

INTERIOR LIGHTING

Scope

This Design Guideline applies to building interior lighting. Refer to Design Guidelines SBA-A and SBA-E for additional interior lighting requirements related to animal facilities and parking structures. Refer to Design Guideline 16521 for requirements related to outdoor lighting.

Related Sections

U-M Design Guideline Sections:

[SBA-A - Animal Facilities](#)

[SBA-E - Parking Structures](#)

[SID-D - Energy and Water Conservation](#)

[16521 - Outdoor Lighting](#)

[Electrical Trades Preferred Manufacturers List](#)

U-M Master Specification Sections:

[16010 - Basic Electrical Requirements](#)

[16511 - Interior Lighting](#)

U-M Standard Details:

[16500 Series - Electrical Standard Details](#)

Reference Documents:

ASHRAE 90.1-2007, "Energy Standard for Buildings Except Low-Rise Residential Buildings"

IES HB-10-2011, "Lighting Handbook"

State of Michigan Building Code

State of Michigan Elevator Code

General

Use U-M Master Specification 16511 "Interior Lighting" to specify interior lighting on all projects. Use the appropriate U-M 16500 Series Standard Details. Edit the specification and details to make them project specific. Turn on hidden text and follow the Spec Editor notes when editing the specification.

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

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

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.

Lighting Levels

Except when special codes (hospital, food service, NIH, etc.) take precedence, provide normal lighting levels as follows. Provide lighting calculations to demonstrate compliance.

- Design lighting levels in accordance with the IES Lighting Handbook. Consider the Occupants' ages, the tasks being performed and the associated need for contrast.
- Design lighting so the ratio of light levels between adjacent spaces does not exceed 10:1.
- Provide normal lighting levels at floor level along the means of egress (including the exit discharge) of 1 footcandle (fc) minimum.
- 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 SID-D, the project's interior lighting power allowances should contribute toward a building total annual energy cost savings at least 30 percent below an ASHRAE 90.1 baseline building.

Upon the loss of normal utility power, provide emergency lighting levels at floor level along the means of egress (including the exit discharge) of 1 fc average and 0.1 fc minimum.

- Provide lighting calculations on a 2 foot by 2 foot grid to demonstrate compliance.
- In a high rise building, ignore Michigan Building Code Paragraph 403.5.5 which requires luminous egress path markings. This code paragraph was published in error.

Lighting Levels in Elevator-Related Spaces

Provide elevator space lighting in accordance with the Michigan Elevator Code and as follows any time the elevator system has the ability to run:

- 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 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 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 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 on your project. If required, control the shaft lighting from 3 locations including the machine or control room, the top landing and the elevator pit.

Normal Lighting Requirements

Provide fluorescent lighting for most indoor applications.

- LED lighting may be used for emergency lighting, highlighting, aisle lighting and decorative lighting. It may be used for ambient lighting where energy savings justify its higher initial cost. Do not retrofit fluorescent fixtures with LED retrofit lamps.
- Metal halide and induction lighting may be used for high ceiling applications.
- Avoid incandescent lighting due to its low efficiency and short lamp life.
- Avoid fiber optic lighting due to its very low efficiency and very high maintenance.

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

Consider indirect lighting to minimize glare, especially in areas with computer monitors.

Avoid locating downlights above shiny floors and stairs where their reflected glare may cause falls.

Locate fixtures and remote ballasts so they are accessible for maintenance by the use of a ladder only, or provide fixtures equipped with a lowering device. Do not locate fixtures or remote ballasts where a lift or scaffolding 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.

Locate ceiling mounted fixtures so their lenses can be removed and their components can be replaced without removing adjacent mechanical or electrical equipment.

Emergency Lighting Requirements

Connect an appropriate number of normal 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.

- In finished spaces, feeding some of the normal lighting fixtures with concealed battery pack units is preferred to sealed beam wall pack emergency lighting units.
- Central battery-inverter systems are strongly discouraged and may be used only with Design Manager approval.

In addition, provide sealed beam 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 MRL elevator machines.
- Mechanical rooms containing boilers, chillers, fans, pumps or compressors.

Emergency lighting in auditoriums, lecture halls, large classrooms, video presentation spaces and laboratories may be capable of being switched off to permit total darkness, but shall be automatically switched on if normal power is lost.

Emergency lighting battery packs and sealed beam emergency lighting units should include self diagnostic and self exercising circuitry to exercise and test themselves for 5 minutes every month and for 30 minutes every 6 months. Provide units with LED status indicating lights visible to the public. Do not provide units containing audible alarms.

Whenever possible, specify remote emergency lighting battery packs rather than in-fixture battery packs so lamp heat does not degrade battery life and battery replacement is easier.

When providing HID lighting fixtures for normal lighting, specify quartz restrike lamps in some of the fixtures or provide some fluorescent fixtures for light immediately after a power outage.

Lighting Fixture Requirements

Except in Housing Facilities, provide lighting fixtures rated for operation at 277 volts wherever possible. Provide only 120 volt fixtures in Housing Facilities.

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

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 lighting fixtures from manufacturers 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, and demonstrate 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.

Specify top covers for pendant bowl and wall sconce fixtures to keep trash and bugs out.

Specify recessed fixtures whose components can be replaced through the fixture apertures unless the ceiling is accessible or a catwalk exists above the ceiling.

Recessed compact fluorescent fixtures should be specified without lenses.

Lamp Requirements

In general, linear fluorescent lamps shall be 4' maximum, T8, with a color temperature of 3500 degrees K and a Color Rendering Index (CRI) of 85 minimum. High output T5 fluorescent lamps matching the T-8 lamps in color temperature and CRI may be used instead when needed to meet special fixture size or photometric requirements. U-tube and normal output T5 fluorescent lamps shall not be used. See Master Specification 16511 for more requirements.

Compact fluorescent lamps shall have a color temperature of 3500 degrees K, a CRI of 80 minimum, and be suitable for use with electronic ballasts. Specify self-ballasted compact fluorescent lamps only for retrofitting existing incandescent fixtures on non-dimming circuits.

High Intensity Discharge (H.I.D.) lamps shall conform to the applicable ANSI codes.

Light Emitting Diode (LED) and induction lamps shall have a color temperature close to 3500 degrees K. LED lamps shall have their LEDs wired in parallel to prevent multiple LED failures.

Request Design Manager 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.

Lamps in a single room or area shall appear close in color temperature.

Lamps shall be of low mercury content and designed to pass the Federal Toxic Characteristic Leaching Procedure (TCLP) test for classification as non-hazardous waste.

Ballast and Driver Requirements

Ballasts for T8 and high output T5 fluorescent lamps shall be NEMA Premium or 90 percent efficient minimum, electronic type, programmed rapid start, parallel 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.

Ballasts for compact fluorescent lamps shall be 90 percent efficient minimum, electronic type, and shall have built-in End of Life (EOL) protection.

Ballasts for H.I.D. fixtures in finished spaces shall be electronic or shall be mounted remotely so ballast noise is not objectionable.

Drivers for LED and induction fixtures shall be electronic and shall not heat to a temperature exceeding 140 degrees F.

Avoid dimmable ballasts that require separate control wiring. If 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 temperatures spaces.

Exit Sign Requirements

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-generators 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 die cast aluminum or polycarbonate housings with universal mounting brackets, brushed aluminum stencil faces, red letters and red directional arrows.

- Provide green letters and arrows only in buildings where existing exit signs have green faces.
- Provide internal emergency battery packs and battery chargers when generator emergency power is not available.
- Provide abuse resistant exit signs in Housing facilities.

Lighting Control Requirements

Lighting controls shall be simple and intuitive to use, including for visitors unfamiliar with the space.

Provide clear, concise signage with ¼ inch high letters adjacent to controls for multiple scene lighting.

Lighting (including emergency lights) in auditoriums, lecture halls, large classrooms, large conference rooms and large research and teaching laboratories shall be capable of being shut off for video presentations. Provide controls to automatically turn on the emergency lights if normal power fails or if the fire alarm system actuates while the emergency lights are shut off.

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

Provide occupancy sensors in most rooms and spaces to control the normal lighting. Occupancy sensors are preferred to timeclocks because they generally save more energy than timeclocks.

- Occupancy sensors may be infrared, ultrasonic or dual technology (infrared combined with ultrasonic or microphonic). Ultrasonic and ultrasonic dual technology sensors shall operate at 40 kHz minimum to avoid hearing aid interference.
- Occupancy sensors shall be powered by the lighting circuit. Battery powered occupancy sensors shall not be used.
- Occupancy sensors in public spaces including corridors, auditoriums, lecture halls, classrooms, conference rooms, libraries, laboratories, toilet rooms and janitors closets shall be automatic "on" and automatic "off". In spaces with computer monitors and in spaces used for video presentations, provide a manual "off" override switch.
- Occupancy sensors in private spaces such as offices shall be manual "on" and automatic "off", and shall include a manual "off" override switch.
- Provide switches in lieu of occupancy sensors in unit substation, electrical, mechanical and telecommunications rooms. Provide switches in lieu of occupancy sensors in laboratories only if an unexpected shut-off of the lights could pose a safety risk.
- Provide multi-contact occupancy sensors to control both the lighting and the ventilation in classrooms, laboratories and offices when required as an Energy Conservation Measure (ECM) in accordance with Design Guideline SID-D.
 - Use the lighting occupancy 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 occupancy sensors for each ventilation zone to control both the lighting and the ventilation in that zone.
 - Wire the occupancy sensors ahead of the manual "off" override switches so the lights can be turned off but the ventilation will remain on while the space is occupied.
- 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 and programming costs far exceed their energy cost savings.
- Consider providing occupancy sensors with integral daylighting sensors to block turning on the lights when the incoming daylight is high.
- When Occupants request dual level switching to control 3 and 4 lamp fluorescent fixtures, provide 2 switches and switch the outside and inside lamps separately. Wire the occupancy sensor ahead of the switches so it controls both sets of lamps. As an alternative to dual switching, provide multi-lamp dimming.
- When occupancy sensors or timeclocks are used to turn off all lighting including the emergency lights during unoccupied hours, the entrance of any person or the actuation of the fire alarm system shall automatically turn emergency lights on.

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

Provide photocell controls to control fixtures in skylights or atrium ceilings to turn off the fixtures when the amount of incoming natural daylight is sufficiently high.

Lamp and Ballast Recycling

Fluorescent lamps and ballasts being demolished or replaced shall be recycled in accordance with the University recycling policy contained in Specification 16010.

Installation Requirements

Lighting fixtures, controls, accessories, conduits and wiring shall be installed, adjusted and tested in accordance with Specification 16511 and the other Division 1 specifications.