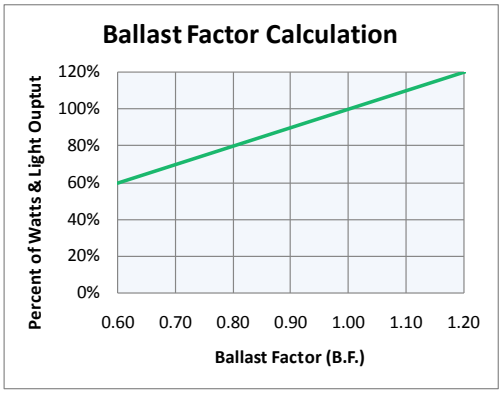
Lighting System Assessment Guidelines

General Lighting Assessment Procedure:

1. Record illuminance levels (foot-candles or lux) in various spaces using a handheld light meter:
   - Office light levels should be taken at desk level (standard is 30 inch above the finished floor [AFF]).
   - Hallway measurements should be taken at the floor level and restroom measurements should be taken at counter height.
   - Develop a grid of points; 2 ft on center for small offices and 10 ft on center for large open spaces, and record light levels at each point on the grid (note minimum, maximum, and average light level for each space).
   - Record nighttime and daytime light levels within each space. Take nighttime and daytime measurements at the same location to determine daylight contribution and note sky condition (clear, partly cloudy, cloudy). This can give a rough sense for expected annual daylight to see if fixture rezoning or other daylight measures are appropriate. Note: Make sure the lighting design can meet nighttime illuminance requirements when reducing lighting power density (LPD) and light levels.
2. Count lamps/ballasts in each room:
   - Count fixtures, lamps, and ballasts—Fixture counts can also be approximated from electrical drawings.
   - Calculate space area and LPD (W/ft^2) for each space type. Fixture wattage = lamp wattage x number of lamps x ballast factor (B.F.).
   - Record fixture type (i.e., recessed, recessed vented, indirect/direct, etc.). If pendant mounted, note the pendant length.
   - Record ceiling height and type.
3. Write down lamp data and ballast data:
   - Look up ballast specifications on the Internet.
   - Record lamp type, lamp color temperature (Kelvin), and lamp wattage.
   - Record ballast type, ballast factor and program, instant, or rapid start.
4. Write down operational hours per day:
   - Calculate operational hours per year.
5. Write down control system and wiring layout:
   - Look for existing occupancy sensors, dimming ballasts, and lighting control systems.
   - Sketch out the configuration of lighting zones within the space.
   - Use the following graph to determine acceptable reduction in ballast factor if the space is over-lit. Ballast factor is proportional to light output and percentage of lamp wattage.



Source: Illuminating Engineering Society of North America

Figure 1. Ballast factor calculation[1]

Retrofit and Redesign Issues:

1. A redesign should be considered when:
   - The space is undergoing a major renovation and the current fixtures are recessed direct fixtures
   - Existing luminaries provide nonuniform light distribution and/or can't meet illumination requirements
2. Look for opportunities to re-zone the space for occupancy and daylighting control.
3. For retrofit or redesign projects, the new design should produce acceptable light quality by:
   - Maintaining uniformity
   - Providing for glare control
   - Improving color rendering.

[1] Calculation based on information from the Illuminating Engineering Society of North America, Fundamentals of Lighting Course, 2009.

Table 1. Recommended Illuminance (IES) and Lighting Power Density (ASHRAE 90.1 version) by Space Type[2]

IESNA Recommended Horizontal Illuminances and ASHRAE/IESNA 90.1 LPD Recommendations		
Space Type	**Illuminance (fc)**	**LPD (W/ft²)**
Open Offices	30 to 50 (5 to 10 with task lighting)	1.1
Private Offices	50	1.1
Conference Rooms	30	1.3
Corridors	5	0.5
Restrooms	10	0.9
Lobby	10	1.3
Copy Rooms	10	
Classrooms	30	1.4
Gymnasiums	100	1.1
Dining Areas	10	0.9
Kitchen	50	1.2
Labs	50	1.4
Libraries	30	1.2 (reading area), 1.7 (stacks)
VDT Areas	3	
Museums (display areas)	30	1
General Warehousing/Storage	10	0.8
Inactive Storage	5	0.3
General Manufacturing	30	1.2 (low bay), 1.7 (high bay)
Residences (General)	5	
Parking Areas (uncovered)	0.2	0.15

Source: ASHRAE and Illuminating Engineering Society of North America

Occupancy Sensor Assessment Tasks:

1. To start, follow the general procedures listed above. Then take the following steps:
   - Determine appropriate mounting configuration (wall or ceiling mounted).
   - Determine appropriate sensor type (ultrasonic, infrared or combination).
   - Determine the number of occupancy sensors per space:
     - Typical coverage range for a wall-mounted sensor is 300–400 ft^2
     - Typical coverage range for a ceiling-mounted sensor is 1,000–2,000 ft^2
   - Determine installation time.
   - Look for opportunities to rewire the space into multiple smaller zones with one occupancy sensor per zone.
   - Determine reduction in operational hours.
   - Note commissioning settings (e.g., manual on and auto off).

Table 2. Recommended Lighting Reduction by Space Type[3]

Space Type	Percent Reduction (%)
Private Office	15-55
Open Office	15-30
Classroom	10-45
Conference Room	25-65
Restroom	30-75
Warehouse	50-75
Storage	45-65

Source: TIAX LLC

[2] Created based on information from *Energy Standard for Buildings Except Low-Rise Residential Buildings*, ASHRAE/IESNA Standard 90.1 (2004); and the *IESNA Lighting Handbook Reference and Application*, Ninth Edition, Illuminating Engineering Society of North America.

[3] Created based on data from *Energy Impact of Commercial Building Controls and Performance Diagnostics: Market Characterization, Energy Impact of Building Faults and Energy Savings Potential, Final Report*; prepared by TIAX LLC for the U.S. Department of Energy; November 2005.

Daylighting Side-Lighting Analysis:

1. Calculate floor to window height (ft).
   - Assume that daylight from side lighting can go 1.5 to 2 times the height of the window into space.

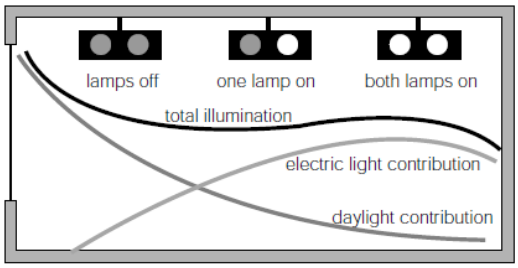


Figure 2. Lighting schematic in a room with stepped lighting controls.[4] ©1997 by Ernest Orlando Lawrence Berkeley National Laboratory; reprinted with permission.

Central Lighting Control System Assessment Tasks:

1. Determine if a central lighting control system is applicable (usually for larger commercial buildings):
   - Count the number of lighting panels and lighting breakers per panel.
   - Determine the number of different lighting schedules that will be needed.

Site Assessment Tools:

1. Use an illuminance meter to record light levels, a roller wheel or ultrasonic range finder to measure space dimensions, and a tape measure to measure floor to window height.
   - Count the number of fixtures located within this area.
   - Record light levels next to windows and make sure glare prevention (e.g., blinds) are blocking any direct sun.
   - Determine rough zoning recommendations (model energy savings in eQUEST).

Daylighting Top-Lighting Analysis:

1. Calculate top floor area.
2. Analyze the roof construction to determine applicability for top lighting.
3. Skylight to floor area ratio should be 3%–5%

[4] O'Connor, J., Lee, E., Rubinstein, F. Selkowitz, S. *Tips for Daylighting with Windows, The Integrated Approach*. Ernest Orlando Lawrence Berkeley National Laboratory. LBNL-39945 1997. http://windows.lbl.gov/daylighting/designguide/dlg.pdf. 1997.

Table 3. Final Energy Savings Recommendations*—Lighting[5]

Item	Component	All Climate Zone Locations					
			W/ft^2	*W/m^2*		W/ft^2	*W/m^2*
Interior Lighting	Lighting power density	Office, open plan	0.68	*7.3*	Office, enclosed	0.8	*8.6*
		Conference/meeting	0.77	*8.3*	Active storage	0.64	*6.9*
		Corridor/transition	0.50	*5.4*	Restrooms	0.82	*8.8*
		Lounge/recreation	0.73	*7.9*	Stairs	0.6	*6.5*
		Electrical/mechanical	1.24	*13.3*	Lobby	1.09	*11.7*
		Other	0.82	*8.8*	OVERALL	0.75	*8.1*
	Fluorescent lamps	T5HO or T8 high-performance with high-performance electronic ballast and compact fluorescent (CFL) with electronic ballast,					
	Occupancy controls	Added for open-office task lights, enclosed office ambient lighting, active storage, restrooms and electrical/mechanical spaces.					
	Plug load lighting	Compact fluorescent (CFL) with electronic ballast					
Exterior Lighting Power Density	Base allowance	750 W					
			W/ft^2	*W/m^2*			
	Parking areas and drives		0.100	*1.08*			
	Walkways		0.160	*1.72*			
	Entry canopies		0.400	*4.31*			
	Façade (use wattage only for façade)		0.075	*0.81*			

Source: Pacific Northwest National Laboratory

* Implementation of these energy measures could allow a new midsize office building to achieve 50% energy savings relative to a building that just meets ANSI/ASHRAE/IESNA Standard 90.1-2004.

[5] Thornton, B.; Wang, W.; Lane, M.; Rosenburg, M.; Liu, B. *Technical Support Document: 50% Energy Savings Design Technology Packages for Medium Office Buildings*. PNNL-18774. Prepared by Pacific Northwest National Laboratory for U.S. Dept. of Energy. www.pnl.gov/main/publications/external/technical_reports/PNNL-19004.pdf. September 2009.