Lighting Basics

An understanding of some of the fundamental terms in lighting technology is basic to good design practice. The more important terms and concepts are reviewed here for this purpose.

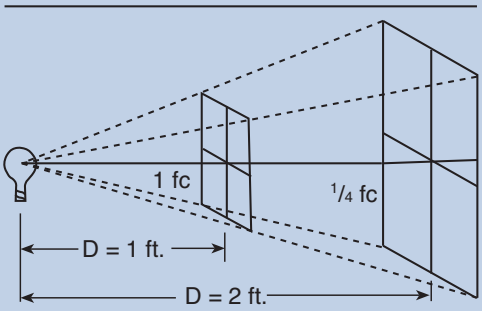

Figure 1

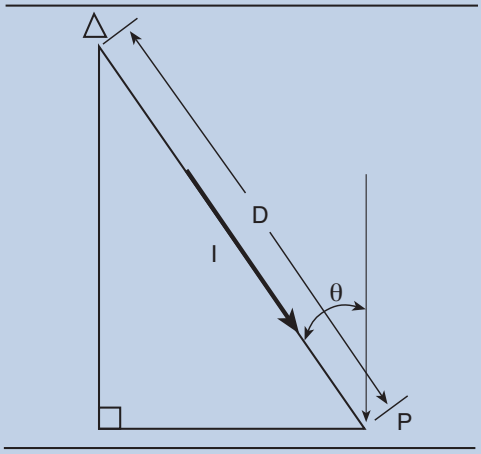

Figure 2

Luminous flux

Luminous flux is the time rate of flow of light as measured in lumens. It is a measure of the total light emitted by a source and is most commonly used for measurement of total lamp output.

Luminous intensity (I)

The candela is the unit of intensity (I) and is analogous to pressure in a hydraulic system. It is sometimes called "candlepower" and describes the amount of light (lumens) in a unit of solid angle. This unit of solid angle is called the steradian. It will be seen from Figure 1 that as the light travels away from the source the solid angle covers a larger and larger area; but the angle itself remains the same, as does the amount of light it contains. Intensity therefore, in a given direction is constant regardless of distance. ***See Figure 1***

$$I = \frac{(\text{lumens})}{(\text{steradians})}$$

Illuminance (E)

Illuminance is the quantity of light reaching a unit area of surface and is measured in footcandles or lux. As the area covered by a given solid angle becomes larger with distance from the source, the included light flux remains the same. The illumination density of light on the surface decreases, therefore, with the square of the distance. Illuminance is defined by the intensity (Î) in candelas directed toward point P, divided by the square of the distance (D) from the source to the surface.

$$E = \frac{I}{D^2}$$

This formula holds only if the receiving surface is perpendicular to the source direction. If light is incident at some other angle, ***See Figure 2***, the formula becomes:

$$E = \frac{I \cos \Theta}{D^2}$$

where E = illuminance in footcandles (fc) or lux
I = intensity in candelas (cd) toward point P
D = distance in feet or meters
Θ = angle of incidence

Luminance (L)

Luminance, often called "brightness," is the name given to what we see. "Brightness" is a subjective sensation varying from very dim or dark to very bright. Objectively it is referred to as luminance, defined as intensity in a given direction divided by a surface's projected area as seen by the observer. The surface may be a luminaire surface or a reflecting surface, such as a wall or roadway.

The direct luminance, or brightness, of luminaires at various angles of view is a major factor in the visual comfort evaluation of an installation using those luminaires. In general, it is desirable to minimize the brightness of ceiling mounted luminaires at the high vertical angles, 60°-90°. When the intensity is in candelas, and the projected area is in meters, the unit of luminance is candelas per square meter (cd/m^2).

Exitance (M)

It is often desirable to calculate the amount of light reflected from room surfaces. The total amount of light reflected, regardless of direction, is Exitance. Exitance = illuminance x reflection factor

$$M = E \times \rho$$

Where E = Illuminance in footcandles
ρ = the reflection factor of the surface expressed as the percentage of light reflected
M = the resulting exitance in lumens per square foot

Metric system

As the U.S.A. moves toward conversion to the metric system to conform with the scientific fields and the rest of the world, our illumination engineering will convert to the International System of Units (SI). Only the terms involving length or area, illuminance and luminance, are affected. Illuminance (E) is stated in lux (lumens per sq. meter) in the metric system. 1fc = 10.76 lux. Luminance (L) is stated in nits (candelas per sq. meter) in the metric system.

1930: Low Bay Primary Source for Industrial Facilities
Holophane developed the first reflector specifically designed to utilize mercury vapor lamps.