



Ch.17 Electric Lighting Applications

Residential Occupancies
Educational Facilities
Commercial Interiors
Industrial Lighting
Special Lighting Application Topics



Introduction

- Ch.6: light, vision, and visual comfort (lighting fundamentals)
- Ch.15: lamps, luminaires, and controls
- Ch.10: daylighting
- Ch.16: electric lighting design
- Ch.17: electric lighting applications
 - special requirements, design approaches, comparative economics, energy consideration for the following:
 - Residential occupancies
 - Educational facilities
 - Commercial interiors
 - Industrial lighting
 - Special lighting: application topics



Residential occupancies: lighting sources

- Incandescent lamps widely used in US: flattering skin color, low first cost, small size, focusability, simple and economic dimmability
- Tungsten Halogen lamps
- Incandescent lamps for closets, pantries, other frequent switched lighting, home offices
- HID appropriate for exterior lighting



The Eaton hotel, Hong Kong (Dec 2007)





Atlanta, Courtyard Marriot (Oct, 2008)



Atlanta, Renaissance hotel (Jul, 2009)



Chicago, The Westin hotel (Jan, 2009)



Gervasi villa, Akron, OH (Oct, 2012)



Design suggestions

- Use general/task lighting approach (illuminance recommendations: Tables 17.1, 17.2)
- Luminance ratio (Fig. 17.1)
- Do not avoid ceiling light sources

TABLE 17.1 Illuminance Recommendations for General Lighting

Activity or Area	Average Lux
Conversation and relaxation	50–100 ^a
Passage areas	50–100 ^a
Areas other than kitchen	200–500
Kitchen	500–1000

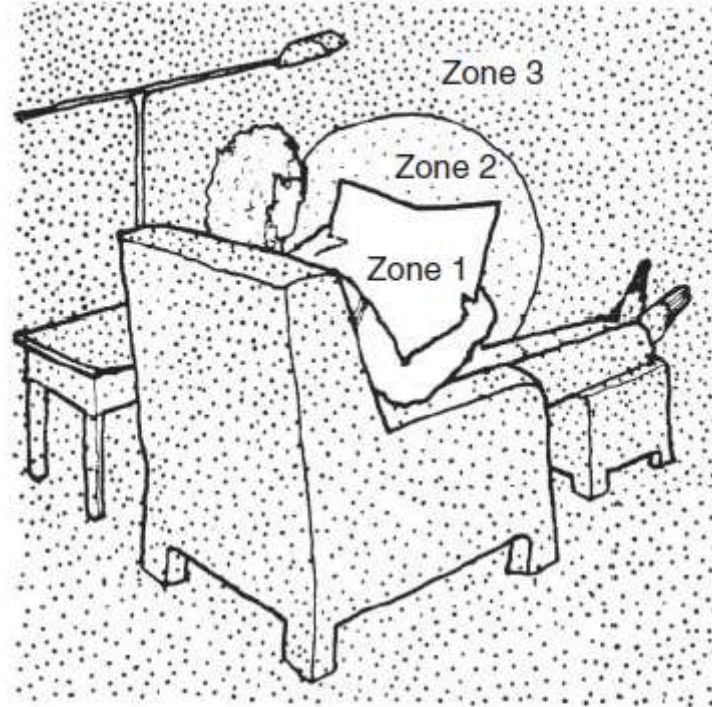
^aGeneral lighting in these areas need not be uniform.

TABLE 17.2 Illuminance Recommendations for Specific Residential Visual Tasks^a

Seeing Task	Typical North American Recommendation: Average Lux ^b	Other Authorities: Average Lux ^b
Dining	100–200	100–150
Grooming, makeup	200–500	500
HANDCRAFT		
Ordinary seeing tasks	200–500	200–500
Difficult seeing tasks	500–1000	500–750
Critical seeing tasks	1000–2000	>1250
KITCHEN ACTIVITIES		
Food preparation and cleaning involving difficult seeing tasks	500–1000	750–1000
Serving and other noncritical tasks	200–500	200–300
Laundry tasks	200–500	100–300
READING AND WRITING		
Handwriting, reproductions, and poor copies	500–1000	750
Books, magazines, and newspapers	200–500	300
SEWING, HAND OR MACHINE		
Dark fabrics	1000–2000	>1250
Medium fabrics	500–1000	700–1000
Light fabrics	200–500	300–500
Table games	200–300	300

^aSelection of illuminance within the given range is based on the criteria given in Section 16.6

^bDivide by 10 to get footcandles. Due to the range of values, use of the exact 10.76 conversion value is unnecessary.



Zone 2 The immediate surroundings (area adjacent to the visual task)

Desirable ratio	1/3 to equal to task*
Minimum acceptable ratio	1/5 to equal to task*

Zone 3 The general surroundings (not immediately adjacent to task)

Desirable ratio	1/5 to 5 times task*
Minimum acceptable ratio	1/10 to 10 times task*

*Typical task luminance range is 40 to 120 cd/m^2 (12-35 fL) and seldom exceeds 200 cd/m^2 (60 fL)

Fig. 17.1 Seeing zones and recommended luminance ratios for residential visual tasks; Zone 1 is the task.

Residential lighting elements



(a) Lighted Cornices

Cornices direct all their light downward to give dramatic interest to wall coverings, draperies, murals, etc. May also be used over windows where space above window does not permit valance lighting. Good for low-ceilinged rooms.



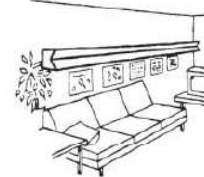
(e) Lighted High Wall Brackets

High wall brackets provide both up and down light for general room lighting. Used on interior walls to balance window valance both architecturally and in lighting distribution. Mounting height determined by window or door height.



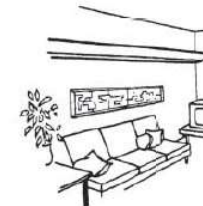
(b) Lighted Valances

Valances are always used at windows, usually with draperies. They provide up-light which reflects off ceiling for general room lighting and down-light for drapery accent. When closer to ceiling than 10 inches use closed top to eliminate annoying ceiling brightness.



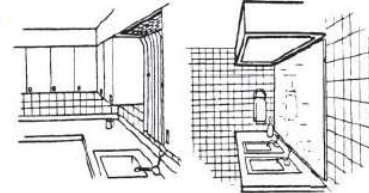
(f) Lighted Low Wall Brackets

Low brackets are used for special wall emphasis or for lighting specific tasks such as sink, range, reading in bed, etc. Mounting height is determined by eye height of users, from both seated and standing positions. Length should relate to nearby furniture groupings and room scale.



(c) Lighted Coves

Coves direct all light to the ceiling. Should be used only with white or near-white ceilings. Cove lighting is soft and uniform but lacks punch or emphasis. Best used to supplement other lighting. Suitable for high-ceilinged rooms and for places where ceiling heights abruptly change.



(g) Lighted Soffits

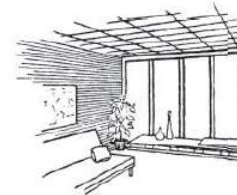
Soffits over work areas are designed to provide higher levels of light directly below. Usually they are easily installed in furred-down area over sink in kitchen. Also are excellent for niches over sofas, pianos, built-in desks, etc.

Bath or dressing room soffits are designed to light user's face. They are almost always used with large mirrors and counter-top lavatories. Length usually tied to size of mirror. Add luxury touch with attractively decorated bottom diffuser.



(d) Lighted Canopies

The canopy overhang is most applicable to bath or dressing room. It provides excellent general room illumination as well as light to the user's face.



(h) Luminous Wall Panels

Luminous wall panels create pleasant vistas; are comfortable background for seeing tasks; add luxury touch in dining areas, family rooms, and as room dividers. Wide variety of decorative materials available for diffusing covers.

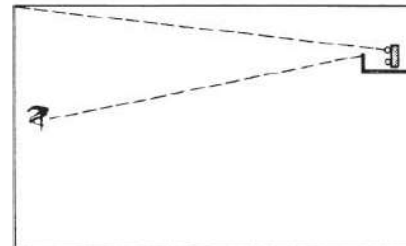
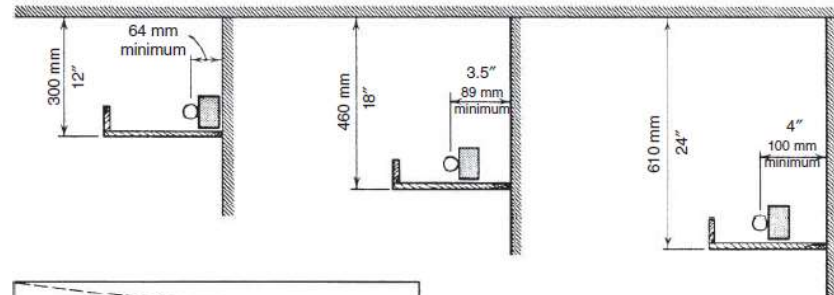
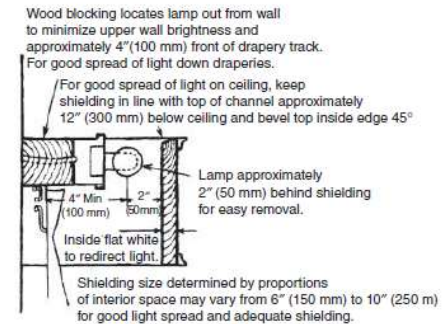
Fig. 17.3 Residential lighting elements. (Courtesy of IESNA.)

Selected lighting elements: construction details

(a) Typical Valance

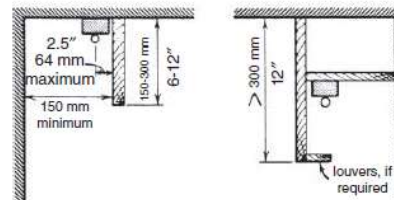
This typical dimensional drawing applies only to commonly encountered window valance situations. Obviously, other window treatments could necessitate modifications in these critical dimensions; i.e., vertical blinds, double-track situations, curved bay windows, etc.

The same "job-tailored" variations can occur in the design of any type of structural lighting device. Therefore, no other dimensional drawings have been included here.



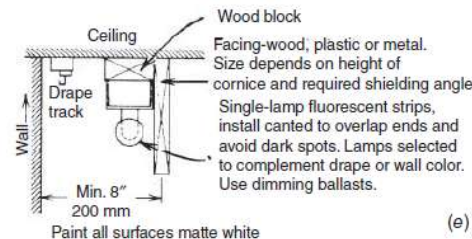
(b) and (c) Cove Installations

Proper cove proportions: Height of front lip of cove should shield cove from the eye yet expose entire ceiling to the lamp. Orientation of fluorescent strip as shown is preferable. Cove interiors should be painted with high reflectance matte-finish paint. *Westinghouse Lighting Handbook (Out of print)*



(d) Typical Cornices

Wallwashing equipment mounted in valances and cornices provides improved brightness ratios and may be used for lighting desks against walls or vertical illumination of walls and objects mounted thereon. *Westinghouse Lighting Handbook (Out of print)*



(e)

Fig. 17.4 Selected lighting elements: construction details.

Residential lighting: control

- In large residences, remote control of lighting becomes more of a necessity than convenience in terms of control, safety, and status information.



Fig. 17.5 Typical wall-mounted master station has five control buttons in addition to "All On" and "All Off" on every master. The control buttons can be arranged to control a single outlet or a group to establish lighting of a scene. Thus, the entry unit might have homecoming, extended absence, path lighting, nightlighting, and garage-lighting scenes, whereas the kitchen master may have lighting scenes for breakfast, dinner, formal and informal entertaining, and night. Each scene can be arranged to turn on, brighten or dim, and shut off selected lighting. (Courtesy of Lutron Electronics Co., Inc.)

Entry master: homecoming, extended absence, path-lighting, night-lighting, garage

Kitchen master: breakfast, dinner, formal and informal entertaining, and night (w/ lighting scenes)



Fig. 17.6 Typical components of a wireless control system. Left to right:

- Bedside master station has five scene buttons and 10 individual outlet controls in addition to "All On" and "All Off" buttons.
- Repeater, which is used in large buildings to strengthen signals.
- Typical radio-controlled wall dimmer with local manual control. (Courtesy of Lutron Electronics Co., Inc.)



Educational facilities

- Lighting requirements: commercial (office) vs. institutional buildings
 - The budget is always tight. maintained by the taxes
- Durable, vandal-proof, maintenance-free, low energy consumption, corrective maintenance rather than preventive maintenance

Educational facilities

- Use sources with highest efficacy: daylight → HPS → fluorescent, metal halide, etc.
- Long life sources → to reduce maintenance
- high ceiling rooms (gyms, assembly rooms) → relamping is difficult → long life sources
- Low LLF must be assumed: unknown cleaning of lighting fixtures, low maintenance, aging of paints and dirt accumulation → reasonable $LLF=0.5$
- Provision must be made for initial overlighting → lumen maintenance
- Lighting equipment must be made for minimum maintenance: rust-preventive plates, ballast replacement without demounting fixtures (e.g. plug-in ballast), high quality finish, etc.



General classrooms

- Requirements

- An appreciable indirect component and good diffusion to minimize the veiling reflections
- Low brightness luminaires with high VCP due to viewing direction (head-up position)
- Daylight is desirable to maximum extent



15 8:03PM

Lenark Mill, Edinburgh (2008 June¹³)



Special-purpose classrooms

- Shops (bench and machine work, like woodshops)
 - Illuminance: 500 lux
 - Adjustability of the lighting is particularly important because of the frequently specular quality of the visual task, such as a metal machining process
- Music rooms: music scores, which are normally held in the vertical position. Both horizontal and vertical illuminance considered.



Special-purpose classrooms

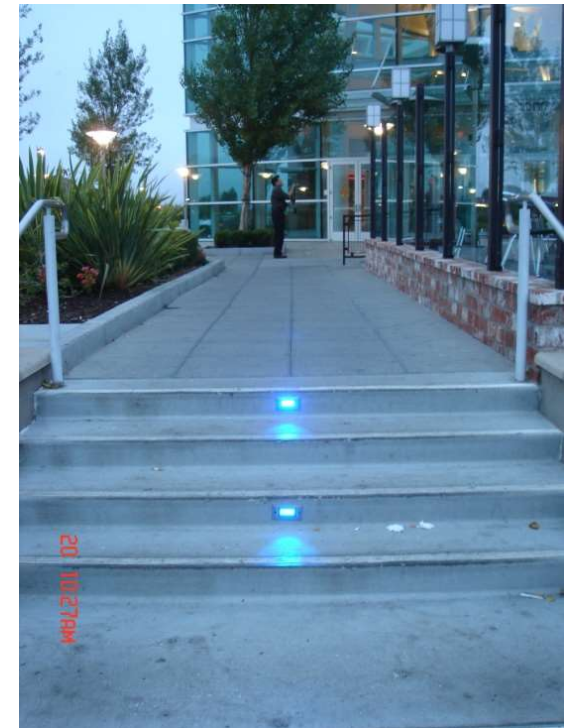
- Art rooms: constant color daylight is important
 - North windows and skylights are highly desirable
 - High CRI lamps are required.
 - For the use of models: adjustable accent lights
 - For display of artwork: adjustable wall illumination (e.g., ceiling track mounted unit)



Fig. 17.9 Art exhibition room illustrating good and bad lighting techniques. The upper wall fenestration is excellent for deep daylight penetration. Track lighting is ideal for display of art. The use of incandescent downlighting for general lighting is excessive and an eyesore. Also, the positioning of the track fixtures can create both direct and reflected glare problems and annoying shadows unless the sources are selected properly and ceiling height is at least 10 ft (3.1 m).

Assembly rooms, auditoriums and multi-purpose rooms

- Varied activities → lighting flexibility is imperative.
- Possible combinations: incandescent (for low coast dimming), fluorescent, HID, architectural elements
- Step lighting: should be mounted to the side or in risers to illuminate the tread
- Stage lighting → theater lighting designer



Step lighting



Fig. 17.10 Schools frequently utilize spaces for multiple functions. This space, typically used as a banquet room, doubles as an assembly room. High-intensity, recessed downlights in combination with large pendants provide sufficient light for both uses. (© Karen Tse; used with permission.)



Fig. 17.11 Institutional cafeteria illuminated by cove lighting and daylight, accented with downlights and suspended pendants in a double-height space. Lighting is even, glare-free, soft in quality, and pleasant, yet of sufficient intensity to permit using the cafeteria as a working-meeting space. (© Karen Tse; used with permission.)

Gymnasium lighting

- Similar to auditoriums (widely varying usages)
- HPS, high CRI MH/L are appropriate for color, life and efficacy.
- During HID startup or restart after an outage, other fixtures should be provided with incandescent or tungsten–halogen lamps, which provide good color for low-intensity lighting → good for social events.
- Multiple lighting levels should be available by switching or dimming.
- All fixtures should be designed for relamping from the floor.

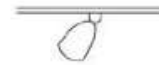
Lecture hall lighting

- Similar to classrooms
- Adjustable level fluorescent lighting is necessary for demonstrations, video, and the like.
- Auxiliary lighting for demonstration table and chalkboard is necessary.
- Controls for lighting should be at the demonstration table.

Specular,
parabolic reflector



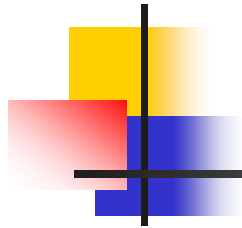
Track-mounted
adjustable
flood/spot



Baffled,
parabolic reflector



Fig. 17.12 Typical lecture room lighting utilizes 45° cutoff baffled parabolic reflector troffers for minimum direct and reflected glare, adjustable track lighting for demonstration table illumination, and an asymmetric reflector for chalkboard lighting. The large display area on the front wall of the room will not experience veiling reflections with the illustrated lighting arrangement.



Laboratory lighting

- Difference between laboratory and classrooms
 - Fixed tables, many items exhibiting specular reflection, vertical surface illumination is important.
- With low ceilings: use direct fixtures running crosswise to the tables
- With high ceilings: indirect lighting is highly desirable due to its high degree of diffuseness.
- Running lights across tables or in aisles are preferable to the transverse direction from the aspect of reflected glare (Fig. 17.13).

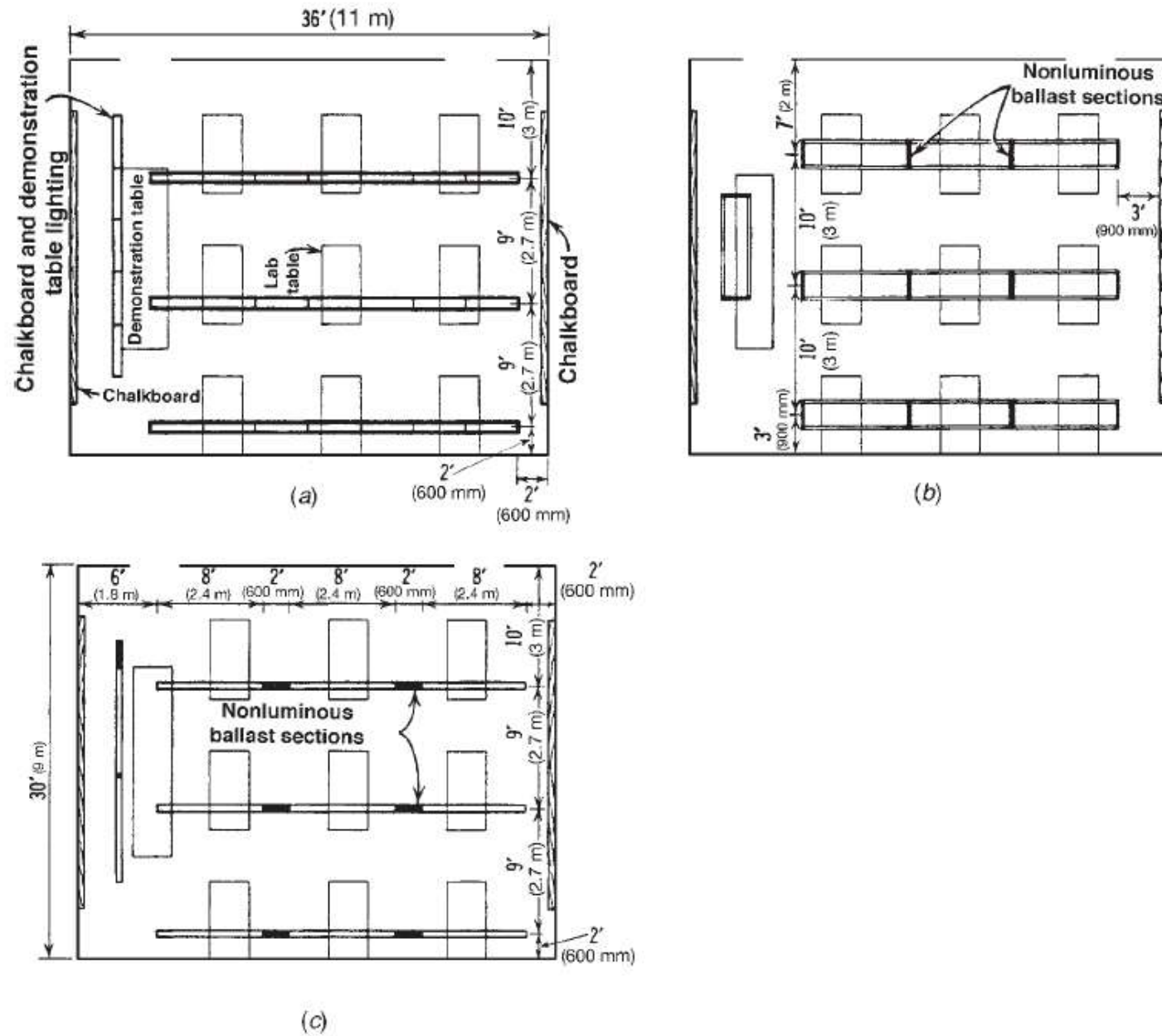


Fig. 17.13 Laboratory lighting schemes. Running fixtures across tables or in aisles is preferable to fixtures in the transverse direction, in terms of reflected glare. (a) Pendant direct-indirect units. (b, c) Variations of the single semi-direct high-output (HO) design.

Library lighting

- General reading rooms: two common solutions
- Solution #1: general lighting over the entire area
 - fluorescent, MH/L (long life, high efficacy, long burning hours): long burning hours in the libraries
- Solution #2: low level general lighting + local reading lighting on the tables or in carrels
 - Reading lighting should be fluorescent and user-adjustable
 - Reading lighting should be arranged to avoid veiling reflections when not user-adjustable.

Library lighting

- Stack areas: vertical surface illuminance best supplied by a special florescent unit (Fig. 17.14)

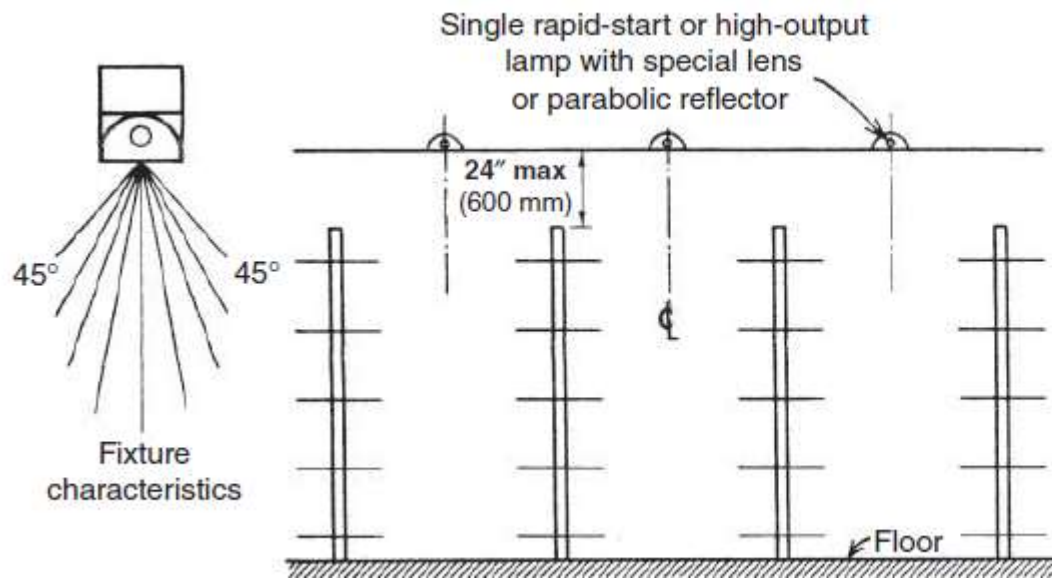
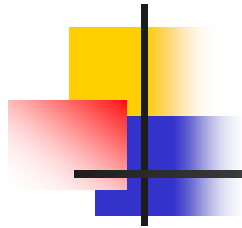


Fig. 17.14 Stack lighting is best accomplished by fixtures with lenses specifically designed for the purpose. Fixtures with baffles and plastic diffusers generally do not give adequate vertical surface illumination.



Special areas

- Sewing rooms, textile and art work spaces
 - Color rendering!!
 - Continuous spectrum sources must be used (incandescent lamps, tungsten-halogen lamps, and daylight)
- Food service areas
 - well lighted to emphasize cleanliness and food attractiveness
 - Color rendering of food is particularly important
- Medical attention spaces:
 - High illuminance and good color rendering for diagnostics
 - Conventional office lighting for records and desk tasks

Corridors and stairways in all types of buildings

- Require special lighting (Fig. 17.15)
- Corridors only for circulation: 10 fc
- bulletin boards or lockers: Fig. 17.15
- No incandescent lamps: low efficacy, high maintenance, frequent relamping

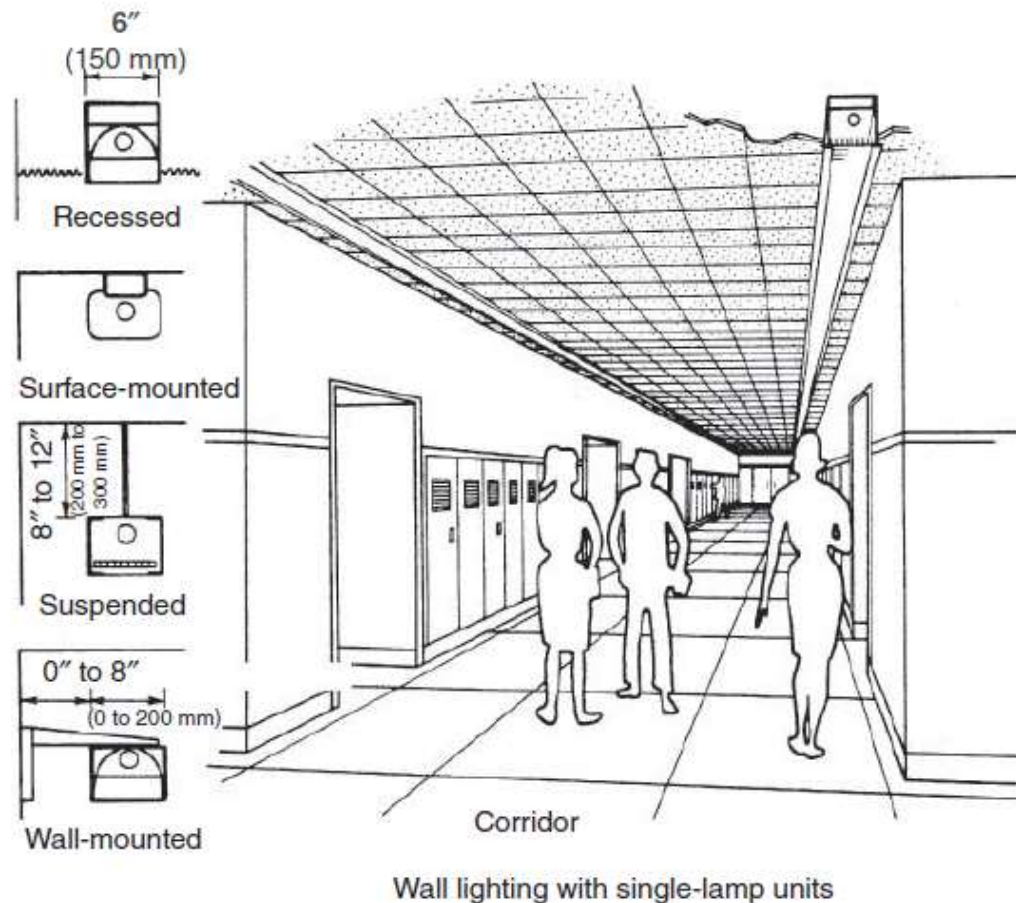


Fig. 17.15 Lighting of school corridors. High-reflectance walls, floor, and ceiling improve utilization of light and increase the feeling of cheerfulness. The lighting technique illustrated is appropriate for school corridors. The rows of luminaires at each sidewall illuminate bulletin boards, special displays, and the faces and interiors of lockers more effectively than do units centered in the ceiling.