to the building automation system using direct BACnet interfacing.

5. **Wireless Systems**
   - **a.** Wireless systems may be considered based on the building spatial functions, as well as constructability within the facility. The University is restricting the deployment of wireless control systems within facilities and spaces where research is being performed due to possible interference and security issues. Where deployed, wireless system devices (wall box controls, interfaces, etc) are preferred to require a line voltage source for power and not solely battery operated. Battery operated devices shall be avoided unless approved by Engineering Services. Self-generating power sourced devices will be considered and approved on a case-by-case basis. All wireless systems must obtain prior approval from Engineering Services.

E. Recommended Facility Lighting Control System Deployments

1. **New Buildings:** consider the use of a building-wide, networked based, digital system for all new buildings unless otherwise directed.
   a. Discuss the need for a/v systems interfacing and system capabilities related to classrooms, lecture halls, performance spaces, special research facilities and other spaces requiring a/v interface.
   b. Wireless systems will not be accepted unless prior approval is given by Engineering Services.

2. **Existing Building – Complete Renovation:** consider the use of a building-wide, networked based, digital system for all renovated buildings unless otherwise directed.
   a. Discuss the need for a/v systems interfacing and system capabilities related to classrooms, lecture halls, performance spaces, special research facilities and other spaces requiring a/v interface.
   b. Wireless systems will not be accepted unless prior approval is given by Engineering Services.

3. **Existing Building – Complete Renovation – Phased Construction:** consider the use of a networked system for all "phased" building renovation areas unless otherwise directed. System may start as a digital, stand-alone, room-based deployment with network cabling and components added or completed based on the building phasing approach. Discuss construction document strategy with Engineering Services to ensure all phases of work receive network systems by a single, common manufacturer.
   a. Discuss the need for a/v systems interfacing and system capabilities related to classrooms, lecture halls, performance spaces, special research facilities and other spaces requiring a/v interface.

b. Wireless systems will not be accepted unless prior approval is given by Engineering Services.

4. **Existing Building – Isolated Renovations:** consider the use of stand-alone, room-based systems where multiple control zones are required. Consider luminaire based sensors where isolated control zones, or independent control is required for the space, or where spatial use is dynamic and may require control zones to be modified over short periods of time. Review final approach with Engineering Services.
5. **Classroom and Lecture Spaces**: refer to the Classroom and Technology design and construction standards for all lighting and control requirements for classrooms, lecture halls and technology spaces.
6. **Exterior Lighting Controls**:
    a. Exterior building mount "Night" lights shall be controlled through lighting contactors via the Central Control System. Refer to the "SITE/NIGHT LIGHTING" section of the BAS Specification for requirements. Contactors shall be fail-safe with device failure to "on".
    b. Exterior "Site" (walkway, roadway, and parking) lights shall be controlled from the CCS (Central Control System) through lighting contactors, utilizing 4-20mA CT's to confirm circuit activation. Refer to the "SITE/NIGHT LIGHTING" section of the BAS Specification for requirements and discuss options with Engineering Services. Contactors shall be fail-safe with device failure to "on".
    c. Contact Engineering Services for typical details related to exterior lighting controls where not included in these standards.

F. **Control System Deployment And Installation Requirements**

1. Deploy "remote" devices such as room controllers, local network devices and other "back-of-house" devices in a common location throughout the project area. Example: install all room controllers (relay packs, etc) concealed above accessible ceilings within the room being controlled, just inside the doorway of the room; install all networking equipment above the ceiling adjacent to the room controller when deployed. Locations of devices shall be similar in each room where possible, and coordinated in-field with Engineering Services at the time of installation.
2. Where directed, provide label on ceiling grid noting equipment located above if deployment is uncommon or special deployments are required for a specific area or space.
3. Provide labeling of all line-voltage conductor branch circuitry at the lighting control equipment terminals; label shall indicate panelboard and circuit number serving device.
4. Contractor and system programmer shall coordinate all room naming and numbering conventions with Engineering Services prior to final system programming and turnover. Architectural construction documents shall not be assumed correct for final naming and room number conventions.
5. All digital interface cabling (CAT 5/6 as specified) shall be deployed incorporating a color-specific outer cable jacket. All cables shall remain the same color throughout the building, regardless of location or installation parameters. Coordinate jacket color selection with Engineering Services (Standard is in development at the time of this writing). Cable color shall not replicate IT Data/Comm or BAS cable colors within the same facility.
6. All digital interfacing and control cabling shall be installed as indicated. All cable shall be plenum rated regardless of installation methods:

a. Above accessible suspended ceilings: Cables shall be installed on J-hooks, cable tray, or other dedicated support structure. Cables shall not be directly fastened to the outside of raceways or other building structures.
b. Above concealed, non-accessible ceilings: Cables shall be installed in raceways.
c. Within open ceiling structures: Cables shall be installed in raceways or dedicated cable tray systems where deployed. Open support structures shall be avoided unless approved by Engineering Services.
d. Inside wall cavities: Cables shall be installed in raceways from device box to above ceiling. Install above ceiling as indicated for ceiling types.
e. Exposed: Cables shall be installed in raceways.

7. All ceiling mounted occupancy sensors must be located at the manufacturer's minimum specified distance from all supply air registers to avoid detector false triggering. Ultrasonic technologies will not be permitted to be "programmed-off" where installation is not per manufacturer's recommendations. Detector relocations will be required if the spacing is not adequate based on field conditions. All costs to relocate the detectors will be incurred by the installing contractor. Deploy "corner" mounted sensors mounted to ceiling or wall with physically adjustable housings for "aiming" where possible to avoid potential conflicts with the ceiling mounted air supply diffusers.
8. Specify an allowance for additional occupancy sensors included as part of contract for field related coverage issues on all larger projects. Allowance shall be representative of a 10% quantity based on total project sensor quantities. Sensors will only be provided to rectify operational issues, and not for post-project attic-stock.
9. The network management interface device, or other lighting control network devices, for digital networked systems shall NOT be located within telecom rooms. These devices shall be located within an electrical room, or other space as directed by Engineering Services. These devices shall be located no more than 72" above finished floor. Do not locate at any location requiring a ladder for access.
10. Require in the contract documents that the successful controls vendor submit final layout drawings for review and approval as part of the shop drawing submittals. Include that the Vendor may have to modify their layout from that designed, as necessary to meet vendor-specific requirements or limitations. No extra costs to be allowed.

G. **Control System Programming, Start-Up and Commissioning:** the following shall be conveyed to the installer for required system programming, start-up, and commissioning actions.

1. Contractor shall provide the lighting controls on-site field services tech accurate documentation of equipment locations as deployed within the facility for on-site programming and system start-up. Construction floor plans shall be used to convey this information. Each deployed device location shall include the device model and serial number on the plan. Use of the device "box" labels shall be permitted to be used. Contractor shall review this approach with Engineering Services prior to implementing the documentation.
2. All cat5/6 cabling shall be tested prior to the system start-up and corrective actions performed (repair/replacement) prior to the start-up activities to minimize on-site delays during start-up. Contractor shall provide cable ringing testing reports seven (7) days prior to the start-up date.

3. All building-wide networked systems requiring integration with the university building automation systems (BAS) shall be coordinated with the OPP Facilities Automation Network Administration Supervisor. Networked lighting control systems will require specific network settings within the software to provide error-free communications with the university BAS system. All IP address requests shall be made as early as possible in the construction timeline to avoid delays in system setup, programming, and integration with the BAS system.
4. All building-wide networked systems start-up and commissioning shall require PSU OPP personnel be on-site for all start-up and commissioning functions. Calendar events shall be coordinated and prioritized based on the OPP personnel availability.
5. Contractor shall provide final networked systems program and/or databases to OPP Engineering Services upon final acceptance of system.
6. Daylight harvesting controls shall be commissioned during overcast as well as clear-sky days to confirm the proper sensor settings for valid operation. Manufacturer/vendor/contractor shall assume multiple day cx is necessary to fulfill this requirement. Commissioning efforts shall include the following activities:
    a. Daylight harvesting sensors shall be calibrated during system programming in-field to satisfy spatial illumination requirements based on field measurements with a certified and/or calibrated hand-held light meter. The sensor light level readings shall not be used to determine final spatial illumination targets. Sensor light level readings shall only be used to determine the permissible dimming range of the lighting source to satisfy the spatial illumination target while in daylight harvest mode.
    b. All furnishings and interior finishes shall be installed prior to calibrating the sensors.
    c. Photo sensors shall be adjusted to determine the threshold for dimming based on the detected light level.
    d. Closed-loop systems shall be calibrated under normal daylight and dusk conditions
    e. Daylight harvesting deployments shall be programmed to react to natural lighting conditions using extended transition times between full output of electric lighting and dimmed levels (and opposite actions) to achieve spatial target values. Transition periods shall be coordinated with Engineering Services.
    f. Daylight harvesting shall not turn fixtures off, unless otherwise approved by Engineering Services. All harvesting functions shall be programmed for dimming.

H. Automatic Lighting Controls Components: All interior building spaces (except mechanical and electrical rooms) shall be controlled via automatic means, typically occupancy sensors, with daylight sensors for additional energy savings where deployed. Paths of egress shall be illuminated at all times under normal operating conditions, based on the required minimum code illumination levels.
    1. ~~All interior building spaces shall be controlled via automatic means, typically occupancy sensors~~.

    1. Occupancy Sensor Requirements

a. Utilize primarily ceiling or aimable wall/ceiling mount as they provide better coverage than wallbox style. Deploy wall mounted sensors where possible to minimize HVAC air stream conflicts with sensors using ultrasonic technology.
b. Use "vandal-resistant" models for wallbox mounting in individual bathrooms and small public rooms.
c. Use dual relay models for offices and similar spaces requiring dual level lighting (switch closest to the door frame controls the low-light level) for all stand-alone deployments.
d. Dual-technology is typically preferred, but consider whether the use of one technology over another is more appropriate for specific applications.
e. When ceiling/wall sensors are used, always provide manual switch(es) on the load side to allow manual-on and user control .
f. ~~Allowable manufacturers of stand-alone equipment are Leviton, Sensor Switch, and Watt Stopper~~.
g. ~~Discuss with Engineering Services the use of networked sensor systems for new construction and major renovation projects. Acceptable products are Lutron Energi Savr Node, Sensor Switch nLight and Watt Stopper DLM. These systems are also appropriate for more complicated control of specific spaces such as:~~
    1. ~~classrooms~~
    2. ~~conference spaces~~
    3. ~~daylight harvest of large areas~~

f. Specify all ceiling and wall-mount (non-wallbox) sensors with output relays to allow the BAS system to monitor occupancy so that local HVAC can reduce to minimum levels when no occupancy is sensed. This is especially effective for large offices, classrooms, labs, and similar spaces. Discuss control strategy with Engineering Services at schematic design phase. Sensor relays shall not be used when a digital networked system is deployed. BACnet interface shall be provided for all networked systems.

2. ~~Require in the contract documents that the successful controls vendor submit final layout drawings for review and approval as part of the shop drawing package. Include that the Vendor may have to modify their layout from that designed, as necessary to meet vendor-specific requirements or limitations. No extra costs to be allowed~~.
3. ~~Specify an allowance for additional sensors and include spare parts turned over to PSU.~~

2. Daylight Sensor Requirements

a. Daylight harvesting deployments shall follow the latest adopted version of the International Energy Conservation Code (IECC)/ASHRAE 90.1.
b. Sensors shall incorporate open or closed loop sensing technology using integral photodiodes. Sensor technology deployments (open/closed-loop) shall be discussed with Engineering Services.
c. Sensors shall be line-voltage, or low-voltage devices based on stand-alone or digital system deployments.
d. Sensors shall offer dimming control and on/off control options for controlled loads.

3. Provide wall box timer switches for Telephone, Mechanical, Janitor, and similar rooms. Switch(es) must give visual warning 5 minutes and audible/visual warning 1 minute before lights turn off, similar to Watt Stopper TS-400. Refer to 265000.01.B for PSU Lighting Control Matrix outlining required time delay settings for each space where deployed.

~~B. Central Lighting Controls:~~

2. ~~When appropriate, and approved by Engineering Services, interior building lighting shall be controlled through a digital networked lighting control system via wall box controls, occupancy sensors and per schedule set by the building users. Discuss this type of control with Engineering Services prior to specifying. Refer to 265000.01.B for PSU Lighting Control Matrix outlining required time delay settings for each space where deployed.~~
    a. ~~Exterior building mount "Night" lights shall be controlled through lighting contactors via the Central Control System. Refer to the "SITE/NIGHT LIGHTING" section of the BAS Specification for requirements. Contactors shall be fail-safe with device failure to "on".~~
    b. ~~Exterior "Site" (walkway, roadway, and parking) lights shall be controlled from the CCS (Central Control System) through lighting contactors, utilizing 4-20mA CT's to confirm circuit activation. Refer to the "SITE/NIGHT LIGHTING" section of the BAS Specification for requirements and discuss options with Engineering Services. Contactors shall be fail-safe with device failure to "on".~~

26 50 00 LIGHTING

.01 General

A. Design shall follow PSU AD64 Energy Conservation Policy.
B. All interior and exterior lighting controls shall be designed, deployed and commissioned in accordance with the PSU Lighting Control Matrix. Areas not specifically addressed in the matrix shall be coordinated with PSU Engineering Services.

Document	Version Date	Description
26 50 00-Lighting-PSU Lighting Control Matrix.pdf	July 2016	University's required interior and exterior lighting control standards; to be used by the Design Professional

26 51 00 INTERIOR LIGHTING

.01 Lighting Design

A. Base bid shall utilize dimmable LED source for all general lighting. Discuss luminaire application with Engineering Services. ~~Although LED is preferred, certain areas such as Mechanical, Electrical, and Telecom may use T8 lamping if approved by Engineering Services. The use of LED will save energy, reduce material sent to recycling, decrease maintenance costs, eliminate Mercury use, and save money on lamp replacements~~.
B. The professional shall submit PDF computer generated point-by-point calculations of most interior spaces to Engineering Services for review. The use of certain "typical" rooms shall be acceptable except when the amount of fenestration or the room orientation changes. Show calculations for each space without daylight contribution as well as with daylight contribution and lighting controls. Point levels shall be legible, shown on a scaled drawing. All pertinent calculation parameters shall be indicated, highlight where the design is non-IES compliant. Engineering Services will provide direction and variance where deemed

adequate. Utilize AGI-32 full calculation mode or similar program, as approved by Engineering Services.

C. The Illuminating Engineers Society Lighting Handbook, current edition, including IES recommended practices, shall be used as a standard for lighting levels. Provide a spreadsheet showing all room names and numbers along with target illumination levels. For television studios and classrooms used for TV production, consult Engineering Services for guidelines.
    1. Refer to 26 00 01 .10 - B Elevator Service and Support for applicable illumination requirements.
D. Medium and high bays in shops, lobbies, etc. shall be LED. Drivers must be rated for high temperature environment. Consider remote mount drivers where fixture mounting heights exceed twenty (20) feet, or access to luminaires is restricted. Remote drivers shall be installed per manufacturer's requirements.
E. Provide a PDF copy of the Luminaire fixture cutsheets with every review submittal showing lighting layouts. Booklet shall be in color and include the light fixture schedule as well as target illumination levels and proposed lighting controls. Include point-by-point calculation results and summary table with submittals.
F. Specify the proper disposal of mercury containing lamps per PSU Policy SY-31 and PCB ballasts per PSU Policy SY-26 for all renovation work.
G. Include the luminaire fixture schedule within the drawings, not within the specifications. As-built drawings shall include final installed luminaire information.

.02 Lamps

A. The use of LED lamps in all luminaires is highly recommended. However, there are instances where fluorescent technology may be deployed where approved by Engineering Services.
B. All LED's shall incorporate a 4000 degree kelvin temperature, and a minimum of 80 CRI; Minimum L70 of 60,000 hours, and minimum efficiency of 90 lumens per watt. Require testing to IES LM-79 and LM-80 standards and life calculations based on IES TM-21. Chips shall be binned to no more than a 2-step MacAdam Ellipse.
C. Variable correlated color temperature (Tunable White) LED systems shall be permitted where approved by Engineering Services. Systems shall offer a range of temperature control from 2700K through 6000K, dimming control from 100% to 1%, and shall offer compatibility with any LED dimming driver/controller including 0-10V, DALI, DMX, etc. Controller types and deployments shall be reviewed with Engineering Services.
D. Linear LED lamps (T-8/T-5 types) intended to replace equivalent fluorescent lamps shall be deployed using a connection to a ballast for operation. Line-voltage or hybrid linear LED lamps bypassing a ballast shall not be utilized. Dedicated LED/driver linear lamp deployments are acceptable with drivers meeting the minimum standards specified elsewhere. LED lamps connecting to a ballast with end-of-life circuit protection shall not be used for normal/emergency or emergency illumination requirements.
E. All LED deployed luminaires shall include field replaceable LED drivers capable of access without removal of ceiling systems or other building components to replace or service the driver.
F. Luminaire LED boards shall be field serviceable and replaceable. LED luminaires not meeting this requirement must be reviewed and approved by Engineering Services.
G. Unless otherwise approved, 48-inch linear fluorescent lamps shall be "extra-long life", either full-wattage (32-watt) T8, or the reduced wattage (28-watt) T8. Typically use low-wattage but confirm selection with Engineering Services.

H. The use of other fluorescent lamps is discouraged. Linear T5HO (high-output) fluorescent lamps are allowed where design applications exist, but only as approved by Engineering Services.
I. Compact fluorescent lamps shall not be specified. LED luminaires or lamps shall be specified instead.
J. Coordinate other lamp wattages and styles with Engineering Services prior to specification.
K. Where permitted, ~~All~~ fluorescent lamps shall ~~will typically~~ incorporate a 4100 degree Kelvin color temperature and a minimum CRI of 82.
    1. Qualifying extra-long life 32 watt T8, 48 inch linear lamps are as follows:
        a. GE Super Long Life: F32T8/SXL/SPX41/ECO
        b. Philips XLL: F32T8/TL841/XLL/ALTO
        c. Sylvania Octron XP/XL: FO32/841/XP/XL/ECO3
    2. Qualifying reduced wattage T8, 48 inch linear lamps are as follows:
        a. GE Ecolux UltraMax: F28T8/XL/SPX41/ECO
        b. Philips XLL: F32T8/ADV841/XLL/ALTO 28W
        c. Sylvania Octron XP/XL: F028/841/XP/XL/SS/ECO3
L. Do not use incandescent lamps, unless specifically approved by Engineering Services. When allowed, provide the following:

    1. "A" lamps shall be long-life, rated 125 volts, with inside frost.
    2. MR-16 lamps, up to 50 watt, shall be replaced with LED equivalent.
    3. Any wallbox dimmers or dimming system shall be set to only allow lamp operation to 90% output. This is to conserve energy as well as to extend lamp life by double.
M. Require that the contractor obtain all similar lamp types through one source from a single manufacturer.
N. Dimming: All dimming luminaires shall be LED. Most applications only require a minimum dimming range of 5% to 10%. Confirm the use of 1% dimming with Engineering Services.
O. CFL Lamp Disposal and Cleanup: Refer to PSU Environmental Health and Safety data sheet for disposal and/or cleanup of broken CFL lamps.
~~P. LED shall be used instead of CFL for all applications (downlights, decorative luminaires, etc.). Specify luminaire with a minimum lumen output (typically 1000 or 2000 lumen), minimum CRI of 80, minimum L70 of 50,000 hours, and minimum efficiency of 70 lumens per watt. Require testing to IES LM-79 and LM-80 standards and life calculations based on IES TM-21. CCT shall be 4000K. Chips shall be binned to no more than a 2-step MacAdam Ellipse. Consult Engineering Services as to acceptable manufacturers.~~

P. LED screw-in lamps using medium base, GU24, GU10, bi-pin etc. shall be approved by Engineering Services prior to specification. PSU prefers purpose-built LED luminaires over socket based solutions. Lamps shall provide flicker-free dimming to 10% where permitted or required.

.03 Ballasts & Drivers

A. Fluorescent ballasts shall be NEMA "premium" efficiency, electronic, CBM and ETL approved with a sound rating of A. Ballast shall also be Class P, thermal cut-out switch, rated where required by U.L. Investigate use of high or low ballast factor as part of the illumination calculations. Linear ballasts shall be as follows:
    1. PRS (programmed rapid start ballast) with parallel lamp operation – use with occupancy sensors or in frequent switching applications.
        a. Advance "Optanium" (PRS)
        b. GE "UltraStart"
        c. Sylvania "PROStart"

d. Universal “ULTim8” (PRS, HE)

2. IS (instant start ballast) – use with manual switched lighting and unswitched emergency luminaires.

    a. Advance “Optanium” (IS)
    b. GE “UltraMax”
    c. Sylvania “QHE”
    d. Universal “ULTim8” (IS, HE)

B. Provide label sticker on each fluorescent luminaire ballast chamber (in 1/8” lettering) to read either “___V; Instant-Start; _.__ Ballast Factor” or “___V; Program-Start; _.__ Ballast Factor” (insert the voltage and ballast factor in each underlined space). As an example, label might read “120V; Program Start; 0.88 Ballast Factor.” Label is to be visible when luminaire cover is opened or, for indirect luminaires, when viewed from a ladder looking into the fixture.

C. LED drivers shall have the following characteristics (unless approved by Engineering Services):

1. Maximum drive current: 350mA.
2. Minimum Efficiency: 85%.
3. Operating Temperature Range: -40°C to 50°C.
4. Minimum Rated Life: 50,000 hours.
5. Dimming range: 100% to 10%
6. UL Class I or II output.
7. Power Factor: 90%.
8. Total Harmonic Distortion: 20%.
9. Comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
10. Consult Engineering Services as to acceptable manufacturers.

D. Specify an in-line disconnect to meet NEC. Further require that the lighting manufacturer provide a “wire nut” connection on the load side of the disconnect, to facilitate ballast replacement.

.04 Luminaires

A. All luminaires shall be UL or CSA/US approved and labeled.

B. Specifications and luminaire schedules shall include multiple manufacturers to provide competitive pricing, unless otherwise approved by Engineering Services.

C. Lens shall be 100% virgin acrylic injection molded prismatic diffusers meeting the ASTM specifications for methacrylite molding compounds D.788-69A. Minimum lens thickness shall be 0.125”.

D. Use of luminaire retrofit kits shall be evaluated based on present market pricing as compared to new luminaire installations. All luminaire retrofit applications shall be approved by Engineering Services.

E. Recommended common space luminaire deployments: The University attempts to minimize the deployment of varying fixture types in common spaces. The following list attempts to provide a recommended luminaire for deployment within building common spaces. Alternate fixture types required for aesthetics, installation methods, etc, shall be discussed and approved by Engineering Services. Final deployments shall consider spatial functions, spatial layouts and user requirements.

1. Corridors, hallways and vestibules: Volumetric LED (Lithonia 2VTL), or low-profile edge-lit flat panel LED (RAB EZPAN, LSI ELFP), or approved equal.
2. General office spaces: Volumetric LED (Lithonia 2VTL). Low-profile edge-lit flat panel LED (RAB EZPAN, LSI ELFP), or approved equal, may be considered for small

or private office spaces. Coordinate flat panel deployments with Engineering Services in all office space environments.

3. Storage spaces: LED wraparound (surface applications), (Eaton Metalux 4CWP series) or edge-lit flat panel LED (RAB EZPAN, LSI ELFP), in suspended ceiling applications.
4. Mechanical and Electrical utility spaces: LED vaportight (Eaton Metalux 4VT2 series).

F. All other spaces shall attempt to utilize the common space luminaire types listed as best possible. Spaces may be designed for increased aesthetic values and may utilize varying styles of luminaires. These luminaires and systems will be evaluated and approved on a fixture-by-fixture basis for operational and maintenance limitations as well as access and installation requirements.

G. In mechanical rooms, storage rooms, and other unfinished areas consider LED fixtures designed for the application.

H. Classrooms

1. For ceilings up to 10 feet, use high quality lensed "volumetric" recessed LED luminaires. Fixtures shall incorporate 0-10v, 10% dimming LED drivers. Common space luminaires described above shall be considered where performance criteria provide required illumination levels.
2. In certain applications, utilize high quality pendant mount indirect/direct LED lighting (with fully separate indirect and direct components) for large lecture halls, as long as luminaires don't interfere with sight-lines and ceiling-mount projection equipment.
3. Refer to the Classroom & Technology Design and Construction minimum requirements for additional information.

I. Consider high quality pendant mount indirect/direct LED lighting for laboratories. Provide dimming ~~2-level switching~~ and occupancy sensing. Incorporate daylight harvesting as appropriate.

J. ~~Use volumetric LED lighting for most office and common space lighting deployments, Review all other deployment types with Engineering Services.~~

K. HID luminaires shall not be used indoors.

.05 Installation

A. When approved, recessed 2x2 luminaires shall be installed such that they are aligned in the same relative orientation from one fixture to the next. Confirm the use of this luminaire type with Engineering Services prior to specification.

B. Cleaning: All luminaires shall be thoroughly cleaned and clear from dust, paint, construction debris and fingerprints after all other trades are complete, but prior to the date of substantial completion.

.06 Commissioning

A. Require that the lighting control elements be properly set and tested for optimal operation. Commissioning agent shall provide a report for the following systems (edit as required for the project):

1. Daylight harvesting
2. Occupancy sensors
3. Interface of BAS for CCS dusk/dawn signals. Also review the settings of the BAS CT's and run tests to confirm when CCS is signaled due to loss of multiple lamps/ballasts
4. Dimming Systems
5. Emergency relays (similar to Bodine GTD)
6. Networked and non-networked digital lighting control systems including all control system function, scheduling event, and networking operational parameters.

Commissioning will not be considered complete until the University provides assigned IP addresses for the networked system and communication is proven successful.

B. Engineering Services shall be invited to attend these sessions. Provide at least 7 days notice prior to any session.

.07 As-Built Documentation

A. Require that the Luminaire Schedule be emended on the as-built documents to reflect the actual products installed.
B. Require that an Excel spreadsheet of the as-built Luminaire Schedule is provided to PSU that includes the information above, including warranty information of lamps, ballasts, LED modules, LED drivers and contact information regarding each luminaire and/or component.
C. Require that all digital lighting control systems devices be located and labeled to reflect actual products installed and final locations.

.08 Spare Parts

~~A.~~ Discuss with Engineering Services what spare parts to require in the specifications. The University will typically decline any and all spare parts stocking unless otherwise directed by Engineering Services for special fixture or deployment types. ~~Typically require the following;~~

1. ~~10% of each lamp type, minimum of five (5).~~
2. ~~10% of each ballast or driver, minimum of five (5).~~
3. ~~5% of each LED module type, minumum of two (2) of each. On projects with a large number of a single type, limit the number of spare parts as they will become outdated quickly.~~
4. ~~10% of replacement lenses and globes, minimum of three (3) of each. Note specifically to which luminaire types this applies and reference the spare parts in the luminaire schedule. If decorative bowls are large, confirm with the end user whether they have space to store these materials.~~

26 52 00 EMERGENCY LIGHTING

.01 General

A. Each building shall be equipped with an egress lighting system as required by the Pennsylvania Department of Labor and Industry or other applicable code(s).
B. Provide emergency lighting along the path of egress, including the exterior of a building and ending at a public way (or as approved by Engineering Services).
C. All egress lighting (which includes stairwell lights, exit lights, selected corridor lights), fire extinguisher identification lights, and elevator cab lights shall operate twenty-four (24) hours a day and shall be connected to the ~~Life Safety panel~~ panelboard as defined in NFPA70, article 700, for life-safety . There may be some deviation from this depending on the type emergency lighting installed and the amount of daylight available in any given space. UL924 transfer devices are permitted to be deployed for select egress paths, classrooms, and other identified spaces and will be evaluated for off control based on the deployment by Engineering Services. Luminaires may also be dimmed in lieu of off where installed as part of a central system with programming capabilities.
D. Battery type emergency lighting is not allowed without prior approval from Engineering Services. Battery type emergency lighting should be provided in all interior building spaces housing the life-safety/stand-by power source (generator), or inside an exterior walk-in enclosure where deployed. Inverter based systems shall not permit dimming control output where inverter systems are approved for use by Engineering Services.

E. Stairwells, lobbies, hallways and entrances shall have ample lighting to allow for night cleaning. Wall mounted ADA compliant fixtures with integral occupancy sensors and dimming drivers shall be provided for step-dim operation. Utilize the Lamar Lighting "VOL" LED series, Lumax "CODLED", or equal luminaire.
F. Do not use of lamps with end-of-life protection (compact fluorescent and T5) in Normal/emergency or emergency lighting applications. Ballasts for these lamps have "end of life" circuitry that can turn off lamps in certain power fluctuation conditions and leave the building without egress lighting until fixtures are de-energized and re-energized. Specify these ballasts to have automatic re-strike capability.
G. Illuminate the corridor-side elevator landing sills to 10 fc maintained (minimum). Do not switch any luminare required for this purpose.
H. All lighting in the building main Electrical Room housing the main switchgear/switchboard lineup shall be connected to a normal/emergency source. Luminaries in this space shall be switched with select luminaries unswitched, operating 24x7. Coordinate layout and switching with Engineering Services.

26 53 00 EXIT SIGNS

.01 General

A. Exit lights shall be green LED and have stencil face with green letters. In small renovation projects, red LED may be used to match existing signs.
B. Flush mount types are desirable because they are more vandal-proof. Consider vandal-resistant models for dormitory design.
C. Self-contained exit signs powered by a radioactive source (tritium or similar) are not acceptable.
D. Equipment shall be UL or CSA/US approved and labeled.

END of revision

Update Commentary:

Section was updated primarily for the following reasons:

1) *An update to the University's lighting standards throughout division 26; to accomplish needed change and revision.*