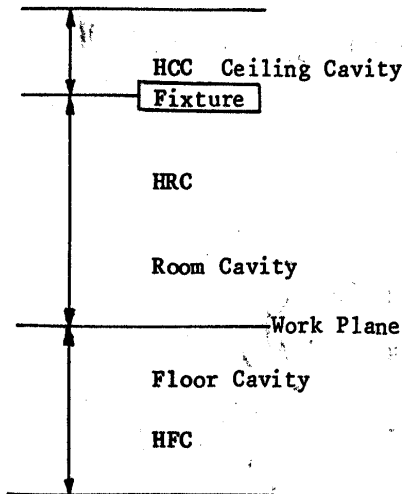


LIGHTING DESIGN CALCALATIONS // -1

PROJECT _____ BY _____ DATE _____ ROOM _____
 FIXTURE _____ LAMPS/FIXTURE _____ LUMENS/LAMP _____ DESIGN LEVEL _____ FOOT CANDLES _____



USE TABLE 2 for CAVITY RATIOS OR:

$$\frac{5(L+W)}{L \times W} = A \quad 5 \left(\frac{\text{ft} + \text{ft}}{\text{ft} \times \text{ft}} \right) = A =$$

$$\text{CEILING CAVITY RATIO} = \frac{\text{HCC}}{\text{A}} = \text{CCR} =$$

$$\text{ROOM CAVITY RATIO} = \frac{\text{HRC}}{\text{HRC}} = \text{RCR} =$$

$$\text{FLOOR CAVITY RATIO} = \frac{\text{HFC}}{\text{HFC}} = \text{FCR} =$$

	SYMBOL	VALUE	TABLE
Room Length, Feet	L	_____	
Room Width, Feet	W	_____	
Ceiling Cavity Height	HCC	_____	
Room Cavity Height, feet	HRC	_____	
Floor Cavity Height, feet	HFC	_____	
Lamp Lumen Depreciation	LLD	_____	B
Maintenance Catagory I, II, III, IV, V, VI			

Dirt Level; Very Clean, Clean, Medium, Dirty, Very Dirty _____
 Cleaning Schedule 12, 24, 36 Months _____ months

<u>Actual Reflectance%</u>	<u>Effective Reflectance%</u>	3, A
R Ceiling _____	R Ceiling _____	
R Wall _____ =	R Wall _____	
R Floor _____	R Floor _____	

Luminaire Dirt Depreciation	LDD	_____	1
Room Surface Dirt Depreciation	RSDD	_____	4
Floor Multiplying Factor	MF	_____	5
Coefficient of Utilization*	CU	_____	

*Coefficient of Utilization from manufacturers literature or
 PAGE 23-31 IES HAND BOOK

Number of Fixtures = _____ FC x _____ Room Length x _____ Room Width

$$\frac{\text{C.U.} \times \text{Lamps}}{\text{Fix}} \times \frac{\text{Lumens}}{\text{Lamp}} \times \text{M.F.} \times \text{LLD} \times \text{LDD} \times \text{RSDD}$$

= _____ Fixtures

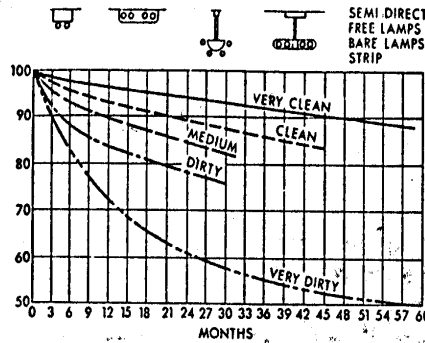
LAMP DATA TABLE B

Watts	Initial Lumens	Initial Lumens/Watt	Lamp Depreciation Lumens LLD	Life (Hours)
Incandescent				
150	2880	19	.93	750
300	6360	21	.88	750
500	10850	22	.91	1,000
Fluorescent				
40	3150	79	.88	20,000
110	9200	84	.87	12,000
215	14500	74	.75	10,000
Deluxe Mercury				
100	4100	41	.85	24,000
175	7850	44	.85	24,000
250	12100	48	.86	24,000
400	22500	56	.85	24,000
1000	63000	63	.75	24,000
Metal Halide				
175	14000	80	.77	7,500
250	20500	83	.76	10,000
400	34000	85	.75	20,000
1000	100000	100	.80	10,000
High Pressure Sodium				
70	5800	83	.90	24,000
100	9500	95	.90	24,000
150	16000	107	.90	24,000
250	25500	102	.91	24,000
400	50000	125	.90	24,000
1000	140000	140	.91	24,000

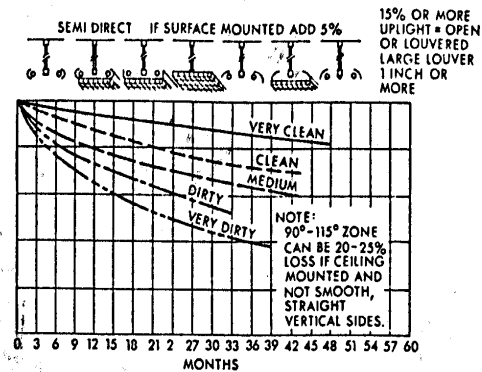
TABLE A SURFACE REFLECTIONS

<u>Ceiling</u>	<u>% Actual Reflectance</u>
White Tile	70%
Light Color Paint	50%
Plywood	30%
 <u>Walls</u>	
White Paint	60-70%
Light Paint	50%
Dark Paneling, Burlap	10%
Bulletin Boards	10%
 <u>Floors</u>	
White Tile	20%
Concrete, wood, carpet	0%

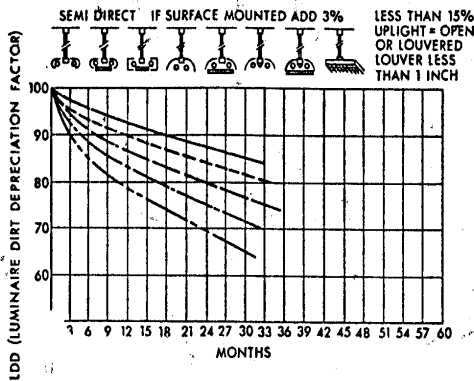
CATEGORY I



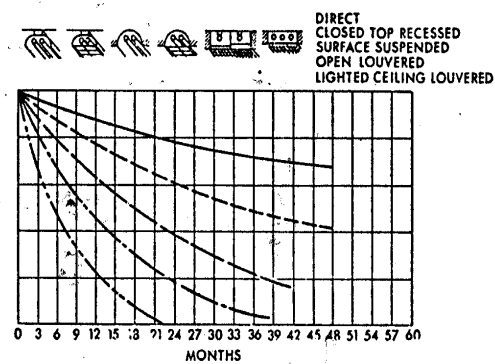
CATEGORY II



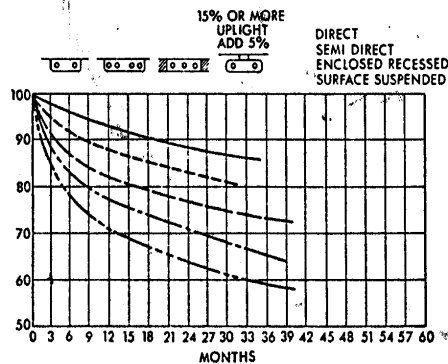
CATEGORY III



CATEGORY IV



CATEGORY V



CATEGORY VI

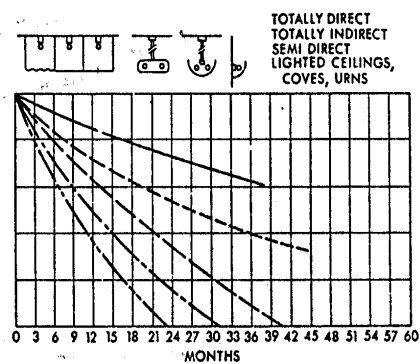


Fig. 9-7. Luminaire Dirt Depreciation factors (LDD) for six luminaire categories (I to VI) and for five degrees of dirtiness as determined from either Figs. 9-8 or 9-9.

TABLE 1 LUMINAIRE DIRT DEPRECIATION LDD

TABLE 2 CAVITY RATIOS FCR,RCR,CCR

11-H

(For cavity dimensions other than those shown below the cavity ratio can be calculated by the formulas on page 9-8.)

Room Dimensions		Cavity Depth																				
Width	Length	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8	9	10	11	12	14	16	20	25	30	
8	8	1.2	1.9	2.5	3.1	3.7	4.4	5.0	6.2	7.5	8.8	10.0	11.2	12.5	—	—	—	—	—	—	—	
	10	1.1	1.7	2.3	2.8	3.4	3.9	4.5	5.6	6.7	7.9	9.0	10.1	11.3	12.4	—	—	—	—	—	—	
	14	1.0	1.5	2.0	2.5	3.0	3.4	3.9	4.9	5.9	6.9	7.8	8.8	9.7	10.7	11.7	—	—	—	—	—	
	20	0.9	1.3	1.7	2.2	2.6	3.1	3.5	4.4	5.2	6.1	7.0	7.9	8.8	9.6	10.5	12.3	—	—	—	—	
	30	0.8	1.2	1.6	2.0	2.4	2.8	3.2	4.0	4.7	5.6	6.3	7.1	7.9	8.7	9.5	11.0	—	—	—	—	
40	0.7	1.1	1.5	1.9	2.3	2.6	3.0	3.7	4.5	5.3	5.9	6.5	7.4	8.1	8.8	10.3	11.8	—	—	—	—	
10	10	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	—	—	—	—	—	
	14	0.9	1.3	1.7	2.1	2.6	3.0	3.4	4.2	5.1	6.0	6.9	7.8	8.6	9.5	10.4	12.0	—	—	—	—	
	20	0.7	1.1	1.5	1.9	2.3	2.7	3.0	3.7	4.5	5.3	6.0	6.8	7.6	8.3	9.0	10.5	12.0	—	—	—	
	30	0.7	1.0	1.3	1.7	2.0	2.3	2.7	3.3	4.0	4.7	5.3	6.0	6.6	7.3	8.0	9.4	10.6	—	—	—	
	40	0.6	0.9	1.2	1.6	1.9	2.2	2.5	3.1	3.7	4.4	5.0	5.6	6.2	6.9	7.5	8.7	10.0	12.5	—	—	
60	0.6	0.9	1.2	1.5	1.7	2.0	2.3	2.9	3.5	4.1	4.7	5.3	5.9	6.5	7.1	8.2	9.4	11.7	—	—	—	
12	12	0.8	1.2	1.7	2.1	2.5	2.9	3.3	4.2	5.0	5.8	6.7	7.5	8.4	9.2	10.0	11.7	—	—	—	—	
	16	0.7	1.1	1.5	1.8	2.2	2.5	2.9	3.6	4.4	5.1	5.8	6.5	7.2	8.0	8.7	10.2	11.6	—	—	—	
	24	0.6	0.9	1.2	1.6	1.9	2.2	2.5	3.1	3.7	4.4	5.0	5.6	6.2	6.9	7.5	8.7	10.0	12.5	—	—	
	36	0.6	0.8	1.1	1.4	1.7	1.9	2.2	2.8	3.3	3.9	4.4	5.0	5.5	6.0	6.6	7.8	8.8	11.0	—	—	
	50	0.5	0.8	1.0	1.3	1.5	1.8	2.1	2.6	3.1	3.6	4.1	4.6	5.1	5.6	6.2	7.2	8.2	10.2	—	—	
70	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.4	2.9	3.4	3.9	4.4	4.9	5.4	5.9	6.8	7.8	9.7	12.2	—	—	
14	14	0.7	1.1	1.4	1.8	2.1	2.5	2.9	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	10.0	11.4	—	—	—	
	20	0.6	0.9	1.2	1.5	1.8	2.1	2.4	3.0	3.6	4.2	4.9	5.5	6.1	6.7	7.3	8.6	9.8	12.3	—	—	
	30	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.6	3.1	3.7	4.2	4.7	5.2	5.8	6.3	7.3	8.4	10.6	—	—	
	42	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.4	2.9	3.3	3.8	4.3	4.7	5.2	5.7	6.7	7.6	9.5	11.9	—	—
	60	0.4	0.7	0.9	1.1	1.3	1.5	1.8	2.2	2.6	3.1	3.5	3.9	4.4	4.8	5.2	6.1	7.0	8.8	10.9	—	—
90	0.4	0.6	0.8	1.0	1.2	1.4	1.6	2.0	2.5	2.9	3.3	3.7	4.1	4.5	5.0	5.8	6.6	7.6	10.3	12.4	—	
17	17	0.6	0.9	1.2	1.5	1.8	2.1	2.3	2.9	3.5	4.1	4.7	5.3	5.9	6.5	7.0	8.2	9.4	11.7	—	—	
	25	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0	8.0	10.0	—	—	
	35	0.4	0.7	0.9	1.1	1.3	1.5	1.7	2.2	2.6	3.1	3.5	3.9	4.4	4.8	5.2	6.1	7.0	8.7	10.9	—	
	50	0.4	0.6	0.8	1.0	1.2	1.4	1.6	2.0	2.4	2.8	3.1	3.5	3.9	4.3	4.5	5.4	6.2	7.7	9.7	11.6	
	80	0.4	0.5	0.7	0.9	1.1	1.2	1.4	1.8	2.1	2.5	2.9	3.3	3.6	4.0	4.3	5.1	5.8	7.2	9.0	10.9	
120	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.7	2.0	2.3	2.7	3.0	3.4	3.7	4.0	4.7	5.4	6.7	8.4	10.1		
20	20	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	7.0	8.0	10.0	12.5	—	
	30	0.4	0.6	0.8	1.0	1.2	1.5	1.7	2.1	2.5	2.9	3.3	3.7	4.1	4.5	4.9	5.8	6.6	8.2	10.3	12.4	
	45	0.4	0.5	0.7	0.9	1.1	1.3	1.4	1.8	2.2	2.5	2.9	3.3	3.6	4.0	4.3	5.1	5.6	7.2	9.1	10.9	
	60	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.7	2.0	2.3	2.7	3.0	3.4	3.7	4.0	4.7	5.4	6.7	8.4	10.1	
	90	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	4.2	4.8	6.0	7.5	9.0	
150	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.4	1.7	2.0	2.3	2.6	2.9	3.2	3.4	4.0	4.6	5.7	7.2	8.6		
24	24	0.4	0.6	0.8	1.0	1.2	1.5	1.7	2.1	2.5	2.9	3.3	3.7	4.1	4.5	5.0	5.8	6.7	8.2	10.3	12.4	
	32	0.4	0.5	0.7	0.9	1.1	1.3	1.5	1.8	2.2	2.6	2.9	3.3	3.6	4.0	4.3	5.1	5.8	7.2	9.0	11.0	
	50	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.5	1.8	2.2	2.5	2.8	3.1	3.4	3.7	4.4	5.0	6.2	7.8	9.4	
	70	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.4	1.7	2.0	2.2	2.5	2.8	3.0	3.3	3.8	4.4	5.5	6.9	8.2	
	100	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.3	1.6	1.8	2.1	2.4	2.6	2.9	3.1	3.7	4.2	5.2	6.5	7.9	
160	0.2	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.7	1.9	2.1	2.4	2.6	2.8	3.3	3.8	4.7	5.9	7.1		
30	30	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.7	2.0	2.3	2.7	3.0	3.3	3.7	4.0	4.7	5.4	6.7	8.4	10.0	
	45	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.4	1.7	1.9	2.2	2.5	2.7	3.0	3.2	3.8	4.4	5.5	6.8	8.2	
	60	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.5	1.7	2.0	2.2	2.5	2.7	3.0	3.5	4.0	5.0	6.2	7.4	
	90	0.2	0.3	0.4	0.6	0.7	0.8	0.9	1.1	1.3	1.6	1.8	2.0	2.2	2.5	2.7	3.1	3.6	4.5	5.6	6.7	
	150	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.8	3.2	4.0	5.0	5.9	
200	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.3	1.5	1.7	1.9	2.0	2.2	2.6	3.0	3.7	4.7	5.6		
36	36	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.4	1.7	1.9	2.2	2.5	2.8	3.0	3.3	3.9	4.4	5.5	6.9	8.3	
	50	0.2	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.7	1.9	2.1	2.5	2.6	2.9	3.3	3.8	4.8	5.9	7.2	
	75	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.3	2.5	2.9	3.3	4.1	5.1	6.1	
	100	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.6	3.0	3.8	4.7	5.7	
	150	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.4	1.6	1.7	1.9	2.1	2.4	2.8	3.5	4.3	5.2	
200	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.3	1.5	1.6	1.8	2.0	2.3	2.6	3.3	4.1	4.9		
42	42	0.2	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	1.9	2.1	2.4	2.6	2.8	3.3	3.8	4.7	5.9	7.1	
	60	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.8	3.2	4.0	5.0	6.0	
	90	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.4	1.6	1.7	1.9	2.1	2.4	2.8	3.5	4.4	5.2	
	140	0.2	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.1	1.2	1.4	1.5	1.7	1.9	2.2	2.5	3.1	3.9	4.6	5.6	
	200	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.9	1.0	1.1	1.3	1.4	1.6	1.7	2.0	2.3	2.9	3.6	4.3	
300	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.7	0.8	0.9	1.1	1.3	1.4	1.5	1.7	1.9	2.2	2.8	3.5	4.2		
50	50	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.8	3.2	4.0	5.0	6.0	
	70	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.4	1.6	1.7	1.9	2.0	2.4	2.7	3.4	4.3	5.1	
	100	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.3	1.5	1.6	1.8	2.1	2.4	3.0	3.7	4.5	
	150	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.7	0.8	0.9	1.1	1.2	1.3	1.5	1.6	1.9	2.1	2.7	3.3	4.0	
	300	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.3	1.4	1.6	1.9	2.3	2.9	3.5	
60	60	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.3	1.5	1.7	1.8	2.0	2.3	2.7	3.3	4.2	5.0	
	100	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.7	0.8	0.9	1.1	1.2	1.3	1.5	1.6	1.9	2.1	2.7	3.3	4.0	
	150	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7												

EFFECTIVE REFLECTANCES 40%-0

Fig. 9-11. Continued

Per Cent Base* Reflectance	40										30										20										10										0										
Per Cent Wall Reflectance	90	80	70	60	50	40	30	20	10	0	90	80	70	60	50	40	30	20	10	0	90	80	70	60	50	40	30	20	10	0	90	80	70	60	50	40	30	20	10	0	90	80	70	60	50	40	30	20	10	0	
Cavity Ratio																																																			
0.2	40	40	39	39	39	38	38	37	36	36	31	31	30	30	29	29	29	28	28	27	21	20	20	20	20	20	19	19	19	17	11	11	11	10	10	10	10	09	09	09	02	02	02	01	01	01	01	00	00	00	
0.4	41	40	39	39	38	37	36	35	34	34	31	31	30	30	29	28	28	27	26	25	22	21	20	20	20	19	19	18	18	16	12	11	11	11	11	10	10	10	09	09	08	04	03	03	02	02	02	01	01	00	00
0.6	41	40	39	38	37	36	34	33	32	31	32	31	30	29	28	27	26	26	25	23	23	21	20	19	19	18	18	17	15	13	13	12	11	11	10	10	10	09	08	08	05	05	04	03	03	02	02	01	01	00	
0.8	41	40	38	37	36	35	33	32	31	29	32	31	30	29	28	26	25	25	23	22	24	22	21	20	19	19	18	17	16	14	15	14	13	12	11	10	10	09	08	07	07	06	05	04	04	03	02	02	01	00	
1.0	42	40	38	37	35	33	32	31	29	27	33	32	30	29	27	25	24	23	22	20	25	23	22	20	19	18	17	16	15	13	16	14	13	12	12	11	10	09	08	07	08	07	06	05	04	03	02	02	01	00	
1.2	42	40	38	36	34	32	30	29	27	25	33	32	30	28	27	25	23	22	21	19	25	23	22	20	19	17	17	16	14	12	17	15	14	13	12	11	10	09	07	06	10	08	07	06	05	04	03	02	01	00	
1.4	42	39	37	35	33	31	29	27	25	23	34	32	30	28	26	24	22	21	19	18	26	24	22	20	18	17	16	15	13	12	18	16	14	13	12	11	10	09	07	06	11	09	08	07	06	04	03	02	01	00	
1.6	42	39	37	35	32	30	27	25	23	22	34	33	29	27	25	23	22	20	18	17	26	24	22	20	18	17	16	15	13	11	19	17	15	14	12	11	09	08	07	06	12	10	09	07	06	05	03	02	01	00	
1.8	42	39	36	34	31	29	26	24	22	21	35	33	29	27	25	23	21	19	17	16	27	25	23	20	18	17	15	14	12	10	19	17	15	14	13	11	09	08	06	05	13	11	09	08	07	05	04	03	01	00	
2.0	42	39	36	34	31	28	25	23	21	19	35	33	29	26	24	22	20	18	16	14	28	25	23	20	18	16	15	13	11	09	20	18	16	14	13	11	09	08	06	05	14	12	10	09	07	05	04	03	01	00	
2.2	42	39	36	33	30	27	24	22	19	18	36	32	29	26	24	22	19	17	15	13	28	25	23	20	18	16	14	12	10	09	21	19	16	14	13	11	09	07	06	05	15	13	11	09	07	06	04	03	01	00	
2.4	43	39	35	33	29	27	24	21	18	17	36	32	29	26	24	22	19	16	14	12	29	26	23	20	18	16	14	12	10	08	22	19	17	15	13	11	09	07	06	05	16	13	11	09	08	06	04	03	01	00	
2.6	43	39	35	32	29	26	23	20	17	15	36	32	29	25	23	21	18	16	14	12	29	26	23	20	18	16	14	11	09	08	23	20	17	15	13	11	09	07	06	04	17	14	12	10	08	06	05	03	02	00	
2.8	43	39	35	32	28	25	22	19	16	14	37	33	29	25	23	21	17	15	13	11	30	27	23	20	18	15	13	11	09	07	23	20	18	16	13	11	09	07	05	03	17	15	13	10	08	07	05	03	02	00	
3.0	43	39	35	31	27	24	21	18	16	13	37	33	29	25	22	20	17	15	12	10	30	27	23	20	17	15	13	11	09	07	24	21	18	16	13	11	09	07	05	03	18	16	13	11	09	07	05	03	02	00	
3.2	43	39	35	31	27	23	20	17	15	13	37	33	29	25	22	19	16	14	12	10	31	27	23	20	17	15	12	11	09	06	25	21	18	16	13	11	09	07	05	03	19	16	14	11	09	07	05	03	02	00	
3.4	43	39	34	30	26	23	20	17	14	12	37	33	29	25	22	19	16	14	11	09	31	27	23	20	17	15	12	10	08	06	26	22	18	16	13	11	09	07	05	03	20	17	14	12	09	07	05	03	02	00	
3.6	44	39	34	30	26	22	19	16	14	11	38	33	29	24	21	18	15	13	10	09	32	27	23	20	17	15	12	10	08	05	26	22	19	16	13	11	09	06	04	03	20	17	15	12	10	08	05	04	02	00	
3.8	44	38	33	29	25	22	18	16	13	10	38	33	28	24	21	18	15	13	10	08	32	28	23	20	17	15	12	10	07	05	27	23	19	17	14	11	09	06	04	02	21	18	15	12	10	08	05	04	02	00	
4.0	44	38	33	29	25	21	18	15	12	10	38	33	28	24	21	18	14	12	09	07	33	28	23	20	17	14	11	09	07	05	27	23	20	17	14	11	09	06	04	02	22	18	15	13	10	08	05	04	02	00	
4.2	44	38	33	29	24	21	17	15	12	10	38	33	28	24	20	17	14	12	09	07	33	28	23	20	17	14	11	09	07	04	28	24	20	17	14	11	09	06	04	02	22	19	16	13	10	08	06	04	02	00	
4.4	44	38	33	28	24	20	17	14	11	09	39	33	28	24	20	17	14	11	09	06	34	28	24	20	17	14	11	09	07	04	28	24	20	17	14	11	08	06	04	02	23	19	16	13	10	08	06	04	02	00	
4.6	44	38	32	28	23	19	16	14	11	08	39	33	28	24	20	17	13	10	08	06	34	29	24	20	17	14	11	09	07	04	29	25	20	17	14	11	08	06	04	02	23	20	17	13	11	08	06	04	02	00	
4.8	44	38	32	27	22	19	16	13	10	08	39	33	28	24	20	17	13	10	08	05	35	29	24	20	17	13	10	08	06	04	29	25	20	17	14	11	08	06	04	02	24	20	17	14	11	08	06	04	02	00	
5.0	45	38	31	27	22	19	15	13	10	07	39	33	28	24	19	16	13	10	08	05	35	29	24	20	16	13	10	08	06	04	30	25	20	17	14	11	08	06	04	02	25	21	17	14	11	08	06	04	02	00	
6.0	44	37	30	25	20	17	13	11	08	05	39	33	27	23	18	15	11	09	06	04	36	30	24	20	16	13	10	08	05	02	31	26	21	18	14	11	08	06	03	01	27	23	18	15	12	09	06	04	02	00	
7.0	44	36	29	24	19	16	12	10	07	04	40	33	26	22	17	14	10	08	05	03	36	30	24	20	15	12	09	07	04	02	32	27	21	17	13	11	08	06	03	01	28	24	19	15	12	09	06	04	02	00	
8.0	44	35	28	23	18	15	11	09	06	03	40	33	26	21	16	13	09	07	04	02	37	30	23	19	15	12	08	06	03	01	33	27	21	17	13	10	07	05	03	01	30	25	20	15	12	09	06	04	02	00	
9.0	44	35	26	21	16	13	10	08	05	02	40	33	25	20	15	12	09	07	04	02	37	29	23	19	14	11	08	06	03	01	34	28	21	17	13	10	07	05	02	01	31	25	20	15	12	09	06	04	02	00	
10.0	43	34	25	20	15	12	08	07	05	02	40	32	24	19	14	11	08	06	03	01	37	29	22	18	13	10	07	05	03	01	34	28	21	17	12	10	07	05	02	01	31	25	20	15	12	09	06	04	02	00	

* Ceiling, floor, or floor of cavity.

TABLE 3

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EFFECTIVE REFLECTANCES 90%-50%

Fig. 9-11. Per Cent Effective Ceiling or Floor Cavity Reflectances for Various Reflectance Combinations

Per Cent Base* Reflectance	90									80									70									60									50												
	90	80	70	60	50	40	30	20	10	0	90	80	70	60	50	40	30	20	10	0	90	80	70	60	50	40	30	20	10	0	90	80	70	60	50	40	30	20	10	0	90	80	70	60	50	40	30	20	10
Cavity Ratio																																																	
0.2	89 88 88 87 86 85 85 84 84 82									79 78 78 77 77 76 76 75 74 72									70 69 68 68 67 67 66 66 65 64									60 59 59 59 58 57 56 56 55 53									50 50 49 49 48 48 47 46 46 44												
0.4	88 87 86 85 84 83 81 80 79 76									79 77 76 75 74 73 72 71 70 68									69 68 67 66 65 64 63 62 61 58									60 59 59 58 57 55 54 53 52 50									50 49 48 48 47 46 45 45 44 42												
0.6	87 86 84 82 80 79 77 76 74 73									78 76 75 73 71 70 68 66 65 63									69 67 65 64 63 61 59 58 57 54									60 58 57 56 55 53 51 51 50 46									50 48 47 46 45 44 43 42 41 38												
0.8	87 85 82 80 77 75 73 71 69 67									78 75 73 71 69 67 65 63 61 57									68 66 64 62 60 58 56 55 53 50									59 57 56 55 54 51 48 47 46 43									50 48 47 45 44 42 40 39 38 36												
1.0	86 83 80 77 75 72 69 66 64 62									77 74 72 69 67 65 62 60 57 55									68 65 62 60 58 55 53 52 50 47									59 57 55 53 51 48 45 44 43 41									50 48 46 44 43 41 38 37 36 34												
1.2	85 82 78 75 72 69 66 63 60 57									76 73 70 67 64 61 58 55 53 51									67 64 61 59 57 54 50 48 46 44									59 56 54 51 49 46 44 42 40 38									50 47 45 43 41 39 36 35 34 29												
1.4	85 80 77 73 69 65 62 59 57 52									76 72 68 65 62 59 55 53 50 48									67 63 60 58 55 51 47 45 44 41									59 56 53 49 47 44 41 39 38 36									50 47 45 42 40 38 35 34 32 27												
1.6	84 79 75 71 67 63 59 56 53 50									75 71 67 63 60 57 53 50 47 44									67 62 59 56 53 47 45 43 41 38									59 55 52 48 45 42 39 37 35 33									50 47 44 41 39 36 33 32 30 26												
1.8	83 78 73 69 64 60 56 53 50 48									75 70 66 62 58 54 50 47 44 41									66 61 58 54 51 46 42 40 38 35									58 55 51 47 44 40 37 35 33 31									50 46 43 40 38 35 31 30 28 25												
2.0	83 77 72 67 62 56 53 50 47 43									74 69 64 60 56 52 48 45 41 38									66 60 56 52 49 45 40 38 36 33									58 54 50 46 43 39 35 33 31 29									50 46 43 40 37 34 30 28 26 24												
2.2	82 76 70 65 59 54 50 47 44 40									74 68 63 58 54 49 45 42 38 35									66 60 55 51 48 43 38 36 34 32									58 53 49 45 42 37 34 31 29 28									50 46 42 38 36 33 29 27 24 22												
2.4	82 75 69 64 58 53 48 45 41 37									73 67 61 56 52 47 43 40 36 33									65 60 54 50 46 41 37 35 32 30									58 53 48 44 41 36 32 30 27 26									50 46 42 37 35 31 27 25 23 21												
2.6	81 74 67 62 56 51 46 42 38 35									73 66 60 55 50 45 41 38 34 31									65 59 54 49 45 40 35 33 30 28									58 53 48 43 39 35 31 28 26 24									50 46 41 37 34 30 26 23 21 20												
2.8	81 73 66 60 54 49 44 40 36 34									73 65 59 53 48 43 39 36 32 29									65 59 53 48 43 38 33 30 28 26									58 53 47 43 38 34 29 27 24 22									50 46 41 36 33 29 25 22 20 19												
3.0	80 72 64 58 52 47 42 38 34 30									72 65 58 52 47 42 37 34 30 27									64 58 52 47 42 37 32 29 27 24									57 52 46 42 37 32 28 25 23 20									50 45 40 36 32 28 24 21 19 17												
3.2	79 71 63 56 50 45 40 36 32 28									72 65 57 51 45 40 35 33 28 25									64 58 51 46 40 36 31 28 25 23									57 51 45 41 36 31 27 23 22 18									50 44 39 35 31 27 23 20 18 16												
3.4	79 70 62 54 48 43 38 34 30 27									71 64 56 49 44 39 34 32 27 24									64 57 50 45 39 35 29 27 24 22									57 51 45 40 35 30 26 23 20 17									50 44 39 35 30 26 22 19 17 15												
3.6	78 69 61 53 47 42 36 32 28 25									71 63 54 48 43 38 32 30 25 23									63 56 49 44 38 33 28 25 22 20									57 50 44 39 34 29 25 22 19 16									50 44 39 34 29 25 21 18 16 14												
3.8	78 69 60 51 45 40 35 31 27 23									70 62 56 47 41 36 31 28 24 22									63 56 49 43 37 32 27 24 21 19									57 50 43 38 33 29 24 21 19 15									50 44 38 34 29 25 21 17 15 13												
4.0	77 69 58 51 44 39 33 29 25 22									70 61 53 46 40 35 30 26 22 20									63 55 48 42 36 31 26 23 20 17									57 49 42 37 32 28 23 20 18 14									50 44 38 33 28 24 20 17 15 12												
4.2	77 62 57 50 43 37 32 28 24 21									69 60 52 45 39 34 29 25 21 18									62 55 47 41 35 30 25 22 19 16									56 49 42 37 32 27 22 19 17 14									50 43 37 32 28 24 20 17 14 12												
4.4	76 61 56 49 42 36 31 27 23 20									69 60 51 44 38 33 28 24 20 17									62 54 46 40 34 29 24 21 18 15									56 49 42 36 31 27 22 19 16 13									50 43 37 32 27 23 19 16 13 11												
4.6	76 60 55 47 40 35 30 26 22 19									69 59 50 43 37 32 27 23 19 15									62 53 45 39 33 28 24 21 17 14									56 49 41 35 30 26 21 18 16 13									50 43 36 31 26 22 18 15 13 10												
4.8	75 59 54 46 39 34 28 25 21 18									68 58 49 42 36 31 26 22 18 14									62 53 45 38 32 27 23 20 16 13									56 48 41 34 29 25 21 18 15 12									50 43 36 31 26 22 18 15 12 09												
5.0	75 59 53 45 38 33 28 24 20 16									68 58 48 41 35 30 25 21 18 14									61 52 44 36 31 26 22 19 16 12									56 48 40 34 28 24 20 17 14 11									50 42 35 30 25 21 17 14 12 09												
6.0	73 61 49 41 34 29 24 20 16 11									66 55 44 38 31 27 22 19 15 10									60 51 41 35 28 24 19 16 13 09									55 45 37 31 25 21 17 14 11 07									50 42 34 29 23 19 15 13 10 06												
7.0	70 58 45 38 30 27 21 18 14 08									64 53 41 35 28 24 19 16 12 07									58 48 38 32 26 22 17 14 11 06									54 43 35 30 24 20 15 12 09 05									49 41 32 27 21 18 14 11 08 05												
8.0	68 55 42 35 27 23 18 15 12 06									62 50 38 32 25 21 17 14 11 05									57 46 35 29 23 19 15 13 10 05									53 42 33 28 22 18 14 11 08 04									49 40 30 25 19 16 12 10 07 03												
9.0	66 52 38 31 25 21 16 14 11 05									61 49 36 30 23 19 15 13 10 04									56 45 33 27 21 18 14 12 09 04									52 40 31 26 20 16 12 10 07 03									48 39 29 24 18 15 11 09 07 03												
10.0	65 51 36 29 22 19 15 11 09 04									59 46 33 27 21 18 14 11 08 03									55 43 31 25 19 16 12 10 08 03									51 39 29 24 18 15 11 09 07 02									47 37 27 22 17 14 10 08 06 02												

* Ceiling, floor, or floor of cavity

TABLE 3-16

RSDD ROOM SURFACE DIRT DEPRECIATION

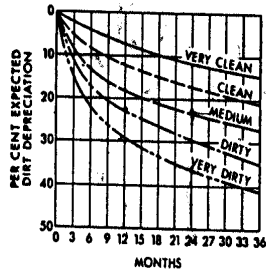


Fig. 9-5. Room Surface Dirt Depreciation Factors

Per Cent Expected Dirt Depreciation	Luminaire Distribution Type																			
	Direct				Semi-Direct				Direct-Indirect				Semi-Indirect				Indirect			
	10	20	30	40	10	20	30	40	10	20	30	40	10	20	30	40	10	20	30	40
Room Cavity Ratio																				
1	.98	.96	.94	.92	.97	.92	.89	.84	.94	.87	.80	.76	.94	.87	.80	.73	.90	.80	.70	.60
2	.98	.96	.94	.92	.96	.92	.88	.83	.94	.87	.80	.75	.94	.87	.79	.72	.90	.80	.69	.59
3	.98	.96	.93	.90	.96	.91	.87	.82	.94	.86	.79	.74	.94	.86	.78	.71	.90	.79	.68	.58
4	.97	.95	.92	.90	.95	.90	.85	.80	.94	.86	.79	.73	.94	.86	.78	.70	.89	.78	.67	.56
5	.97	.94	.91	.89	.94	.90	.84	.79	.93	.86	.78	.72	.93	.86	.77	.69	.89	.78	.66	.55
6	.97	.94	.91	.88	.94	.89	.83	.78	.93	.85	.78	.71	.93	.85	.76	.68	.89	.76	.65	.54
7	.97	.94	.90	.87	.93	.88	.82	.77	.93	.84	.77	.70	.93	.84	.76	.68	.89	.76	.65	.53
8	.96	.93	.89	.86	.93	.87	.81	.75	.93	.84	.76	.69	.93	.84	.76	.68	.88	.76	.64	.52
9	.96	.92	.88	.85	.93	.87	.80	.74	.93	.84	.76	.68	.93	.84	.75	.67	.88	.75	.63	.51
10	.96	.92	.87	.83	.93	.86	.79	.72	.93	.84	.75	.67	.92	.83	.75	.67	.88	.75	.62	.50

FLOOR MULTIPLYING FACTORS FOR OTHER THAN 20% MF

Fig. 9-13. Multiplying Factors for Other than 20 Per Cent Effective Floor Cavity Reflectance

% Effective Ceiling Cavity Reflectance, ρ_{cc}	80				70				50			30			10			
	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	
For 30 Per Cent Effective Floor Cavity Reflectance (20 Per Cent = 1.00)																		
Room Cavity Ratio	1	1.092	1.082	1.075	1.068	1.077	1.070	1.064	1.059	1.049	1.044	1.040	1.028	1.026	1.023	1.012	1.010	1.008
2	1.079	1.066	1.055	1.047	1.068	1.057	1.048	1.039	1.041	1.033	1.027	1.026	1.021	1.017	1.013	1.010	1.006	
3	1.070	1.054	1.042	1.033	1.061	1.048	1.037	1.028	1.034	1.027	1.020	1.024	1.017	1.012	1.014	1.009	1.005	
4	1.062	1.045	1.033	1.024	1.055	1.040	1.029	1.021	1.030	1.022	1.015	1.022	1.015	1.010	1.014	1.009	1.004	
5	1.056	1.038	1.026	1.018	1.050	1.034	1.024	1.015	1.027	1.018	1.012	1.020	1.013	1.008	1.014	1.009	1.004	
6	1.052	1.033	1.021	1.014	1.047	1.030	1.020	1.012	1.024	1.015	1.009	1.019	1.012	1.006	1.014	1.008	1.003	
7	1.047	1.029	1.018	1.011	1.043	1.026	1.017	1.009	1.022	1.013	1.007	1.018	1.010	1.005	1.014	1.008	1.003	
8	1.044	1.026	1.015	1.009	1.040	1.024	1.015	1.007	1.020	1.012	1.006	1.017	1.009	1.004	1.013	1.007	1.003	
9	1.040	1.024	1.014	1.007	1.037	1.022	1.014	1.006	1.019	1.011	1.005	1.016	1.009	1.004	1.013	1.007	1.002	
10	1.037	1.022	1.012	1.006	1.034	1.020	1.012	1.005	1.017	1.010	1.004	1.015	1.009	1.003	1.013	1.007	1.002	
For 10 Per Cent Effective Floor Cavity Reflectance (20 Per Cent = 1.00)																		
Room Cavity Ratio	1	.923	.929	.935	.940	.933	.939	.943	.948	.956	.960	.963	.973	.976	.979	.989	.991	.993
2	.931	.942	.950	.958	.940	.949	.957	.963	.962	.968	.974	.976	.980	.985	.988	.991	.995	
3	.939	.951	.961	.969	.945	.957	.966	.973	.967	.975	.981	.978	.983	.988	.988	.992	.996	
4	.944	.958	.969	.978	.950	.963	.973	.980	.972	.980	.986	.980	.986	.991	.987	.992	.996	
5	.949	.964	.976	.983	.954	.968	.978	.985	.975	.983	.989	.981	.988	.993	.987	.992	.997	
6	.953	.969	.980	.986	.958	.972	.982	.989	.977	.985	.992	.982	.989	.995	.987	.993	.997	
7	.957	.973	.983	.991	.961	.975	.985	.991	.979	.987	.994	.983	.990	.996	.987	.993	.998	
8	.960	.976	.986	.993	.963	.977	.987	.993	.981	.988	.995	.984	.991	.997	.987	.994	.998	
9	.963	.978	.987	.994	.965	.979	.989	.994	.983	.990	.996	.985	.992	.998	.988	.994	.999	
10	.965	.980	.989	.995	.967	.981	.990	.995	.984	.991	.997	.986	.993	.998	.988	.994	.999	
For 0 Per Cent Effective Floor Cavity Reflectance (20 Per Cent = 1.00) CARPETS																		
Room Cavity Ratio	1	.859	.870	.879	.886	.873	.884	.893	.901	.916	.923	.929	.948	.954	.960	.979	.983	.987
2	.871	.887	.903	.919	.886	.902	.916	.928	.926	.938	.949	.954	.963	.971	.978	.983	.991	
3	.882	.904	.915	.942	.898	.918	.934	.947	.936	.950	.964	.958	.969	.979	.976	.984	.993	
4	.893	.919	.941	.958	.908	.930	.948	.961	.945	.961	.974	.961	.974	.984	.975	.985	.994	
5	.903	.931	.953	.969	.914	.939	.958	.970	.951	.967	.980	.964	.977	.988	.975	.985	.995	
6	.911	.940	.961	.976	.920	.945	.965	.977	.955	.972	.985	.966	.979	.991	.975	.986	.996	
7	.917	.947	.967	.981	.924	.950	.970	.982	.959	.975	.988	.968	.981	.993	.975	.987	.997	
8	.922	.953	.971	.985	.929	.955	.975	.986	.963	.978	.991	.970	.983	.995	.976	.988	.998	
9	.928	.958	.975	.988	.933	.959	.980	.989	.966	.980	.993	.971	.985	.996	.976	.988	.998	
10	.933	.962	.979	.991	.937	.963	.983	.992	.969	.982	.995	.973	.987	.997	.977	.989	.999	

Lighting Calculations

Type of Lightning System to use.

1. Incandescent Lumens/watt

Use ONLY for residential occupancies, service areas where
Seldom uses, outside floodlights, and explosion proof areas. 20 Lumens/watt

2. Fluorescent

- a. All interior locations, offices, shops, warehouses,
comfort stations, etc.
- b. Do not use in explosion proof areas, too expensive. 80 Lumens/watt

3. Mercury Vapor

- a. DO NOT USE in any location.
Metal Halide much more efficient
And cost effective. 50 Lumens/watt

4. Metal Halide

- a. Interior industrial lighting in shops
And warehouses 85 Lumens/watt

5. Low and High Pressure Sodium

- a. Use for exterior area lighting and security
Building lighting.

Most sufficient source. 125 Lumens/watt

Design of Lighting Systems

Basic Data Needed

1. Design level foot candles F.C. IES 9-81 – 9-95 or Page 16
2. Room Length feet : L Ft.
3. Room Width feet : W Ft.
4. Height of work plane from floor, HFC, Ft.
5. Height of room cavity, work plane to fixture, HRC, Ft.
6. Height of ceiling Cavity, fixture to ceiling, HCC, Ft.
7. Reflectance of Ceiling, Walls, Floor.

TABLE A

<u>Ceiling</u>	<u>%Actual Reflectance</u>
White Tile	70%
Light Color Pain	50%
Plywood	30%
<u>Walls</u>	
White Paint	60-70%
Light Paint	50%
Dark Paneling, Burlap	10%
Bulletin Boards	10%
<u>Floors</u>	
White Tile	20%
Concrete, wood, carpet	0%

8. Cleaning Schedules

12, 24, 36 months

9. Dirt Levels

- | | |
|----------------|---|
| a. Very Clean: | - Hospitals, clean rooms, Doctors office |
| b. Clean: | - Offices with little outside dirt infiltration. Typical high rise office |
| c. Medium: | - Typical Forest Service Office |
| d. Dirty: | - Shops, warehouses |
| e. Very Dirty: | - Shops, producing fumes: i.e., welding shops, carpenter shops. |

10. Maintenance Category

- I. Semi-direct Free Lamps, Bare strip lamps.
- II. 15% or more up light, open or louvered large louver 1 inch or more.
- III. Less than 15% up light open or louvered louver less than 1 inch.

- IV. Direct closed top recessed surface suspended open louvered lighted ceiling louvered.
 - V. Direct, semi-direct, enclosed recessed, surface recessed with lens.
 - VI. Totally direct, totally indirect, semi-direct lighted ceilings, coves, urns.
11. Type of fixture, Forest Service Standard, F1, F2, etc.
 12. Number of lamps per fixture 1, 2, 3, 4, 5, 6, etc.
 - a. Use 3 TUBE fluorescent in offices with dual switching, for 2 or more light level capability.
 13. Lumens Per Lamp, Lamp Lumen Depreciation: LTD

INCANDESCENT See Table B or below

- a. Lighting systems for general illumination use should never use incandescent. Too inefficient.

		<u>Lamp Lumens</u>	<u>Lamp Lumen Depreciation</u>
b. <u>Fluorescent</u>			
Standard 40 W:	F40 T12 CW	3150 Lumens	.85
	F96 T12 CW	9200 Lumens	.85
<u>Metal Halide</u>			LLD
175 Watt		14,000 Lumens	.77
400 Watt		34,000 Lumens	.75
<u>High Pressure Sodium</u>			
150 Watt		16,000 Lumens	.90
250 Watt		25,000 Lumens	.91
400 Watt		50,000 Lumens	.90

14. Luminaries Dirt Depreciation: LDD

See Table 1 Need Cleaning Schedule and Maintenance Category.

15. Calculate Cavity Ratios, CCR, R, R, FCR

Calculate room cavity ratio; floor cavity ratio, ceiling cavity ratio or use table 2.

$$\text{Cavity Ratio} = \frac{5 (\text{Cavity Height}) (L + W)}{(L \times W)}$$

$$\text{CCR, Ceiling Cavity Ratio} = 5 (\text{HCC}) \frac{(L + W)}{(L \times W)}$$

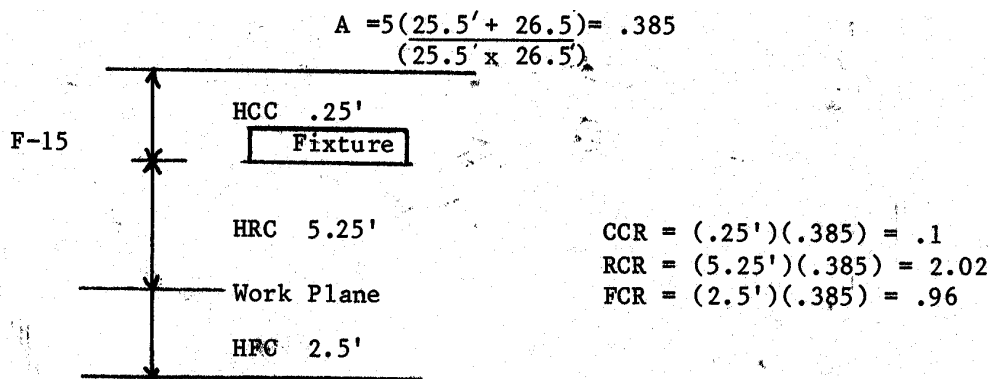
$$\text{RCR, Room Cavity Ratio} = 5 (\text{HCR}) \frac{(L + W)}{(L \times W)}$$

$$\text{FCR, Floor Cavity Ratio} = 5 (\text{HFC}) \frac{(L + W)}{(L \times W)}$$

Easy Way (Measurements in tenths of a foot)

$$A = \frac{(L + W)}{(L \times W)} \times 5 \quad L = 25.5 \quad W = 26.5 \quad (\text{Example})$$

$$\begin{aligned} \text{Ceiling Cavity Ratio} &= \text{HCC} \times A &= \text{CCR} \\ \text{Room Cavity Ratio} &= \text{HRC} \times A &= \text{RCR} \\ \text{Floor Cavity Ratio} &= \text{HFC} \times A &= \text{FCR} \end{aligned}$$



16. Effectiveness Reflectance
Use Table 3

Actual wall reflectance = effective wall reflectance.

Find ceiling and floor reluctance

Example: Ceiling Reluctance 70% actual reflectance

OCR = .1 Wall Reflectance 50% actual reflectance
 RCR = 2.02 Floor Reflectance 0% actual reflectance
 FCR = .96

Enter Table 3

70% Ceiling reflectance CCR .1 Effective Ceiling Reflectance = 69%
 50 % actual wall reflectance = 50 % effective wall reflectance
 0 % Floor reflectance; Effective Floor Reflectance = 4%
 50% Wall Reflectance
 FCR = 2.1

17. Room Surface Dirt Depreciation: RSDD

Use Table 4 . Need cleaning schedule, room dirt factor, luminaries distribution type, (most are direct) and room cavity ratio. Example: Medium dirt, 24 months, room cavity ratio 2.02%, find expected percent dirt depreciation %. Enter Table 4 @ RCR 2.02, 20% expected dirt depreciation, direct type luminaries and find room surface dirt depreciation RSDD of .95.

18. Multiplying Factors for Floors, MF (for floor reflectance other than 20%)

Use Table 5

Example: Carpet 4% effective reflectance

RCR = 2.02, 68% ceiling, 50% wall, effective reflectance = actual reflectance.

MF = .9

19. Coefficient of Utilization, CU

From manufacturers literature on page 9-12 to 9-30 IES Handbook.

Example: RCR = 2.02, 68% ceiling, 50% wall, 4% floor, Type # 43, page 9-28, CU .56.

Insert numbers into formula: Fixture E-F-15, 4 Lamp 3150 Lumens/Lamp

$$\text{No fixtures} = \frac{(\text{Design Level FC}) (\text{Room Length Ft}) (\text{Room Width Ft})}{\text{Lamps} \frac{\text{LU}}{\text{LMP}} \text{CU} \times \text{MF} \times \text{LLD} \text{LLD} \text{RSDD}}$$

		<u>Table</u>
Room Length	L = 25.5 Ft.	Given
Room Width	W = 26.5 Ft.	Given
Lamp Lumen depreciation	LLD = .85 See 13 above or Table B	

Room Surface dirt depreciation	LDD = .77	Table 1
Multiplying factor floor	RSDD = .95	Table 4

Cleaning Schedule:	24 months	
Dirt Level	Medium	
Maintenance Category	V	
Coefficient of Utilization	CU = .56	
Lamps/fixture	4	
Lumens/ lamp	3150	Table A
Design Level	50 FC	Page 9-28 IES

<u>Actual Reflectance %</u>	<u>Effective Reflectance %</u>
Ceiling	68
Wall	50
Floor	4

Number of Fixtures =

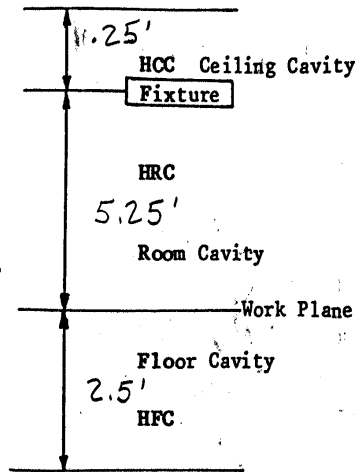
$$\frac{(50 \text{ FC}) (25.5 \text{ ft.}) (26.5 \text{ ft.})}{(4 \text{ Lamps}) \times (3150 \text{ Lumens}) \times (.56 \text{ CU}) \times (.9 \text{ MF}) \times (.85 \text{ LLD}) \times (.77 \text{ DD}) \times (.95 \text{ RSDD})}$$

(fixture) Lamp

= 8.3 Fixtures : Use 8 fixtures

LIGHTING DESIGN CALCULATIONS

Project Tonasket By Steve Date 2-5-80 Room Office
 Fixture F-15 Lamps/Fixture 4 Lumens/Lamp 3150 Design Level 50 Foot Candles



Use Table 2 for Cavity Ratios Or:

$$\frac{5(L + W)}{L \times W} = A \quad 5(25.5 \text{ ft.} + 26.5 \text{ ft.}) = A = .385$$

(25.5 ft. x 26.5 ft.)

$$\text{Ceiling Cavity Ratio} = \frac{\text{HCC}}{\text{A}} = \frac{.25}{.385} = \text{CCR} = .10$$

$$\text{Room Cavity Ratio} = \frac{\text{HRC}}{\text{A}} = \frac{5.25}{.385} = \text{RCR} = 2.02$$

$$\text{Floor Cavity Ratio} = \frac{\text{HFC}}{\text{A}} = \frac{2.5}{.385} = \text{FCR} = .96$$

	<u>Symbol</u>	<u>Value</u>	<u>Table</u>
Room Length, Feet	L	25.5	
Room Width, Feet	W	26.5	
Ceiling Cavity Height	HCC	.25	
Room Cavity Height, feet	HRC	5.25	
Floor Cavity Height, feet	HFC	2.5	
Lamp Lumen Depreciation	LLD	.85	B
Maintenance Category I, II, III, IV, <u>V</u> , VI			
Dirt Level; Very Clean, Clean, <u>Medium</u> , Dirty, Very Dirty		<u>Med</u>	
Cleaning Schedule 12, <u>24</u> , 36 Months		<u>24 months</u>	

Actual Reflectance %

R Ceiling 70
 R Wall 50
 R Floor 0

Effective Reflectance %

R Ceiling .68
 R Wall .50
 R Floor .04

Luminaire Dirt Depreciation	LLD	<u>.77</u>	1
Room Surface Dirt Depreciation	RSDD	<u>.95</u>	4
Floor Multiplying Factor	MF	<u>.90</u>	5
Coefficient of Utilization *	CU	<u>.56</u>	

*Coefficient of Utilization from manufacturers literature or Page 23-31 IES Handbook

Number of Fixtures =

$$\frac{50 \text{ FC} \times 25.5 \text{ Room Length} \times 26.5 \text{ Room Width}}{\dots}$$

$$\frac{.56 \text{ C.U.} \times 4 \text{ Lamps} \times 3150 \text{ Lumens} \times .90 \text{ M.F.} \times .85 \text{ LLD} \times .77 \text{ x LDD} \times .95 \text{ RSDD}}{\dots} = 8.3 \text{ Fixtures} \quad \text{Use 8 Fixtures}$$

Table L-1.1. U.S. Forest Service Recommended Lighting Levels

<u>Task or Area</u>	<u>Design Level (FC)</u>	<u>Average Level Range (FC)</u>
Service or Public Areas	15	12-18
Calculation Areas within Office Space, but not at work areas	30	24-36
Normal Office work, Reading, Writing, Etc.	50	40-60
Office Work, Prolonged, Visually Difficult or Critical in Nature	75	60-90
Auditoriums	30	20-40
Cafeteria	30	20-40
Conference Rooms	30	25-35
Corridors, Lobbies, & Means of Egress	15	10-18
Kitchen (Average)	50	30-70
Mechanical Rooms (General areas)	10	5-15
Storage Areas	10	25-35
Storage Areas (Fine Details Required)	30	25-35
Toilets	20	15-30

Note: These are only recommended values. There is no conclusive data about how much light is really needed for someone to perform a specific task.

General Services Administration
Region 10
Auburn, WA 98002

November 4, 1981

GSA Regional Bulletin FPMR 10-9-44
Public Buildings And Space

To: Heads of Federal agency offices, GSA Region 10

Subject: Energy conservation in federally owned or leased space

- 1) Purpose. This bulletin informs agency officials and employees of the latest energy conservation practices being implemented in Government-owned and leased facilities.
- 2) Expiration data This bulletin contains information of a continuing nature and will remain effect until canceled.
- 3) Background. President Reagan rescinded the Emergency Building Temperature Regulations, effective February 17, 1981. Policies governing the heating and cooling functions under the control of GSA are stated in Federal Property Management Regulation 101-20. 116-3. This regulation states that workspace temperatures shall be maintained during working hours at 65° to 68°F during the heating season and 78° to 80°F during cooling seasons.
- 4) Conservation measures. The practices listed below are being used in GSA-operated and Government-owned and – leased buildings.
 - a. Temperature levels. Temperature levels in office space are maintained at a maximum of 65° to 68°F during the heating season and no lower than 78° to 80°F during cooling season. Temperature in warehouse space will be adjusted lower than 65°F depending upon the activity conducted within the space.
 - b. Lighting Levels. Lighting levels at work stations (desk tops) for general office work are maintained at 50 foot-candles under the nonuniform lighting concept. A 30-foot candle level is maintained in work areas and a maximum of 10-foot candles in nonworking areas. Outside lighting, except for security, is eliminated.
 - c. General. Window drapes and blinds are to be used to reduce heat losses by closing them during nighttime and on cold, cloudy days. In addition, the

president has directed that executive departments and establishments initiate the following steps to further conserve energy immediately:

- i. Reduce electrical use generally throughout agency activities, particularly lighting.
 - ii. Reduce petroleum use by eliminating unnecessary activities and vehicle trips and combining and consolidating the essential ones.
 - iii. Reduce agency activities that use large amounts of energy and could be deferred.
 - iv. Ensure that all agency heads aggressively pursue employee awareness programs on energy conservation and promote employee use of carpools and mass transit.
- d. Exceptions. Exceptions to the prescribes policies may be necessary for the protection and operation of certain specialized equipment, such as computers; for maintaining the health and efficiency of employees; and for certain specialized installations, such as greenhouses, hospitals and laboratories. Such exceptions may be granted only after consultation with appropriate technical personnel of the unit requesting the exception and the presentation of necessary supporting evidence. Exceptions will be granted by the offices responsible for the operation and maintenance of the facility and must be concurred in the agency's energy conservation coordinator.
- e. Agency cooperation.
- i. Agency heads have been extremely cooperative in this conservation program which has yielded an appreciable reduction in energy consumption. We ask your further cooperation as their will be periods of discomfort and adjustment as new measures are implemented. All employees should once again be alerted to this program and advised that measures taken will not create hazards, impair the provision of vital services, or curtail the proper functioning of agency activities. All actions taken will be consistent with employee safety standards. Consideration will continue to be given to employees with visual impairment or to special work condition requirements.

Electrical Characteristics

High pressure sodium.

Lamp	70W					100W					100W				
Ballast type/circuit diagram*	HPF Autotransformer/6					HPF Autotransformer/6					Lag NPF**/7				
Nominal primary voltage (volts)	120	208	240	277	480	120	208	240	277	480	120	208	240	277	480
Starting line current (amps)	.95	.55	.48	.40	.24	1.3	.75	.65	.56	.33	3.3				
Operating line current (amps)	.80	.46	.40	.35	.20	1.15	.66	.58	.50	.29	2.3				
Primary lamp extinguishing voltage (volts)	90	156	180	206	360	90	156	180	206	360	96				
Input wattage (watts) (VA)	88 VA					128 VA					122				
Secondary open circuit voltage (volts)	130					130					120				
Power factor	Over 90%					Over 90%					50%				
Lamp wattage regulation at ±5% line voltage variation	±12%					±12%					±10%				
Minimum ambient starting temperature	-20°F					-20°F					-20°F				

Not available

Lamp	150W, 55V					150W, 100V					150W, 55V				
Ballast type/circuit diagram*	HPF Autotransformer/6					HPF Autotransformer/6					Lag NPF**/7				
Nominal primary voltage (volts)	120	208	240	277	480	120	208	240	277	480	120	208	240	277	480
Starting line current (amps)	1.9	1.1	.95	.82	.48	1.84	1.07	.93	.80	.46	4.8				
Operating line current (amps)	1.65	.95	.83	.72	.42	1.62	.94	.81	.70	.41	3.4				
Primary lamp extinguishing voltage (volts)	90	156	180	208	360	90	156	180	208	360	102				
Input wattage (watts)	185					180					175				
Secondary open circuit voltage (volts)	128					240					120				
Power factor	Over 90%					Over 90%					50%				
Lamp wattage regulation at ±5% line voltage variation	±12%					±12%					±10%				
Minimum ambient starting temperature	-20°F					-20°F					-20°F				

Not available

Lamp	250W					400W					1000W				
Ballast type/circuit diagram*	Lead/5					Lead/5					Lead/5				
Nominal primary voltage (volts)	120	208	240	277	480	120	208	240	277	480	120	208	240	277	480
Starting line current (amps)	Less than operating					Less than operating					Less than operating				
Operating line current (amps)	2.6	1.5	1.3	1.13	.65	3.9	2.3	2.0	1.7	1.0	9.1	5.2	4.5	3.9	2.35
Primary lamp extinguishing voltage (volts)	75	130	150	170	305	75	130	150	170	300	87	152	176	210	375
Input wattage (watts) (VA)	300					450					1068				
Secondary open circuit voltage (volts)	225					220					400				
Power factor	Over 90%					Over 90%					Over 90%				
Lamp wattage regulation at ± ___% line voltage variation	±10% @ ±10%					±10% @ ±10%					±12% @ ±10%				
Minimum ambient starting temperature	-20°F					-20°F					-20°F				

Metal halide.

Lamp	175W					250W					400W				
Ballast type/circuit diagram*	Peak Lead Autotransformer/1					Peak Lead Autotransformer/1					Peak Lead Autotransformer/1				
Nominal primary voltage (volts)	120	208	240	277	480	120	208	240	277	480	120	208	240	277	480
Starting line current (amps)	Less than operating					Less than operating					Less than operating				
Operating line current (amps)	1.8	1.0	.86	.78	.45	2.6	1.5	1.3	1.13	.65	3.8	2.2	1.9	1.7	1.0
Primary lamp extinguishing voltage (volts)	66	115	132	152	264	60	104	120	135	240	56	96	112	130	223
Input wattage (watts) (VA)	210					290					450				
Secondary open circuit voltage (volts)	300					325					300				
Power factor	Over 90%					90%					Over 90%				
Lamp wattage regulation at ±10% line voltage variation	±7%					±7%					±10%				
Minimum ambient starting temperature	-20°F					-20°F					-20°F				

*Circuit diagrams are shown on back page. **Not UL listed.

Metal halide (con't).

Lamp	Two 400W					1000W					1500W				
	Peak Lead (Isolated Secondary)/3					Peak Lead Autotransformer/1					Peak Lead Autotransformer/1				
Ballast type/circuit diagram*															
Nominal primary voltage (volts)	120	208	240	277	480	120	208	240	277	480	120	208	240	277	480
Starting line current (amps)	Less than operating					Less than operating					Less than operating				
Operating line current (amps)	7.8	4.5	3.9	3.4	2.0	9.5	5.5	4.8	4.1	2.4	14.5	8.4	7.2	6.3	3.6
Primary lamp extinguishing voltage (volts)	60	104	120	140	240	74	123	142	168	303	75	130	150	173	300
Input wattage (watts)	875					1075					1140				
Secondary open circuit voltage (volts)	610					415					415				
Power factor	Over 90%					Over 90%					Over 90%				
Lamp wattage regulation at ±10% line voltage variation	±8%					±10%					±10%				
Minimum ambient starting temperature	-20°F					-20°F					-20°F				

Mercury.

Lamp	100W					175W					250W				
	CWA/1					CWA/1					CWA/1				
Ballast type/circuit diagram*															
Nominal primary voltage (volts)	120	208	240	277	480	120	208	240	277	480	120	208	240	277	480
Starting line current (amps)	Less than operating					Less than operating					Less than operating				
Operating line current (amps)	1.05	.60	.52	.45	.27	1.8	1.0	.9	.8	.5	2.4	1.4	1.2	1.1	.65
Primary lamp extinguishing voltage (volts)	65	115	130	150	260	65	115	130	150	260	65	115	130	150	260
Input wattage (watts) (VA)	120					200					216				
Secondary open circuit voltage (volts)	245					250					240				
Power factor	Over 90%					Over 90%					Over 90%				
Lamp wattage regulation at ±10% line voltage variation	±5%					±5%					±5%				
Minimum ambient starting temperature	-20°F					-20°F					-20°F				

Lamp	175W					250W					400W				
	Lag NPF/7					Lag NPF/7					CWA/1		MCW/2		
Ballast type/circuit diagram*															
Nominal primary voltage (volts)	120	208	240	277	480	120	208	240	277	480	120	208	240	277	480
Starting line current (amps)	5.5	3.2	2.9	2.2	1.5	9.0	5.2	3.9	2.9	2.3	Less than operating				
Operating line current (amps)	3.3	1.9	1.5	1.5	.85	5.4	3.1	2.6	2.1	1.3	3.8	2.2	1.9	1.7	1.0
Primary lamp extinguishing voltage (volts)	90	155	180	210	360	90	155	180	210	360	65	115	135	150	260
Input wattage (watts) (VA)	200					285					445		156		
Secondary open circuit voltage (volts)	240					240					245		250		
Power factor	50%					50%					Over 95%		98%		
Lamp wattage regulation at ±__% line voltage variation	±12% @ ±5%					±12% @ ±5%					±5% @ ±10%		**		
Minimum ambient starting temperature	-20°F					-20°F					-20°F				

Lamp	400W					Two 400W					1000W				
	MCW/2					MCW/3					CWA/1				
Ballast type/circuit diagram*															
Nominal primary voltage (volts)	120	208	240	277	480	120	208	240	277	480	120	208	240	277	480
Starting line current (amps)	Less than operating					Less than operating					Less than operating				
Operating line current (amps)	4.0	2.4	2.0	1.7	1.0	7.25	4.2	3.6	3.2	1.8	9.1	5.9	4.6	4.0	2.3
Primary lamp extinguishing voltage (volts)	65	115	135	150	260	70	120	140	160	280	75	130	145	170	290
Input wattage (watts) (VA)	445	445	445	450	460	870					1075				
Secondary open circuit voltage (volts)	245					250					525				
Power factor	Over 95%					98%					95%				
Lamp wattage regulation at ±10% line voltage variation	±5%					†					±5%				
Minimum ambient starting temperature	-20°F					0°F					-20°F				

*Circuit diagrams are shown on back page. **±2.5% @ ±10% †±2.5%