Point calculations using candlepower data

This method is especially useful in the determination of variation of illuminance levels and the uniformity of illumination provided by a lighting design. It is most frequently used in heavy industrial and design where inter-reflections are not a consideration, such as in track lighting and floodlighting.

The point-by-point method accurately computes the illuminance level at any given point in an installation by summing up the illumination contributions to that point from every luminaire individually. It does not account for contributions from other sources such as reflection from walls, ceiling, etc. For accuracy, the calculation distance from source to point of calculation should be at least five times the maximum luminaire dimension. Using the photometric distribution for the unit, we may calculate values for specific points, as follows for horizontal surfaces.

$$fc = \frac{\text{candlepower} \times \cos \Theta}{D^2}$$

Example:

A single 400W HPS Prismpack luminaire is mounted 26' above a work plane. We wish to find the initial horizontal illuminance at a point 15' to one side of the luminaire. *See figure 2*.

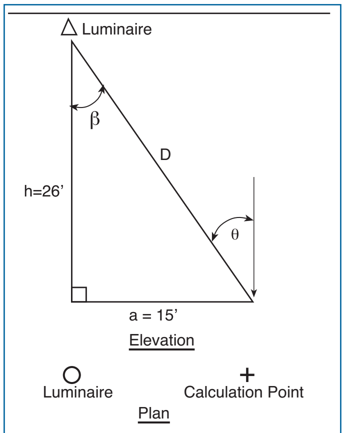


Figure 2

Solution:

Since $$fc = \frac{\text{candlepower} \times \cos \Theta}{D^2}$$

we need to determine the angle β and look up the cp at this angle. We also must determine the distance D.

$$\text{Since } D^2 = a^2 + h^2$$
$$D^2 = (15)^2 + (26)^2$$
$$D = 30 \text{ feet}$$
$$\text{Tangent } \beta = \frac{a}{h}$$
$$\beta = \text{arc tangent } \frac{15}{26}$$
$$\beta = 30°$$

Now we can determine the candlepower of this luminaire from the cp curve, figure 3, to be 18936 (cp). When lighting a horizontal surface, angle β is equal to angle Ο. The illuminance (E) is then:

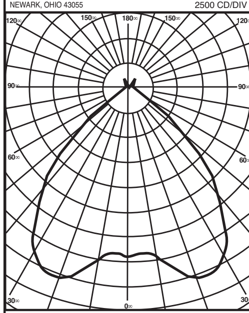
$$E = \frac{18936 \times \cos 30°}{(30)^2} = 18.2 \text{ fc}$$

When many point calculations must be done by hand, a variation of the basic formula is somewhat more useful.

$$fc = \frac{\text{Candlepower} \times (\cos \Theta)^3}{h^2}$$

This version of the formula lets us deal with only the net mounting height of the fixtures and candlepower angles and eliminates the necessity to calculate each separate distance "D".

PHOTOMETRIC TEST REPORT
HOLOPHANE CORPORATION
HOLOPHANE RESEARCH & DEVELOPMENT CENTER
NEWARK, OHIO 43055
2500 CD/DIV



DISTRIBUTION DATA

VERTICAL ANGLE	CANDLE POWER	ZONAL LUMENS
0	16880	
5	16774	1601
10	17611	
15	19672	5576
20	20262	
25	20286	9389
30	18936	
35	16925	10632
40	14199	
45	10411	8063
50	6367	
55	3256	2921
60	1296	
65	732	727
70	574	
75	417	441
80	301	
85	219	239
90	57	
95	35	38
105	46	48
115	64	63
125	77	69
135	141	109
145	574	360
155	867	402
165	14	4
175	18	2
180	7	

TEST OF HOLOPHANE
PP5K400HP00XXJ39

POSITION OF LAMP Set Position
LAMP 400W Clear HPS LUMENS 50000
WATTS 400 BULB TYPE E-18
TEST DISTANCE 25 FT. S.C. 1.4

OUTPUT DATA

ZONAL DEGREES	ZONAL LUMENS	TOTAL EFFIC.
0-30	16567	33.1
30-60	21616	43.2
60-90	1407	2.8
0-90	39591	79.2
90-180	1096	2.2
0-180	40686	81.4

TESTED BY Wanota Newland
CERTIFIED BY B.L. Slotterback
TEST NO. 42181

Figure 3

Point calculations using the isofootcandle chart

The isofootcandle chart can also be used to find the illuminance at a specific point. It is found by defining the horizontal distance from the fixture to that point in terms of a ratio of distance to mounting height, then looking up that ratio on the chart. If the actual mounting height of the fixture is different than the isofootcandle chart's assumed mounting height, a correction factor must be applied using the following formula:

$$\text{correction factor} = \frac{\text{chart MH}^2}{\text{actual MH}^2}$$

Example:

Using the same layout and fixtures as were used in the example on page 13, determine the illuminance level, between the two units, on the far side of the road using Chart 1.

Solution:

From either fixture, point A is 60 feet to the street side (2.0 M.H.) and 140 feet down the street (4.7 M.H.). Looking at the isofootcandle curve, we find that the illuminance value at that point is .30 fc. This is the contribution from one luminaire and should be summed with other contributions for total footcandles. Since the isofootcandle chart mounting height is the same as our mounting height, no further correction is necessary.

Computer programs

Point-by-point calculations can be time consuming. Our lighting software, Visual, can perform such calculations for many analysis points and luminaires in a fraction of the time necessary to do the same calculations by hand.

2002: LunarOptics® Solution for IESNA Cut-Off
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