Electric Lighting Design

Interior Lighting

Good Design Practice

EL1 ***Lighting Walls and Ceilings* (Climate Zones: all)**

Better eye adaptation and luminous comfort are achieved when light is distributed to the walls and ceilings. Totally direct solutions should be avoided, since they create harsh shadows and dim rooms. To light walls, use wall wash luminaires or locate fixtures closer to walls. In open plan offices, lower furniture partitions and translucent partitions are more energy efficient than higher partitions for both daylighting and electric lighting.

EL2 ***Task Lighting* (Climate Zones: all)**

Consider hardwiring the lower output level of a two-stepped T8 electronic ballast (ballast factor 0.40 to 0.50) for undercabinet lighting, since full output is too bright and wastes energy. Use "articulated" task lights (i.e., adjustable in three planes by the worker) with compact fluorescent sources for desktops. Provide local switches on task lighting, or connect them to specialized plugstrips controlled by local occupancy sensors.

EL3 ***Reflectances* (Climate Zones: all)**

A 90% ceiling reflectance is preferred for indirect luminaires and daylighting. Reflectance values are available from paint and fabric manufacturers. Reflectances should be verified by the quality assurance provider. Avoid shiny surfaces (mirrors, polished metals, or stone) in work areas. See DL3.

EL4 ***Lamps and Ballasts* (Climate Zones: all)**

To achieve the maximum 0.9 W/ft^2 connected load recommended in chapter 3, "high performance" T8 lamps and instant start ballasts were assumed. High-performance T8 lamps are defined, for the purpose of this document, as having a lamp/ballast efficacy of 92 lumens per watt, based on "mean lumens" (published in the lamp catalogs as the degraded lumen output occurring at 40% of the lamp's rated life) and the input watts of a very efficient two-lamp parallel Instant Start electronic ballast. High-performance T8s also are defined as having a CRI of 85 or higher and a 92% lumen maintenance over their rated life. The higher performance is achieved either by increasing the output (3100 lumens) while keeping the same 32-watt input as standard T8s or by reducing the wattage while keeping the light output similar to standard T8s (e.g., 2750 lumens for 28 watts or 2850 lumens for 30 watts). The higher output 3100-lumen versions are visibly brighter than standard T8s, but a ballast with a BF of 0.77 may be used to provide a more comfortable lamp brightness above work stations without sacrificing efficiency. Program Start ballasts are recommended on frequently switched lamps (switched on and off more than five times a day) because they greatly extend lamp life over frequently switched Instant Start ballasts. Instant Start T8 ballasts typically provide greater energy savings and are the least costly option, plus the parallel operation allows one lamp to operate even if the other burns out. However, an Instant Start ballast may reduce lamp life, especially when controlled by occupancy sensors in rooms such as corridors, toilets, and interior offices. T5 ballasts should always be Program Start.

EL5 *Occupancy Sensors* (Climate Zones: all)

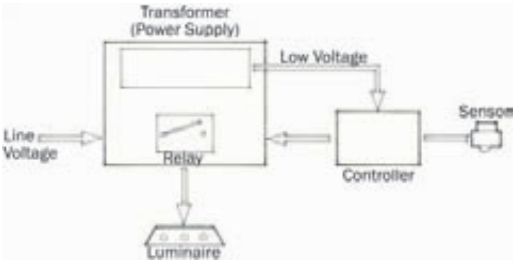

Figure 4-23. (EL5) Occupancy-sensing control.

The greatest energy savings are achieved with manual On, automatic Off occupancy sensors in daylighted spaces. This avoids unnecessary operation when electric lights are not needed and greatly reduces the frequency of switching. In open plan offices, ceiling-mounted ultrasonic sensors should be connected to an automatic or momentary contact switch so that the operation always reverts to manual On after either manual or automatic turn Off. Automatic time scheduling is an alternative to occupancy sensors in open plan offices. In private offices, infrared wall box sensors should be pre-set for manual On automatic Off operation. In nondaylighted areas, ceiling-mounted occupancy sensors are preferred. In every application it should not be possible for the occupant to override the automatic Off setting, even if set for manual On. Unless otherwise recommended, factory-set occupancy sensors should be set for medium to high sensitivity and a 15-minute time delay (the optimum time to achieve energy savings without excessive loss of lamp life). Work with the manufacturer for proper placement, especially when partial-height partitions are present.

EL6 *Multi-Level Switching* (Climate Zones: all)

Consider going beyond the minimum control requirements of local codes or Standard 90.1-1999, by providing more discrete levels of switching controls. Label all switches. Specify luminaires with multiple lamps to be factory wired for inboard-outboard switching or inline switching. The objective is to have each level of light uniformly distributed. Avoid checkerboard patterns. Avoid nonuniform switching patterns unless different areas of a large space are used at different times.

EL7 *Electric Lighting and Daylight Controls* (Climate Zones: all)

Factory-setting of calibrations should be specified when feasible to avoid field labor. Lighting calibration and commissioning should be performed after furniture installation but *prior* to occupancy to ensure user acceptance.

EL8 *Exit Signs* (Climate Zones: all)

Use LED exit signs or other sources that consume no more than 5 watts per face. The selected exit sign and source should provide the proper luminance to meet all building and fire code requirements.

Options

EL9 *Fluorescent T5 Sources* (Climate Zones: all)

T5HO and T5 lamps may be part of a solution. They have initial lumens per watt that compare favorably to the high-performance T8. In addition to energy, T5s use fewer natural resources (glass, metal, phosphors) than a comparable lumen output T8 system. However, when evaluating the lamp and ballast at the "mean lumens" of the lamps, T5HO lamps perform more poorly. On instant start ballasts,

high-performance T8s are 13% more efficient than T5s. In addition, since T5s have higher surface brightness and should not be used in open-bottom fixtures, it may be difficult to achieve the 30% savings and maintain the desired light levels using current T5 technology as the primary light source.

EL10 *Light Fixture Distribution* (Climate Zones: all)

Recessed direct fixtures may meet the watts per square foot allowance and the illuminance recommendations for offices, but they do not provide the same quality of light as pendant direct-indirect lighting fixtures. Extensive use of totally indirect luminaires or recessed direct-indirect (coffer-type) fixtures may not achieve the desired light levels while meeting the 0.9 W/ft^2 goal.

Sample Design Layouts for Office Buildings

The 0.9 W/ft^2 foot goal for lighting power (shown in each Recommendation Table in chapter 3) represents an average lighting power density for the entire building. Individual spaces may have higher power densities if they are offset by lower power densities in other areas. The example design described below is one way (but not the only way) that this watts-per-square-foot limit can be met. Daylight controls (see DL9) are assumed in all open office plans and under all skylights (see DL7).

EL11 *Open Plan Office* (Climate Zones: all)

The target lighting in open offices is 30 average maintained footcandles for ambient lighting with a total of at least 50 footcandles provided on the desktop by a combination of the ambient and supplemental task lighting.

Open plan offices account for approximately 20% of the floor area. Assuming an 8 foot by 8 foot work station and a 4 foot center aisle, this layout is about 1.03 W/ft^2 including task lighting wattage. Use daylight dimming ballasts and photocell control in daylight zone (within 12 feet of window wall) if WWR is greater than 25% in this area. Use occupancy sensor local control or scheduling on all luminaires.

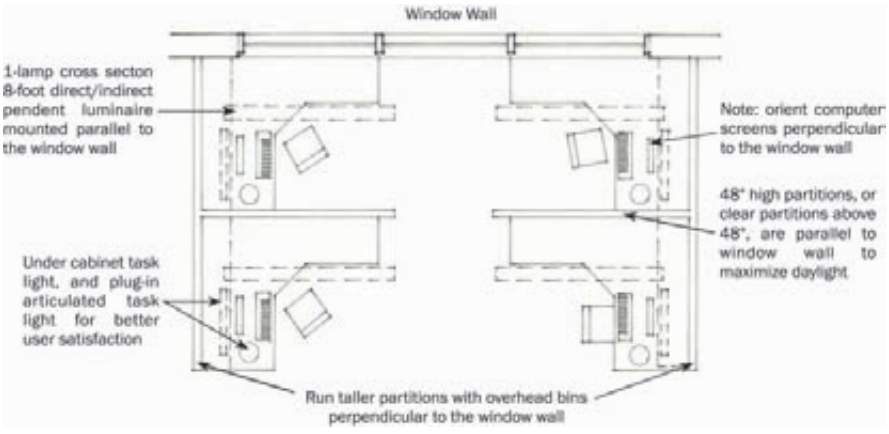

Figure 4-24. (EL11) Layout for open plan office.

EL12 *Private Office* (Climate Zones: all)

The target lighting in private offices is 30 average maintained footcandles for ambient lighting with a total of at least 50 footcandles provided on the desktop by a combination of the ambient and supplemental task lighting.

Private office plans account for approximately 25% of the floor area. Assuming a 10 foot by 12 foot office, this layout is about 0.94 W/ft^2 including task lighting wattage. Use occupancy sensor local control.

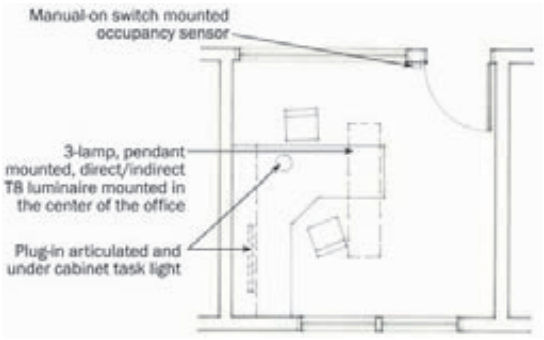

Figure 4-25. (EL12) Layout for private office.

EL13 *Lobbies* (Climate Zones: all)

The target lighting in the lobby is 10-15 average maintained footcandles. Highlight wall surfaces and building directory.

Lobbies account for approximately 10% of the floor area. The layout in Figure 4-26 is about 1.09 W/ft^2.

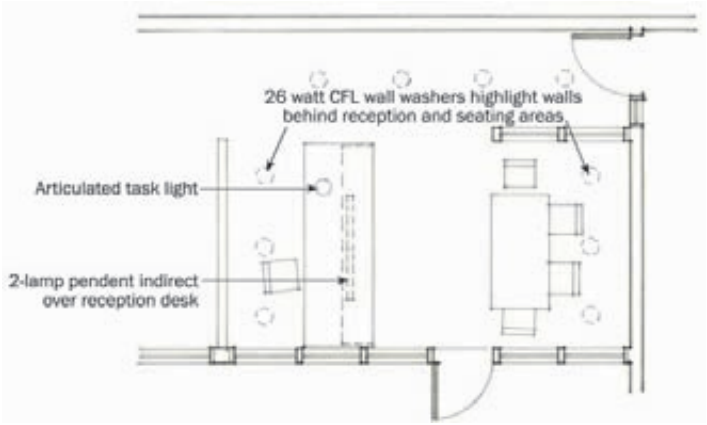

Figure 4-26. (EL13) Layout for lobby.

EL14 *Corridors*

The target lighting in the corridors is 5-10 average maintained footcandles. Choose luminaires that light the walls and provide relatively uniform illumination.

Corridors account for approximately 10% of the floor area. Optional layouts using one-lamp 1 × 4 or 26-watt CFL sconce or ceiling luminaires may be used to minimize the number of lamp types on the project. This layout yields 0.55 W/ft^2 when spaced 12 feet on center in a 5-foot-wide corridor.

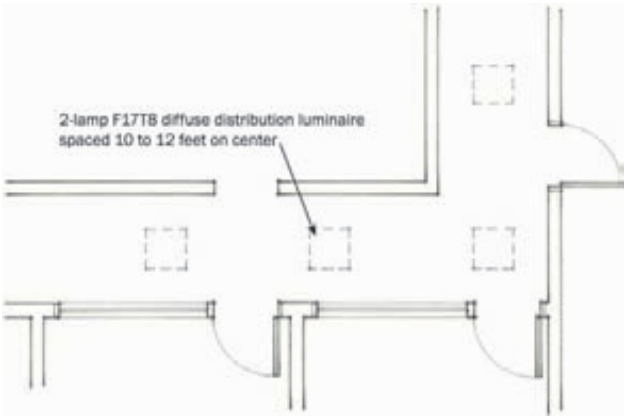

Figure 4-27. (EL14) Layout for corridors.

EL15 *Conference/Meeting Rooms* (Climate Zones: all)

The target lighting in the conference room is 30-40 average maintained footcandles. Use occupancy sensor local control.

Conference rooms account for approximately 10% of the floor area. The layout in Figure 4-28 is about 1.02 W/ft^2.

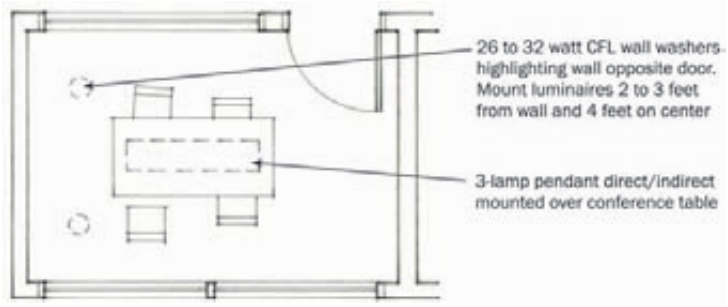

Figure 4-28. (EL15) Layout for Conference/meeting rooms.

EL16 *Storage* (Climate Zones: all)

The target lighting in the storage is 5-15 average maintained footcandles.

Storage areas account for approximately 15% of the floor area. The layout in Figure 4-29 is about 0.78 W/ft^2.

Note: Lighting in remaining 10% of the office space is composed of various functions including restrooms, electrical/mechanical rooms, stairways, workshops, and others. Average the connected load in these spaces to 0.75 W/ft^2, which is equivalent to about one two-lamp high-performance T8 luminaire every 80 ft^2. Use occupancy sensors or timers where appropriate.

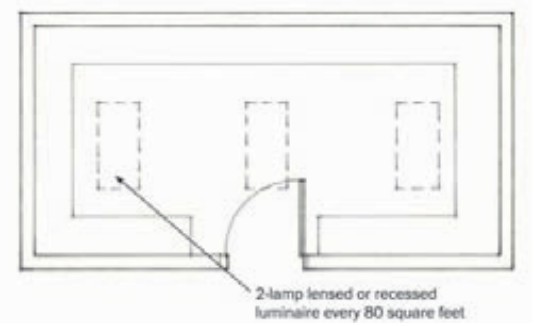

Figure 4-29. (EL16) Layout for storage area.

The designed lighting power density does not exceed the recommended 0.90 W/ft^2 for the total building interior.

Cautions

The recommendations in chapter 3 will only be successful and acceptable to owner and occupants if the following lighting design safeguards for the quality and quantity of light are met:

EL17 *Overhead Glare Control* (Climate Zones: all)

Specify luminaires properly shielded for worker comfort. Avoid T5 lamps in open-bottomed fixtures. Avoid specular (shiny) louvers, cones, or reflectors visible to occupants from any angle. Use efficient fixtures and proper distribution. Include the partial height partitions in lighting calculations and for spacing. Use more fixtures of lower wattage rather than the reverse.

References

Know-How Guide for Office Lighting, available at Designlights.org
NBI Advanced Lighting Guidelines, available at newbuildings.org
EPRI Lighting Controls Smart and Simple, available from IESNA at IESNA.org
ANSI/IESNA RP-1-04, Recommended Practice on Office Lighting, available from IESNA at IESNA.org

HVAC

Good Design Practice

HV1 *General* (Climate Zones: all)

The HVAC equipment for this Guide includes packaged unit systems and split systems generally referred to as air conditioning or heat pump units that are warm air heating systems. These systems are suitable for projects with no central plant. This Guide does not cover water-source or ground-source heat pumps nor systems that use liquid water chillers or purchased chilled water for cooling nor oil, hot water, solar, steam, or purchased steam for heating. These systems are alternative means that may be used to achieve 30 percent or greater savings over Standard 90.1-1999 and where used, the basic principles of this Guide would apply.

The systems included in this Guide are available in pre-established increments of capacity and are characterized with an integral refrigeration cycle and heating source. The components are factory designed and assembled and include fans, motors, filters, heating source, cooling coil, refrigerant compressor, controls, and condenser. The components can be in a single package or a split system that separates the evaporator and condenser sections.

Performance characteristics vary among manufacturers, and the selected equipment should match the calculated heating loads and sensible and latent cooling loads and take into account the importance of meeting latent cooling loads under part-load conditions. See HV3 “Cooling and Heating Loads,” for calculating the loads; HV4 “Humidity Control,” for meeting latent cooling loads under part load conditions, and HV13 “Thermal Zones,” for recommendations on zoning the building. See HV21 “Zone Temperature Control,” for a discussion on location of space thermostats. The equipment should be listed as being in conformance with electrical and safety standards, and its performance ratings should be certified by a nationally recognized certification program.