INSTRUCTIONS

for

MEAR'S

ELECTRIC LIGHTING CALCULATOR

Lumen Method

and

GLARE INDEX CALCULATOR

for Electric Lighting Installations

M. H. MEAR & Co.,
56 Nettleton Road, Dalton,
HUDDERSFIELD. Yorks.,
England.
Telephone Huddersfield 28589

CALCULATOR DESIGNERS & MANUFACTURERS
PLASTIC ENGRAVERS

METRIC MODELS

These instruments are exactly similar in design to the standard models with English calibrations except that the Length, Width and Height scales are calibrated in metres, Illumination is in lux and the Luminous Area of Fitting is in square centimetres. The method of use does not therefore change but the following is an example similar to that on pages 10 and 11 but in metric dimensions.

EXAMPLE

Room size ... ... 8m x 12m x 3m high. Use - General Office.

Illumination required 400 lux - from I.E.S. Code.

Reflection Factors... Ceiling 70%. Walls 50%.

Proposed Fittings ... Enclosed plastic diffusers for twin 65W fluorescent tubes. Colour - deluxe warm white.

From instruction booklet - Lighting design lumens = 2 x 2860 = 5780

Mounting Height above working plane ... ... = 3 m — 1 m = 2 m

Maximum spacing, from notes on calculator (Semi-direct fitting) ... ... = $1\frac{1}{2}$ x 2 m = 3 m

Room Index - from calculator ... ... = 2.4

Coefficient of Utilisation - from reverse side of calculator = .55

Setting calculator to above details of length, breadth, coefficient of utilisation, and required illumination:

Total Installed Flux = 88,000 lumens.

No. of Fittings = 16 at 5780 lumens each.

Arrangement of fittings say 4 rows of 4 in each row.

Spacings will be 8m ÷ 4 = 2m and 12m ÷ 4 = 3m which is just satisfactory.

Check for Glare

Fitting details as obtained from manufacturers list:

Upward Light Output Ratio	22%
Downward ,, ,, ,,	48%
Luminous Area	2900 sq. cm.
B.Z. Number	6

From these:

Flux Fraction Ratio	= 22÷48	=	.46
Downward Flux	= .48 x 5780	=	2780 lumens

Assume fittings are arranged lengthways along longest dimension of room:

From front of calculator looking along longest dimension:

Equivalent Length = 6.7 and Equivalent Width = 4.5

From back of calculator using red section for fittings looked at endways and the scales for BZ 6:-

Basic Glare Index = 18.5

Alternatively looking along the room's shortest dimension the equivalent length becomes 4.5 and the width 6.7. The fittings are now seen crossways so that the green scales must be used and:-

Basic Glare Index = 19.7

This is the worst direction of viewing giving the highest basic glare index and correcting this for Flux Fraction Ratio, Reflectances, Luminous Area, height and Downward Flux on the front of the calculator gives:

Correction = —1.2

Therefore **Final Glare Index = 19.7 — 1.2 = 18.5**

Limiting Glare Index from I.E.S. Code for General Office = 19.0.

The installation is therefore satisfactory for glare.

A check may be desirable with the full I.E.S. method in the event of a rigid specification but in this case the check gives an identical result of 18.5.

MEAR'S

ELECTRIC LIGHTING CALCULATOR

This instrument has been designed to give quickly and accurately the number and size of the lighting fittings necessary for any room in commercial and industrial premises and also to show the total light requirement in lumens.

It uses the Lumen method, solving the following formula:

$$F = \frac{Eav \times L \times B}{C \times M \times N}$$

where F = lighting design lumens for the lamp(s) in each fitting

Eav = average illumination in lumens/sq. ft. required in service.

C = coefficient of utilisation for the fitting which varies with the type of fitting, size of room and reflectance factors for the walls and ceiling.

L = length of room.

B = breadth of room.

N = number of fittings.

M = maintenance factor which allows for the reduction of light output in service due to dust and dirt.

The front of the instrument performs the necessary calculations and in addition indicates suitable spacings for different types of fitting as well as minimum mounting heights for open industrial fittings. The reverse side tabulates typical coefficients of utilisation for a wide range of lamp fittings.

REQUIRED LEVEL OF ILLUMINATION.

The amount of illumination desirable in a room varies with the type of work being carried out and the recommended levels for many types of industry and process are given in the Illuminating Engineering Society's Code "Recommendations for Good Interior Lighting".

The first step therefore is to decide the required level of illumination in lumens/sq. ft. on the basis of the I.E.S. code or from the user's specification.

TYPE OF FITTING

The type of fitting to be used on a particular installation depends on many factors which cannot satisfactorily be dealt with in a short note. The choice depends upon the light distribution required upwards, downwards and horizontally, the possibility of discomfort from glare, the efficiency of the fitting, the suitability of its appearance in conjunction with its surroundings, cleaning, maintenance, etc.

The lighting design lumens for the standard types of lamps to be installed in the various fittings can be obtained from the tables on pages 5 and 6 or if available from the actual manufacturer's data.

Fittings are classified according to the proportion of their total light output which goes upwards or downwards, i.e.

$$\frac{\text{upward lumens} \times 100}{\text{upward} + \text{downward lumens}}$$

Thus

Direct	give	0	—	10%	of their light upwards.
Semi-direct		10	—	40%	
General Diffusing		40	—	60%	
Semi-indirect		60	—	90%	
Indirect		90	—	100%	

MOUNTING HEIGHT OF FITTINGS.

The mounting height is often limited by the height of the ceiling, and fittings may be arranged close to the ceiling or suspended. With most fittings, reducing the height increases the efficiency very slightly as more light reaches the working surface directly. Such a reduction however necessitates placing the fittings closer together resulting in a larger number of smaller fittings at a probably greater total cost.

In general therefore it is usually more economical to mount the fittings higher and thus take advantage of the wider permissable spacing. It is also better practice as it reduces glare and except with unusually lofty ceilings it improves the general appearance of the room due to the better brightness distribution.

Indirect and semi-indirect fittings should however be suspended sufficiently below the ceiling to provide acceptable variations of ceiling brightness and to avoid the fittings themselves masking too great a proportion of the brighter ceiling areas. A suspension distance of $\frac{1}{4}$ to $\frac{1}{3}$ of the ceiling height is usual.

There are certain minimum mounting heights for open type industrial fittings which should be maintained to avoid glare and these are given on the calculator. The height available in the room often therefore determines the maximum wattage of the lamp which can be used.

SPACING OF FITTINGS.

The allowable spacing between fittings varies with the mounting height and also with the type of fitting. Generally accepted spacings are given on the calculator but individual manufacturers recommendations may vary from these and should be used where available for the particular fitting being installed.

It will seldom be possible to space fittings at equal intervals in both directions. Where the spacing in one direction differs from the other, neither must exceed the maximum and the wider of the two should not normally exceed $1\frac{1}{3}$ times the narrower.

At low mounting heights the length of eight foot tubular fluorescent fittings could exceed the allowable spacing and overlap be indicated to maintain such a spacing. As however the light output is spread over the length rather than concentrated at a point, larger spacings lengthways are acceptable such that the distance between the ends of adjacent fittings should not exceed half the length of the fitting for open and diffusing types or not more than one third for louvered types.

The maximum spacing between the rows of these fittings should conform to the normal rule on the calculator.

MAINTENANCE FACTOR.

For normal lighting installations assuming cleaning of lamps and fittings every six weeks or so the average illumination in service will be about 80% of the initial illumination with everything in its original state of cleanliness. The usually accepted maintenance factor of 0.8 is therefore built into the calculator. Instructions are given on the quadrant for applying other factors such as could apply to dirty working conditions.

Some situations, e.g. in foundries where smoke or steam can be present in the interior necessitate the application of an additional ABSORPTION FACTOR to allow for the partial absorption or scattering of light before it reaches the working plane.

COEFFICIENT OF UTILISATION.

The reverse side of the calculator gives coefficients of utilisation for typical lighting fittings representative of those widely used for general lighting purposes. Each segment deals with a group of fittings which have similar coefficients, each group having been ascribed a basic Downward Light Output Ratio which has been used in calculating the coefficient for the group. The actual Downward Light Output Ratio of a fitting can vary slightly from that of its group and in these cases a greater degree of accuracy can be obtained by multiplying the coefficient by the ratio of the D.L.O.R.'s as instructed on the calculator. These coefficients have been reproduced by kind permission of the British Lighting Council.

ROOM INDEX.

To find the coefficient of utilisation it is necessary to know the room index and scales are provided on the front to rapidly determine this.

CEILING AND WALL REFLECTION FACTORS.

It is also necessary to fix values for the reflection of light from the ceilings and walls of the room and these can either be measured by comparison of the walls and ceiling with standard colour cards available from certain lamp and fittings manufacturers, the factor being given on the matching card. Alternatively it can be approximated from the following details:

	Reflection Factor %
White; pale cream; light yellow; pale tints of green, blue, pink or grey	70
Bright yellow; very light green, blue, pink or grey	50
Deep pink; orange; light green, blue or grey	30
Red; dark green; dark blue; dark grey	10

Allowance must also be made for uncurtained windows, dark cupboards, furniture, doors, etc., which can reduce the average reflectance.

LUMEN OUTPUT OF VARIOUS TYPES OF LAMPS

The following tables of lumen output of various types of lamps will be useful in selecting sizes to install. Individual manufacturers figures will differ slightly from these and can be used if available. The outputs are given as 'Lighting Design Lumens' and in each case the output is the average throughout the life of the lamp.

FLUORESCENT MERCURY LAMPS.

Type & Wattage	Lighting Design Lumens
MBF/U 50	1,300
,, 80	2,500
,, 125	4.600
,, 250	10,400
,, 400	18,000
,, 700	32,000
,, 1000	46,800
,, 2000	118,000

Type & Wattage	Lighting Design Lumens
MBFR/U 125	4,900
,, 250	10,000
,, 400	17,200
,, 700	31,300
,, 1000	44,000

STANDARD INCANDESCENT LAMPS - Pear Shape.

Watts	Finish	Lighting Design Lumens	
		240V Single Coil	240V Coiled Coil
25	Pearl	200	
40	,,	325	390
60	,,	575	665
100	,,	1,160	1,260
150	,,	1,960	
200	Clear	2,720	
300	,,	4,300	
500	,,	7,700	
750	,,	12,400	
1000	,,	17,300	
1500	,,	27,500	

Silica coated lamps are available in 40 to 200W sizes with a lumen output approximately 10% less than the above figures.

TUBULAR FLUORESCENT LAMPS - Lumen Output.

Nom. Lamp Watts	Nom. Length & dia.	Lighting Design Lumens	Approximate Lighting Design Lumens					
			Daylight	Natural Natural-3	De-luxe - Wm.White	Warmtone	De-luxe - Natural	Artificial Daylight
		Warm White & White			Colour-Matching			
					Colour-32			
					Kolor-rite			
					Colour-34			
4	6″ x $\frac{5}{8}$	135	128	101	88	94	74	54
6	9″ x $\frac{5}{8}$	245	233	184	159	171	135	98
8	12″ x $\frac{5}{8}$	360	340	270	235	250	200	145
13	21″ x $\frac{5}{8}$	660	625	495	430	460	365	265
15	18″ x 1	680	640	510	440	475	375	270
15	18″ x 1$\frac{1}{2}$	650	620	490	425	455	360	260
20	2′ x 1$\frac{1}{2}$	1050	1000	790	680	735	580	420
20(B)	2′ x 1$\frac{1}{2}$	870	820	650	560	610	480	350
30	3′ x 1	1750	1660	1310	1140	1220	960	700
30	3′ x 1$\frac{1}{2}$	1700	1610	1270	1100	1190	930	680
40	2′ x 1$\frac{1}{2}$	1550	1470	1160	1010	1080	850	620
40	4′ x 1$\frac{1}{2}$	2650	2510	1990	1720	1850	1450	1060
40(B)	4′ x 1$\frac{1}{2}$	2240	2130	1680	1450	1570	1230	900
50	5′ x 1	3100	2940	2320	2020	2170	1700	1240
65	5′ x 1$\frac{1}{2}$	4400	4180	3300	2860	3080	2420	1760
80	5′ x 1$\frac{1}{2}$	4850	4600	3650	3150	3400	2650	1940
85	8′ x 1$\frac{1}{2}$	6400	6100	4800	4150	4500	3500	2560
120	5′ x 1$\frac{3}{8}$	5880	5600	4400	3800	4100	3230	2350
125	8′ x 1$\frac{1}{2}$	8300	7900	6200	5400	5800	4550	3300
Circular Lamps:								
22	8$\frac{1}{4}$″d. x 1$\frac{1}{8}$	850	810	640	550	600	470	340
32	12″d. x 1$\frac{1}{4}$	1500	1420	1120	970	1050	820	600
40	16″d. x 1$\frac{1}{4}$	2150	2040	1600	1400	1500	1180	860

(B) refers to MCFB lamp(s) for filament-ballast circuit.