



Office Lighting Guidelines Best Practices for Efficiency

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UI and CL&P

Introduction

Commercial office buildings use about 25% of all the electricity consumed in the country for lighting. Advances in state-of-the-art lighting technology can significantly reduce energy use and costs while providing light levels and quality recommended by the Illuminating Engineering Society of North America. In order to ensure compliance with applicable energy codes, achieve typical lighting energy levels substantially less than the energy code allowance, and contribute to regional energy and demand management, the following guidelines for office lighting are strongly recommended. Note that projects adhering to these guidelines qualify for substantial benefits from utility incentive programs and through LEED and other certification programs and may offer significant tax deductions and energy cost savings.

Spaces Affected

These Guidelines are intended to be used by contractors, architects, engineers, and others responsible for designing, specifying and/or building new lighting systems, including new buildings, tenant fit-out, remodeling, and/or energy-upgrade initiatives.

In general, these Guidelines should be applied to the following spaces:

- Typical private offices
- Typical open office areas
- Office area corridors
- Conference rooms
- Building lobbies
- Elevator lobbies
- Building “core” and circulation areas

Facilities Less Affected

These Guidelines are not necessarily intended to address any of the following space types.

- Showrooms
- Food service spaces
- Video teleconference spaces
- Laboratories and other spaces with special requirements for lighting

However, the principles of cost effective, energy efficient design expressed by these Guidelines should be employed in these or other space types whenever possible.

Implicit Considerations

These Guidelines were developed in consideration of applicable codes and standards in the U.S., including the following:

- Standards of the Illuminating Engineering Society of North America, including IESNA/ANSI RP-1, American National Standard for Office Lighting. IESNA Standards apply in the USA, Canada and Mexico
- Standards of Underwriters Laboratories.

- State of Connecticut Energy Efficiency Standards, including ANSI /ASHRAE/ IESNA 90.1-2001 with all addenda.

Compliance Documentation

Designs shall be certified using COM-CHECK 3.4 or higher. For the Code to be used, select ASHRAE/IESNA 90.1-2004. If these guidelines are followed closely, the resulting designs should achieve approximately 25-35% better than 90.1-2004 and 40-50% better than 90.1-2001. NOTE: Achieving performance significantly better than these target values is very difficult and not recommended without design involving considerable expertise.

General Design Strategies

All designs must comply with applicable codes and ordinances. Note that in general, the following requirements will result in lighting designs that demand less power (watts per square foot floor area) than mandated by the energy code. The energy cost savings realized by this practice will often pay back the incremental cost for the more efficient system within 3 years. Additionally, in many cases the first cost of lighting may be less than traditional designs because these Guidelines optimize the amount and type of lighting equipment than can be used.

Design Approach

A complete, hardwired lighting system must be installed complying with the following lighting power density requirements:

- a. Private offices should not exceed an average power density of 0.80 watts per square foot.
- b. Open office areas shall not exceed an average power density of 0.70 watts per square foot for general lighting. Task lighting must be counted as described below.
- c. Conference rooms and similar spaces shall not exceed a connected power density of 1.0 watts per square foot.
- d. Core areas including elevator lobbies, mailrooms, lunchrooms, restrooms, copy rooms, locker rooms, and similar spaces shall not exceed a connected lighting power density of 0.6 watts per square foot.
- e. Hallways, corridors, storage rooms, mechanical and electrical rooms, and similar spaces shall not exceed a connected power density of 0.5 watts per square foot.
- f. Lobbies and Atriums should not exceed 1.0 watts per square foot. (Atriums are 0.6 watts per square foot for the first three floors and 0.2 watts per square foot thereafter).
- g. Any other space not listed shall not exceed a connected power density of 0.5 watts per square foot.

Additional lighting, such as lighting within furniture systems, may be installed in open office space. Because many projects are designed and constructed before the furniture systems are selected, accounting for task lighting is difficult. When provided, it should not exceed 0.25 w/sf, or alternately, the combination of general lighting and task lighting should not exceed 0.90 w/sf.

There are a few space types, such as video teleconferencing, showrooms, retail space, and food service space that usually require more lighting power than provided above. For these uncommon space types, an appropriate lighting power density requirement should be determined from ASHRAE/IESNA/ANSI 90.1-2004.

Table A – Summary of Allowed Lighting Power by Code and Guideline Criteria

Space Type	Energy Code Maximum 90.1- 2004* (w/sf)	Maximum Lighting Power to Achieve Guideline Criteria (w/sf)
a -Private Office	1.1	0.8
b – Open Office	1.1	0.7
c – Conference Room	1.3	1.0
d – Core Areas	0.8	0.6
e - Hallways	0.5	0.5
f – Lobbies	1.3	1.0
g – Other	Varies	0.5

** Note: 90.1-2004 is equivalent to 90.1-2001 with addenda g that is the energy requirement of the Connecticut Building Code*

Principal Lighting Systems

For most spaces, designers should employ lighting layouts that conform to the criteria presented in Table A. Spacing measurements are taken from the plan view center of the luminaire.

Luminaires should be mounted at least 1/3 of the indicated mounting distance away from any ceiling-high partition. If more than one type of luminaire (excluding exit signs) is to be located within one space enclosed with ceiling high partitions, the spacing between different luminaires must be the larger of the required spacings for the two luminaires in Table A.

In general, do NOT use incandescent lighting, halogen lighting, or track lighting systems or monopoints of any kind or voltage of operation.

Other Lighting Systems

In every building, there are a number of other lighting situations. Consult with Table B for suggestions for efficient solutions.

Special Allowance for Decorative and Accent Lighting

Energy codes permit decorative and accent lighting when using the space-by-space method, and provide an additional power allowance for them. Properly applied, these allowances can permit significant additional lighting power and still permit a project to meet the energy code and other targets such as a LEED criterion. However, for the purposes of this program, such additional power is not consistent with exceptional energy efficiency.

In order to permit architects, interior designers, and lighting designers the ability to add lighting for aesthetic effects or décor, this program has chosen to limit the use of this added energy to 0.1 watts per square foot for the entire building or the amount permitted by the code, whichever is less.

Controls

By code, each interior space enclosed by ceiling high partitions must have separate local switching and some form of automated-off control (occupancy sensing, time based scheduling, or other). In addition, wherever possible, provide separate switching for lights in daylighted zones.

In order to comply with code requirements and ensure maximum energy savings, specify the most appropriate lighting control option(s) as described below..

1. Ceiling mounted motion sensor with transformer/relay, auxiliary relay and series switch. The sensor should be located to look down upon the work area in order to detect small hand motion as well as major movements. The sensor may be mounted to the upper wall if a ceiling location is not workable. More than one sensor can be used for a large room or a room with obstructions, such as a library or server room. The main transformer relay should control the overhead lighting system (usually 277 volt) and the auxiliary relay should control at least one half of a receptacle to switch task lights and other applicably controlled plug loads. Note that the light switch is in series so that it can only turn lights off in an occupied room; it can not override the motion sensor's "off" control.
2. Similar to above, but without auxiliary relay and connection to receptacle. Must control at least two luminaires or banks of lighting groups and be equipped with two manual override (off) switches for either hi-low light level switching or alternate fixture switching. May also be used to control multiple dimmers or a multi-channel preset dimming controller.
3. Ceiling mounted motion sensors connected to programmable time controller. During programmed "on" times, the lights remain on. During programmed "off" times, motion within the space initiates lights on for a time out period. Controller shall be programmable according to day of the week and shall have an electronic calendar to permit programming holidays.
4. Workstation motion sensor connected to a plug strip or task light with auxiliary receptacle.
5. One or more ceiling mounted motion sensors with transformer/relay, minimum 2 luminaires controlled.
6. Switchbox motion sensor, one or more luminaires controlled.
7. Programmable time controller with manual override switch(es) located in a protected or concealed location. Separate zones for retail and similar applications where displays can be controlled separately from general lighting. May also control dimmers.
8. In addition to any of the above, an automatic daylighting sensor connected to dimming ballast(s) in each luminaire in the daylighted zone.

Lamps, Ballasts and Fixtures

General

Ballasts for all fluorescent lamps and for HID lamps rated 150 watts and less must be electronic. Harmonic distortion should be less than 20%,

T-8 System Ballasts

Because instant start ballasts are the most efficient and least costly, they should be used in all longer duty cycle applications where the lights are turned on and off infrequently. Fluorescent systems controlled by motion sensors in spaces where the lights will be turned on and off frequently should employ program start ballasts. Stepped level and dimming electronic ballasts may also be used.

Four-foot T-8 fluorescent lighting systems must employ “high efficiency” electronic ballasts. For more information about these ballasts, go to <http://www.cee1.org/com/com-lt/com-lt-specs.pdf>. For T-5, T5-HO and all other fluorescent and compact fluorescent lamps, standard electronic ballasts shall be used.

When doing the design, take full advantage of ballasts best matching the exact lighting need. Standard ballasts are designed to achieve normal light output (NLO) from the lamp, but there are also reduced light output (RLO) and high light output (HLO) ballasts. These ballasts seldom cost more, but allow better tuning of the lighting to the room. A good designer can use a combination of ballasts to reduce the number of lamps and/of fixtures on the project.

Table B – Light Output and Power for Efficient Instant Start T-8 Electronic Ballasts

Ballast Type	Ballast Factor	Watts per Lamp	Relative Power compared to NLO	Relative Lumens compared to NLO
Normal Light Output (NLO)	0.88	27	100%	100%
Reduced Light Output (RLO)	.78	24	89%	89%
High Light Output (HLO)	1.15	35	129%	130%

Metal Halide Ballasts

All metal halide ballasts for indoor use should be electronic. For outdoor use, use electronic ballasts for lamps 150 watts and less. Most can not be dimmed and there are not any different ballast factor versions.

Lamps

For general lighting, fluorescent lamps should be low mercury T-8, T-5, or T5-HO lamps. T-8 lamps in particular must be high performance T-8 lamps. A current list of efficient lamps and ballasts is available at www.cee1.org/com/com-lt/lamps-ballasts.xls.

Some of the lighting systems may also require the use of metal halide or compact fluorescent lamps. As a general rule, these lighting systems are less efficient than those using T-8 or T-5

linear lamps and should only be used where absolutely needed. Incandescent and halogen lighting should be avoided.

Application Notes

Open Offices

For general illumination in spaces with ceilings 9'6" or higher, suspended linear fluorescent indirect, direct/indirect or semi-indirect lighting systems should be considered. General layouts should be between 0.6 and 0.8 W/SF using high performance luminaires and high performance T-8, T-5 or T-5HO lamps.

For lower ceiling spaces, troffers are generally required. Modern high efficiency T-5 troffers are strongly recommended, although standard lens troffers optimized for T-8 lamps can also be used. Design for approx. 0.6 to 0.8 w/sf.

Private Offices

If the ceiling height is at least 9'6", suspended linear fluorescent lighting should be a consideration for private offices, although recessed troffers can also be used at any normal ceiling height. Luminaires should use T-8 or T-5 lamps as described for open offices. Lighting power density should be around 0.7-0.8 W/SF.

Executive Offices, Board and Conference Rooms

Executive offices can be designed similarly to private offices (above). If desired, a premium approach using compact fluorescent downlights, wallwashers, and/or sconces can be used, but the overall design should not exceed 1.0 W/SF. If the number of executive offices is high, lighting power levels should be reduced to match the recommendations for private offices, above. Board rooms are one of the locations where decorative lighting is typically used; there are a large number of compact fluorescent decorative chandeliers, sconces and pendants from which to choose.

Office Corridors

Corridors can be lighted a number of ways. The key is to limit the power of each luminaire to about 20-35 watts. Power density should be about 0.5-0.6 W/SF overall, so this means placing a luminaire every 40 to 70 square feet. Luminaires with too much power, e.g. troffers with 2 lamps, need to be spaced every 96-100 sf. Note that these luminaires may be equipped with emergency battery backup when needed as an alternative to less attractive "bug eye" type emergency lighting.

Other Applications

The following luminaire types are generally recommended for these areas:

- Artwork, bulletin/display surfaces, etc. using compact fluorescent wallwashers or track. Only use what's needed.

- Utility spaces, including cable and equipment rooms, using strip lights, industrials, or surface luminaires. Use low ballast factor ballasts in these spaces, and consider 8 foot fixtures with tandem 4' lamps to improve uniformity. Try to limit power to about 0.6-0.8 w/sf.
- Lobby spaces, cafeterias, and other public spaces as much as possible using appropriate selections. Compact fluorescent downlights with some decorative compact fluorescent lighting is a typically good choice.

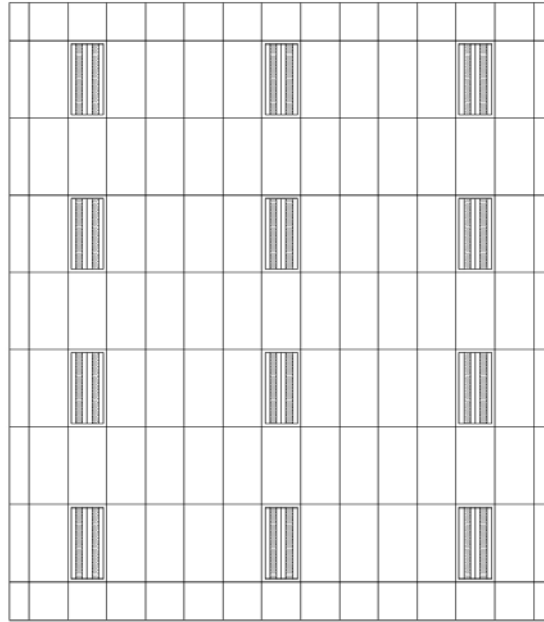
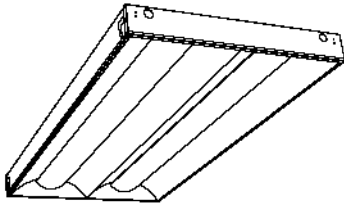
TABLE C –Principal Lighting Systems

<i>Primary Application</i>	<i>Luminaire Type</i>	<i>Lamps or total lamp watts</i>	<i>Spacing between luminaires in plan view (OC = on centers)</i>	<i>Lamp ballast system</i>
PATTERN 1 General use – spaces of all types (ceilings up to 12')	Nominal 4' recessed extra high efficiency fluorescent troffer	(2) F28T8 lamps	8' x 10' on centers	Two level electronic ballast with maximum of 1.0 ballast factor
PATTERN 2 General use – spaces of all types (ceilings up to 12')	Nominal 4' recessed low cost high efficiency fluorescent troffer	(2) F32T8 lamps	8' x 8' on centers	High efficiency T-8 electronic ballast with low ballast factor (48 watts)
Open offices	Suspended linear indirect fluorescent fixtures, consisting of nominal 4' sections in continuous rows with electronic ballast(s). Requires minimum 9'-6" ceiling	(1) F54T5HO per 4' section	Continuous rows no closer than 15' apart	Typically 60 input watts per 4' unit. Dimmable ballast may be used for daylighting control
General use – spaces with high ceilings (9'6" or greater)	Suspended linear direct/indirect fluorescent fixtures, consisting of nominal 4' sections alone or in continuous rows Requires minimum 9'-6" ceiling.	(1) or (2) F32T8 per 4' section. Note" single lamp luminaires permit better uniformity.	Single units or rows of 8', 12', 16' or longer.	Use ballast factor to manage lighting power. Dimmable ballast may be used for daylighting control.
Downlighting for lobbies and corridors	Recessed or semi-recessed compact fluorescent downlights	(1) CF26 or CF32 lamp	26 watt : 6' x 8' or at least 45 sf each 32 watt: 8' x 8' or at least 60 sf each	Check fixture efficiency carefully.

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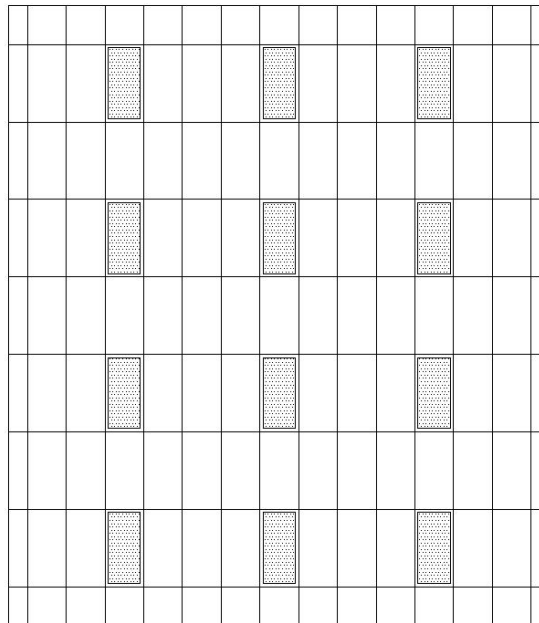
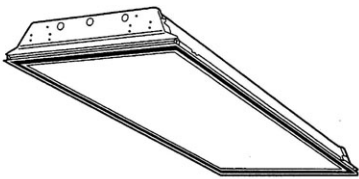


PATTERN 1
GENERAL LIGHTING
SUITABLE FOR MEDIUM
AND LARGE ROOMS

HIGH PERFORMANCE T5
LUMINAIRE WITH (2) T5
LAMPS AND 1.0 BALLAST
FACTOR BALLAST

66 FC INITIAL/59 FC MAINTAINED
IN AN EMPTY ROOM
AT 0.80 WATTS PER SQUARE FOOT

53 FC INITIAL/45 FC MAINTAINED
IN AN EMPTY ROOM
AT 0.65 WATTS PER SQUARE FOOT



PATTERN 2
GENERAL LIGHTING
SUITABLE FOR MEDIUM
AND LARGE ROOMS

HIGH PERFORMANCE T8
LUMINAIRE WITH (2) T8
LAMPS AND 0.78 (REDUCED)
BALLAST FACTOR BALLAST

59 FC INITIAL/52 FC MAINTAINED
IN AN EMPTY ROOM
AT 0.80 WATTS PER SQUARE FOOT

48 FC INITIAL/40 FC MAINTAINED
IN AN EMPTY ROOM
AT 0.65 WATTS PER SQUARE FOOT

TABLE D – Other Lighting Systems

Suggestions for Other Lighting Systems				
<i>Applications</i>	<i>Lighting Systems</i>	<i>Luminaire Watts</i>	<i>Spacing</i>	<i>Note</i>
Lobbies, atriums, etc.	Metal halide, induction, or multiple compact fluorescent lamp (of equivalent lamp watts with electronic ballasts) downlights, pendants, etc.	100 watts or less 150 watts or less 250 watts or less 400 watts or less	No less than 12' OC No less than 15' OC No less than 18' OC Not less than 22' OC	Mounting height at least 12' AFF; only recommended for high bay spaces.
Corridors, lobbies, meeting rooms, etc.	Compact fluorescent (including twin tube, quad tube, or triple tube) or metal halide downlights, wallwashers, monopoints and similar directional luminaires Wall sconces using any of the above light sources	40 watts or less 60 watts or less 80 watts or less 100 watts or less	No less than 6' OC No less than 8' OC Not less than 10' OC No less than 12' OC	Any space height
Undercabinet and undershelf task lighting	Hardwired undercabinet or undershelf fluorescent luminaires nom. 2', 3' or 4' in length and employing an electronic ballast	No greater than 8.5 watts per foot of luminaire	When mounted underneath permanent overhead cabinets.	Luminaires may be mounted end-to-end if needed to accommodate cabinet length. Use low ballast factor ballast.
Specific accent lighting for art and displays	Low-voltage downlights, accent lights or monopoint lights having an integral transformer	Rated at 37 watts or less	Very limited use	For accent lighting only – should not be used for general lighting
Toilet rooms	Over mirror: use wall or mirror mounted lights, preferably with a light colored soffit over the vanity to reflect light. Balance of space: use compact fluorescent downlights or T-8 wall slots or cove lights	Up to 35 watts per vanity; compact fluorescent downlights using 18 to 26 watt lamps.	One luminaire per vanity in a toilet or locker room; or one luminaire per landing in a stairwell.	Use low ballast factor ballasts on cove and slot lights. Troffers can be used but consider 1 lamp fixtures to permit better uniformity.