Common Space Lighting Guidelines

Best Practices for Efficiency

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Drafted by

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Commissioned by

UI and CL&P

Photo (left) courtesy Finelite (right) courtesy Lightolier

Introduction

Commercial buildings use about 50% 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 these guidelines generally provide substantial benefits from utility incentive programs and through LEED and other certification programs and may offer significant tax deductions and other benefits.

Facilities 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:

- Corridors
- Restrooms
- Lobbies
- Conference rooms
- Stairwells
- Support space workrooms
- Electrical and mechanical rooms

Facilities Less Affected

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

- Office areas
- Industrial and commercial manufacturing and assembly areas
- 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 and the IESNA Lighting Handbook, Ninth Edition. IESNA Standards apply in the USA, Canada and Mexico
- Standards of Underwriters Laboratories.
- Energy efficiency standards of the States of Connecticut, Massachusetts, and IESNA/ASHRAE/ANSI 90.1-2001.

General Design Requirements

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.

Lighting Systems

General Requirements

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

a. Conference and meeting rooms and similar spaces shall not exceed a connected power density of 1.0 watts per square foot.
b. Core areas including mailrooms, lunchrooms, restrooms, copy rooms, and similar spaces shall not exceed a connected lighting power density of 0.7 watts per square foot.
c. Mechanical and electrical rooms shall not exceed 1.2 w/sf
d. Hallways, corridors, storage rooms, locker rooms and similar spaces shall not exceed a connected power density of 0.6 watts per square foot.
e. Lobbies and Atriums should not exceed 1.0 watts per square foot.
f. Any other space not listed shall not exceed a connected power density of 0.5 watts per square foot.

Compliance Documentation

Designs shall be certified using COM-CHECK 3.1 release 1 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.

Special Allowance for Decorative and Accent Lighting

Energy codes permit decorative and accent lighting and usually provide an additional power allowance for them. Properly applied, these allowances can permit 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.

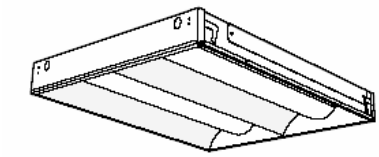
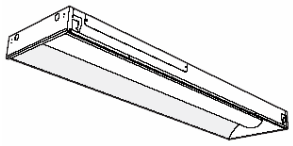
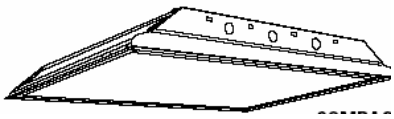
In order to permit architects, interior designers, and lighting designers the ability to add lighting for aesthetic effects or décor, this program has chosen to limit the use of this added energy to 0.5 watts per square foot or the amount permitted by the code, whichever is less for restrooms, lobbies, hallways and conference rooms only. The decorative lighting allowance can not be used for any other common space.

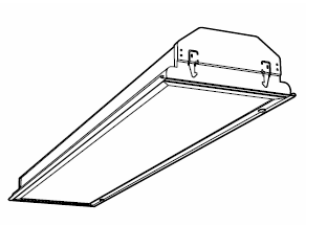
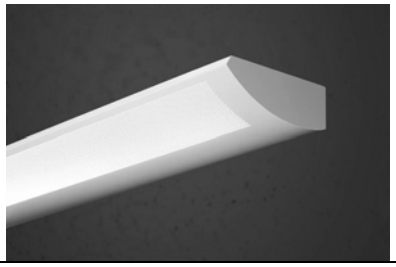
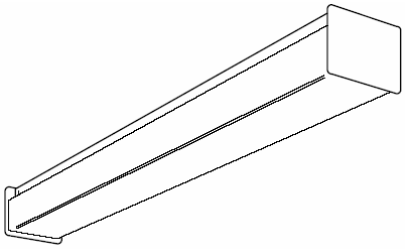
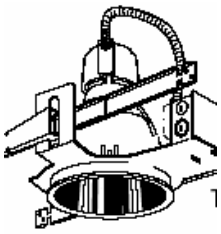
Typical Lighting Systems

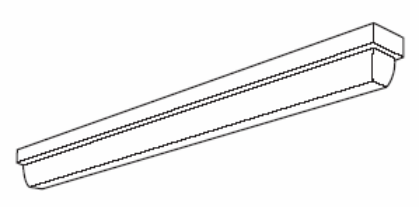
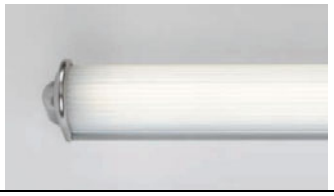
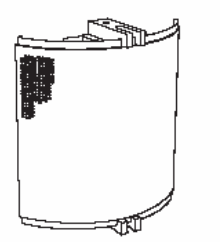
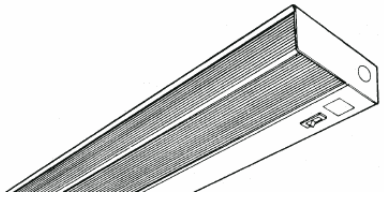
Most commercial buildings use conventional, generic lighting products. If chosen and used properly, in general these lighting products can be very efficient as well as cost effective. A good example is a 2' x 4' troffer with 2 or 3 T8 lamps. As described in the Office Lighting Guideline, by using high performance lamps and ballasts and proper layouts, these lighting systems can be extremely energy efficient.

However, too often these same luminaires are also used in hallways, lobbies and other areas. This is usually not a good idea. While office areas are often lighted to 30-50 footcandles, hallways are generally 10-15 footcandles and often less, and lobbies should be 20-30 footcandles. Using standard office lighting results in either overly bright hallways with too much energy use, or spotty lighting. In other words, different lighting systems are needed for many of these spaces.

Since these are finished spaces, it's generally not acceptable to use bare lamp fixtures. The trick is to find appealing and efficient fixtures with connected power in the range of 25-40 watts. There are about a dozen generic lighting system types that should be considered. As a general rule, pick luminaires that have at least 40% coefficient of utilization at 80/50/20 and RCR=7.

Lighting System	**Description**	**Applications Information**
Recessed Lighting Systems (grid and flanged)		
	2'x 2' high performance troffer with (2) F14T5 lamps and electronic ballast. Choice of instant start and program start ballasts.	Maximum energy efficiency with high efficiency instant start ballasts. Power ranges from 27 watts (ballast factor 0.90) to 34 watts (ballast factor ~1.10). Typically 10% more efficient than generic lens fixture.
	1'x 4' high performance troffer with (1) F28T5 lamp and electronic ballast. Choice of instant start and program start ballasts.	Power 33-34 watts at 1.05 ballast factor. About 10% more efficient than generic lens fixture.
	Generic lens 2'x 2' troffer with (2) F17T8 high performance lamps and electronic ballast. Choice of instant start and program start ballasts. High efficiency ballasts are available.	Use ballast factor to fine tune the application. Watts range from 27 watts (.80 ballast factor) to 43 watts (1.28 ballast factor). Maximum energy efficiency with high efficiency instant start ballasts.

	Generic lens 1'x 4' troffer with (1) F32T8 high performance lamps and electronic ballast. Choice of instant start or program start ballast. High efficiency ballasts are available.	Use ballast factor to fine tune the application. Watts range from 25 watts (.77 ballast factor) to 43 watts (1.37 ballast factor) with 1 lamp. Maximum energy efficiency with high efficiency instant start ballasts.
Surface Mounted Lighting Systems		
	Surface wall mounted indirect luminaire with single F32T8 lamp. Note: must have light colored walls (reflectance >60%) to meet the efficiency criterion of this section.	Must only be used in spaces with light colored walls and ceilings. Use ballast factor to fine tune the application. Watts range from 25 watts (.77 ballast factor) to 43 watts (1.37 ballast factor). Maximum energy efficiency with high efficiency instant start ballasts.
	Corridor wraparound with (1) F32T8 lamp and high efficiency electronic ballast. Choice of instant start and program start ballasts. High efficiency ballasts are available.	Use ballast factor to fine tune the application. Watts range from 25 watts (.77 ballast factor) to 43 watts (1.37 ballast factor). Maximum energy efficiency with high efficiency instant start ballasts. Use these lights in most electrical and mechanical rooms to prevent lamp breaking.
Better quality lighting systems, somewhat less efficient		
	Recessed downlight with (1) compact fluorescent 26 or 32 watt triple tube lamp. In some cases an 18 watt fixture may be acceptable.	Most of these fixtures permit the use of 26, 32 or 42 watt lamps. Be wary of using 42 watt lamps as spacing can become quite large. Use ballast factor carefully; for 26 watt lamps, ballasts range from 26 watts (BF~.95) to 29 watts (BF~1.10). For 32 watt lamps, ballasts are typically 36 watts at BF~1.0.
	Surface downlight with (1) compact fluorescent 26 or 32 watt triple tube lamp. In some cases an 18 watt fixture may be acceptable.	See above
	Semi recessed downlight with (1) compact fluorescent 26 or 32 watt triple tube lamp.	Most of these fixtures permit the use of 26, 32 or 42 watt lamps. Be wary of using 42 watt lamps as spacing can become quite large. Use ballast factor carefully; for 26 watt lamps, ballasts range from 26 watts (BF~.95) to 29 watts (BF~1.10).

Special Purpose Lighting (<0.40 CU at 80/50/10 RCR =7)		
	Surface mounted vandalism resistant luminaire with single F32T8 lamp. About 20% less efficient than normal duty fixtures.	Use ballast factor to fine tune the application. Watts range from 25 watts (.77 ballast factor) to 43 watts (1.37 ballast factor). Maximum energy efficiency with high efficiency instant start ballasts.
	Vanity light for toilet rooms. While many lamp types are possible, preference should be given to fixtures that use T-8 or T-5 lamps.	Limit the use of these fixtures to toilet and bath vanities. Be aware of the total fixture watts.
	Surface wall mounted sconce luminaire with 26 watt compact fluorescent lamp.	Sconces are generally not an efficient luminaire but provide a reasonable amount of useful light. Sconces with low wattage compact fluorescent lamps can be used in combination with downlights or other higher-efficiency fixtures to create an upscale appearance.
	Undercabinet mounted task light with single T8 lamp. Available in 2', 3' and 4' lengths. Similar results possible with F14T5, F21T5 and F28T5 lamps. Other lamps are less efficient.	Use ballast to optimize this installation. Use of a two level (50%) ballast, hard wired to 50% light, is generally recommended. In this mode, a 3' fixture is only 16 watts and a 4' fixture is only 19 watts. For a 2' fixture, use a reduced light output efficient ballast for 14 watts.

Ballasts

General

In general, high power factor, low harmonic ballasts should be used for all fluorescent lighting. Exceptions might be made for very low wattage lamps (<20 watts) as some of the more efficient ballasts have high harmonics and/or low power factor. As long as only a few are used, the impact will be minimal.

Ballast factor, on the other hand, is a ***variable***. Ballast factor simply describes how much of the rated light of the lamp is generated when the ballast is used. The efficiency stays about the same, so the power goes up as the ballast factor goes up. For example, ballasts for F32T8 lamps are typically rated as reduced light output (BF~.78, 24 watts per lamp), normal light output (BF~.88, 27 watts per lamp) or high light output (BF~1.15, 35 watts per lamp). A dimming ballast is technically a variable ballast factor ballast. With many of these lighting situations, often the secret of really low energy use it to employ a ballast with low ballast factor, or even to use of the stepped ballasts (0-30-70-100 or 0-50-100) hard-wired in the low light position. There are a lot of fluorescent applications where only 50% of the normal light is plenty.

Ballast starting type is another significant consideration. For compact fluorescent lamps, most modern electronic ballasts are *programmed start* (PS), which exhibits a short starting delay but permits may on/off cycles with minimum lamp life effects. For T-5 and T-8 lamps, you can choose between program start and instant start (IS), which are more efficient and start the lamp instantly, but will cause short lamp life with frequent switching. Most dimming ballasts are rapid start (RS), a less efficient method of operation necessary to allow lamps to dim. Two level ballasts are usually rapid start.

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 as discussed below. T-8 fluorescent lighting systems should employ "high efficiency" electronic ballasts.

Lamps

Designs should employ the following lamp types:

Generic Lamp Types	***Requirements***	***Suppliers and Product Families***
Four foot T-8 lamps* F32T8	TCLP compliant (low mercury) lamps with barrier coat and high lumen phosphor (minimum 3,100 initial lumens). Premium long life rated lamps.	Sylvania "XPS" Philips "Advantage" GE "HL"
Fluorescent T-8 lamps F17T8*, F25T8	TCLP compliant (low mercury) lamps with barrier coat and high lumen phosphor. Premium long life rated lamps. Minimum 1400 initial lumens for F17T8 and 2200 initial lumens for F25T8	Sylvania "XPS" Philips ALTO TL8xx" GE "SPX/ECO"
**In some cases, the use of low wattage T-8 lamps may be warranted. These lamps are less energy efficient than standard 32 watt high efficiency T-8 lamps, but in critical situations, they can be used to reduce power. Note that these lamps are not fully compatible with all T-8 ballasts and applications. Among other issues, they are not dimmable, and may take considerable time to warm up.*		
Fluorescent T-5 and T-5HO lamps F14T5, F21T5, and F28T5	Standard T-5 lamps.	Sylvania "Pentron" Philips "Silhouette" GE "T5"
Compact fluorescent 4-pin lamps CF13, CF18, CF26, and CF32,	Standard twin, quad, and triple tube lamps. Be sure to use the four pin lamps as they operate properly on electronic ballasts.	Sylvania Dulux Philips PL GE "Biax"

Application Notes

Hallways and Corridors

Note: Due to the high room cavity ratios of most corridors and similar narrow spaces, interior finishes are critical. White ceilings and light colored walls are especially important; use deep and saturated colors for accents only. Keep the floor reflectance as high as possible.

For general illumination, layouts should be between 0.45 and 0.55 W/SF. IESNA recommendations are at least 5 footcandles, so all of the following meet minimum criteria. For spaces with finished ceilings up to 10 feet, and assuming 80% ceiling reflectance, average wall reflectance (including doors) of 50%, and floor reflectance of 20%, some of the possible lighting systems and combinations include:

- With high performance luminaires and T-8 or T-5 lamps, light levels of 15-20 footcandles are possible.
- With standard fluorescent fixtures and T-8 lamps, light levels of 12-17 footcandles are possible.
- With compact fluorescent downlights, light levels of 10-15 footcandles can be expected.
- With a 50/50 mixture of compact fluorescent downlights and sconces, light levels of 5-10 footcandles will likely result.
- Indirect lighting can be used if the spaces are light colored and the ceiling is a flat surface. Under ideal conditions, light levels of 10-15 footcandles can occur, but generally expect levels of 5-10 footcandles.

In the photos at left, the results of several lighting systems are illustrated.

- In the top photo, a corridor is lighted with compact fluorescent downlights. The deep scallops of the downlight create strong patterns on the wall. The result is very dramatic. Care must be taken to keep downlights on equal spacing and if possible, to create a lighting pattern that is harmonious with the wall finish.
- In the center photo, uplights are used to provide soft illumination. The result is bright and even, but not dramatic. This approach requires a sufficiently regular pattern of wall space.
- In the bottom photo, a combination of sconces and downlights is used. This is a nice combination; this space would be less glaring if the wall and ceiling finishes were lighter.

Toilet Rooms

There are three areas to commercial toilet rooms; the entry including a vestibule (if there is one); the vanity area; and the toilet area. Men's rooms urinals are sometimes opposite the vanities, and sometimes opposite the stalls.

The most common lighting design in these spaces addresses each part separately:

- The entry is lighted by downlights or sconces. See the top photo at left. It is a good idea to place this lighting on a 24/7 emergency lighting circuit for safety and egress. All the rest of the lighting can be controlled by time or motion sensors.
- The vanity is lighted by some combination of overhead trough (top photo), sconces (top photo), and/or vanity lights (middle photo). Try to avoid downlights because of deep shadows on faces.
- The "wet wall" behind the toilets can be lighted by a continuous downlight slot, as in the bottom photo, by a continuous uplight. Be sure to use reduced light output ballasts in either of these techniques. Additional circulation lighting can also use downlights, but be wary of cumulative wattage. Remember, IESNA recommendations for the circulation area are only 5 footcandles. Don't feel compelled to over-light a toilet room circulation zone.

Design the toilet room for <0.8 watts per square foot, including the vestibule and entry. Also, it's acceptable to use up to 0.5 w/sf of decorative allowance for sconces (top photo) when used in conjunction with a regular lighting system. Nonetheless, low power is not easy; for example, in the middle photograph, each vanity light is 27 watts, so the total power of the three vanity lights – 81 watts – uses the lighting power allowance for over 100 square feet. Take full advantage of reduced power ballasts and even consider 13 and 18-watt compact fluorescent lamps in downlights and sconces.

Lobbies

Lobbies are expected to be dramatic and special. In addition to general lighting, decorative and accent lighting is often part of the design. The general lighting of the lobby can be performed at about 0.8 w/sf using downlights, a very common solution. The rest of the lighting involves a combination of decorative and accent lighting. In order to stay within the 0.5 w/sf decorative lighting allowance of these Guidelines, special lighting must also be efficient.

The following luminaire types are generally recommended for these areas:

- Wallwashers (photo, above). Compact fluorescent 26 or 32 watt lamps, or metal halide 20 or 39 watt lamps.
- Art accent lights, 20 watt halogen IR MR16 fixtures or 20 watt ceramic metal halide MR16 or T4.5 lamp fixtures.
- Sconces and chandeliers using 13, 18, and 24/27 watt twin tube and 13, 18, 26 and 32 watt compact fluorescent lamps.

Photo courtesy Lightolier

Even the most elaborate chandeliers are often available with compact fluorescent or HID sources. For example, in the photo at left, a chandelier using (4) 26 watt compact fluorescent lamps illuminates a large lobby area. While it may be tempting to use incandescent chandeliers with screw-in compact fluorescent lamps, energy code requirements make it necessary to seek out and use decorative lighting with permanently-installed ballasts and hardwired sockets for high efficacy sources.

To meet these guidelines, choose the appropriate wattage lamps and be careful how many fixtures are used. Because decorative luminaires are not often efficient, use a combination of general lighting and decorative lighting to meet both energy and lighting goals.

Control Recommendations

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.

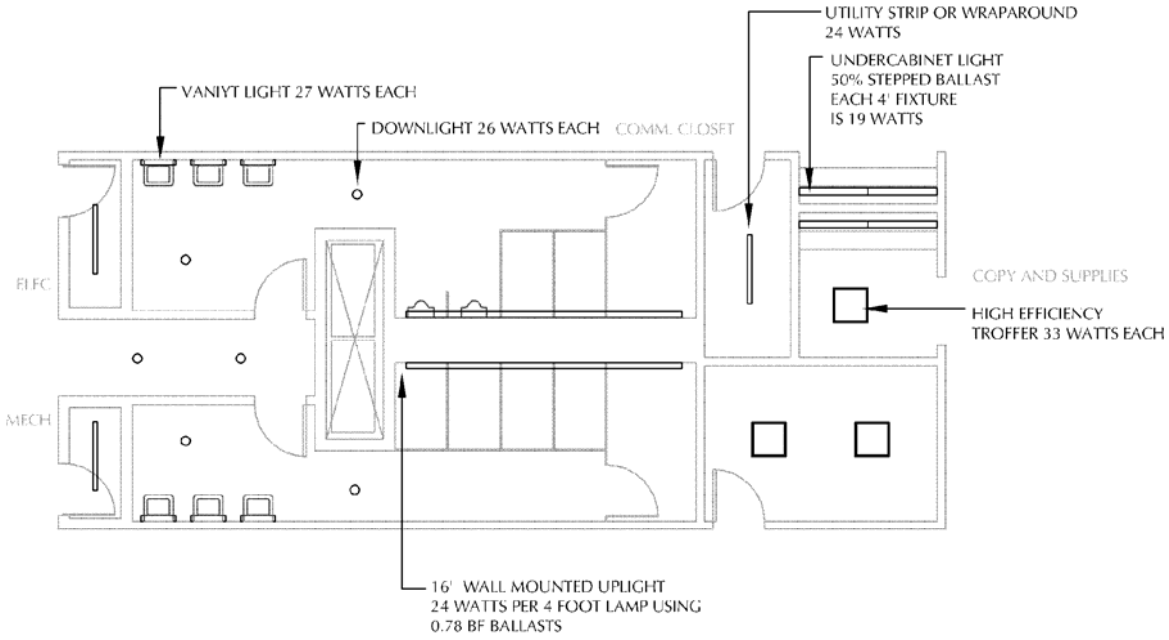
Most public spaces are best equipped with a combination of time-of-day programmable switching, backed up by motion sensor(s). Lights are energized for the normal operating time of the building, and for the rest of the time, lights are turned on briefly when needed. This minimizes cycling problems of just using motion sensors, and corresponds well to business operations.

In buildings of limited occupancy or use, motion sensors can be used in restrooms and other spaces with occasional use. Be use to use program start ballasts, and short lamp life won't occur. And of course, for spaces with sufficient daylight, such as lobbies and atriums, use automatic daylighting controls in addition to save the maximum amount of energy.

Controls for utility spaces like electrical and mechanical rooms require special consideration for workers. In general, in small spaces where workers are unlikely to become trapped, motion sensors are fine. But in larger spaces where motion sensors might not "see" the worker, use a conventional wall switch for safety.

An Efficient Core

This design uses a number of the elements discussed above. Light levels meet IESNA recommendations for each space, and perhaps just as importantly, the design is attractive. Consider providing emergency powered circuits to one downlight in each toilet room and one of the two lights in the toilet corridor.



AN EFFICIENT COMMERCIAL CORE

AREA: 1108 SF
POWER: 811 WATTS
POWER DENSITY: 0.73 W/SF

ELEC AND MECH ROOMS	128 SF	154 WATTS ALLOWED
TOILET ROOMS	598 SF	418 WATTS ALLOWED
COPY, COFFEE AND WORK ROOMS	300 SF	210 WATTS ALLOWED
CORRIDOR	82 SF	50 WATTS ALLOWED
TOTAL	1108 SF	832 WATTS ALLOWED