

Basis of Design

This section applies to the design and installation of lighting systems.

Design Criteria

- Select interior lighting to achieve initial system efficiencies greater than 64 lumens per watt. Efficiency can be calculated as follows:
 - 1) Determine the initial lumen output (Initial lamp lumens X ballast factor X luminaire efficiency) for the luminaires.
 - 2) Determine the input watts for each luminaire type.
 - 3) Then calculate the system efficiencies for the different spaces lighted by the various lamp/luminaire types in lumen output per watt.
- Do not rely on prescriptive measures to meet the Seattle Energy Code.
- The lighting design shall maximize the use of recessed and direct/indirect 2' x 4' luminaires using linear fluorescent fixtures T8 or T5. T8 and T5 lamps shall be 20,000+hr rated life for at least 90% of all lighting. In special cases where architectural aesthetics is desired and cannot be achieved by linear fluorescent lighting, compact fluorescent fixtures may be considered. The use of compact fluorescents shall be kept to a minimum and coordinated with UW Campus Engineering. Compact fluorescents, when used, shall have "end-of-life" protection.
- Consider utilizing suspended luminaires as part of an integrated ceiling system design only. If pendant fixtures are used, ensure proper coordination with projector locations and screens in classrooms.
- Use of custom or special order fixtures shall be prohibited, unless approved by UW Campus Engineering in writing.
- Use of incandescent and mercury vapor lamps are prohibited, unless approved by UW Campus Engineering in writing for special cases.
- Do not use fluorescent lamps over 48 inches, T12, U-Bend, or circline lamps, and lamps less than 13 watts (except for auditorium pathway and step lighting). Avoid the use of 1 lamp and 4 lamp T8 ballasts.
 - 1) Fluorescent lamps greater than 12 watts must be 80+CRI, separable from ballast, and rapid start.
 - 2) Typical lamps should be 3500K.
 - 3) In food service areas, any lamp may be 3000K and compact fluorescent lamps may be 2700K.
 - 4) Use amalgam lamps where compact fluorescent is used in cold or widely variable temperature locations.
- Design for prescribed light levels that use realistic maintenance factors based on products actually used.
 - 1) For example, the UW-approved F32T8/835 lamps produce an initial 2950 lumens and have a lumen depreciation of 5%, while the more commonly used F32/T735 lamps produce an initial 2850 lumens and have a lumen depreciation factor of 12%. There is an 8% difference in maintained lumens between the two lamp types.

- 2) T8 luminaires will probably not be cleaned until lamps are replaced at 24,000 to 30,000 hours.
- When making light level calculations, use a ballast factor of .87 for normal output T8 ballasts, 1.18 for high output ballast, and 1.0 for compact fluorescent ballast.
 - For radio frequency-sensitive areas such as laboratory and medical center procedure areas, use ballast meeting FCC CFR 47 Part 18 class B requirements and/or provide luminaires with sufficient RFI shielding, including shielded lenses and high integrity ground bonding.
 - Ballasts for lamps shall be normal and high output. Do not use low output T8 ballasts. Avoid the use of 1 lamp and 4 lamp T8 ballasts.
 - Instant start ballasts are not acceptable unless required by special conditions and approved by UW Campus Engineering.
 - Coordinate selection of surface finishes with the architect so as to control brightness ratios, glare, and contrast, while using surface finishes with maximum reflection factors and minimum deterioration.
 - Coordinate with the architect so the lighting system can be maintained. Access to the luminaires must be considered in design.
 - Access to all lighting equipment must not put personnel at risk and shall not require that personnel bring equipment such as ladders or manlifts unless approved by University plan review.
 - Lenses, ballasts, fuses, and all other fixture components shall be available for purchase as individual replacement components for maintenance and repair. Fixtures that require an entire unit to be purchased to replace defective parts are not acceptable.

Average Maintained Foot-candles at Work Surfaces

- 70 Laboratories, drafting rooms
- 50 Paperwork-intensive offices, shops, kitchens, library study areas, etc.
- 35-42 Classrooms, lecture rooms, classroom auditoriums, computer-oriented offices and general-purpose computer work stations/labs. Consider two-level switching (50/17fc.) for mixed computers and paperwork.
- 30 Non-classroom auditoriums, conference rooms
- 20 Restrooms, mechanical and electrical rooms, locker rooms, etc.
- 10 Special computer labs: Consider two-level switching (30/10fc.) for mixed uses.

Minimum Maintained Foot-candle:

- 15 Corridors, passageways and stairways adjacent to spaces with more than 50 foot-candles
- 10 Corridors, passageways, stairways, storerooms, etc.
- 2.5 Covered parking garages
- 1 Open parking
- 1 Roadway (use IES recommendation to suit security level)
- 0.5 Walkways (use IES recommendation to suit security level)

Specific Application Requirements

- Due to maintenance difficulties uplights and bollards shall not be used for landscape lighting unless approved by Campus Engineering and the UW Landscape Committee.
- Roadway, pathway and Site lighting: Streets, parking lots, sidewalks, and pathways will generally be illuminated with pole mounted HPS luminaires.
 - 1) In general, pathway lighting in the UW Seattle campus shall match the performance and appearance of the Archetype series AR/SAR by KIM lighting. Other types of light fixtures to be considered shall be reviewed and approved by the UW Landscape Committee.
 - 2) Exterior Lighting systems in the UW Seattle campus may have to integrate with the "Cascade" lighting system employed in the campus. Coordinate integration requirements with Campus Engineering.
 - 3) Lighting equipped with "cut-off" features to prevent horizontal and vertical light pollution. There shall be zero light above 90 degrees horizontal. In campus perimeters prevent light pollution from affecting neighboring communities. Fixture types near bodies of water such as lake Washington, Portage Bay, etc, shall prevent light from reflecting on the water affecting neighboring communities.
 - 4) Protect all street and walkway luminaires with waterproof in-line fuse holders located in each pole base.
 - 5) The fuse shall be on the line side of the ballast.
 - 6) Fixture shall be available in type II, type III, type IV, and type V, square distributions and shall be interchangeable.
 - 7) Reflectors shall be field rotatable in 90 degree increments, to allow design flexibility in producing very high illumination levels for special applications or for maintaining a consistent fixture orientation throughout the site. Reflector shall be labeled to show the orientation of the light pattern, and can be field adjusted.
 - 8) Relamping shall be quickly accomplished without tools. The entire electrical module shall snap out without tools, and includes quick-disconnect plugs on all wiring. It shall allow for a spare module to be quickly inserted to eliminate downtime, while the old module is repaired and stored for future use.
 - 9) The lens frame shall be removable without tools, providing easy lens replacement in the event that breakage occurs. For safety during relamping, the door frame shall be prevented from lifting out of its hinges when hanging in the normal down position.
 - 10) Fixtures shall have poles that match existing poles used on campus. Get manufacturer and model number from UW Campus Engineering.
 - 11) Fixtures shall fit or shall be completely adaptable to existing poles utilized on campus.
- Classroom lighting:
(Information maintained by Classroom Support Services.)
 - 1) Educational and classroom spaces at the University require use of audio-visual teaching aids.
 - 2) General classroom lighting should provide 35-42 foot candles at the seat level. Lighting provided for rooms with sloped or tiered floors must take into account the

floor slope to provide consistent foot candles of light across the entire seating area of the classroom.

- 3) Classroom lighting must have a full range of brightness, from a comfortable reading level to notetaking in a darkened room. Lighting controls within classrooms will be integrated into the UW's approved equipment and room control system.
 - 4) Provide dimmable low level lighting from 2 to 8 fc. at desk tops, for note taking while viewing projected images. Provide switching for 60% of all luminaires including all perimeter luminaires. Provide dimming for the remaining note-taking luminaires. Dimming shall be accomplished with F32T8/835 lamps and ballasts designed to dim to a 10% ballast factor.
 - 5) In some cases, notetaking light levels may be obtained with selected switching of lamp fixtures rather than true dimming. CSS staff must review and approve the proposed notetaking lighting system for instructional rooms.
 - 6) Notetaking light fixtures shall be located only over the seating area. Note-taking luminaires should provide sharp cutoff optics to minimize illumination of walls and projection screen.
 - 7) Switching to permit operation of the general lighting system by the instructor, speaker and/or projectionist. Low voltage relay control is recommended.
 - 8) An instructor's spot light should be provided in "C" and "E" level rooms that will allow the instructor to be seen by students during multimedia presentations or other times when the room is darkened. The spot light should be separately switched via a manual switch and the equipment and room control system. Special care must be given to prevent light from spilling onto the projection screen.
 - 9) Provide Independent switching for chalk/marker board and podium lighting as needed.
 - 10) Permanent broadcast lighting shall be provided in Distance Learning/Broadcast classrooms (Level "E"). Required location, controls, type of fixtures, foot candles, and color temperature shall be determined in cooperation with CSS and C&C/UWTV.
 - 11) General lighting should be in or close to the ceiling. Pendant luminaires tend to interfere with the viewing of projection screens and pendant-mounted video monitors.
 - 12) Mount luminaires so lamps are parallel to the front wall.
 - 13) Refer to Section 18A, Classroom Support Services for additional information
 - 14) Classrooms may use Owner-provided lighting systems. Provide wireways and wiring necessary for Owner-provided lighting and control systems.
- Sports and non-classroom auditoriums:
 - 1) Fluorescent lighting may be used for most applications.
 - 2) Metal halide and other high efficiency lamps may be used for sports and coliseum facilities.
 - 3) Alternate phasing of HID lamps to reduce flicker effect and to ensure that sufficient instant-start light sources are utilized to avoid total darkness immediately following a momentary power outage
 - 4) Fluorescent light fixtures are preferred to low wattage HID lamps.

- Library lighting: Maintain a minimum of 50 foot-candles at all study and work surfaces and 15 foot-candles on the vertical surface of a book on the bottom shelf of each stack. Lighting design must be closely related to fixed furniture placement. Study carrels and stacks divide the area into cubicles and aisles. Normal on-center stack spacing is 4' 6".
- Corridor, entrance lobby, and public area lighting: Break the circuiting into different categories:
 - 1) "Y" circuits: Luminaires located in (non-daylighted) interior areas requiring operation whenever the building is in use
 - 2) "Z" circuits: Luminaires located in (daylighted) open stairways or exterior areas requiring operation during hours of darkness. "Z" circuits should incorporate daylight sensor control with manual override where practical.
 - 3) "Y" and "Z" circuits shall operate by mechanically-held relays or contactors wired for multiple control as follows:
 - 3.01 Local manual control on each floor (key type or to be located in janitor closets, permitting operation only by authorized personnel)
 - 3.02 Master manual, keyed control on main floor
 - 3.03 Master remote control from central supervisor control system
- Wet Laboratory Lighting: Provide egress lighting on emergency power near door inside wet laboratories.

Controls

- Multiple switching and split circuiting is preferred to single switching of higher light levels.
- Control all interior lighting with local switching. Do not use standard circuit breakers as light switches.
- Lighting control panels and relays for difficult access spaces such as vivariums, bio-hazard areas, operating rooms, patient rooms, and procedure rooms shall be readily accessible, preferably in hallway outside of space.
- When automatic controls are to be used, occupancy sensors are generally preferred to master lighting control systems to avoid maintaining time schedules.
 - 1) All lighting controls shall switch loads when output voltage is approximately 0.
 - 2) Occupancy sensors shall operate in series, with an ON/OFF switch having the look and feel of a typical light switch and mounted in a typical light switch location.
 - 3) Occupancy sensors shall fail ON.
 - 4) Occupancy sensors shall have time delay adjustments of 10 to 30 minutes before turning lights OFF. Choose delay settings to minimize ON time while limiting the number of starts to less than 12 per day. Provide a statement of occupancy sensor adjustments in the construction documents. When in doubt, use 10 minutes for meeting spaces such as classrooms and 30 minutes for other applications.
 - 5) Ensure that the most effective type of sensor is used for different applications. For example, infrared sensors are acceptable for single offices, ultrasonic detectors are more effective for partitioned office spaces, and dual-technology sensors may be necessary for large classrooms. Select the appropriate sensor that will prevent nuisance "on-off" activation of lights.

- 6) Location of occupancy sensors shall be coordinated with furniture layout, ceiling mounted fixtures and devices, and other features that may impede its operation.
- 7) Occupancy sensors shall employ wiring methods that will facilitate future relocation of the sensors. For example consider using MC cabling or open-wiring (low voltage) with added lengths that allows relocation anywhere within the space.
- Automatic controllers and time clocks shall maintain time and schedule through a 72-hour power failure.
- Lighting control panels and contactors shall be located away from occupied spaces and be accessible. Electrical spaces and corridor ceiling spaces are acceptable. Latching type relays will be used.
- Systems utilizing a carrier frequency for control shall not be used.
- Locate photocells in protected accessible areas.
- Conduit layout for control wiring shall allow for future changes to the operation of the light fixtures without having to install new conduit from lighting control panels. Conduit shall sized for spare capacity to install additional control wires. A “star” layout shall be used. “Daisy chaining” light fixtures shall be avoided.

Classroom Lighting Control:

(Information maintained by Classroom Support Services.)

- 1) Manual switching for room lights should be provided at every entrance to the room.
- 2) Minimum required manual classroom light switching in Level “A” rooms is as follows

Preset	Lighting
1	All On
2	½ On (i.e., one half of fixtures or half of all lamps off)

- 3) Minimum required manual classroom lighting switching in Level “C” and “E” rooms is as follows:

Preset	Lighting
1	All On
2	½ On (i.e., one half of fixtures or half of all lamps off)
3	Front Off; (i.e., fixtures in the front of ceiling projector switched off; fixtures in back of ceiling projector switch on)
4	Notelights On; dim up/dim down

- 4) In addition to manual switches, “C” and “E” level rooms should have complete lighting control via the equipment and room control system at the podium , wall, and/or remote handheld device.
- 5) Equipment and room control system should replicate manual switches and expand on functions to include separate switching of chalk/marker board lights; distance

learning/broadcast lights, podium/speaker spot light. The instructional rooms will have the UW standardized presets in all general use rooms to allow faculty to go from room to room and understand the system.

- 6) Duplicative lighting controls should be provided in the projection booth and control room that allows remote control of lights in the room.
- 7) Lighting control systems must be integrated into the building lighting system. Building lighting control systems should be specified to meet Facilities Services Design Guide requirements.
- 8) Low Voltage Control Cabinet
 - A) Provide relay cabinet GE RB-3 (minimum) with RT-1 transformer and RR-8 or RR-9 relays, or as required to support room control system
 - B) Provide relay controls for all circuits as listed below, or as specified to support the room control system:
 - (a) House lights (e.g., fluorescent, split ballast fixtures for 2 levels of general lighting over the seating area of the auditorium)
 - (b) Notetaking lights (e.g., incandescent downlight fixtures over the seating area, with motorized dimmer.
 - (c) Front lights (e.g., fluorescent over instructor area)
 - (d) Board lights (e.g., fluorescent over chalk/marker boards)
 - (e) Projection screen (e.g., 2 relays, 1 for up, 1 for down)
 - (f) Audio system (e.g., receptacle in audio cabinet)
 - (g) Booth Lights (e.g., fluorescent)
- 9) Provide one SPDT low-voltage momentary switch at each auditorium entrance door. Program entrance door switches to turn on only general fluorescent lights upon entering room but turn off all lighting upon leaving. This can be accomplished economically by using a diode matrix to selectively control standard GE RR-type relays.
- 10) Projection booth fluorescent light should be controlled by a low-voltage momentary switch at the booth entrance door.
- 11) Provide control stations at podium and projection booth for full control of all classroom functions (lights, projection screen, audio). If no podium is specified, provide a fixed control station in the instructor area.
- 12) Refer to Section 18A, Classroom Support Services for additional information.

Design Evaluation

The following information is required to evaluate the design.

- Schematic Design Phase: Zones with foot-candle levels are needed for the lighted spaces; provide information on: fixture types to be used, Energy Code requirements, lighting control designs being considered. Describe daylighting plan.
- Design Development Phase: Describe the use of daylighting, fixture layout and the switching schemes to be used in the different lighted spaces. Point-to-point light level calculations with the factors used in calculating the levels are needed at this stage to evaluate the efficacy of the design.
- Construction Design Phase: At this stage a description of all of the fixtures to be used must be provided with the schedules circuited with the lighting homeruns. Control diagrams are required for the different areas of the lighting design.

Submittals

- Luminaires, lamps and ballasts shall be submitted with all lighting control equipment to be used in the design.

Related Sections

- Facilities Services Design Guide – Electrical - General Requirements

Products, Material and Equipment

- Average luminaire efficiency shall be greater than 75% for the entire interior lighting system. Use white reflecting surfaces with a total reflectance greater than 88% and anodized aluminum reflecting surfaces with a total reflectance greater than 93%.
- Flat lenses shall be mounted in frames designed for replacement with lenses up to .38 inch thick.
 - 1) Clear plastic lenses shall be 0.125 inch minimum thickness virgin acrylic.
 - 2) Use pattern 12 lenses where a diffuse light source is desired.
 - 3) Pattern 15 lenses are preferred to minimize imaging on video monitors.
 - 4) Areas intended for exclusive computer use may require Holophane #8248 or high efficiency parabolic louvers.
 - 5) Sealed luminaires with Corning pattern 79 glass lenses are preferred in sterile areas.
- Fluorescent lamp sockets shall be selected for high frequency ballast use. Typically provide knife-edge lamp sockets. Provide Vossloh rotary lock sockets or similar easy-to-use positive locking sockets for lamps that can fall out of the luminaire if the socket connection fails (such as strip and industrial luminaires).
- Building entrance, landscape and courtyard lighting shall have automatic control. Use enclosed amalgamated compact fluorescent up to 42 watt and 70 watt or higher high

pressure sodium. Luminaires shall be heavy-duty cast non-ferrous metal construction designed to withstand anticipated weather conditions.

- All lighting luminaires including ballasts in fluorescent luminaires shall be equipped with disconnects. Disconnects shall be Sta-Kon disconnects by Thomas & Betts, Cat. No. LD-2, or equal.
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Fluorescent T8 Lamp Ballasts

- This specification uses the term “programmed start” to describe ballasts incorporating a starting sequence in which lamps are not started until the $R_p/R_c \geq 4.25$ and ≤ 6.25 .
- Transient Protection shall meet IEEE 587, Category A requirements.
- Socket voltage to luminaire ground or another socket shall not exceed the socket voltage rating under any operating condition.
- Power current flow to lamps shall alternate at greater than 42 kHz.
- Current Crest Factor shall be >1.35 and ≤ 1.5 for rapid start and programmed start ballasts and <1.7 for instant start ballasts.
- Ballast shall be UL listed, Class P.
- Ballast shall have a sound rating of A or better.
- Ballasts designated Normal Output shall be programmed-start and have a ballast factor of .85 to .93
- Ballasts designated High Output shall be rapid-start and have a ballast factor of 1.18 to 1.28.
- Ballasts designated Dimming shall be programmed-start and have a ballast factor range of $\leq .05$ to $\geq .90$.
- Ballasts designated Low Temperature shall be used where lamps sometimes start in temperatures below 50° F. Low Temperature ballasts shall start F32T8 lamps at 0° F, shall be normal or high output, shall have less than 20% THD and may be instant start.
- Compact fluorescent lamps shall have rapid-start ballasts.

Fluorescent T4/T5 Lamp Ballasts

- Ballasts shall be electronic rapid-start with a ballast factor of .95 to 1.05, a power factor greater than .95, and less than 15% total harmonic distortion.
- Ballasts shall have protection circuitry which turns off the lamp at the end of lamp life, or if an inappropriate lamp is installed, before damage occurs to lamps, socket, or ballast.

Illuminated Exit Signs

- Illuminated EXIT signs shall use Light Emitting Diodes (LEDs) or cold cathode T-1 lamps as the source of illumination.
 - 1) The housing and faceplate shall be white in color (other colors must be approved).
 - 2) Input power shall be less than 5 watts per face and operate on dual voltage 120/277 VAC.

- 3) EXIT signs shall comply with UL 924 and EPA EnergyStar Specifications at the end of 5 years of continual use.
- Letters shall be green, not less than 6 inches high, and strokes shall not be less than 0.75 inch wide. Luminance contrast shall be greater than 0.8.
 - 1) At the end of 5 years of continual use (when measured at 0 degrees and 45 degree viewing angles), average luminance shall be greater than 15 candelas/meter, minimum luminance shall be greater than 8.6 candelas/meter, and maximum-to-minimum luminance ratio shall be less than 20:1.
 - 2) Letter illumination shall appear even when viewed in a typical installation.
 - 3) The manufacturer shall replace all defective parts for 5 years from the date of purchase.

Installation, Fabrication and Construction

- Design louvers and lenses to open easily, hang open from the luminaire and be removed from the luminaire, all without the use of tools.
- Support pendant-mounted fluorescent fixtures with one hangar 6 to 18 inches from each end of the luminaire, with a minimum of one hangar, plus an additional one hangar per 8 feet of luminaire.

END OF DESIGN GUIDE SECTION