DESIGN GUIDELINE 265100
INTERIOR LIGHTING

Scope

This guideline defines the requirements and standards for design of new or renovated interior lighting systems. The guideline covers system design requirements, lighting system components and lighting controls.

Related Sections

U-M Design Guideline Sections:
3.1 DG - Sustainable Design and LEED Requirements
3.2 DG - Energy and Water Conservation
5.2 DG - Animal Facilities
5.6 DG - Parking Structures
6.3 DG 260526 - Grounding and Bonding for Electrical
6.3 DG 260533 - Electrical Materials and Methods
6.3 DG 260800 - Electrical Acceptance Tests
6.3 DG 265600 - Exterior Lighting

U-M Master Specification Sections:
7.3 MS 260500 - Common Work Results for Electrical
7.3 MS 265100 - Interior Lighting

U-M Standard Details:
260000 Series - Electrical Standard Details

Reference Documents:
- ASHRAE 90.1, "Energy Standard for Buildings Except Low-Rise Residential Buildings"
- IESNA, "Lighting Handbook"
- Michigan Elevator Code
- Michigan Building Code
- NFPA 101 - Life Safety Code
- USGBC, LEED Reference Guide for Green Building Design and Construction

Design Requirements

Use U-M Master Specification 265100 "Interior Lighting" as basis for design and specifying interior lighting on all projects. Use the appropriate U-M 260000 Series Standard Details. Edit the specification and details to make them project specific. When editing the specification, turn on hidden text and follow the Spec Editor notes.

Design light levels in accordance with the IES Lighting Handbook. Design for the full range of occupant ages, the tasks being performed and the associated need for contrast.

Show the target design footcandle (fc) levels for each space in Design Development review documents.

The project's interior lighting power allowance shall not exceed the interior lighting power allowances listed in ASHRAE 90.1. When required by Design Guideline 3.2, the project's interior lighting power allowances should contribute toward a building's total annual energy cost savings goal below ASHRAE 90.1 baseline building. Design documents shall include a tabulation of rooms with design lighting power densities (LPD) and associated ASHRAE allowable LPD's.

Where applicable during the Schematic Design phase identify LEED credits that will be pursued associated with the design of the lighting and lighting controls for the project.

Promote the use of skylights, clerestory windows, light shelves and other architectural features to channel non-glaring natural daylight into the building and minimize the use of electrical lighting.

Promote the use of light colored finishes on ceilings, walls, and floors to increase light reflectivity and reduce the need for artificial ambient light.

Minimum ambient lighting levels should be coupled with task lighting as needed. Promote the use of under-shelf and table lamp task lights on laboratory benches, office desks, study tables, and other work surfaces to further reduce the need for artificial ambient light.

Provide lighting calculations on a 2 foot by 2 foot grid to show normal power lighting levels and to demonstrate compliance with code requirements for egress and emergency lighting.

Normal Lighting:
Corridors and toilet rooms shall be designed for a lighting level of 10 fc average minimum, at floor level.

Design lighting so the ratio of light levels between adjacent spaces does not exceed 10:1.

Provide linear fluorescent and/or light emitting diode (LED) lighting for most applications. Avoid incandescent, HID and compact fluorescent lighting.

Provide vertical illumination across the full length and height of chalk and marker boards, library shelves, wall-mounted art, signage, and other vertical surfaces requiring illumination.

Consider indirect lighting to minimize glare. Avoid locating downlights above shiny floors and stairs where reflected glare may cause falls.

Locate fixtures, remote ballasts and/or remote LED drivers so they are accessible for maintenance by the use of a 10'-0 step ladder only, or provide fixtures equipped with a lowering device. Obtain Design Manager's approval before locating fixtures, remote ballasts, and/or remote LED drivers where a lift, scaffolding or bosun chair is required for maintenance.

Locate wall fixtures sufficiently below ceilings and provide cove fixtures with adequate access openings so lamps and ballasts can be replaced without removing fixtures or cutting coves. Coves with lighting shall comply with the maintenance accessibility requirements noted above.

Locate recessed mounted fixtures so their lenses can be removed and their components can be replaced without removing adjacent architectural, mechanical, or electrical equipment

Egress Lighting

Along the building-code-defined means of egress (including the exit discharge) provide a lighting level (at floor level) of 1 fc minimum at all times. Means of egress shall include designated aisles, corridors, passageways, stairs, ramps, escalators and landings leading from all occupied spaces to an exit or public way. Private offices and space within an individual's work cubicle need not be included in the means of egress (for lighting purposes), but aisles serving these spaces are. Because aisles could be relocated in open offices with movable furniture and/or furniture-based partitions, the above-noted minimum egress lighting level shall be provided throughout these open office spaces. Egress lighting for open office spaces with fixed partitions is only required along designated aisles.

Egress lighting fixtures required to satisfy minimum fc levels that also serve as emergency lighting shall be continuously illuminated or controlled by occupancy sensors (OS) via UL924 control units. Egress lighting shall not be controlled by manual switches. Lighting in stairways and for elevator landings may be partially controlled by OS but lighting levels shall not be reduced at any time below code-mandated minimum fc levels. Spaces that require egress lighting and incorporate dimming controls shall be designed to prevent reduction of lighting levels below required minimum egress lighting levels or include an interface with the fire alarm system for lighting control similar to requirements for an assembly occupancy.

Egress lighting systems in buildings or portions of buildings under State Bureau of Fire Safety jurisdiction shall also comply with NFPA 101 requirements associated with utilizing OS for control, including interface with the fire alarm system (when fire alarm system is capable of controlling lights). Compliance with these NFPA requirements is applicable only for portions of the egress lighting system located within egress paths defined in NFPA 101.

Emergency Lighting:

Provide an emergency lighting level (at floor level) along the means of egress (including the exit discharge) of 1 fc average and 0.1 fc minimum. A maximum-to-minimum illumination uniformity ratio of 40 to 1 shall not be exceeded.

Connect an appropriate number of lighting fixtures to generator-backed emergency lighting circuits whenever generator emergency power is available. If generator emergency power is not available, provide emergency lighting battery pack units.

- Do not locate emergency lighting battery pack units outdoors or in unheated spaces.
- In finished spaces, backing up normal lighting fixtures with battery pack units is preferred to providing sealed beam LED wall pack emergency lighting units.

- Emergency battery pack units shall not contain audible alarms.
- Battery-inverter systems for single room applications may be used with Design Manager's approval. Central battery-inverter systems shall not be used.

Provide sealed beam LED wall pack emergency lighting units in the following rooms even when generator-backed emergency lighting is provided:

- Unit substation and emergency generator rooms.
- Elevator machine rooms, elevator control rooms, and on Machine-Room-Less (MRL) elevator machines.
- Mechanical rooms containing boilers, chillers, fans, pumps or compressors.

Lighting in Elevator-Related Spaces:
Provide elevator space lighting in accordance with the Michigan Elevator Code. Strict compliance is mandatory to obtain an elevator permit.

- Elevator lobbies: 10 fc minimum at elevator door sills at floor level with the elevator doors closed.
- Elevator machine rooms and control rooms: 19 fc minimum at floor level everywhere.
- Spaces containing elevator machinery (MRL elevator machines, remote sheaves, etc.): 19 fc minimum on the equipment.
- Elevator pits: 10 fc minimum at floor level everywhere.
- When the elevators are capable of operating on generator standby power, connect all elevator space lighting to generator emergency power.
- When the elevators are not capable of operating on generator standby power, connect elevator space lighting to generator emergency power anyway if emergency power is available. If generator emergency power is not available, provide 1 fc average and 0.1 fc minimum of battery-backed emergency lighting in elevator spaces.
- Several U-M departments (typically - Healthcare, Housing, Engineering, Parking) require and will pay separately for vertical-mounted, metal guarded, fluorescent strip lights the full height of each elevator shaft. Coordinate with the Design Manager to determine if elevator shaft lighting is required. If required, control the shaft lighting from 3 locations including the machine or control room, the top landing and the elevator pit.

Control Systems:
Designs for control systems shall be represented on project specific drawings. Proposed locations of all system equipment, components and devices shall be shown. A submission package for lighting control systems that consist of manufacturers cut sheets alone is not acceptable. Include wiring diagrams, sequence of operation and programming instructions at Design Development phase.

Lighting System Components

Lighting Fixtures:
Lighting fixtures shall be listed and labeled by Underwriters Laboratories (UL) or other approved Nationally Recognized Testing Laboratory (NRTL). Provide fixture types known to have been used with success elsewhere. Do not specify newly developed or unproven fixtures.

Specify manufacturers listed in the Electrical Preferred Manufacturers List (PML). When necessary to meet special architectural or photometric requirements, request Design Manager approval before specifying fixtures from other manufacturers. Demonstrate to the Design Manager that the proposed fixtures are available from a local supplier known by U-M for good quality products and service. Demonstrate that replacement parts are readily available.

To obtain competitive pricing, specify a minimum of three manufacturers for each fixture type. To reduce pricing, specify fixtures from local suppliers who can package multiple fixture types. After the Design Development phase, the lighting designer shall send a copy of the lighting fixture schedule to each of the lighting representatives listed in the Electrical PML Section 265100 to request comments and recommended equivalents. The lighting designer shall evaluate the proposed recommendations to ensure design compliance and then incorporate equivalents into the lighting fixture schedule. The proposed lighting equivalents shall meet or exceed the design requirements as well as any other requirements in the U of M Design Guidelines. Refer to Electrical PML for local supplier information.

Provide lighting fixtures rated for operation at 277 volts wherever possible. Fixtures rated for operation at 120 volts may be required for Housing facilities, renovation projects, track lighting and for specialty applications.

Lighting fixtures in Housing facilities shall be high abuse / impact resistant, especially in student rooms and corridors.

Specify top covers for pendant bowl and wall sconce fixtures to keep debris, dust and bugs out.

Lighting fixtures installed adjacent to, or in direct contact with, insulation shall be IC rated.

Lamps:
In general, linear fluorescent lamps shall be 4’ maximum, T8, with a color temperature of 3500 degrees K, Color Rendering Index (CRI) of 85 minimum and average rated life of 24,000 hours, minimum.

High output T5 fluorescent lamps matching the T8 lamps in color temperature and CRI may be used only when necessary to meet special fixture or photometric requirements. U-tube and normal output T5 fluorescent lamps shall not be used.

LED sources shall have a color temperature of 3500 degrees K, a CRI of 80 minimum, and a lumen maintenance L70 rating of 50,000 hours minimum.

Halogen MR type lamps are prohibited. LED MR type lamps may be used.

Request Design Manager's approval before specifying lamp technologies other than those listed above. Demonstrate to the Design Manager that the proposed lamp technologies provide unique advantages to the project.

Ballasts and Drivers:
Ballasts for T8 and high output T5 fluorescent lamps shall be NEMA Premium Ballast (NPB) program compliant, electronic type, programmed start, series circuited, and rated

for a minimum start temperature of 0 degrees Fahrenheit. Ballasts shall be of the single, two, three, or four-lamp type as appropriate for the switching scheme, and shall only serve one fixture.

LED drivers shall be electronic-type, labeled as compliant with radio frequency interference (RFI) requirements of FCC Title 47 Part 15, and comply with NEMA SSL 1 "Electronic Drivers for LED Devices, Arrays, or Systems". LED drivers shall have a sound rating of "A", have a minimum efficiency of 85 percent, and be rated for a THD of less than 20 percent at all input voltages.

Dimmable ballasts/drivers with 0-10V controls are preferred. When separate control wiring is required clearly show this on the plan drawings. Route it in the same conduit as the power wiring when allowed by code and the manufacturer.

Ballasts and drivers shall be rated for the extremes of ambient temperature in which they are located. Specify ballasts and drivers rated for reliable starting to minus 20 degrees F for fixtures mounted in unheated spaces. Specify high ambient temperature ballasts and drivers for fixtures mounted indoors in direct sunlight or in high ambient temperature spaces.

Exit Signs:
Provide exit signs to meet code egress requirements, in rooms where code requires two or more exit doors, and in rooms designed for 50 occupants or more. In addition, provide exit signs in unit substation rooms, engine-generator rooms and large mechanical rooms.

Exit signs shall be on at all times and shall be LED illuminated. Radioactive, self-luminous and photoluminescent exit signs of any type shall not be used.

Exit signs shall have stencil faces, red letters and red directional arrows. Provide green letters and arrows only in buildings where existing exit signs have green faces.

Provide abuse resistant exit signs in University Housing facilities and parking structures.

Lighting Control Requirements

Design lighting controls with an understanding of the user's operational requirements and functional needs for the building and the spaces within it. Requirements of the controls shall be defined at the schematic design phase of the project. Basis of Design shall be updated with this information.

Lighting controls shall be a straightforward, cost effective means of reducing energy consumption and maintenance costs. The systems shall be placed, labeled, and configured to be 'user friendly' and intuitive.

Lighting controls for all building spaces shall comply with the applicable version of ASHRAE 90.1.

Sensors and any interfaced lighting control components shall fail to the 'ON' position so that lights are not disabled by a failed occupancy sensor or ancillary interface device.

Control each room and each block of open office space separately. Lights shall not be controlled from panel circuit breakers.

Do not provide proprietary control systems that inhibit competition and are difficult to maintain by the users.

Do not provide device-addressable lighting controls or a BACNet interface between the lighting controls and the HVAC controls at this time. These technologies are not sufficiently developed yet, and their additional installation, programming, and maintenance costs far exceed their energy cost savings.

Provide lighting control for the following typical spaces as noted below:

- Corridors and Lobbies – Occupancy sensors
- Offices, Workrooms, Breakrooms, Storage Rooms – Vacancy sensors.
- Open Offices – Dimming controls and vacancy sensors.
- Small Conference Rooms - Dimming controls and vacancy sensors.
- Small Classrooms - Dimming controls and vacancy sensors.
- Large Conference Rooms – Multi-zone controls with dimming and vacancy sensors.
- Large Classrooms – Multi-zone controls with dimming and vacancy sensors.
- Restrooms and Locker Rooms - Occupancy sensors.

Vacancy / Occupancy Sensors:
Specify vacancy / occupancy sensors in most rooms and spaces to control the lighting. Define proposed sensor types and technologies in Basis of Design.

Show sensor locations on the reflected ceiling or lighting plan drawings. Do not make the Contractor responsible for determining sensor locations. Follow manufacturer's spacing instructions to achieve total space coverage. Indicate the manufacturer's recommended separation from supply air diffusers and other building features which can affect proper sensor operation. Include interferences from furniture, partitions, soffits, ceiling height variations, etc.

Sensors may be passive infrared or dual technology (infrared/microphonic or infrared/ultrasonic). Infrared/microphonic sensors are preferred to infrared/ultrasonic OSs which are susceptible to nuisance activations from ventilation air currents.

- Supplemental power pack units shall be located above the ceiling (accessible) adjacent to the associated light switch/occupancy sensor location.
- Infrared/ultrasonic sensors shall operate at 40 kHz minimum to avoid interfering with hearing aids. See DG 5.2 for restrictions in animal facilities.
- Sensors shall operate without producing an audible clicking noise during switching.
- Sensors shall be powered by the lighting circuit. Battery powered sensors shall not be used.

Provide a schedule showing the required sensor settings for each area type. Include "manual on", "auto on", "auto off" and the "time delay" in seconds.

Provide manual switches in lieu of sensors in unit substation, electrical, mechanical and telecommunications rooms and in spaces where an unexpected shut-off of the lights could pose a safety risk.

Provide multi-contact sensors to control both the lighting and the ventilation.

- Use the lighting sensors to reduce the room ventilation, turn the ventilation off or widen the thermostat dead band during unoccupied periods.
- When an area has multiple ventilation zones, provide separate sensors for each ventilation zone to control both the lighting and the ventilation in that zone.

Location of occupancy sensors shall be coordinated with furniture layout, ceiling mounted fixtures and devices, and other features that may impede its operation.

Photocell Sensors:
Specify photocell sensors in areas where daylight harvesting is required per ASHRAE 90.1.

Depending on the area, in response to photocell daylight readings, lighting control schemes can consist of bulk switching, staged switching, or dimming. Areas where a particular illumination level is required, such as an office, should use dimming. Areas such as atriums, gyms or public spaces should consider bulk or staged switching.

In rooms with large windows, orient fixtures in rows parallel to the windows. Provide daylighting controls to switch off or dim the fixtures near windows when the incoming daylight is high.

Photocell sensors shall be equipped with adjustable cloud or shadowing delay and adjustable set point functions. Provide a schedule showing the required photocell settings for each area type.

Dimming Systems:
Dimming systems shall not be 'shared' among multiple rooms, unless those rooms are separated by a movable partition.

Whenever possible, install new systems to be similar in operation and function to other systems already in the building for easier understanding and operation by 'Users'.

In rooms with an A/V system, dimming system controls shall be interfaced with the A/V system User controls.

Master Automated Lighting Control System:
Prior to specifying a master lighting control system perform a cost-benefit analysis (at the schematic design phase) to justify this method and complexity of controls.

Lamp and Ballast Recycling

Lamps, ballasts and drivers being demolished or replaced shall be recycled in accordance with the University recycling policy contained in Specification 260500.