

Interior Locations and Tasks			Horizontal		Vertical	
			Lux	Footcandles	Lux	Footcandles
Auditoriums						
	Assembly		100	10		
	Social Activity		50	5	30	3
Drafting/Graphic Arts						
	CAD stations		100	10	30	3
	Mixed CAD and paper task		300	30	30	3
	Mylar					
	high contrast		500	50	100	10
	low contrast		1000	100	300	30
	Vellum/Mylar					
	high contrast		500	50	100	10
	low contrast		1000	100	300	30
	Overlays					
	Light Table		100	10	30	3
	Prints		500	50	100	10
Educational Facilities						
	Corridors				100	10
	Classrooms					
	General	SEE READING				
	Art Rooms		500	50	300	30
	Drafting	SEE DRAFTING/GRAPHICS				
	Home Economics	SEE RESIDENCES				
	Science Laboratories		500	50	300	30
	Lecture Rooms					
	Audience (reading)	SEE READING				
	Demonstration		1000	100	500	50
	Music Rooms (reading)	SEE READING				
	Sight Saving Rooms		1000	100	500	50
	Study Halls (reading)	SEE READING				
	Typing (reading)	SEE READING				
	Gymnasiums					
	Basketball		1000	100	300	30
	Social Events		50	5	30	3
	Cafeterias	SEE FOOD SERVICE FACILITIES				
	Dormitories	SEE RESIDENCES				
Food Service Facilities						
	Cleaning		100	10		
	Dining		100	10	30	3
	Food Displays		500	50		
	Food Storage					
	Non-refrigerated		50	5	30	3
	Refrigerated		50	5	30	3
	Gallery		500	50	100	10
	Kitchen		500	50	30	3
	Pantry		300	30	30	3
	Refuse Area		100	10		
	Sculleries		500	50	100	10
Libraries						
	Reading Stacks		300	30		
	Bookstacks					
	Active				300	30
	Inactive				50	5
	Book Repair or Binding		300	30	30	3
	Cataloguing		300	30		
	Card Files (paper)		300	30	50	5
	Carrels - indiv study desks		300	30		
	Circulation Desk		300	30		
	Map, Picture & Print Room	SEE GRAPHIC DESIGN				
	Audiovisual Areas		300	30		
	Audio Listening Areas		300	30		
	Microform Areas		300	30		
	Locker Rooms		100	10	30	3
Offices R Filing (see reading)			500	50	100	10
General and Private (see reading)						
	Open plan office					
	Intensive VDT use		300	30	50	5
	Open plan office					
	Intermittent VDT use		500	50	50	5
	Private Office (small)		500	50	50	5
	Mail Sorting		500	50	30	3
	Copy Rooms		100	10	30	3

Reading

Copied Tasks

Microfiche Reader	30	3	30	3
Photograph (moderate detail)	500	50		
Thermal Copy (poor)	1000	100		
Photocopies	300	30		
Photocopies (3rd generation)	500	50		

Data Processing Tasks

VDT Screens	30	3	30	3
Impact Printer				
good ribbon	300	30		
2nd carbon and greater	500	50		
ink jet or laser printer	300	30		
keyboard reading	300	30		

Machine Rooms

Active Operations	300	30		
Tape Storage	300	30	50	5
Machine Area	100	10		
Equipment Service	500	50	100	10
Thermal Print	500	50		

Handwritten Tasks

#2 pencil and softer	300	30		
#3 pencil	500	50		
#4 pencil and harder	1000	100		
Ball-point pen	300	30		
Felt-tip pen	300	30		
Handwritten Carbon Copy	500	50		
White Boards			50	5
Chalk Boards			500	50

Printed Tasks

6-Point Type	500	50		
8- and 10- Point Type	300	30		
Glossy Magazines	300	30		
Maps	500	50		
Newsprint	300	30		
Typed Originals	300	30		
Telephone Books	500	50		

Residences

General Lighting	50	5		
Conversation, Relaxation, Entertainment	30	3	30	3
Passage Areas	30	3	30	3

Specific Visual Tasks

Dining	50	5		
Grooming				
Makeup and Shaving	300	30	50	5
Dressing Evaluation (mirror)	300	30	50	5

Handcrafts and Hobbies

Ordinary Tasks	300	30	50	5
Difficult Tasks	500	50	100	10
Critical Tasks	1000	100	300	30
Easel Hobbies			300	30

Ironing

	300	30		
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Kitchen Counter

Critical Seeing (cutting)	500	50	100	10
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General	300	30	50	5
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Kitchen Range

Difficult Seeing (cooking)	500	50	100	10
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Kitchen Sink

Difficult Seeing	500	50	100	10
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Noncritical (cleanup)	300	30	50	5
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Laundry

	300	30	30	3
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Music Study

	300	30	50	5
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Reading

Casual Chair	300	30	50	5
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Serious Chair	500	50	100	10
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Casual Bed	300	30	50	5
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At Desk

Casual	300	30	30	3
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Serious	500	50	100	10
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Sewing

Table Games	300	30	50	5
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Toilets and Washrooms

	50	5	30	3
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Interior Locations and Tasks Based on ANSI/IESNA RP-3-00			Horizontal		Vertical		Minimum for Safety		
			Lux	Footcandles	Lux	Footcandles	Lux	Footcandles	
Auditoriums	Assembly		100	10			50	5	
	Social Activity		50	5					
Drafting/Graphic Arts	CAD stations		100	10	30	3			
	Mixed CAD and paper task		300	30	30	3			
	Drafting Rooms						10	1	
	Vellum/Mylar	high contrast		500	50	100	10		
		low contrast		1000	100	300	30		
	Overlays								
	Light Table			100	10	30	3		
Prints			500	50	100	10			
Educational Facilities	Corridors					100	10	10	1
	Classrooms	General		see Reading				5	0.5
		Art Rooms		500	50	300	30		
		Science Laboratories		500	50	300	30		
	Lecture Rooms							10	1
		Audience (reading)		see Reading					
		Demonstration/Laboratory		1000	100	500	50	50	5
		Music Rooms (reading)		see Reading					
		Sight Saving Rooms		1000	100	500	50		
		Study Halls (reading)		see Reading					
		Typing (reading)		see Reading					
	Shops						10	1	
	Gymnasiums	Basketball		1000	100	300	30	10	1
		Social Events		50	5	30	3		
		Bleachers						5	0.5
		Swimming Pools						20	2
	Cafeterias						see Food Service Facilities		
	Dormitories						see Residences/Dormitories		
	Food Service Facilities	Cleaning		100	10				
Dining			100	10	30	3			
Food Displays			500	50					
Food Storage		Non-refrigerated		50	5	30	3		
		Refrigerated		50	5	30	3		
Gallery			500	50	100	10			
Kitchen			500	50	30	3	20	2	
Pantry			300	30	30	3			
Refuse Area			100	10					
Sculleries			500	50	100	10			
Reading Stacks			300	30			20	2	
Libraries	Bookstacks	Active			300	30			
		Inactive			50	5			
	Book Repair or Binding		300	30	30	3			
	Cataloguing		300	30					
	Card Files (paper)		300	30	50	5			
	Carrels - indiv study desks		300	30					
	Circulation Desk		300	30					
	Map, Picture & Print Room		see Drafting/Graphic Arts						
	Audiovisual Areas		300	30					
	Audio Listening Areas		300	30					
Microform Areas		300	30						
Locker Rooms		100	10	30	3	10	1		
Offices RP-1-04	Filing (see reading)		500	50	100	10			
	General and Private (see reading)								
	Open plan office	Intensive VDT use		300	30	50	5	10	1
		Intermittent VDT use		500	50	50	5	10	1
	Private Office (small)		500	50	50	5	5	0.5	
	Mail Sorting		500	50	30	3			
	Copy Rooms		100	10	30	3			
Reading	Copied Tasks	Microfiche Reader		30	3	30	3	20	2
		Photograph (moderate detail)		500	50				
		Thermal Copy (poor)		1000	100				
	Data Processing Tasks	Photocopies		300	30				
		Photocopies (3rd generation)		500	50				
		VDT Screens		30	3	30	3		
		Impact Printer: good ribbon		300	30				
		2nd carbon and greater		500	50				
		ink jet or laser printer		300	30				
		keyboard reading		300	30				
	Machine Rooms	Active Operations		300	30				
		Tape Storage		300	30	50	5		
		Machine Area		100	10				
		Equipment Service		500	50	100	10		
	Handwritten Tasks	Thermal Print		500	50				
		#2 pencil and softer		300	30				
		#3 pencil		500	50				
		#4 pencil and harder		1000	100				
		Ball-point pen		300	30				
		Felt-tip pen		300	30				
		Handwritten Carbon Copy		500	50				
	White Boards				50	5			

Suggested School Lighting Guide

Interior Locations and Tasks Based on ANSI/IESNA RP-3-00		Avg. Measured Horizontal Footcandles	
Auditoriums	Assembly	10	
	Social Activity	5	
Drafting/Graphic Arts	CAD stations	10	
	Mixed CAD and paper task	30	
	Drafting Rooms	Vellum/Mylar high contrast	50
		low contrast	100
	Overlays		
	Light Table	10	
	Prints	50	
Educational Facilities	Corridors		
	Classrooms	General	see Reading
		Art Rooms	50
		Science Laboratories	50
	Lecture Rooms	Audience (reading)	see Reading
		Demonstration/Laboratory	100
		Music Rooms (reading)	see Reading
		Sight Saving Rooms	100
		Study Halls (reading)	see Reading
		Typing (reading)	see Reading
		Shops	
	Gymnasiums	Basketball	100
		Social Events	5
		Bleachers	
	Cafeterias		see Food Service Facilities
	Dormitories		see Residences/Dormitories
	Food Service Facilities	Cleaning	10
		Dining	10
		Food Displays	50
		Food Storage	Non-refrigerated
Refrigerated			5
Gallery		50	
Kitchen		50	
Pantry		30	
Refuse Area		10	
Sculleries		50	
Libraries	Reading Stacks	30	
	Bookstacks	Active	
		Inactive	
	Book Repair or Binding	30	
	Cataloguing	Card Files (paper)	30
		Carrels - indiv study desks	30
		Circulation Desk	30
		Map, Picture & Print Room	see Drafting/Graphic Arts
		Audiovisual Areas	30
		Audio Listening Areas	30
		Microform Areas	30
Locker Rooms		10	
Offices RP-1-04	Filing (see reading)	50	
	General and Private (see reading)	Open plan office	
		Intensive VDT use	30
		Intermittent VDT use	50
	Private Office (small)	50	
	Mail Sorting	50	
	Copy Rooms	10	
Reading	Copied Tasks	Microfiche Reader	3
		Photograph (moderate detail)	50
		Thermal Copy (poor)	100
		Photocopies	30
		Photocopies (3rd generation)	50
	Data Processing Tasks	VDT Screens	3

Suggested School Lighting Guide

Toilets and Washrooms	Impact Printer: good ribbon	30	
	2nd carbon and greater	50	
	ink jet or laser printer	30	
	keyboard reading	30	
	Machine Rooms	Active Operations	30
		Tape Storage	30
		Machine Area	10
		Equipment Service	50
		Thermal Print	50
		Handwritten Tasks	30
	#2 pencil and softer	50	
	#3 pencil	50	
	#4 pencil and harder	100	
	Ball-point pen	30	
	Felt-tip pen	30	
	Handwritten Carbon Copy	50	
	White Boards		
	Chalk Boards		
	Printed Tasks	6-Point Type	50
		8- and 10- Point Type	30
		Glossy Magazines	30
		Maps	50
		Newsprint	30
Typed Originals		30	
Telephone Books		50	
Toilets and Washrooms		5	

School Light Level Tables from the IESNA

Lighting and Daylighting Overview

Table 11—IESNA Recommended Illumination Levels for General Visual Tasks

Category	Description	Recom
Orientation and Simple Visits	Public spaces (Corridors at night, entrance canopy)	
	Simple orientation for short visits (Waiting rooms, elevators) Working spaces where simple visual tasks are performed (Lobbies, corridors, locker rooms)	
Common Visual Tasks	Performance of visual tasks of high contrast and large size (Meeting rooms, storage areas, copy rooms)	
	Performance of visual tasks of high contrast and small size, or visual tasks of low contrast and large size (Filing, open offices, private offices)	
	Performance of visual tasks of low contrast and small size (Feature displays & inspection areas) Performance of visual tasks near threshold (Surgery & sewing)	

Source: IESNA Lighting Handbook, 9th ed. (2000), p. 10–13

Table 12—Illumination Criteria for Daylit Classrooms

Activity (Scene)	Task Light Level (average at desks in classroom)	Acceptable Variation of Task Light Level	
Reading, artwork, social time, etc.	45 footcandles (minimum of 30 footcandles)	30–250 footcandles	
Normal Lecture Chalkboard or whiteboard	45 footcandles (minimum of 30 footcandles)	30–250 footcandles; dimming to lower levels may be useful	lig c
Screen Lecture	15 footcandles	Dim to lower levels is permissible; higher levels should probably not be used.	I fc se re

Table 13—Teaching Technologies and Impacts

Medium	Requires external illumination	Sensitivity to ambient light	R
Chalkboard (black or green)	Yes, at least 30–40 vertical footcandles are recommended	Not at all	N
Markerboard (white or gray)	Yes, at least 10–15 vertical footcandles are recommended	Specular finish can cause bright flashes	S W a
Television (CRT)	No	Specular (glass) screen is subject to bright flashes from windows and lights; room may need to be darkened for best visibility.	S W b W a
Video display (flat panel)	No	Room may need to be darkened for best visibility	S W S
Rear projection (self contained)	No	Room may need to be darkened for best visibility	S W S
Smart Screen with self contained rear projection	No	Room will need to be darkened	R S
Front Screen Video Projection	No	Room will need to be darkened	R S
Conventional overhead projection	No	Almost none	N
Conventional film and slide	No	Room will need to be darkened	R S

REFERENCES:

Illuminating Engineering Society of North America (IESNA). *IESNA Lighting Handbook*. www.iesna.org/.

Illuminating Engineering Society of North America. (IESNA). *IESNA RP-3-00: Lighting Facilities*. www.iesna.org/

Illuminating Engineering Society of North America (IESNA), IES LEM-3-07, *IESNA Guide to Lighting Systems in Commercial and Institutional Spaces*.

Examples of Recommended Light Meters



Note: We have not actually tested this light meter, but the specifications look ac

Manufacturer: EXTECH

\$220

Model: EA30

Source: www.grainger.com Item # 3MY54

Accuracy +/- 3%

Range: 0 to 20,000 foot candles

Note: TVA's has had good accuracy

Manufacturer: Konica Minolta

Model: T-10

\$940 <http://www.tequipme>

Accuracy +/- 2%

Source: Equipment

The latest generation of Konica Minolta lux meters replaces the globally successful small, easy-to-use handheld units, can measure intermittent light sources, can form multi-point units, and are available in an extremely large measurement range with automatic range switching. All of that with Konica Minolta's T-10 in a small, compact design.

Areas of application

Konica Minolta lux meters are used for the quantity of ambient light measurement of average value. Examples of their use include indoor and street illumination, theater, architectural, forestry, and agriculture. They are used in hard-to-reach spaces and for the metering of very large areas (in lumens) by serial connection to a PC. Data values can also be visualized and automated by using the PC software.



Instructions on an approach to the measurement of light levels in schools

Measuring Light Intensity

Lumens Footcandles and Lux Candlepower

In doing lighting efficiency work, you need to measure light intensity. You also need to know how to express light intensity for selecting lamps and for laying out the overall lighting configuration. Unfortunately, lighting terminology tends to be confusing and somewhat inconsistent. This brief Note introduces you to the terms that the lighting trade uses to communicate about light intensity, and it points out which of these terms are important to know.

Lumens

“Lumen” is the unit of total light output from a light source. If a lamp or fixture were surrounded by a transparent bubble, the total rate of light flow through the bubble is measured in lumens. Lumens indicate a rate of energy flow. Thus, it is a power unit, like the watt or horsepower.

Typical indoor lamps have light outputs ranging from 50 to 10,000 lumens. You use lumens to order most types of lamps, to compare lamp outputs, and to calculate lamp energy efficiencies (which are expressed as lumens per watt).

Note that lumen output is not related to the light distribution pattern of the lamp. A large fraction of a lamp’s lumen output may be useless if it goes in the wrong directions.

Footcandles and Lux

“Footcandles” and “lux” are units that indicate the density of light that falls on a surface. This is what light meters measure. For example, average indoor lighting ranges from 100 to 1,000 lux, and average outdoor sunlight is about 50,000 lux.

The footcandle is an older unit based on English measurements. It is equal to one lumen per square foot. It is being replaced by lux, a metric unit equal to one lumen per square meter. One footcandle is 10.76 lux. Although footcandles are now officially obsolete, they probably will continue to be used because many existing light meters are calibrated in footcandles.

The general term for lux or footcandles is “illuminance.” The general term is sometimes used by lighting engineers, but the units of lux or footcandles are more commonly used.

Brightness In Summary ...

You use footcandles or lux to measure the adequacy of lighting on the task. Footcandles and lux relate only to the task area, not to the lighting equipment or to the geometry of the space. For example, you could create an illumination level of 100 lux on a surface by using a single spotlight located far away, or by using many cove lights nearby.

For energy conservation work in existing facilities, you need a light meter that measures illuminance in footcandles or lux. You will use it continually as you lay out lighting, select fixtures to be delamped, etc. Light meters have become inexpensive, so you can afford to spend the money to get a rugged electronic unit of good quality, rather than the older type that uses a fragile meter movement. Figure 1 shows a footcandle meter.

Candlepower

“Candlepower” is a measure of lighting concentration in a light beam. It is used primarily with lamps that focus, such as spotlights and PAR lamps. In lamps where candlepower is specified, the candlepower rating usually applies only to a small spot in the center of the beam.



Fig. 1 Footcandle meter. The meter is used to measure “illuminance.” It is the only measuring instrument that you need for most applied lighting efficiency work. Being an older model, this meter indicates in units of footcandles. Newer models indicate in units of lux.

The official unit of candlepower is the “candela,” which is equal to one lumen per steradian. (A steradian is a fraction of the surface area of a sphere that is to the square of the radius divided by the total surface area. This is approximately 8% of the total surface area.) This term is rarely used in practical work. Lamp catalogs usually list “candlepower” rather than candelas. I like using “horsepower” as both a general term and a specific unit. To confuse matters further, candelas were earlier called “candles.”

Brightness

In general, “brightness” is an expression of the amount of light emitted from a surface per unit of area. “Brightness” is not an official term of the lighting industry, and lighting designers may become huffy when you use it. However, the concept is essential for understanding visual quality, especially in relation to contrast and glare.

Brightness does not inherently relate to lamp output, even to light sources. The light could be reflected or transmitted. For example, the bright surface could be the surface of a fluorescent tube, a page of a book, a window with a view of the sky, or a store window reflecting the street.

The closest official term is “luminance,” which is expressed as candelas per square meter of light emitting surface. (Luminance used to be measured in “footlamberts,” which is now an obsolete term.) For example, the luminance of a heavily overcast sky is 1,000 candelas per square meter, and the luminance of a typical frosted light bulb is about 100,000 candelas per square meter.

Luminance is defined in terms of the direct light emission. The details get technical, and probably will not need to deal with them. In brief, the brightness of an object usually depends on the direction from which you look at it.

Note that luminance has nothing to do with the area of the light emitting surface. The light source could

Notes on Measuring Light Levels:

Consult the instructions on the light meter you are using for specific details about your light meter.

Using a light meter, place it on the top of the desk or worksurface.

Do not let your body shadow or other shadows interfere with the reading

Measure the incident light at several locations to get an average.

Take three readings near the center of the room, spaced several feet apart to determine the average for the room.

Write the average reading on your survey form

Alternative if a lot of daylight is in the space at the time the reading is taken:

Measure the light level as before with the lights on

Measure the light level with the lights off

Subtract the two readings to determine the difference

Write the average reading of the difference on your survey form

Recommended Illuminance (fc)

3 fc

5 fc

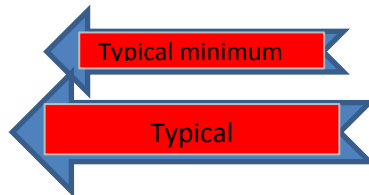
10 fc

30 fc

50 fc

100 fc

300–1,000 fc



Other Considerations

Daylight glare control required

Additional vertical surface lighting for board should be considered

Maximum of 5 vertical spotcandles at any point on screen; room use shades required

Recommended provisions

None

Should not be opposite windows; not suitable for use as a projection surface

Should not be opposite windows; curved screens can be affected by skylights, windows and lights from many angles

Should not be opposite windows or directly washed by skylights.

Should not be opposite windows or directly washed by skylights

Room will require darkening shades

Room will require darkening shades

None

Room will require darkening shades

10th ed. 2000.

Guidelines for Educational

Guidelines for Upgrading

ceptable.

ty and experiences using this type meter.

<http://www.minolta.net/MinoltaT10.asp>

Minolta Minolta lux meters, the T-10, and other models of the T-1 series. The meters are capable of measuring light intensity. They can be connected to each other to be easily controlled with a PC. They have a measuring range of 0.01 to 299,000 lx, a large, backlight LCD, and Minolta's renowned high level of precision.

They are used whenever brightness and light intensity must be measured. Even the measurement of illuminance is possible. They are used for the measurement of workplace lighting, the production of lamps, as well as for agricultural applications. Deployment under water is possible, just as measurement of surfaces and projectors (ANSI) is possible. They have several receptor heads. Metered data is displayed graphically and even fully controlled by software.

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small as a lamp filament, or it could be as large as the whole sky, or it could be a task area, such as a desk top.

Measuring brightness (“luminance”) is tricky and requires specialized equipment. For practical work, learn how to avoid excessive brightness, so you won’t need to measure it. If you do a good job of laying out lighting, people within the space will not be subjected to brightness that is severe enough to cause glare.

Luminance is the converse of illuminance. The former describes the intensity of light that is leaving a surface, whereas the latter describes the intensity of light that is falling on a surface. For light reflected from a surface, luminance equals illuminance multiplied by the percentage of reflectance.

“Brightness” also is used to describe the subjective sensation of light intensity. This sensation largely depends on the overall layout of the scene surrounding the viewer. An uncomfortable level of brightness is described as “glare.” (The term “glare” is used in several ways. It is an important concept, but is not precisely defined by the lighting trade. Various types of glare are explained in Reference Note 51, Factors in Lighting Quality.)

In Summary ...

So, here is the overall picture. A lamp produces a certain amount of light, measured in lumens. This light falls on surfaces with a density that is measured in footcandles or lux. A person looking at the scene sees different areas of his visual field in terms of levels of brightness, or luminance, measured in candelas per square meter.

Many characteristics other than light intensity are important in selecting light sources. These include color, operating temperature, starting time, etc. To learn about all of them, see Reference Note 52, Comparative Light Source Characteristics.