May 7, 2013

Electrical Design Standards – Bulletin #1

The following revisions are made to the Electrical Design Standards issued on July 12, 2010 and are effective immediately. They will be incorporated into the Standard at its next general re-issue.

The Project Manager must consult with the appropriate operating division of Facilities & Services Department before giving approval for any deviations from this Standard.

Replace Sections 16510, 16510.1, 16510.2, 16510.3, and 16510.4.1 to read:

16500 LIGHTING AND LIGHTING CONTROLS

PART 1: GENERAL

1.01 RELATED SECTIONS

1.02 (NB – These Sections to be announced. This 16500 can be read independently for lighting designs)

1.03 INTENT AND BACKGROUND

A. The University of Toronto (UofT) has committed to continuous and on-going energy use reductions and resource use efficiencies for all operations. These efficiencies are to be realized through standardized product specifications, integrated designs based on life cycle costing and best value for the U of T.

B. The intent of this section is to establish U of T's guidelines for the design, specification, installation, and operation of interior/exterior lighting and lighting control systems.

C. This section will provide guidance to establish a degree of lighting solution consistency and standardization across campus. Fluorescent lights shall be T8-32W with instant or programmed start ballasts and suitable for the ambient temperatures and on/off cycles. For exterior lights, LED lamps and fixtures shall be preferred.

D. U of T requires systems that produce a comfortable, cost effective, efficient and safe illuminated environment. U of T also requires lighting control systems that are designed to be robust, reliable, maintainable, and easily operated. Finally, all life cycle cost assessments are to be considered for lighting systems, lamps, fixtures and lighting control systems.

E. Any proposed deviations from this standard must be submitted in writing to U of T project manager(s) for approvals.

1.04 DESIGN CONSIDERATIONS

A. ENERGY CODE

1. Designs shall meet lighting power densities requirements, levels and performance criteria established in the following reference standards:

a. Ontario Building Code (OBC-2012)
b. ANSI/ASHRAE/IESNA - 90.1 – 2010 Edition
c. ANSI/ASHRAE/USGBC/IES 189.1 – 2009 Edition
d. International Dark Sky Association – IDA/IES Model Lighting Ordinance
e. Canadian Underwriters Laboratories
*f. Energy Star (www.*oee.nrcan.gc.ca)
g. Consortium for Energy Efficiency (www.cee1.org)
h. Design Lights Consortium (www.designlights.org)
i. Ontario Power Authority – saveONenergy Program Criteria (2012) (www.saveonenergy.ca)

2. Prepare a life cycle cost assessment for lighting solutions that presents the costs to operate and replace lamps over 10 year cycle min.

3. Certification: All lamps and fixtures shall be CSA, UL-Canada, or equivalent with recognized certificate marks in OESC; all fluorescent and compact lamps shall be Energy Star/Design Lighting Consortium listed, all ballasts shall be Energy Star/Consortium for Energy Efficiency listed.

4. LED technologies listed with Energy Star/DLC tested to IESNA LM-80-08.

5. All lamps shall be certified as required to meet applicable energy conservation Incentive program(s).

B. ILLUMINATION LEVELS

1. Unless otherwise indicated in this document, illumination levels shall conform to recommended minimum values identified by the current edition of the Illuminating Engineering Society of North America (IESNA) Lighting Handbook.

2. Lighting designer shall also refer to the guidelines of IESNA Recommended Practice RP-3, Lighting for Educational Facilities, 2010 Edition.

3. Exterior lighting levels will be based on IESNA/IDA lighting zone 2 (LZ2) hardscape criteria, refer to IESNA TM-15.

4. If task illumination levels as defined in the IESNA Lighting Handbook are not sufficient based on site specific application, ambient and task lighting

levels may be adjusted to a higher level with concurrence of University of Toronto Facilities & Services. Ambient light level should not be less than one-third the task light level.

5. In small areas, such as restrooms or portions of egress areas, where a single luminaire is installed, specify a long life two-lamp fixture with instant start ballast so that the failure of one lamp will not leave the area in darkness.

6. Designer is to ensure that applications where dimming, daylight harvesting, high end trim, level scheduling or similar strategies are to be implemented can be achieved with selected lamps and ballasts.

C. LIGHTING EFFICIENCIES

1. Light loss factors

   a. Ballast factors should not be less than 0.88.
   b. The product of lamp lumen depreciation (LLD) and luminaire dirt depreciation (LDD) should not be greater than 0.65.
   c. ballasts shall be parallel wired for multiple lamp fixtures to ensure at least one lamp stays on with single lamp failure.

2. Ensure operating temperatures for energy-saving lamps are suitable according to manufacturer's guidelines and warranties.

3. All incandescent lighting is banned.

4. All fluorescent ballasts must be high power factor, energy-efficient, multiple-input types, CEE-Qualifying High Performance or Reduced-Wattage Ballasts, instant start or programmed start. Rapid start not accepted.

5. Where occupancy controls are used with fluorescent lamps, programmed start ballasts are to be used; where fluorescent lamps are on > 8 hrs/day, instant start ballasts are to be used.

6. Ballasts shall not interfere with infrared devices and be inaudible in a 27dBA ambient.

7. T8 long life Fluorescent lamps are base design and to meet the current CEE High Performance criteria and listed. Standard High-performance lamps shall be: 32W, T8, Med Bi-pin, ≥2,700 initial lumens, ≥ 60,000 hour life at 3 hours per start with programmed start ballasts, ≥ 90% lumen maintenance, CCT 3500-3700 K^0, ≥ 80 CRI.

8. When T5 based solutions are pre-approved, ballasts will have end of life shut down circuitry, actively preventing overheating in linear fluorescent applications.

9. All non-LED fixtures will use initial luminaire lumens after efficiencies have been considered. If the fixture efficiency is not shown, 70% will be assumed.

10. All interior lighting solutions shall allow for strategies including high end

trim from 50% - 100%, occupancy/vacancy, daylight harvesting, personal dimming with compatible ballast/lamp combinations.

11. All switches shall be specification grade, rated, 20A, when used to control ballasted lamp fixtures.

12. See section 2.05 for Acceptable Manufacturers

D. LIGHT EMITTING DIODE (LED) LIGHTING SYSTEMS

1. Solid state lights (SSL) or LED, are the base lighting design solution for exterior applications. Follow IDA/IES darksky standards for LZ 2.

2. Fixtures such as pots, keyless lamp holders where lamps are on for > 8hrs/day will compare LED with fluorescent using LCC analysis.

3. Equivalent LED lamp replacement for all applications, including CFL units, shall be based on initial luminaire lumens, assumes 70% fixture efficiency for non-LED fixtures.

4. All LED fixtures shall be cUL or CSA certified, be covered by a tier one factory supported min. 3 year parts warranty. Where applicable, wet location rated fixtures to be used.

5. Lamps will use chip on board (COB) version chip technology in lamps and or/SMD for fixtures. Chip model and manufacturer to be submitted with every proposal/quote.

6. Colour temperatures to be 3700 – 4100 ^{0}K for interior applications and 5000 – 6000 ^{0}K for exterior applications.

7. For ceiling applications ≥2400 lumens; for flood wall, ≥2800 lumens; for entrance wall ≥700 lumens. Minimum luminous flux is 120 lm at 85^{0}C.

8. Fixtures/lamps to be rated using LM-80-08 rating for > 35,000 hours on retrofit applications and > 50,000 hours for fixtures.

9. Exterior applications to have factory integrated photovoltaic light level sensor and control.

10. Flood light applications are to have >35^0 beam angle.

11. LED lamps will be base specified instead of halogen lamps. Retrofit pot fixtures to be Edison base LED preferred, > 50,000 hour life using LM-80-08 rating , CRI > 80, rated for wet and damp locations.

12. All LED lamps will include heat dissipation features to allow normal operation and design life in fixtures being specified.

13. See Section 2.05 for Acceptable Manufacturers.

E. LEED CERTIFICATION

1. Lighting and lighting control equipment shall be evaluated and suitable for contribution to LEED certification points.

2. Designer shall define and describe the applicable LEED point eligibility with the design.

F. INTERFACE

1. If used, Lighting Control System shall be capable of communicating to and have the ability to interface with and be controlled by the facility Building Automation Control System (BACS).

2. Lighting systems will communicate to the BACS using native BACnet IP protocol, and, therefore, not require a gateway or translator. It will communicate through the Facilities & Services Ethernet LAN to the enterprise management system.

3. Daylighting will be considered during fixture layout to ensure fixture dimming or shutting off within 5 m of perimeter outside windows when suitable light levels are present.

4. Office zoning shall allow for on/off/dimming and daylighting (where appropriate daylight levels available) controls individually.

1.05 TOTAL LIFE CYCLE COST OF OWNERSHIP

A. The lighting system design shall consider solutions that offer the lowest total life cycle cost of ownership.

B. The designer/engineer of record shall collaborate with all associated manufacturer's to provide total cost of ownership information (life cycle cost analysis) for proposed lighting systems to U of T Facilities & Services. The designer shall prepare an energy density evaluation of the lighting systems.

C. Inductively coupled fluorescent systems may be considered for area where maintenance costs could be a factor.

D. Where possible, luminaire height should be kept to a minimum to allow lamp replacement from an 8 foot ladder.

E All fixtures will be compared using initial luminaire lumens taking into consideration fixture efficiency. If luminaire efficiency is not shown, 70% will be assumed.

1.06 DOCUMENTATION

A. Designers shall submit the following information to U of T as required by contract documents. Coordinate the submission to allow for review and comment prior to the release of construction documents.

1. Luminaire, lamp, sensors and controls specification sheets.

2. Lighting calculations for all types of spaces, including foot-candle levels and watts per square foot (lighting power density) and energy density (kWh/gross floor area) based on a specified projected operation.

3. A point-to-point photometric layout shall be submitted for each typical space. Layout shall depict average, maximum and minimum illumination values in the horizontal work plane at 30 inches above finished floor level.

4. Additional information may be required to depict day lighting contribution and the impact to illumination values.

B. Reflected ceiling plans, specifications (lamp, ballast, & luminaire), calculations, renderings, and lighting control basis of design are to be provided for approval by Project Management.

C. A training plan including lighting design parameters, daylighting consideration, dark sky consideration, O&M criteria and controls operation is to be provided and its implementation is to be coordinated with U of T Project Management. Operation and Maintenance (O&M) manuals to be provided at the time training is conducted.

D. At the conclusion of the project, as-built documentation shall be submitted to reflect the final installed condition, including records of field settings.

E. The lighting controls manufacturer shall commission and certify in writing that the installed system meets all performance criteria.

F. Documentation required to complete any active incentive programs shall be provided with the design.

PART 2: PRODUCT REQUIREMENTS

2.01 SYSTEM DESCRIPTION/PERFORMANCE

A. Lamps and luminaires shall be selected for high efficiency, initial luminaire lumens including fixture efficiencies, application based illumination, low energy, and best value life cycle cost.

B. Lighting systems shall be designed to achieve the required levels of illumination while minimizing energy consumption. Illumination levels are measured in maintained horizontal foot-candles on a working surface located 0.75 m above floor level, within a tolerance of plus or minus 20 percent in non-work areas, in accordance with the current edition of the IESNA Lighting Handbook for average maintained lumens. Target levels to be < 1 W/sq.ft. for interior applications.

C. Fixture performance at design is to use initial luminaire lumens including efficiency. If efficiency is not specified, 70% will be used for non-LED luminaires.

D. Ballasts are to be remote-mounted only when considerations such as noise, temperature, radio-frequency interference, and electromagnetic fields are critical.

E. Fluorescent fixtures in areas where subjected to physical damage will use acrylic lenses or other approved protection.

F. High intensity discharge (HID) lamps are rarely appropriate for indoor use due to their low CRI, high energy usage and rated life expectancy. Efficient LED, high bay fluorescent (HBF) fixtures, induction lamps shall be base design consideration where HID would be considered.

G. Do not provide luminaires with fuses or receptacle outlets.

2.02 LIGHTING CONTROL REQUIREMENTS

The table below contains the control strategies that shall be considered for both retrofit and new construction work.

Space	Occupancy/ Vacancy	Daylight Harvesting	Scene Based Dimming	Personal Control	Central Control
Auditorium	A	B	A	A	B
Residence Bedroom	A	B		A	
Classroom	A	B	A	A	B
Conference Rooms	A	B	A	A	B
Corridors*	A	B			B
Dining Halls	A	B	B	B	B
Gymnasiums	A	B	A	A	B
Kitchens	B				
Laboratories	A	B			
Lecture Halls	A	B	A	A	B
Libraries	A	B	B		
Lobbies	A	B	B		B
Locker Rooms	A	B			B
Lounges	A	B	B	B	
Mechanical/Electrical Rooms	B			A	
Music Rooms	A	B		A	B
Open Office	A	B		B	B
Private Offices	A	B		A	B
Stairways*	A	B			
Storage Areas	A				
Toilets*/Common/General areas	A	B			
Waiting Areas	A	B			
Workshops				A	
Toilets-residence/private/handicap	A | B |				

KEY: *Where not in conflict with applicable codes. Consider partial shut-down strategies.
A - Required for this space B – Optional for this space

2.03 LIGHTING CONTROL SYSTEM CONSIDERATIONS

A. OCCUPANCY/VACANCY SENSORS

1. Vacancy (manual on) sensors should be considered where nuisance activations could be an issue. All offices shall include occupancy controls.

2. Timeout options should have a range from 1 minute to 30 minutes.

3. Dual technology ultrasonic and passive infrared (PIR) devices are preferred.

4 If equipped with an integral photo sensor for daylight harvesting, this feature should have the capability to be disabled.

B. DAYLIGHT HARVESTING

1. Shall be considered for control of lighting in areas adjacent to exterior facades and in areas containing skylights. Shall be compatible with on/off and dimming strategies. Refer to ANSI/ASHRAE/IESNA 90.1/189.1 – 2009.
2. One exterior daylight sensor per facade is the required minimum. Designer to layout perimeter circuits to allow for daylighting control. Daylight control is to be capable of switching and continuous dimming of multiple zones.
3. All controls (daylight sensors, occupancy sensors, wall stations) shall be capable of connection directly to the ballast or LED driver for ease of installation. Upon loss of control signal, ballasts/drivers shall default to full on state.
4. Automated shading must be approved by the project manager before consideration.

C. PERSONAL CONTROL

1. Shall be provided to allow the user of the space to directly control the lighting in the space and include dimming. Where daylight harvesting is possible, personal control shall include daylight/dimming strategies.
2. Low voltage controls shall be compatible with 0 – 10 V program start ballasts.

D. SWITCHING SYSTEMS

1. Shall be utilized for areas where dimming is not appropriate. Centralized panels and distributed switching modules shall be rated for 1,000,000 electrical operations.
2. Switching Systems shall be capable of astronomic time clock and occupancy control.
3. Pin based Time clock systems are not allowed.

E. TOTAL BUILDING LIGHTING CONTROL

1. Digital lighting management (DLM) shall be considered in all new construction and renovation projects.
2. DLM shall be an intelligent, distributed control system that automatically maximizes lighting energy efficiency that includes room controllers,

occupancy sensors, switches, daylighting sensors, lighting control panels, interfaces and accessories to provide energy saving strategies.

3. DLM can be provided as a dedicated system, incorporated into the BAS or the design shall provide the specifications and sequences to use an existing or planned BAS technology.

4. DLM shall be capable of interfacing seamlessly with the F & S Ethernet LAN based enterprise management system for control, monitoring, and reporting using native BACnet IP protocol.

5. Shall continue to operate independently if communications with the BAS is lost. DLM shall be compatible with ballasts and lamps.

6. Shall provide the following capabilities to the BAS/BACnet IP system:

   a. Graphical display of energy consumption.
   b. Change sensor settings, set parameters for sensors, dimming, daylighting
   c. Switch or dim individual loads
   d. Activate scheduled pre-set scenes
   e. Deliver occupancy status information directly to the BAS.
   f. Implement a dynamic load shed.
   g. Provide status of all components of the system.
   h. Implement after hours mode for set point change in occupied and unoccupied states.

2.04 MANUFACTURER SUPPORT AND COMMISSIONING

A. All lighting control equipment shall be integrated and commissioned to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.

B. When occupant sensors, time switches, programmable schedule controls, or photo sensors are installed, at a minimum, the following shall be confirmed:

1. Placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance.

2. Time switches and programmable schedule controls are properly programmed.

3. Photo sensor controls reduce electric light levels.

4. Dimming levels are operating as programmed.

C. DLM control system supplier shall conduct, commission and certify the functional testing. Provide commissioning report, including all field settings.

D. DLM control system supplier shall provide technical support during normal business hours, maximum 24 hour turn around.

E. DLM control system supplier shall offer a commissioning service and service contract for the system being installed.

2.05 ACCEPTABLE MANUFACTURERS

Based on campus wide experience and in the interests of consistency for lamps and fixture types, the following technologies are pre-approved and must be used as base for any supplier designs, new and retrofit/renovation. Alternates must be approved by Facilities & Services before use.

A. Interior Spaces Fluorescent Lamps: OsramSylvania Octron series XB 800(Base spec), GE Ecolux, Philips Advantage, Lutron; warrantied for three (3) years min.

B. Exterior and Interior LED lamps: Chip on board: CREE(Base spec), Sharp, Citizen or Bridgelux; warrantied for 5 years or longer

C. Fluorescent: OsramSylvania (Base spec), GE, Philips, Cooper, Core Products, Standard Products

D. Ballasts: OSRAM/Sylvania Quicktronic (Base spec), GE Ultrastart, Philips Optanium; Lutron; warrantied for 5 years

E. Control systems: Lutron Electronics, WattStopper, Encellium, GE, Douglas.

2.06 QUALITY CONTROL

A. After the lamps have been in service for approximately 100 hours, obtain foot-candle measurements during periods of darkness at a sufficient number of locations to demonstrate that the design criteria has been met. Submit the results to the University of Toronto Project Manager.

B. For noise, electrical or wireless sensitive applications, verify that ballasts noise/electrical/wireless specifications meet F & S specifications.

C. Acceptable suppliers are to be used as base design and signed off by authorized project managers. Alternates will be screened by the U of T project management before being allowed to supply.

D. Lamp, ballast and fixture manufacturers/suppliers will be dedicated and experienced lighting solution providers. Preference will be given to Tier One companies with local lighting solutions market presence > 5 years.

E. Must meet or cUL. CSA certifications, suitable and rated for the application, meet or exceed the University of Toronto Design Standards and be approved by the Project Manager.

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