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 ... ... = 3m — 1m = 2m

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

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.

GLARE INDEX CALCULATOR

FOR

ELECTRIC LIGHTING INSTALLATIONS

Direct glare discomfort arises from an excessive amount of light entering the eye directly from fittings near to the normal line of sight. Some degree of glare arises from all fittings, not necessarily sufficient to cause discomfort, but the amount varies with the type of fitting and a larger room, a lower mounting height or a greater number of fittings can increase the total glare to an objectionable degree.

This calculator has been designed to give the glare index for electric lighting installations in accordance with the method recommended by the British Lighting Council, this method being a slightly shortened version of the fundamental procedure developed by the Illuminating Engineering Society.

This system determines a Glare Index which is a measure of the glare experienced by an occupant of a room seated at the midpoint of one wall and looking horizontally at the centre of the opposite wall.

It is based upon the British Zonal Classification (B.Z. number) of the fittings being used and assumes that these fittings are arranged in a substantially regular pattern and is applicable only to working situations, where continuous glare can cause discomfort or even inability to perform the task with full efficiency. In other installations e.g. display, glare may be desirable for effect.

This index should be less than the Limiting Glare Index for the particular task and location as given by the Illuminating Engineering Society in their publication "Recommendations for Good Interior Lighting" which can also be referred to for further information.

Various technical details of the fittings are required to perform the necessary calculations and these are obtained from the manufacturers catalogue, i.e.

BZ Number. This is an indication of the type of light distribution from the fitting. There are 10 BZ numbers to cover the whole range of fittings and a particular fitting does not necessarily have a constant number, it may change according to the Room Index.

Flux Fraction Ratio. This is the ratio Upward Flux ÷ Downward Flux

or Upper Flux Fraction ÷ Lower Flux Fraction

or Upward Light Output Ratio ÷ Downward Light Output Ratio

Luminous Area of Fitting. For the BZ numbers 2 to 8 dealt with on the calculator this is the orthagonally projected luminous area as seen from vertically beneath the fitting.

Downward Flux. This is obtained by multiplying the total flux from the lamp(s) installed in each fitting by the D.L.O.R. (Downward Light Output Ratio) of the fitting.

SEQUENCE OF CALCULATIONS.

Having obtained this data and knowing the length and width of the room and proposed height of fittings proceed in accordance with the instructions on the calculator. The main sequence of calculation is indicated at the bottom of the front side of the main dial and comprises firstly the determination of the equivalent length and width of the room, secondly the finding of the Basic Glare Index, then thirdly the adjusments to give the Final Glare Index.

More detailed instructions on the reverse side and on the front quadrant amplify the performance of each step of the calculation and once the sequence is understood it will be found that the Final Glare Index can be obtained in a few seconds after assembly of the installation and fitting details.

ACCURACY.

The I.E.S. information on which this calculator is based is in the form of tables where room sizes proceed in quite large steps and as these steps apply both to length and width of room and to the flux fraction ratio some difficult interpolation is necessary

This difficulty does not arise with the calculator as fully calibrated scales are provided so that the exact length can be set to the exact width, the flux fraction ratio set exactly and the glare index read off directly.

The basic tabular information when plotted graphically yields curves showing the variation of glare index with equivalent length and width of room. Arithmetical interpolation between tabulated figures assumes a straight line graph and raises slight errors. The calculator eliminates these as it automatically takes into account the curvature of the graph. In addition the opportunity has been taken to draw the nearest smooth curve through the tabulated points with a resultant slight correction to certain points mainly corresponding to a room length of 4H.

As mentioned above, the calculator is based upon the British Lighting Council's shortened method of determining the Glare Index and we have checked a large number of the results obtained by this method with the full I.E.S. procedure and we estimate that over 85% are within 0.3 of the I.E.S. glare index and approximately 94% are within 0.4. The maximum error among the remainder is 1.2 and this along with most of the other significant differences occurs at an extreme room size of 12H x 12H. For all practical purposes these differences are negligible unless rigid conformity with a particular specification is necessary when values should be checked by the full I.E.S. method if they fall within 1.0 of the limiting glare index.

In this connection it is useful to remember that people cannot normally detect differences in glare index much less than one unit and also that errors in estimating reflectances of walls, ceiling and floor can result in very much greater differences.

EFFECT OF LIGHTER FLOORS.

The calculator gives glare indices for rooms with dark floors having a reflectance factor of 14%.

Figures are however given by the Illuminating Engineering Society for rooms with lighter floors having a reflectance factor of 30% and whilst these are not often used, the lighter floor does reduce the glare index. The reduction varies with a number of factors but the following tables gives the approximate reduction for various flux fraction ratios.

Flux Fraction Ratio	Approximate reduction in Final Glare Index
0	0.7 for small rooms to 3.3 for large rooms
.33	0.6 ,, ,, ,, ,, 2.3 ,, ,, ,,
1.0	0.6 ,, ,, ,, ,, 1.8 ,, ,, ,,
3.0	0.6 ,, ,, ,, ,, 1.2 ,, ,, ,,

Actual reductions for all sizes of rooms, different B.Z. numbers, etc. are given in the I.E.S. Code and can be applied directly to the calculator results.

REFERENCE BOOKS

For further information on the design of lighting installation and full details of Glare calculations the following publications are suggested:-

The I.E.S. Code — Recommendations for Good Interior Lighting, price 12/6d. obtainable from The Illuminating Engineering Society, York House, Westminster Bridge Road, London, S.E.1.

Interior Lighting Design Handbook, price 13/6d.
obtainable from The British Lighting Council, 16-18 Lancaster Place, London, W.C.2.

EXAMPLE

Room size ... ... 25′ x 40′ x 10′ high. Use - General Office.

Illumination required 30 lumens/sq. ft. 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 ... ... = 9′ 9″ — 3′ = 6′ 9″

Maximum spacing, from notes on calculator (Semi-direct fitting) ... ... = $1\frac{1}{2}$ x 6′ 9″ = 10′ $1\frac{1}{2}$″

Room Index - from calculator ... ... = 2.3

Coefficient of Utilisation - from reverse side of calculator = .54

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

Total Installed Flux = 70,000 lumens.

No. of Fittings = 12 at 5780 lumens each.

Arrangement of fittings say 3 rows of 4 in each row.

Spacings will be 25′ ÷ 3 = 8′ 4″ and 40′ ÷ 4 = 10′ 0″ which is just satisfactory.

Check for Glare

Fitting details as obtained from manufacturers list:

Upward Light Output Ratio	22%
Downward ,, ,, ,,	48%
Luminous Area	450 sq. in.
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 = 7.0 and Equivalent Width = 4.4

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

Basic Glare Index = 18.6

Alternatively looking along the room's shortest dimension the equivalent length becomes 4.4 and the width 7.0. 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.