

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 Are | | 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 ²) |
|---|--|
| 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.

Recommended Light Levels

Additional Recommended Light Levels Indoors

| Office Space | |
|--|---------|
| Normal work station space, open or closed offices ¹ | 500 |
| ADP Areas | 500 |
| Conference Rooms | 300 |
| Training Rooms | 500 |
| Internal Corridors | 200 |
| Auditoria | 150-200 |
| Public Areas | |
| Entrance Lobbies, Atria | 200 |
| Elevator Lobbies, Public Corridors | 200 |
| Ped. Tunnels and Bridges | 200 |
| Stairwells | 200 |
| Support Spaces | |
| 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 |
| Specialty Areas | |
| 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 |



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

Calculating Illumination

Illumination can be calculated as

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

where

I = illumination (lux, lumen/m²)

L_l = lumens per lamp (lumen)

C_u = coefficient of utilization

L_{LF} = light loss factor

A_l = area per lamp (m²)

Example - Illumination

10 incandecent lamps of 500 W (10600 lumens per lamp) are used in an area of 50 m². 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
- 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.