

# Recommended Light Levels

## Recommended Light Levels (Illuminance) for Outdoor and Indoor Venues

This is an instructor resource with information to be provided to students as the instructor sees fit. Light Level or Illuminance, is the amount of light measured in a plane surface (or the total luminous flux incident on a surface, per unit area). The work plane is where the most important tasks in the room or space are performed.

### Measuring Units of Light Level - Illuminance

Illuminance is measured in foot candles (*ftcd, fc, fcd*) or lux (in the metric SI system). A *foot candle* is actually *one lumen of light density per square foot*; *one lux* is *one lumen per square meter*.

- $1 \text{ lux} = 1 \text{ lumen} / \text{sq meter} = 0.0001 \text{ phot} = 0.0929 \text{ foot candle (ftcd, fcd)}$
- $1 \text{ phot} = 1 \text{ lumen} / \text{sq centimeter} = 10000 \text{ lumens} / \text{sq meter} = 10000 \text{ lux}$
- $1 \text{ foot candle (ftcd, fcd)} = 1 \text{ lumen} / \text{sq ft} = 10.752 \text{ lux}$

### Common Light Levels Outdoors from Natural Sources

Common light levels outdoor at day and night can be found in the table below:

Condition	Illumination	
	(ftcd)	(lux)
Sunlight	10,000	107,527
Full Daylight	1,000	10,752
Overcast Day	100	1,075
Very Dark Day	10	107
Twilight	1	10.8
Deep Twilight	.1	1.08
Full Moon	.01	.108
Quarter Moon	.001	.0108
Starlight	.0001	.0011
Overcast Night	.00001	.0001

### Common Light Levels Outdoors from Manufactured Sources

The nomenclature for most of the types of areas listed in the table below can be found in the City of Los Angeles, Department of Public Works, Bureau of Street Lighting's "DESIGN STANDARDS AND GUIDELINES" at the URL address under **References** at the end of this document.



The National Optical Astronomy Observatory (NOAO) is the U.S. national observatory operated by the Association of Universities for Research in Astronomy, Inc. (AURA) under cooperative agreement with the National Science Foundation (NSF).



# Recommended Light Levels

## A. RECOMMENDATIONS FOR LIGHTING LEVELS FOR ROADWAYS AND SIDEWALKS IN LUX (FC)

The illumination standards for roadway lighting will be adhered to by all engineers.

### Illuminance Method – Recommended Values

Road and Pedestrian Conflict <b>Are</b>		Pavement Classification (Minimum maintained Average Values)			Uniformity Ratio $E_{av} / E_{min}$	Veiling Luminanc Ratio $L_{vma} / L_{ev}$
Road	Pedestrian Conflict	R1 lux/fc	R2 & lux/fc	R4 lux/fc		
Freeway Class A		6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Freeway Class		4.0/0.4	6.0/0.6	5.0/0.5	3.0	0.3
Expressway	High	10.0/1.0	14.0/1.4	13.0/1.3	3.0	0.3
	Medium	8.0/0.8	12.0/1.2	10.0/1.0	3.0	0.3
	Low	6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Major	High	12.0/1.2	17.0/1.7	15.0/1.5	3.0	0.3
	Medium	9.0/0.9	13.0/1.3	11.0/1.1	3.0	0.3
	Low	6.0/0.6	9.0/0.9	8.0/0.8	3.0	0.3
Collector	High	8.0/0.8	12.0/1.2	10.0/1.0	4.0	0.4
	Medium	6.0/0.6	9.0/0.9	8.0/0.8	4.0	0.4
	Low	4.0/0.4	6.0/0.6	5.0/0.5	4.0	0.4
Local	High	6.0/0.6	9.0/0.9	8.0/0.8	6.0	0.4
	Medium	5.0/0.5	7.0/0.7	6.0/0.6	6.0	0.4
	Low	3.0/0.3	4.0/0.4	4.0/0.4	6.0	0.4

Recommended Illuminance for the Intersection of Continuously Lighted Urban Streets  
(Based on the values in Table 2 for R2 and R3 pavement classifications)

Functional Classification	Illuminance for intersections			$E_{avg} / E_{min}$
	Average Maintained Illumination at Pavement by Pedestrian Area Classification lux/fc			
	High	Medium	Low	
Major/Major	34.0/3.4	26.0/2.6	18.0/1.8	3.0
Major/Collector	29.0/2.9	22.0/2.2	15.0/1.5	3.0
Major/Local	26.0/2.6	20.0/2.0	13.0/1.3	3.0
Collector/Collector	24.0/2.4	18.0/1.8	12.0/1.2	4.0
Collector/Local	21.0/2.1	16.0/1.6	10.0/1.0	4.0
Local/Local	18.0/1.8	14.0/1.4	8.0/0.8	6.0



The National Optical Astronomy Observatory (NOAO) is the U.S. national observatory operated by the Association of Universities for Research in Astronomy, Inc. (AURA) under cooperative agreement with the National Science Foundation (NSF).



# Recommended Light Levels

## Common and Recommended Light Levels Indoors

The outdoor light level is approximately *10,000 lux* on a clear day. In the building, in the area closest to windows, the light level may be reduced to approximately *1,000 lux*. In the middle area its may be as low as *25 - 50 lux*. Additional lighting equipment is often necessary to compensate the low levels.

Earlier it was common with light levels in the range *100 - 300 lux* for normal activities. Today the light level is more common in the range *500 - 1000 lux* - depending on activity. For precision and detailed works, the light level may even approach *1500 - 2000 lux*.

The table below is a guide for recommended light level in different workspaces:

Activity	Illumination (lux, lumen/m <sup>2</sup> )
Public areas with dark surroundings	20 - 50
Simple orientation for short visits	50 - 100
Working areas where visual tasks are only occasionally performed	100 - 150
Warehouses, Homes, Theaters, Archives	150
Easy Office Work, Classes	250
Normal Office Work, PC Work, Study Library, Groceries, Show Rooms, Laboratories	500
Supermarkets, Mechanical Workshops, Office Landscapes	750
Normal Drawing Work, Detailed Mechanical Workshops, Operation Theatres	1,000
Detailed Drawing Work, Very Detailed Mechanical Works	1500 - 2000
Performance of visual tasks of low contrast and very small size for prolonged periods of time	2000 - 5000
Performance of very prolonged and exacting visual tasks	5000 - 10000
Performance of very special visual tasks of extremely low contrast and small size	10000 - 20000

Generally, factors that affect the effectiveness of illumination are quantity and quality of light, amount of flicker, amount of glare, contrast and shadows. Each factor must be adjusted differently to optimize illumination in emergency, safety, operations, and security situations, for instance. Lighting Standards also serve to address the plethora of other concerns associated with the design, placement, installation, and minimum energy requirements and efficient allocation of illumination in different locations with different purposes, as well as the efficiency, durability, cost, and maintainability.



The National Optical Astronomy Observatory (NOAO) is the U.S. national observatory operated by the Association of Universities for Research in Astronomy, Inc. (AURA) under cooperative agreement with the National Science Foundation (NSF).



# Recommended Light Levels

## Additional Recommended Light Levels Indoors

<b>Office Space</b>	
Normal work station space, open or closed offices <sup>1</sup>	500
ADP Areas	500
Conference Rooms	300
Training Rooms	500
Internal Corridors	200
Auditoria	150-200
<b>Public Areas</b>	
Entrance Lobbies, Atria	200
Elevator Lobbies, Public Corridors	200
Ped. Tunnels and Bridges	200
Stairwells	200
<b>Support Spaces</b>	
Toilets	200
Staff Locker Rooms	200
Storage Rooms, Janitors' Closets	200
Electrical Rooms, Generator Rooms	200
Mechanical Rooms	200
Communications Rooms	200
Maintenance Shops	200
Loading Docks	200
Trash Rooms	200
<b>Specialty Areas</b>	
Dining Areas	150-200
Kitchens	500
Outleased Space	500
Physical Fitness Space	500
Child Care Centers	500
Structured Parking, General Space	50
Structured Parking, Intersections	100
Structured Parking, Entrances	500

# Recommended Light Levels

## Calculating Illumination

Illumination can be calculated as

$$I = L_l C_u L_{LF} / A_l \quad (1)$$

where

$I$  = illumination (lux, lumen/m<sup>2</sup>)

$L_l$  = lumens per lamp (lumen)

$C_u$  = coefficient of utilization

$L_{LF}$  = light loss factor

$A_l$  = area per lamp (m<sup>2</sup>)

## Example - Illumination

10 incandecent lamps of 500 W (10600 lumens per lamp) are used in an area of 50 m<sup>2</sup>. With  $C_u = 0.6$  and  $L_{LF} = 0.8$  illumination can be calculated as

$$\begin{aligned} I &= 10 (10600 \text{ lumens}) (0.6) (0.8) / (50 \text{ m}^2) \\ &= \underline{1018 \text{ lux}} \end{aligned}$$

## References

- 1) [http://www.engineeringtoolbox.com/light-level-rooms-d\\_708.html](http://www.engineeringtoolbox.com/light-level-rooms-d_708.html)
- 2) <http://www.illuminate.com/lightlevels.htm>
- 3) <http://bsl.lacity.org/downloads/business/BSLDesignStandardsAndGuidelines0507Web.pdf>
- 4) <http://www.gsa.gov/portal/content/101308>
- 5) <http://www.ncef.org/pubs/lighting.pdf>

The last reference was not quoted above but is very worth reviewing. It specifies lighting sources for schools, which in most cases is where students will take their measurements for the Safety activity. The table on its page 3 is a guide for choosing electric lighting systems for school applications. Note that mean lumens per watt is the measure of the energy efficiency of the lamp system, much the way miles per gallon measures the energy efficiency of an automobile. And a luminaire is the proper term for a lighting fixture.



The National Optical Astronomy Observatory (NOAO) is the U.S. national observatory operated by the Association of Universities for Research in Astronomy, Inc. (AURA) under cooperative agreement with the National Science Foundation (NSF).

