

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.



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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 equal 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. This is 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 trade, 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 lamps, or 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 with reflections.

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 about 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 direction of light emission. The details get technical, and you 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 size of the light emitting surface. The light source could be as

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.

