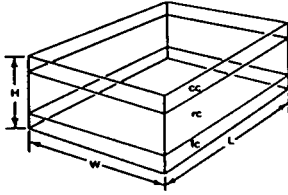


LIGHTING DESIGN – LIGHTING LEVEL CALCULATIONS

The Zonal Cavity approach to calculate average illumination levels is based on the concept of dividing any room into three cavities. (1) The space between the ceiling and the luminaires is the "ceiling cavity." (2) The space between the luminaires and the work plane is the "room cavity." (3) The space between the work plane and the floor is the "floor cavity."



Room Surface Reflectances:

pc = Ceiling
pw = Walls
pf = Floor

Effective Cavity Reflectances:

The combination of actual reflectances within a given cavity into one reflectance at the face of the cavity.

pcc = Effective Ceiling Cavity Reflectance
pfc = Effective Floor Cavity Reflectance

Coefficient of Utilization: (CU)

Portion of lamp lumens which reach the work plane. Affected by fixture design, room proportions, and room-surface reflectances.

Light Loss Factor: (LLF)

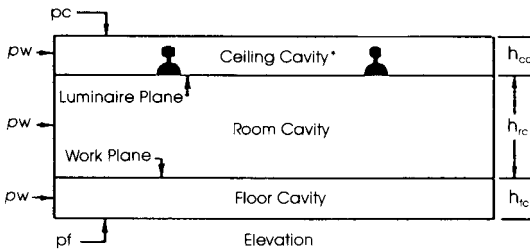
Depreciation of initial lighting level due to Lamp Lumen Depreciation (LLD) and accumulation of dirt on the lamp and luminaire surface (Luminaire Dirt Depreciation — LDD). Affected by fixture design, lamp choice, number of burning hours and type of interior.

Ballast Factor: (BF)

The commercial ballast performance relative to reference ballast.

Other Factors:

See IES Lighting Handbook for recurring and non-recurring factors that lead to still greater accuracy, including the determination of effective cavity reflectances.



W = Room Width
L = Room Length

Ceiling Cavity = Volume bounded by walls, ceiling and luminaire plane.
h_{cc} = height of ceiling cavity. *For surface mounted or recessed fixtures h_{cc} = 0.
Floor Cavity = Volume bounded by walls, floor and work plane.
h_{fc} = height of floor cavity.

Room Cavity = Volume bounded by walls, luminaire plane and work plane.

h_{rc} = height of room cavity.

Cavity Ratio = Dimensions of Cavity Expressed as Mathematical Relationship;

RCR = Room Cavity Ratio;

CCR = Ceiling Cavity Ratio;

FCR = Floor Cavity Ratio;

Room Cavity Ratio (RCR)

$$RCR = \frac{5 h_{rc} (L+W)}{L \times W} \quad \text{For Square Rooms } RCR = \frac{10 h_{rc}}{W} (L=W)$$

$$\text{For Irregular Shaped Rooms } RCR = \frac{2.5 (\text{Cavity Height} \times \text{Cavity Perimeter})}{\text{Area of Cavity Base}}$$

Ceiling Cavity Ratio (CCR)

$$CCR = \frac{5 h_{cc} (L+W)}{L \times W} = RCR \frac{h_{rc}}{h_{cc}}$$

Floor Cavity Ratio (FCR)

$$FCR = \frac{5 h_{fc} (L+W)}{L \times W} = RCR \frac{h_{rc}}{h_{fc}}$$

*For square rooms or irregular rooms calculate RCR then use the ratio of the cavity heights to determine CCR and FCR.

The approximate average illumination level or number of luminaires may be calculated as follows:

1. Determine Room Cavity Ratio (RCR)
2. Determine Reflectances

Typical approximate reflectances:

Ceiling:		Walls:	
Standard White Paint	80%	White Paint	80%
Rough White Paint	50%	Rough Light Paint	30%
Rough Light Paint	30%		

Floors:	
Dark Concrete	20%
Carpet Average	15%

3. Find Coefficient of Utilization

Knowing the ceiling, walls and floor reflectances and the room cavity ratio (calculated in step 1), the coefficient of utilization may be found from the manufacturers published data or typical data found in the current IES Handbook. See Table 1 below for example. For a room cavity ratio of 1.0 and reflectances of 30 (ceiling), 30 (wall), and 20 (floor) the CU equals 0.63 for this luminaire.

4. Compute Average Footcandle Level or Number of Luminaires using formulas A and/or B.

A. Number of Luminaires = $\frac{\text{(Maintained Illuminance (FC) Desired)} \times \text{(Area in Square Feet)}}{\text{(Lamp Lumens/Luminaire)} \times \text{(CU)} \times \text{(LLD)} \times \text{(BF)}}$

B. Maintained Illuminance (FC) = $\frac{\text{(Number of Luminaires)} \times \text{(Lamp Lumens Per Luminaire)} \times \text{(CU)} \times \text{(LLD)} \times \text{(BF)}}{\text{(Area in Square Feet)}}$

COEFFICIENTS OF UTILIZATION FOR 20 PERCENT EFFECTIVE FLOOR CAVITY REFLECTANCE																
Effective Ceiling Cavity Reflectance	80			70			50			30			10			0
Wall Reflectance	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	0
Room Cavity	COEFFICIENTS OF UTILIZATION—ZONAL CAVITY															
1	75	71	68	73	69	66	69	66	64	65	63	61	62	61	59	57
2	64	59	54	63	58	53	60	55	51	57	53	50	54	51	48	47
3	56	49	44	54	48	43	52	47	42	49	45	41	47	43	40	38
4	48	41	36	47	40	35	45	39	35	43	38	34	41	36	33	31
5	42	35	30	41	34	29	39	33	29	37	32	28	36	31	27	26
6	37	30	25	36	30	25	35	29	24	33	28	24	32	27	23	22
7	33	26	21	32	25	21	31	25	20	29	24	20	28	23	20	18
8	29	22	18	29	22	18	27	21	17	26	21	17	25	20	17	15
9	26	20	15	26	20	15	25	19	15	24	19	15	23	18	15	13
10	23	17	12	23	17	12	22	16	12	21	16	12	20	15	12	10

See manufacturers published data for actual coefficients of utilization.

