Isofootcandle Distribution Curves vs. Actual Lighting Conditions

The NFPA 101 code requires even illuminance, over a specified area, of 1 footcandle average with a minimum illuminance of 0.1 footcandle at any point with a ratio of not more than 40 to 1 maximum to minimum illuminance. To meet this requirement, for Emergency Lighting, several considerations must be taken into account when using Isofootcandle Distribution Curves to determine distances between units.

Isofootcandle Distribution Curves show the illuminance for specified footcandle values at various distances. These curves reflect measurements in ideal conditions with the measuring device normal (90 degrees) to the incoming light. (See **Fig. 1**)

Fig. 2 shows a 3D illustration of Isofootcandle Distribution Curve No. 25 for a 50 Watt, 12 degree MR16 Lamp. The light pattern for this lamp is symmetrical in horizontal and vertical planes. This curve shows a distance of 112 ft for an illuminance of 1 footcandle. However, when this lamp is lighting a Path of Egress, three factors must be taken into account to determine the number of and spacing of Emergency Lighting Units and the illumination "E" at any point on the floor.

1. The distance "**d**" from the lamp (the Inverse Square Law)
2. The cosine of angle "ϴ" that the light strikes the floor (Lambert's Cosine Law)
3. The distance from the center of the beam (Lamps with narrow Beam Angles will fall off rapidly in intensity as the distance increases from the center of the beam)

In **Fig. 3** a typical two unit configuration is shown lighting a 3 ft. wide by 65 ft. Long Path of Egress. The lamps are arranged so that the beams overlap producing light under opposite units. This is generally necessary to provide even illumination along the whole length of the path. Small areas can be covered with a single lamp. In this example the large angle "ϴ" results in a cosine of 75 degrees that cuts the illuminance "**E**" at beam center by 74%. Because of these factors the maximum spacing for this type of lamp to meet NFPA 101 without the benefit of ceiling, wall, or floor reflections is 65 feet or about 30 feet per lamp.

For more information consult the
Illuminating Engineering Society of North America **Lighting Handbook**.

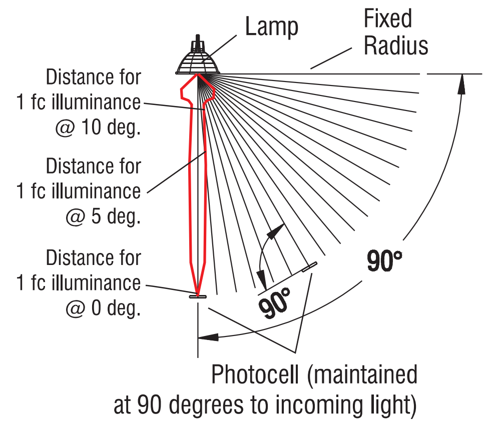

Figure 1

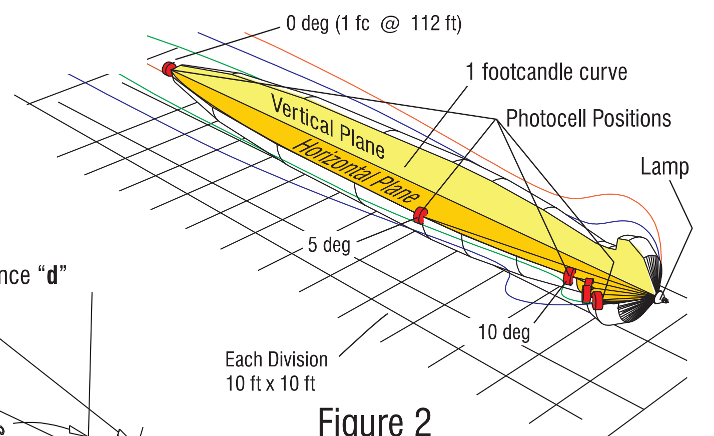

Figure 2

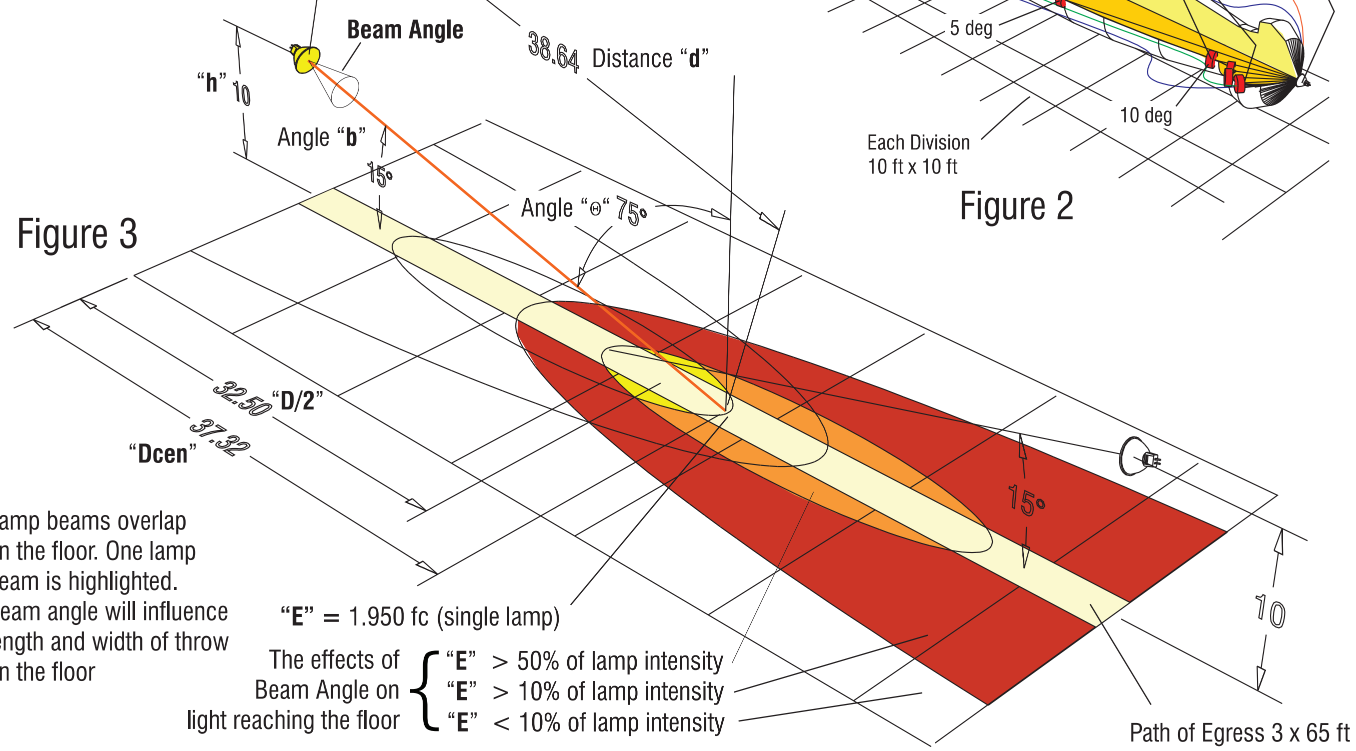

Figure 3

Lamp beams overlap on the floor. One lamp beam is highlighted. Beam angle will influence length and width of throw on the floor

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Conductor Size for Remote Loads

In the layout design of emergency lighting systems, low voltage load wire runs must be of significant size to limit voltage drop in accordance with the National Electric Code to 5% of the nominal. To determine the correct wire size use the following formula and tables.

$$\text{Formula: } CM = \frac{440 \times W \times D}{V^2}$$

CM = Wire size in circular mils
W = Load in watts (emergency light load)
D = Distance (Battery to Load) in Feet
V = Line Voltage ($V^2 = V \times V$)
440 = Constant including factor for allowable voltage drop 5%

V^2 for 6V = 36
V^2 for 12V = 144
V^2 for 24 V = 576
V^2 for 32V = 1024

After calculating the circular mills required to carry the specified load at the allowable voltage drop, refer to the chart below to determine the wire size from the corresponding circular mill size, or use the tables below.

Circular Mill Size	Ampere Capacity	Wire Gauge
6,530	20	12
10,380	25	10
16,510	35	8
26,250	50	6
41,740	70	4

This table shows the maximum length of a given low voltage circuit, assuming that the total load is concentrated at the end of the load circuit. If loads are spaced at varying positions along the circuit length wire gauge distances may be increased, which in turn may permit cost savings by the use of a smaller wire size.

Total Watts On Wire Run	6-Volt Systems Wire Gauge Maximum Distance in Feet				12-Volt Systems Wire Gauge Maximum Distance in Feet				24-Volt Systems Wire Gauge Maximum Distance in Feet			
	#12	#10	#8	#6	#12	#10	#8	#6	#12	#10	#8	#6
13	41	65	110	165	165	260	415	660	680	1045	1668	2640
18	30	47	75	120	110	190	300	475	475	754	1200	1900
25	21	32	54	86	85	136	215	340	340	544	860	1360
30	18	28	45	71	71	112	180	285	284	452	720	1145
35	15	24	39	62	61	97	154	245	244	388	616	980
50	11	17	27	43	42	68	108	170	168	272	432	650
60	9	14	22	36	35	52	90	140	143	227	360	573
75		11	18	29	29	45	72	114	116	180	288	456
100			14	22	21	34	54	86	84	135	216	344
150			9	15	14	23	36	57	56	90	144	228
200				11	10	17	27	43	40	67	108	172
250						14	21	34	32	54	84	137
300						11	18	28	26	45	72	115
400									21	34	54	86
Constant	534	849	1350	2148	2137	3397	5403	8590	8548	13588	21613	34363

To calculate the maximum load on a run of known length:

Divide the length into the constant shown in the above tables. Example: A 45 foot run of #10 wire on a 12 volt system can be rated as: 3397 / 45ft = 75 watts

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