HOLOPHANE®

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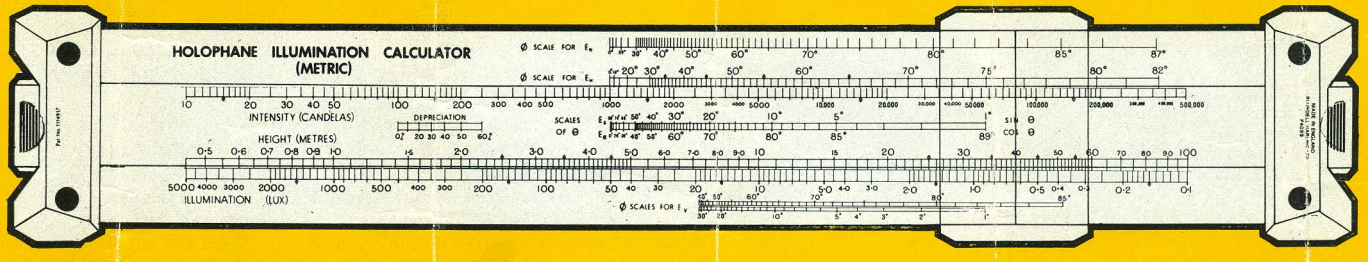
Illumination Calculator

A slide rule specifically designed for the calculation of point illuminances in various planes



This slide rule simplifies the calculation of horizontal, vertical and normal illuminances by the point-by-point method saving long, complicated and tedious calculations. Also it will enable the lighting engineer, whether he is a user or a specifier, to quickly check that the design of an installation is correct.

DESCRIPTION OF SLIDE RULE

Both sides of the slide rule are functional.
One side is an 'ANGLE CALCULATOR' which is used to find the relative angles normally associated with lighting calculations.

There are five scales.

A –scale: Marked 'Height–φ' on left and 'Length–θ' on right.
B –scale: Marked 'Length–φ' on left and 'Width–θ' on right.
C –scale: Marked 'Scale of θ'.
D –scale: Marked 'Scale for φ'.
D'–scale: Marked 'Index ψ'.

The other side is an 'ILLUMINATION CALCULATOR' which is used to find the values of illuminance on the various planes described above.

There are six main scales and two auxiliary scales.

Top of rule: A'–scale: Marked 'φ scale for E_N'.
A –scale: Marked 'φ scale for E_H'.

Slide: B –scale: Marked 'Intensity (Candelas)'.
C –scale: Marked 'Height (Metres)'.

Bottom of rule: D –scale: Marked 'Illumination (Lux)'.
D'–scale: Marked 'φ scale for E_V'.

There are also two scales on the centre of the slide, the first of which is used for depreciation calculations and another marked 'Scale of θ' which is used in vertical illuminance calculations.

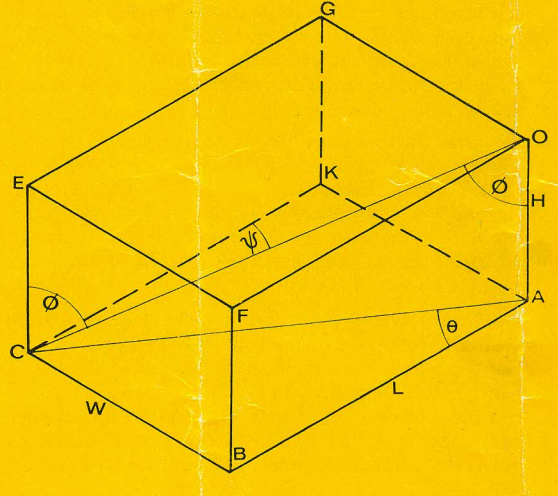


FIG. 1

THE FUNCTION OF THE ILLUMINATION CALCULATOR

The calculator solves the following formulae.

Illumination on Normal Plane: $E_N = \frac{I \cos^2 \varphi}{H^2}$

Illuminance on Horizontal Plane: $E_H = \frac{I \cos^3 \varphi}{H^2}$

Illuminance on Vertical Plane: $E_V = \frac{I \cos^2 \varphi \sin \varphi}{H^2}$

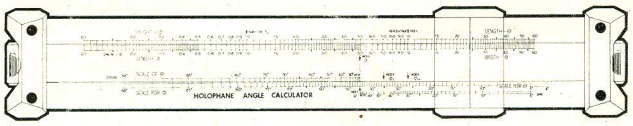
Figure 1 is a diagram showing the angles which will be used in practice.
The light source is at O, which is at height H above the working plane.

The test point C is fixed by the length-L and width-W in plan and the direction AC is at the angle θ (theta) in plan from the direction of length. The formulae for E_N, E_H and E_V are as shown but the illuminance E_S on the wall CEGK and the illuminance E_E on the end wall BCEF can also be calculated:

Illuminance on side wall: $E_S = \frac{I \cos^2 \varphi \sin \varphi \sin \theta}{H^2}$

Illuminance on end wall: $E_E = \frac{I \cos^2 \varphi \sin \varphi \cos \theta}{H^2}$

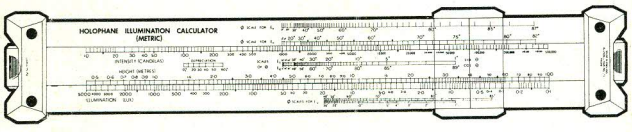
These two formulae can be solved immediately on the illumination calculator.



HOW TO USE THE ANGLE CALCULATOR

These notes detail the methods of calculating the angles θ and φ from the known dimensions for height, length and width from the fitting to the point being considered.
The angle in plan, θ, is measured from the direction of length.
The angular elevation φ is measured from the downward vertical.
Check answers are provided below so that the method of calculation can be verified.

1. **To calculate θ from length L and width W:**
   Set the cursor on the length L on the A–scale, marked 'Length–θ'.
   Set the width W on the B–scale, marked 'Width–θ', under the cursor.
   Read the angle θ on the D-scale, marked 'Scale for θ', opposite the 'Index θ' on the C–scale.
2. **To calculate φ from length L, width W and height H.**
   Calculate θ as above.
   Set the cursor on the height H on the A–scale, marked 'Height–φ'.
   Set the length L on the B–scale, marked 'Length–φ', under the cursor.
   Move the cursor to the value of θ on the C–scale, marked 'Scale of θ'.
   Read the angle φ on the D–scale, marked 'Scale for φ', under the cursor.
3. **To calculate the plan distance AC from the length L and width W.**
   Calculate θ as for 1.
   Set this value of θ on the C–scale, marked 'Scale of θ'. opposite the 'Index ψ' (psi) on the D–scale.
   Set the cursor on the length L on the B–scale.
   Read the plan distance AC on the A–scale under the cursor.



HOW TO USE THE ILLUMINATION CALCULATOR

The intensity 'I' in these notes is that in the direction OC in Fig. 1, which is obtained from polar distribution data at the angle φ for symmetrical fittings or the angle (θ, φ) for asymmetrical fittings. θ and φ are the angles of latitude and longitude shown on the sinusoidal charts which are often used for iso-candle diagrams.

1. **Horizontal Illuminance (E_H).**
   Set the cursor on the angle of elevation φ on the A–scale.
   Set the intensity I on the B-scale under the cursor.
   Move the cursor to the height H on the C–scale.
   Read the horizontal illuminance E_H on the D–scale under the cursor.
2. **Normal Illuminance (E_N). Normal to OC.**
   Set the cursor on the angle of elevation φ on the A'–scale. (at the top of the rule).
   Set the intensity I on the B–scale under the cursor.
   Move the cursor to the height H on the C–scale.
   Read the normal illuminance E_N on the D–scale under the cursor.
3. **Vertical Illuminance (E_V) in a vertical plane at point C normal to the line AC.**
   Set the cursor on the angle of elevation φ on the D'–scale (at the bottom of the rule).
   Set the intensity I on the B–scale under the cursor.
   Move the cursor to the height H on the C–scale.
   Read the vertical illuminance E_V on the D–scale under the cursor.
4. **Side Wall Illuminance (E_S) at point C in the vertical plane CEGK.**
   First, calculate the vertical illuminance E_V as for 3.
   Set the cursor on this value of vertical illuminance on the D–scale.
   Move the slide so that the zero (90°) on the 'Scales of θ' marked 'Es' on the middle scale is under the cursor.
   Move the cursor to the angle in plan θ on the scale marked 'Es'.
   Read the illuminance on the side wall Es on the D–scale under the cursor.
5. **End Wall Illuminance (E_E) at point C in the vertical plane BCEF.**
   This calculation is identical to that of E_S except that the centre 'scale of θ' marked E_E is used starting at 0° instead of 90°, i.e. This is the same position as the calculation for E_S but using a different scale.
6. **Illuminance on an Inclined Plane.**
   The illuminance on any plane at the test point may be calculated if the angle of incidence between the normal to the plane and the ray OC is known:
   First calculate the normal illuminance E_N as described in 2.
   Set the cursor on the value of the normal illuminance on the D–scale.
   Set the zero (0°) of the 'Scales of θ', marked E_E on the middle scale, under the cursor.
   Move the cursor to the known angle of incidence on the inclined plane, using the scale E_E.
   Read the oblique illuminance on the D–scale under the cursor.
7. **Depreciation for Maintenance Factors**
   Set the cursor on the value of the initial illuminance on the D–scale.
   Set the zero of the depreciation scale, in the middle of the rule, under the cursor.
   Move the cursor to the appropriate figure for the depreciation loss.
   Read the depreciated illuminance value on the D–scale under the cursor.

CHECK CALCULATIONS

The following figures have been worked out to provide examples which may be used for checking the method of calculation:

Data
Height –H=8m, Length –L=7m, Width –W=1·5m.
Intensity –I=5,000 cd.

Answers:

θ =12·1°	φ =41·8°	Length AC=7·2m.
E_N=43·4 Lux.	E_H=32·4 Lux.	E_V normal to say OC=28·9 Lux.
E_S= 6·0 Lux.	E_E =28·3 Lux.	

Holophane®
A Johns-Manville Company

Holophane Europe Ltd . Bond Avenue . Bletchley . Milton Keynes . MK1 1JG . England

☎ Milton Keynes (0908) 74661 Telex 826429 Telegrams Holophane Milton Keynes

HOLOPHANE, GREENWOOD PLAZA, DENVER, COLORADO 80217
THE HOLOPHANE COMPANY, LTD., 1620 STEELES AVE., BRAMALEA, ONT., CANADA
HOLOPHANE S.A. de C.V. APARTADO POSTAL 75–415, MEXICO 14, D.F., MEXICO
HOLOPHANE AUSTRALIA, 16 LANGRIDGE ST., COLLINGWOOD, MELBOURNE, VICTORIA 3066, AUSTRALIA.

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