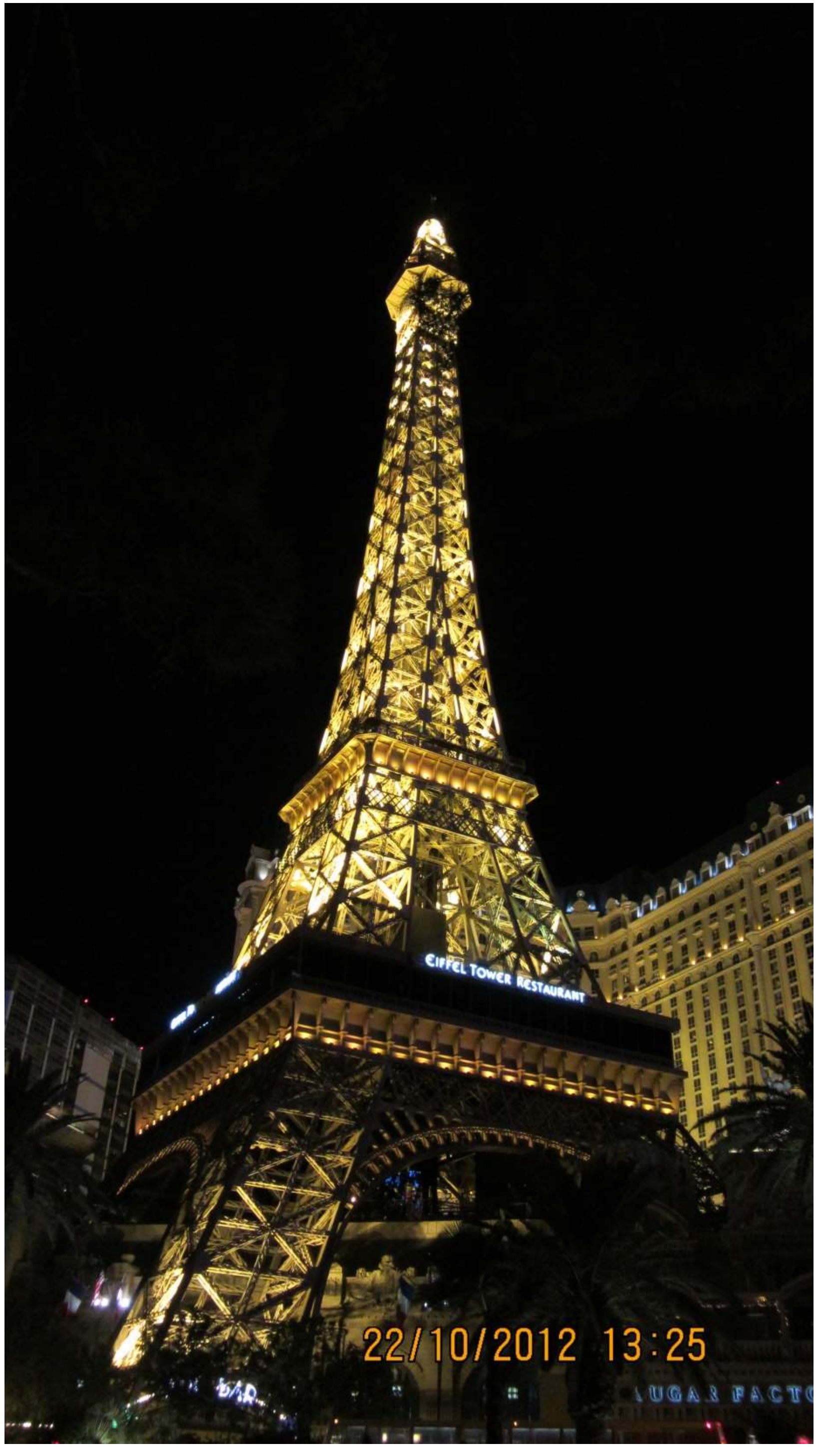
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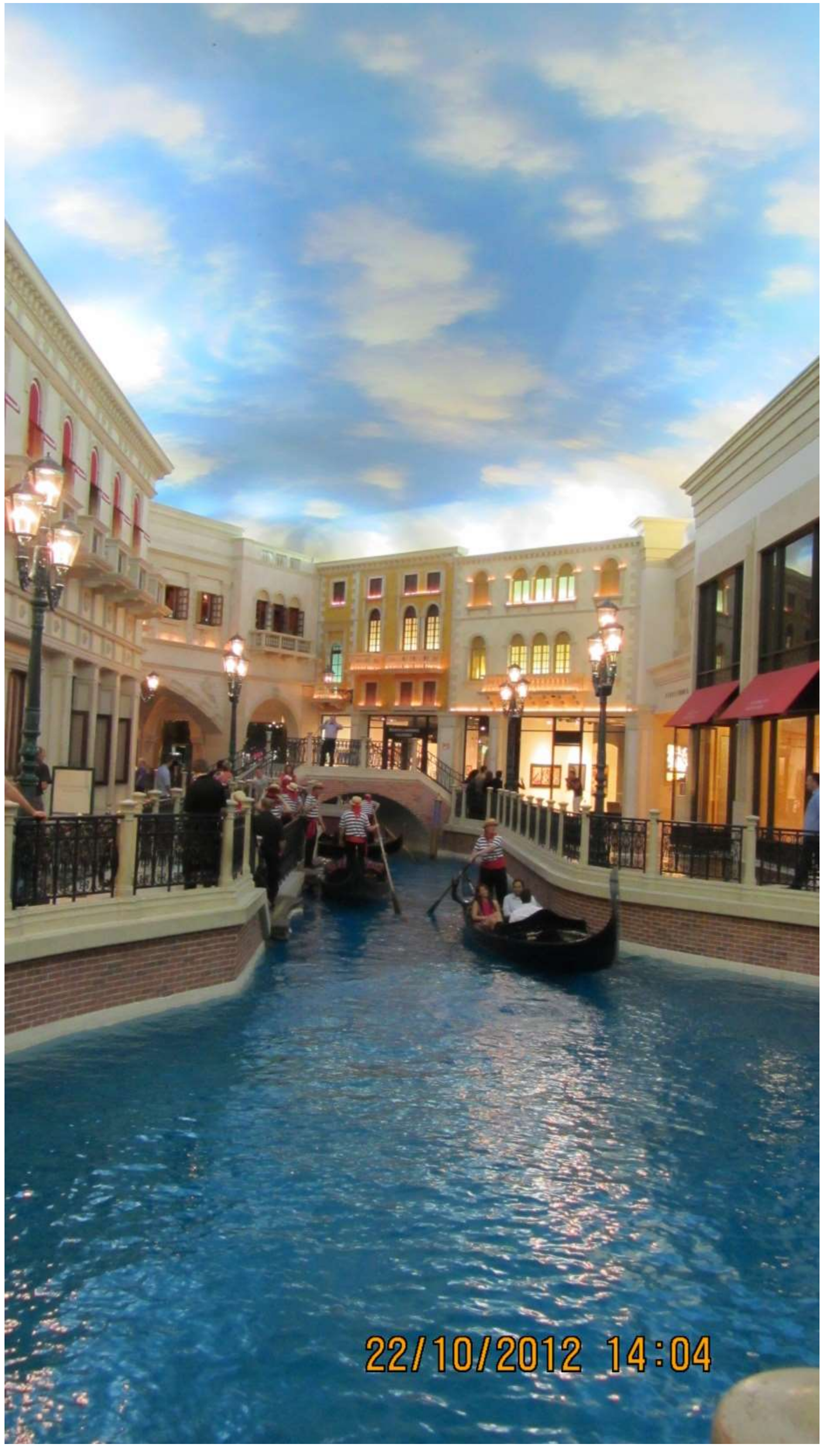
22/10/2012 14:04

Wynn hotel, Las Vegas, NV (Oct. 2012)

Caesars palace hotel, Las Vegas, NV (Oct. 2012)


TRAM STATION
TO
MANDALAY
BAY
LUXOR
21/10/2012 12:42


21/10/2012 12:42


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HK Symphony of Light (2007 Dec)

Flood lighting application guide

TABLE 17.4 Lighting Application Guide

			Watts per Square Foot (W/m²)[b] Generally Required							
Application	**Minimum Footcandles (lux) Maintained[a]**		**Tungsten-Halogen**		**Mercury**		**Metal-Halide**		**High-Pressure Sodium**	
Automobile Parking										
Attendant parking	2 (20)		0.38 (3.8)		0.17 (1.7)		0.11 (1.1)		0.075 (0.75)	
Industrial lots	1 (10)		0.13–0.15 (1.3–1.5)		0.06–0.07 (0.6–0.7)		0.037–0.044 (0.4–0.5)		0.026–0.03 (0.26–0.3)	
Self-parking lots	1 (10)		0.13–0.15 (1.3–1.5)		0.06–0.07 (0.6–0.7)		0.037–0.044 (0.4–0.5)		0.026–0.03 (0.26–0.3)	
Shopping Centers										
Neighborhood	1 (10)		0.13–0.19 (1.3–1.9)		0.06–0.09 (0.6–0.9)		0.037–0.055 (0.4–0.6)		0.026–0.038 (0.3–0.4)	
Average commercial	2 (20)		0.26–0.3 (2.6–3.0)		0.12–0.135 (1.2–1.4)		0.075–0.087 (0.7–0.9)		0.052–0.06 (0.5–0.6)	
Heavy traffic	5 (50)		0.65 (6.5)		0.29 (2.9)		0.19 (1.9)		0.13 (1.3)	
Automobile Sales Lots										
Front row (front 20 ft [6 m])	50 (500)		10 (100)		4.5 (45)		2.9 (29)		2.0 (20)	
Remainder	10 (100)		1.5–1.8 (15–18)		0.68–0.81 (6.8–8.1)		0.44–0.52 (4.4–5.2)		0.3–0.36 (3.0–3.6)	
Building										
Construction	10 (100)		1.5–1.8 (15–18)		0.68–0.81 (6.8–8.1)		0.44–0.52 (4.4–5.2)		0.3–0.36 (3.0–3.6)	
Excavation	2 (20)		0.26–0.3 (2.6–3.0)		0.12–0.14 (1.2–1.4)		0.075–0.09 (0.7–0.9)		0.052–0.06 (0.5–0.6)	
	Adj. Area									
Buildings up to 50 ft (1 5 m) High	**Light**	**Dark**	**Light**	**Dark**	**Light**	**Dark**	**Light**	**Dark**	**Light**	**Dark**
Light surfaces	15 (150)	5 (50)	3.3 (33)	1.2 (12)	1.5 (15)	0.54 (5.4)	0.96 (10)	0.35 (3.5)	0.66 (7)	0.24 (2.4)
Medium light surfaces	20 (200)	10 (100)	4.3 (43)	2.2 (22)	1.94 (19)	1.0 (10)	1.25 (13)	0.64 (6)	0.86 (9)	0.44 (4.4)
Dark surfaces	50 (500)	20 (200)	10.0 (100)	4.3 (43)	4.5 (45)	1.94 (19)	2.9 (29)	1.2 (12)	2.0 (20)	0.86 (9)
	Adj. Area									
Billboards and Signs	**Light**	**Dark**	**Light**	**Dark**	**Light**	**Dark**	**Light**	**Dark**	**Light**	**Dark**
Good contrast	50 (500)	20 (200)	10 (100)	4.3 (43)	4.5 (45)	1.94 (19)	2.9 (29)	1.25 (13)	2.0 (20)	0.86 (8.6)
Poor contrast	100 (1000)	50 (500)	20 (200)	10 (100)	9.0 (90)	4.5 (45)	5.8 (58)	2.9 (29)	4.0 (40)	2.0 (20)
Protective Lighting										
Gates and vital area	5 (50)		1.2 (12)		0.54 (5.4)		0.35 (3.5)		0.24 (2.4)	
Building surrounds	1 (10)		0.15–0.19 (1.5–1.9)		0.07–0.09 (0.7–0.9)		0.044–0.055 (0.44–0.55)		0.03–0.04 (0.3–0.4)	
Roadways										
Along buildings	1 (10)		0.24 (2.4)		0.11 (1.1)		0.07 (0.7)		0.05 (0.5)	
Open areas	0.5 (5)		0.08–0.1 (0.8–1.0)		0.036–0.045 (0.36–0.45)		0.023–0.029 (0.23–0.29)		0.02 (0.2)	
Storage yards	20 (200)		3.6–.3 (36–43)		1.6–1.94 (16–19)		1.04–1.25 (10.4–12.5)		0.72–0.86 (7.2–8.6)	
Storage yards (inactive)	1 (10)		0.15–0.19 (1.5–1.9)		0.07–0.09 (0.7–0.9)		0.044–0.055 (0.44–0.55)		0.03–0.04 (0.3–0.4)	
Shopping Centers										
Parking areas (attraction)	5 (50)		0.65 (6.5)		0.29 (2.9)		0.19 (1.9)		0.13 (1.3)	
Buildings (attraction)					(See Buildings)					
Used car lots					(See Automobile Parking)					

[a]All illuminance levels for ground area applications are horizontal values.

[b]SI conversions are approximate, using a factor of 10 (versus 10.76).

Light pollution

- Place light where it is required = Do not place light where it is not required.
- light pollution: unwanted light in public spaces
  - e.g. excessive brightness
- light trespass: intrusion of unwanted light onto private property
  - e.g. light intrusion into windows

Fig. 17.29 *A "lollypop" fixture, even if aesthetically pleasing to some, gives poor illumination downward (note the large collar). This type of luminaire causes light pollution. (Photo by Nathan Majeski.)*

No standard or guideline so far..

- a few simple guides:
  - Light all exterior vertical surfaces from above, not below, wherever possible. This reduces sky-light pollution.
  - Use luminaires with sharp cutoff beyond the illuminated area. Shields can be added.

Remote source lighting

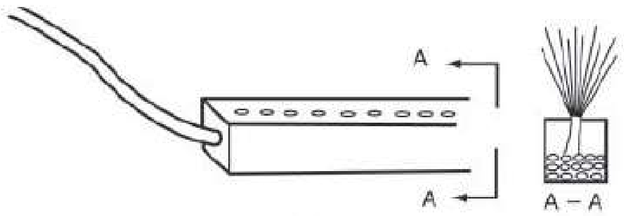
- The needs for remote source luminaire.
  - Display lighting for light and heat-sensitive objects (old books, fabrics, drawings, paintings, objects containing organic materials, dyes, coloring, objects sensitive to UV light)
  - Relamping is critical (e.g. high-ceiling auditoriums, difficult-access locations, clean rooms, security entrance limitations, air-traffic control rooms[no tolerations/no disturbance allowed], continuous-process manufacturing control areas)
  - Lamp heat is highly undesirable and heat removal is difficult, and expensive (e.g. store show windows, refrigerated showcases)
  - Presence of electrical wiring is undesirable (e.g. patient controlled hospital bed lighting, light sources used by children)
  - Electrically hazardous space (explosion-proof lighting)
  - The electric and magnetic fields produced by fluorescent and HID lamps are unacceptable
  - The light source must be very small and effectively invisible
- Two basic designs: fiber optic lighting + light guides

Fiber optic lighting

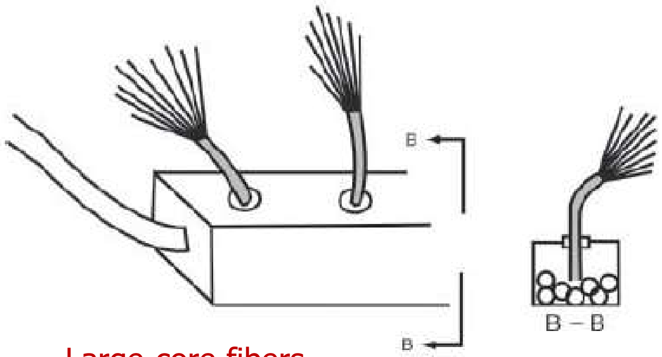
- The physical principle: total internal reflection (100% reflections).
- have been used in communications.
- limited use in lighting applications due to high cost, small light-carrying capacity, large bending radius.
- Applicable for the following:
  - A single remote source can supply a large number of relatively small point-source lights
  - The heat, UV content, and electrical fields are removed.
  - Absence of electrical wiring

(1) Axial mode linear devices

- A bundle of fibers is placed in a longitudinal enclosure → individual fibers or small groups of fibers are brought out of the enclosure as a light-emitting point (Fig 17.31(a))
- large-core fibers and/or multiple fiber bundles (Fig. 17.31(b)) compared to the closely spaced tiny light points.
- retail display lighting, accent lighting, decorative lighting



Individual fibers (a)



Large-core fibers or fiber bundles (b)

Fig. 17.31 Linear constructions using end-light fibers. (a) A light bar is simply a box containing multiple tails that are brought out of the box-type container at intervals, usually equal. Selecting fiber size, exit spacing, and illuminator size creates a low-intensity linear lighting fixture. (b) By using large fibers and/or bundles brought out in adjustable groups, the designer can readily construct a linear bar with adjustable multihead spotlights.

(2) Axial-mode discrete sources

- By large groups of end-light fiber bundles → semi-conventional lighting fixtures
- Absence of heat & electricity, low maintenance, higher efficiency of high output lamps in the illuminators / use of free daylight

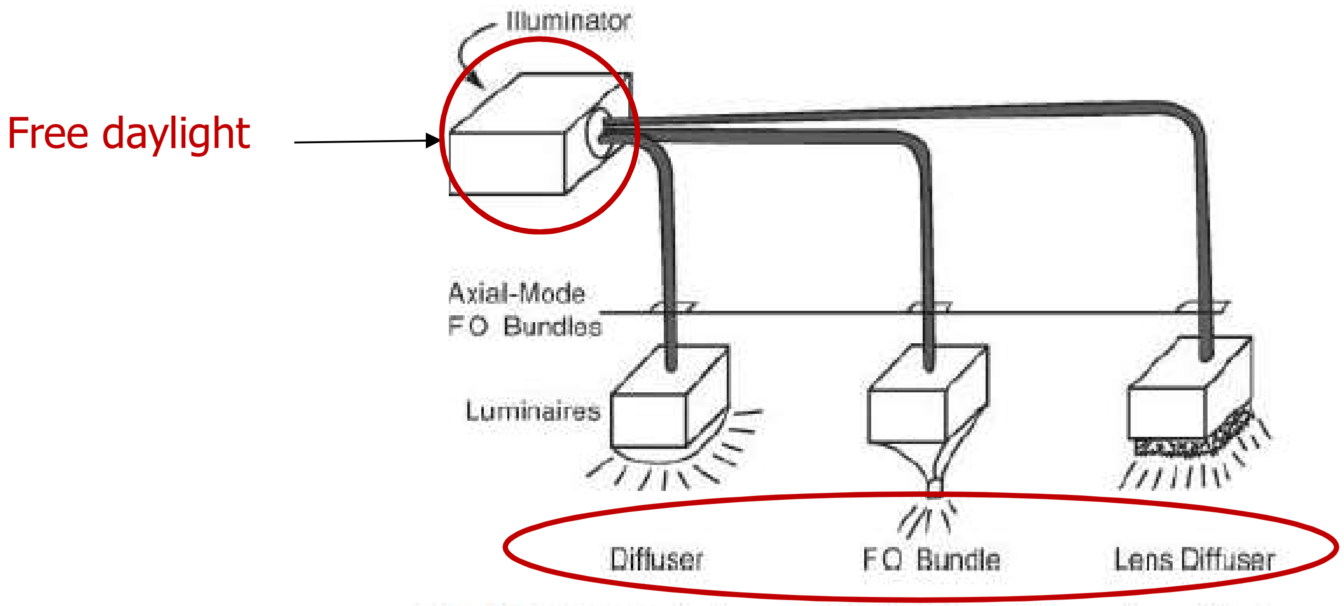


Fig. 17.32 Relatively large end-light FO bundles can be utilized as point sources in conventional types of lighting fixtures.

(2) Axial-mode discrete sources

color filter used in the illuminator

(3) Lateral mode FO lighting

- Due to transparent cladding and sheathing(피복), it emits light throughout their length
- Linear lighting, path lighting, all sorts of decorative trim lighting

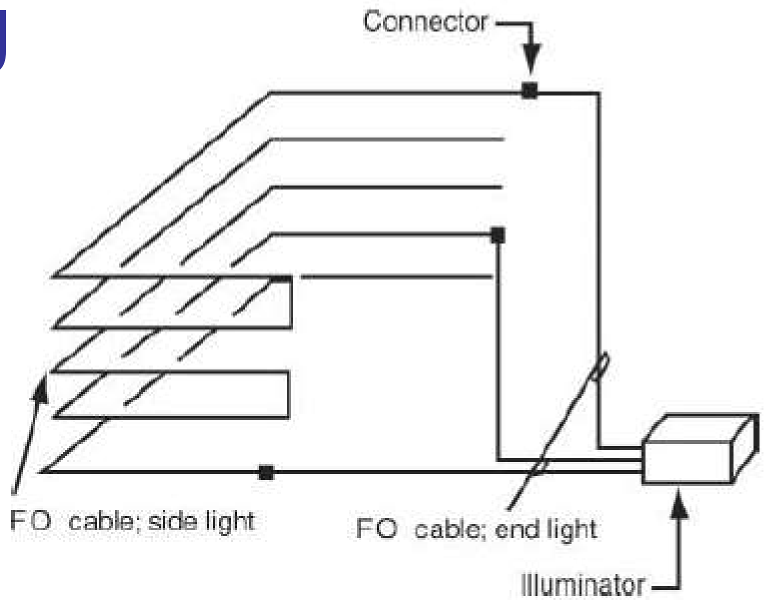
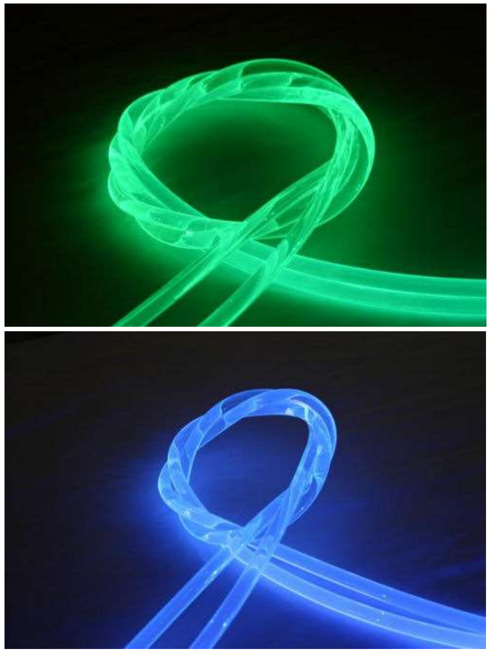
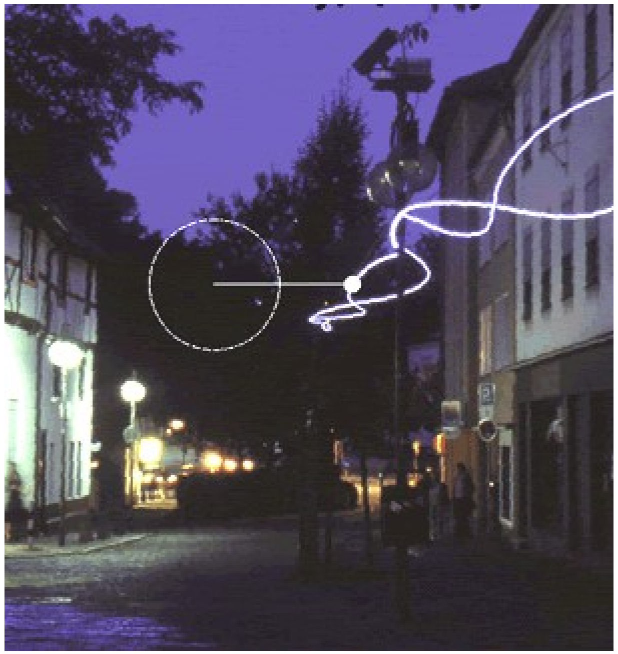


Fig. 17.33 Side-light-emitting FO cables are ideal for linear lighting tasks such as stair-edge illumination, under-shelf lighting, and outline lighting of all sorts. The illustrated 3-tail arrangement is representative of this type of FO lighting.

color filter used in the illuminator





Hollow light guides

- Figs.17.34, 17.35
- The attenuation is the principal problem with light guides and pipes.
  - The best metallic mirrors' specular reflection: 95%
  - (dust): 95% initial specular reflectance → 85% semi-diffuse reflection: overall light attenuation

Due to attenuation of reflected sunlight, lower-floor windows are larger than those at upper floors

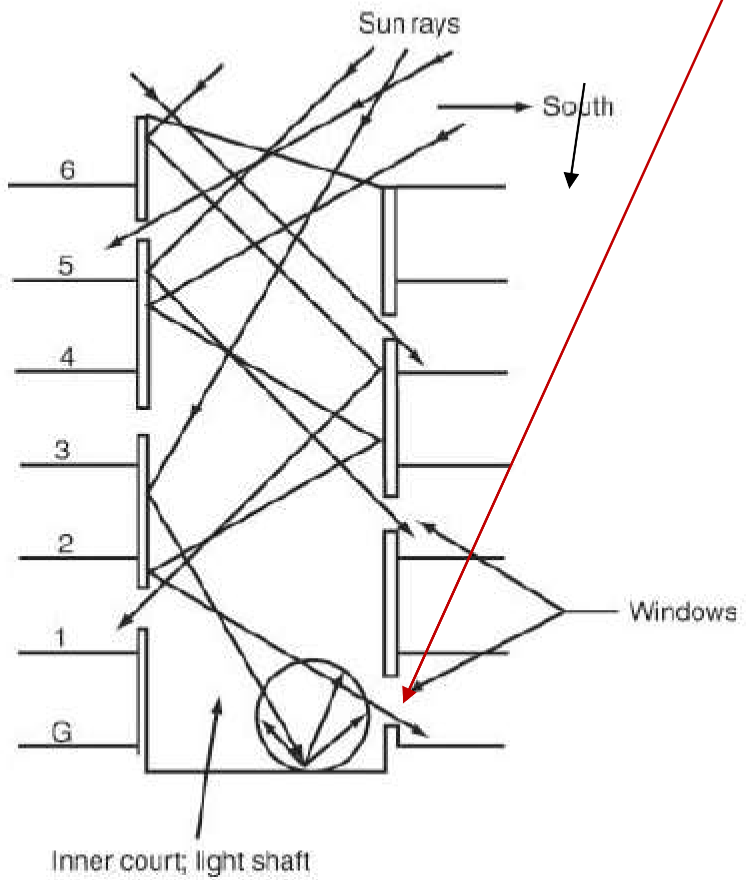


Fig. 17.34 An interior court or light well (shaft) with a reflective wall surface acts as a light guide to introduce daylight at lower floors. Buildings in the northern hemisphere are oriented as shown. Due to attenuation of re-reflected sunlight beams traveling down the shaft, lower-floor windows are larger than those at upper floors to capture more (of the attenuated) light. (Reprinted from NASA Tech Brief LAR-12333.)

Hollow light guides

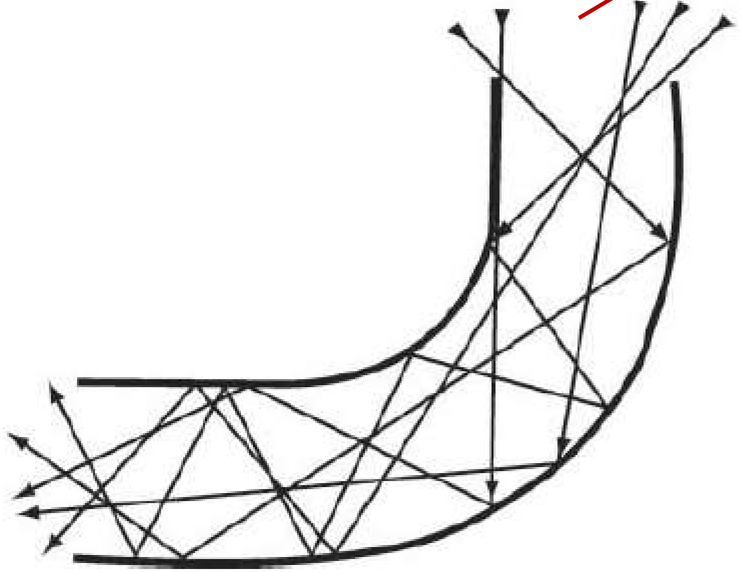
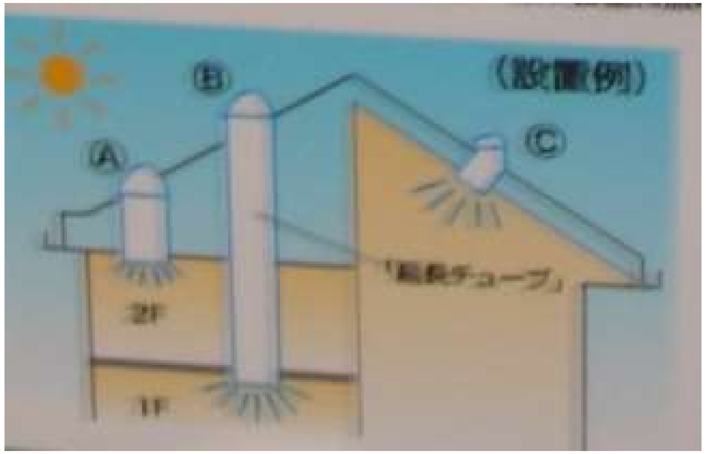


Fig. 17.35 Curvature in a light guide increases the number of reflections that a light ray makes over the guide length, thereby increasing attenuation. (Reprinted from NASA Tech Brief LAR-12333.)

This must be very large to capture enough skylight and sunlight.

Only very short guides are practical due to light attenuation.



Jan 2010
TEPIA, Tokyo, Japan

Similar to Fig. 17.34


4 1:18PM

To overcome attenuation…

- Collimate the incoming light → can reduce cross-sectional area of the guide
- dynamic sun tracking system required with collimating lenses and mirrors
- Two axes: azimuth (from east to west), altitude (up and down)

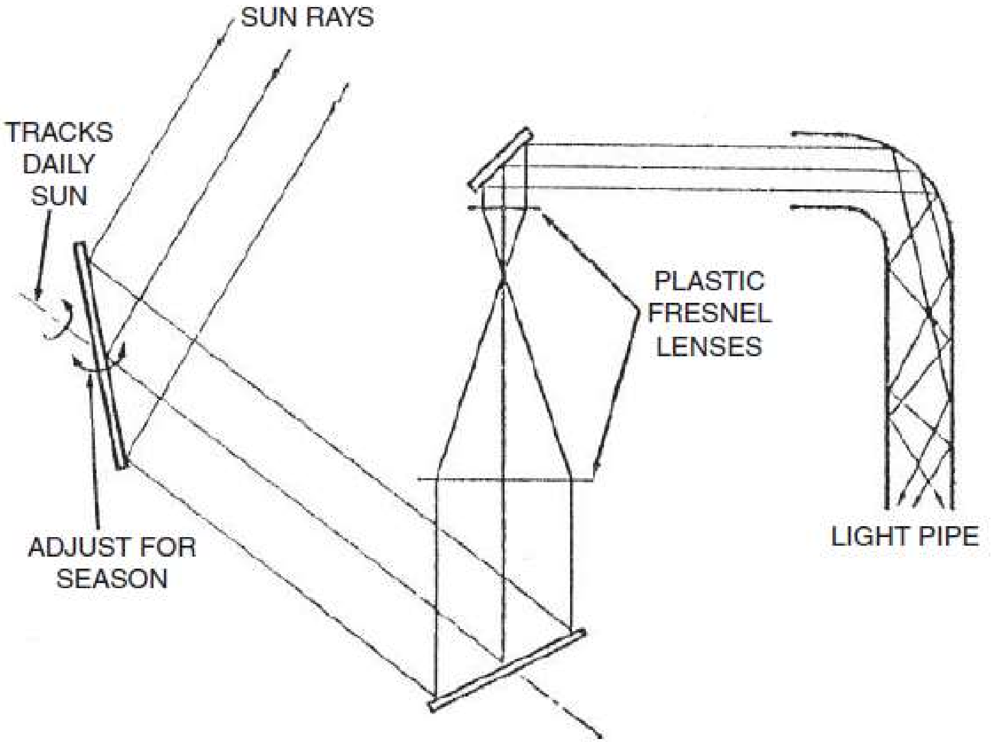


Fig. 17.36 Concentration and collimation of sunlight can be accomplished with a sun-tracking mirror and an optical train of mirrors and lenses. Full tracking of the sun requires altitude and azimuth drives on the collection mirror. To reduce costs without severely reducing collection efficiency, a full azimuth drive tracks the sun from east to west daily, while the mirror tilt around a horizontal axis (altitude tracking) is adjusted only seasonally to the mid-season position. The sun's maximum altitude varies 23.5° from equinox to solstice. (Reprinted from NASA Tech Brief LAR-12333.)

Prismatic light guides

- First introduced in 1981 (US patent 4260220, 1981)
- the facets of the prismatic exterior transparent acrylic walls of the pipe act as total internal reflection "mirrors". → very low loss of light
- At each reflection, only 2% of the light lost by absorption. 6% escaped through the wall.
- This 6% "loss" converts the light guide into a long, rectangular lighting fixture emitting light uniformly over its entire length.

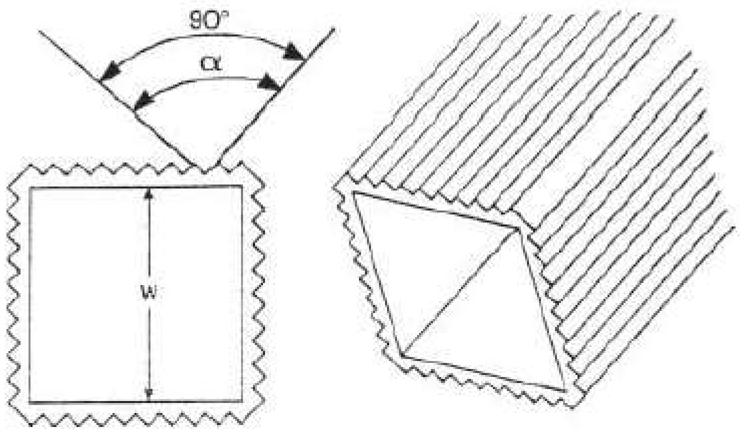


Fig. 17.37 *Views of the hollow, clear acrylic, prismatic light guide developed by L. A. Whitehead. The cross section measures 13-cm (≈5 in.) square, and the prism angle α is 90°. (Reprinted from Whitehead, 1982.)*

- Placing a mirror at the end of the guide: increasing the light output

Prismatic film light guide

- In 1988, the 3M developed a thin plastic prismatic film.
- At the prism face, total internal reflection (1% loss at each reflection)
- As a result, tubular hollow light guides can extend for lengths of several hundred feet.
- constructed to handle very large quantities of light, in contrast to FO.
- can be coupled to a very-high-output light sources
- Economies in wiring, luminaires, installation, maintenance offset the initial cost.

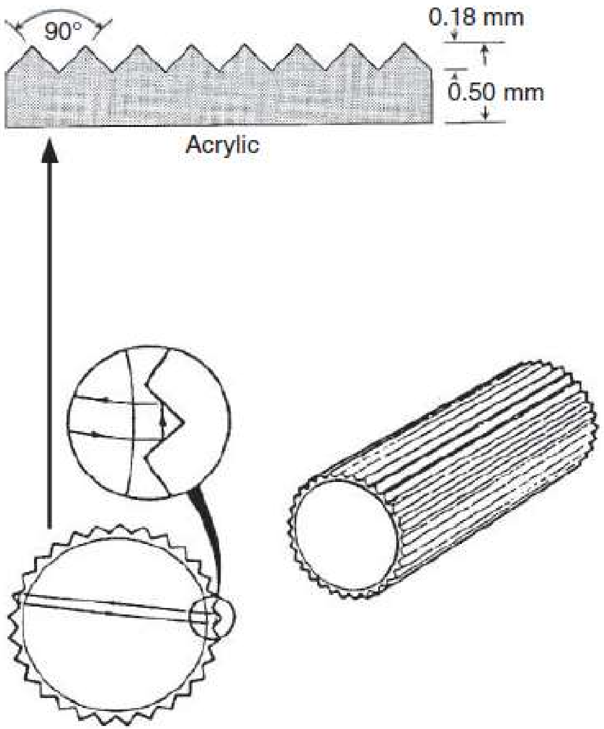
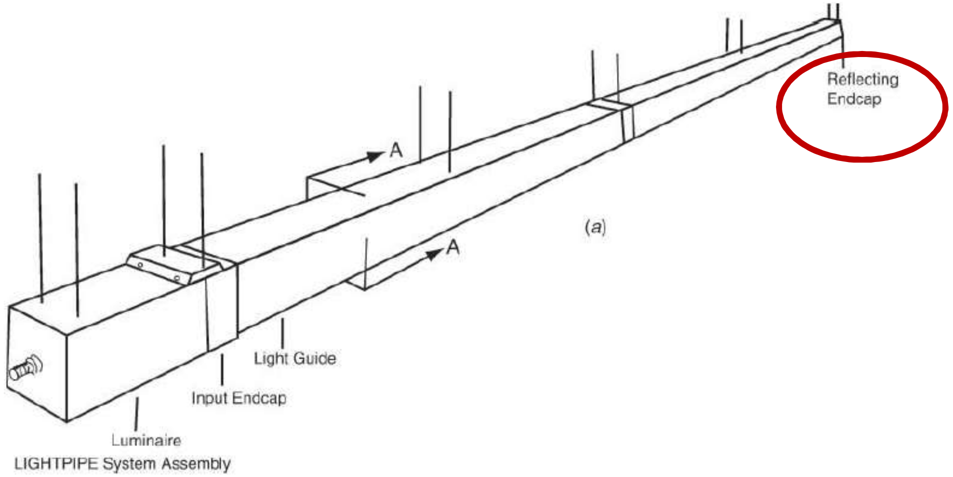
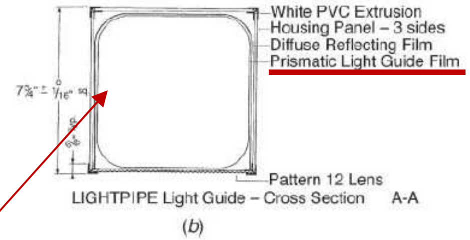


Fig. 17.38 Circular hollow light guide. If the prismatic plastic film is formed into a cylindrical shape as shown, it will act as a light guide with very low losses (0.18 mm = 0.007 in.; 0.5 mm = 0.02 in.). (Reprinted from a paper presented at Globalcon '96 by K. G. Kniepp of the 3M Company.)

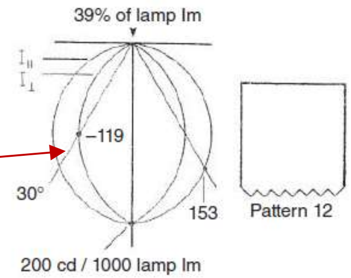
Photos: 3M examples

Light guide example





Three sides enclosed.
light emitting downward only



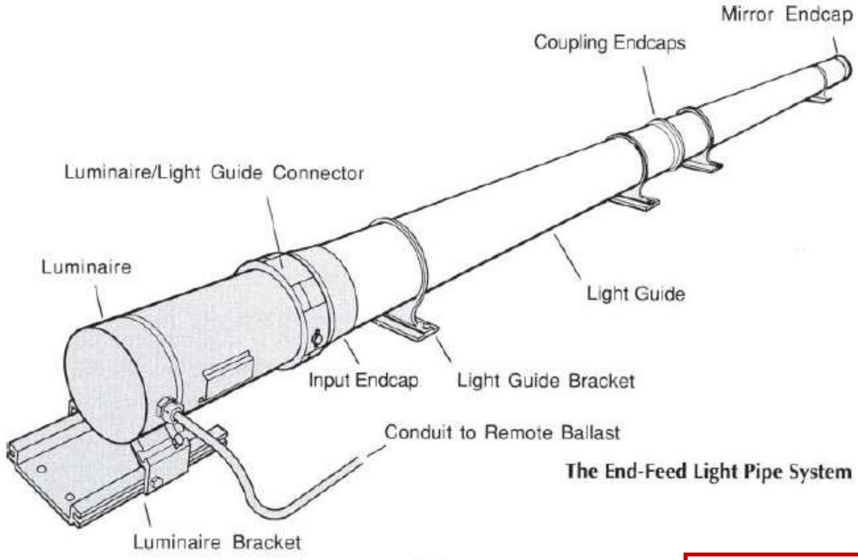
Pcc	80		50		30	
Pw	50	30	50	30	50	30
RCR						
0	.46	.46	.43	.43	.41	.41
1	.41	.40	.39	..38	.37	.37
2	.37	.35	.35	.33	.34	.32
3	.33	.31	.32	.30	.31	.29
4	.30	.27	.29	.26	.28	.26
5	.27	.24	.26	.23	.25	.23
6	.25	.22	.24	.21	.23	.21
7	.22	.19	.21	.19	.21	.19
8	.20	.17	.19	.17	.19	.17
9	.18	.15	.18	.15	.17	.15
10	.17	.14	.16	.14	.16	.13

CU Table – One Side Emitting

(c)

Fig. 17.39 Details of a rectangular light-guide fixture. (a) The entire lighting unit comprises a "luminaire" at one end containing the light source (250- or 400-W metal-halide lamp) and its accessories connected to the hollow prismatic light guide. The end of the guide is sealed with a mirror that reflects the light back into the light guide. (b) The light guide itself is enclosed on three sides and equipped with a prismatic lens diffuser on the open (bottom) surface through which light is emitted. This specific design is usable to a length of 40 ft (12 m). Longer units are equipped with light sources at both ends. (c) Photometric characteristics of the luminaire-light guide assembly. (Courtesy of TIR Systems, LTD.)

Example



(a)

CU Tables — End-Feed System

ρ_{cc}	70		50	
ρ_w	50	30	50	30
RCR				
0	.34	.34	.32	.32
1	.30	.29	.29	.28
2	.26	.25	.25	.24
3	.24	.21	.23	.21
4	.21	.19	.20	.18
5	.19	.16	.18	.16
6	.17	.14	.16	.14
7	.15	.13	.15	.12

CU Table - 90° Emitting

ρ_{cc}	70		50	
ρ_w	50	30	50	30
RCR				
0	.36	.36	.34	.34
1	.30	.29	.28	.27
2	.26	.24	.24	.23
3	.23	.20	.21	.19
4	.20	.17	.19	.16
5	.17	.15	.17	.14
6	.15	.13	.15	.12
7	.14	.11	.13	.11

CU Table - 120° Emitting

ρ_{cc}	70		50	
ρ_w	50	30	50	30
RCR				
0	.39	.39	.36	.36
1	.33	.31	.30	.29
2	.28	.25	.26	.24
3	.24	.22	.23	.20
4	.21	.18	.20	.17
5	.19	.16	.18	.15
6	.17	.14	.16	.13
7	.15	.12	.14	.11

CU Table - 180° Emitting

ρ_{cc}	70			50	
ρ_w	50	30		50	30
RCR					
0	.39	.39	.39	.35	.35
1	.32	.30	.28	.29	.27
2	.27	.24	.22	.24	.12
3	.23	.20	.18	.21	.18
4	.20	.17	.15	.18	.16
5	.18	.14	.12	.16	.13
6	.16	.13	.10	.14	.11
7	.14	.11	.09	.13	.10

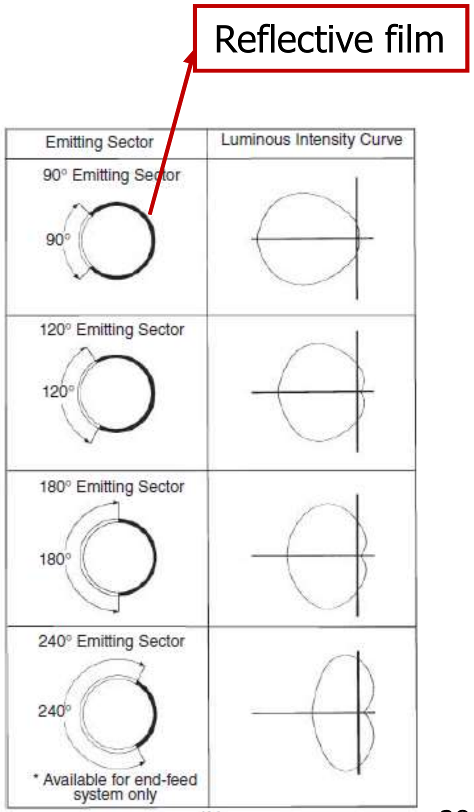
CU Table - 240° Emitting

Length of Run (feet)		10 ft.	20 ft.	30 ft.	40 ft.
Lumens/foot		500 lm/ft.	270 lm/ft.	165 lm/ft.	110lm/ft.
Peak Luminous Intensity (cd)\(Mean Exitance (lm/ft²))	90° emitting	1569\(1070)	1708\(583)	1569\(357)	1435\(245)
	120° emit	1143\(850)	1243\(462)	1143\(283)	1043\(194)
	180° emit	1091\(631)	1187\(343)	1091\(210)	998\(144)
	240° emit	696\(497)	757\(270)	696\(166)	N/A

Note: All values listed are based on the maintained output of a single T250 luminaire.

Photometric Data - End-Feed System

(c)



(b)

***Fig. 17.40** Details of a 7-in. (178-mm) diameter hollow prismatic end-feed light-guide fixture. (a) The entire unit consists of an opaque "luminaire" section containing a 250-W metal–halide lamp connected to a 7-in. (178-mm) diameter acrylic tube up to 44 ft (13 m) in length containing prismatic optical film and terminating in a reflective (mirrored) endcap. (b) The portion of the tube circumference that emits light (uniformly) is controlled by placement of a diffuse reflecting film between the inner prismatic film and the outer transparent acrylic envelope (see Fig. 17.39b). The reflective film is shown as the black portion of the tube circumference. (c) Photometric data for an end-feed system with a single 250-W metal-halide source. (Courtesy of TIR Systems, Ltd.)*

Light guide example

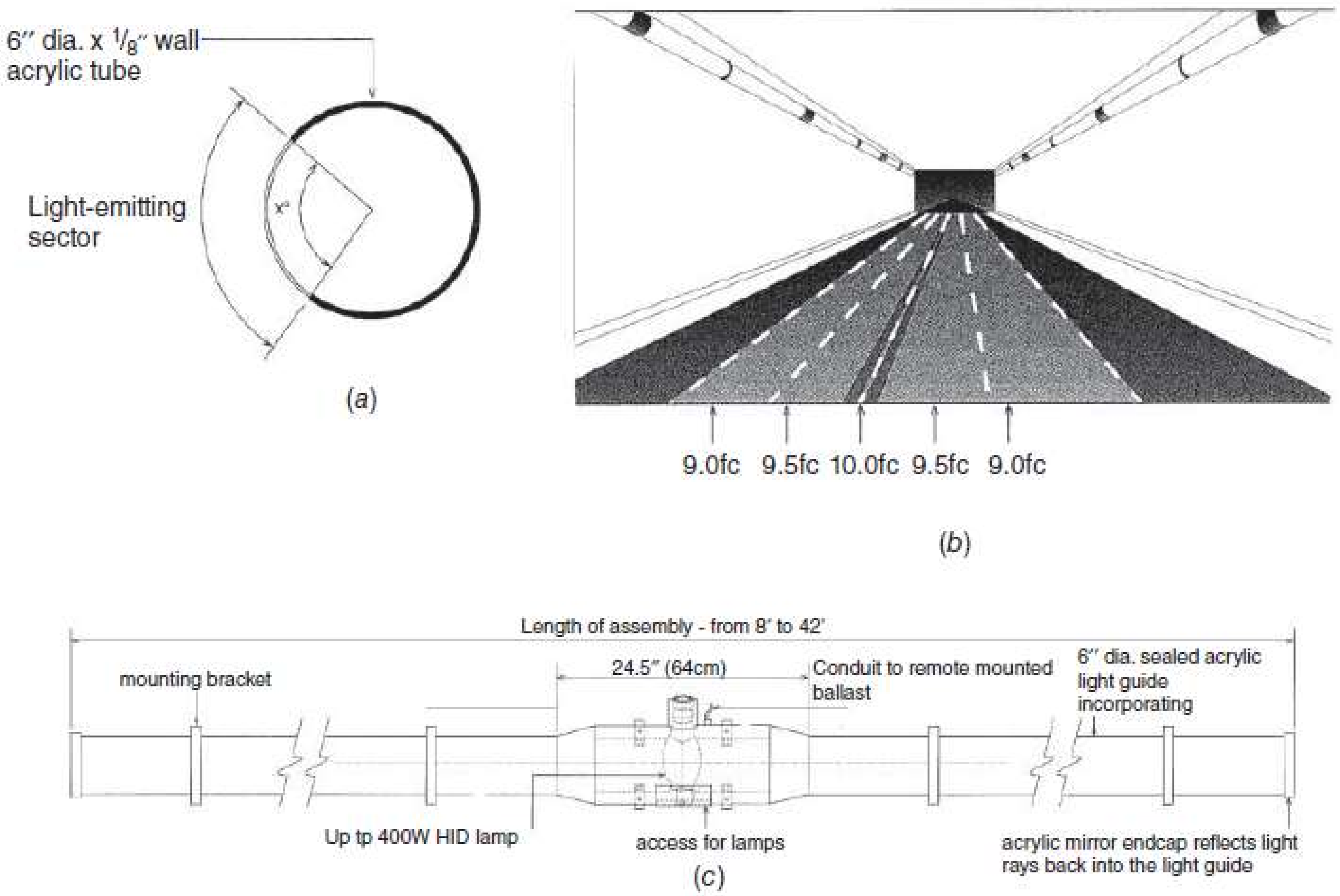
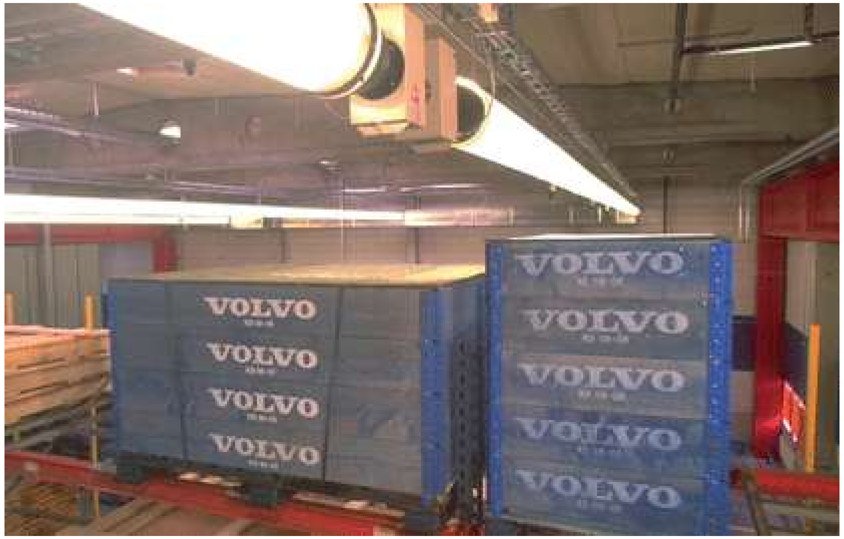


Fig. 17.41 *Application of a prismatic tubular light guide to tunnel lighting. (a) Section demonstrating how light is emitted from the light guide. (b) Perspective drawing showing tubular lighting on both sides of the tunnel and the resultant uniform tunnel illuminance levels. (c) Drawing of one section of the center-feed light guide. (Courtesy of TIR Systems, Ltd.)*

high bay industrial and commercial installations, large exterior signs, tunnel illumination, highway signs, continuous rail guidance illumination, exterior architectural lighting, etc.


VOLVO
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