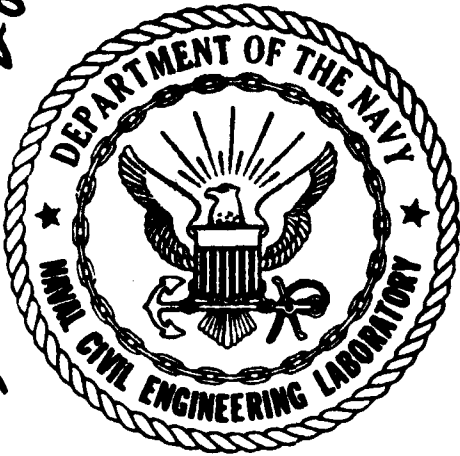


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CR 83.038

NAVAL CIVIL ENGINEERING LABORATORY
Port Hueneme, California

Sponsored by
NAVY ENERGY & NATURAL RESOURCES
R&D OFFICE
NAVAL FACILITIES ENGINEERING COMMAND

DAYLIGHTING COEFFICIENT OF UTILIZATION TABLES

August 1983

An Investigation Conducted by
APPLIED SOFTWARE ANALYSIS
2741 Iris Ave., Suite A
Boulder, Colorado 80302

N62583-83-MR-513

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METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures				Approximate Conversions from Metric Measures			
Symbol	When You Know	Multiply by	To Find	Symbol	When You Know	Multiply by	To Find
in	inches	2.5	centimeters	mm	millimeters	0.04	inches
ft	feet	30	centimeters	cm	centimeters	0.4	inches
yd	yards	0.9	meters	m	meters	3.3	feet
mi	miles	1.6	kilometers	km	kilometers	1.1	yards
in ²	square inches	6.5	square centimeters	cm ²	square centimeters	0.16	square inches
ft ²	square feet	0.09	square meters	m ²	square meters	1.2	square yards
yd ²	square yards	0.8	square meters	m ²	square kilometers	0.4	square miles
mi ²	square miles	2.6	square kilometers	km ²	hectares (10,000 m ²)	2.5	acres
	acres	0.4	hectares	ha			
oz	ounces	28	grams	g	grams	0.035	ounces
lb	pounds	0.45	kilograms	kg	kilograms	2.2	pounds
	short tons (2,000 lb)	0.9	tonnes	t	tonnes (1,000 kg)	1.1	short tons
tsp	teaspoons	5	milliliters	ml	milliliters	0.03	fluid ounces
Tbsp	tablespoons	15	milliliters	ml	liters	2.1	pints
fl oz	fluid ounces	30	milliliters	ml	liters	1.06	quarts
c	cups	0.24	liters	l	liters	0.26	gallons
pt	pints	0.47	liters	l	cubic meters	35	cubic feet
qt	quarts	0.95	liters	l	cubic meters	1.3	cubic yards
gal	gallons	3.8	liters	l			
ft ³	cubic feet	0.03	cubic meters	m ³			
yd ³	cubic yards	0.76	cubic meters	m ³			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature



*1 in. = 2.54 (exactly) For other exact conversions and more detailed tables, see NBS Misc. Publ. 266, Units of Weights and Measures, Price \$2.25, SD Catalog No. C13.10-266.

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the computer program which created the tables is included.

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1. Summary

The purpose of this research was to develop and describe a methodology through which the effects of daylight in an interior environment may be quickly and accurately predicted.

The research resulted in the computer program DAYCU2, which is implemented in FORTRAN-77 on the DEC VAX 11/780 minicomputer. The program will run without modification on any other model in the VAX series, and should be transportable with minimum conversion effort onto any other computer system which supports ANSI standard FORTRAN-77 and has sufficient memory (approx. 150k bytes).

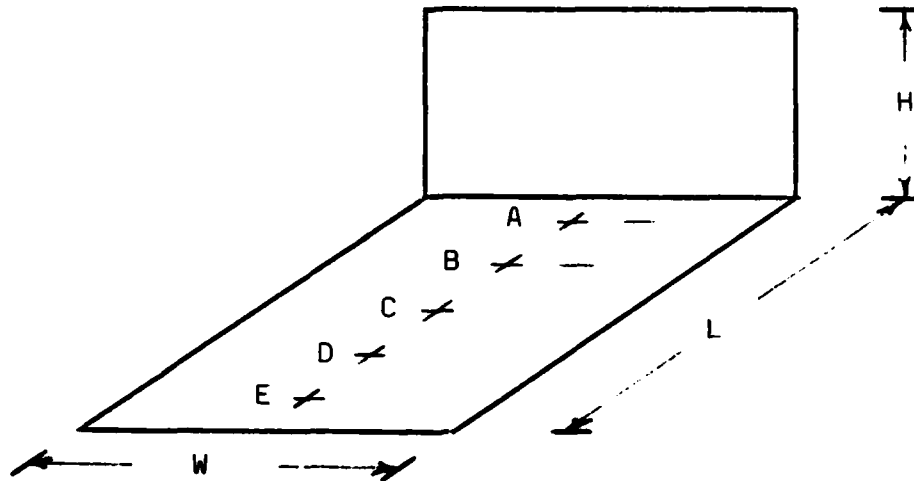
Executing DAYCU2 generates the daylighting coefficient of utilization (CU) tables, which appear in Appendix T of this document. To use the tables, the user need only determine the vertical illuminance at the window produced by the sky and by the ground. If venetian blinds are involved the user must also determine the vertical illuminance produced by the sun. Once these illuminances are determined, a few multiplications and additions yield the predicted illuminance at any of 5 target points within the room.

The remaining sections of this document discuss:

1. The underlying assumptions involved in the generation of the CU tables.
2. How to use the CU tables.
3. Comparisons of results obtained with the CU tables against those obtained from the method given in the IES publication RP-5.
4. The mathematical basis and logic flow of the computer program DAYCU2.
5. Advice for getting the most out of the tables.

The CU tables themselves are given in Appendix T. Other appendices contain the DAYCU2 computer program source code and additional mathematical formulae and derivations not appropriately included elsewhere.

2. Characteristics of the Daylighting Environment



The following sub-sections describe the parameters and assumptions used in building the CU tables:

2.1 Room Characteristics

One wall of the room is completely occupied by the window. The transmittance of the window is 1; from Bryan¹, the transmission loss due to angle of incidence is assumed to obey

$$\text{Loss} = 1.018 \cos \psi (1 + \sin^3 \psi)$$

where ψ is the angular displacement between the incident ray and a normal to the window. Wall reflectances (except the window-wall) are all 50%; floor reflectance is 30%; ceiling reflectance is 70%. CU tables are generated for all combinations of the following ratios of room depth and room width to window height:

Room width / window height = $\frac{1}{2}$, 1, 2, 3, 4, 6, 8, infinity

Room depth / window height = 1, 2, 3, 4, 6, 8, 10

2.2 Target Points

Target points A, B, C, D, and E are located along the floor at distances of 10%, 30%, 50%, 70%, and 90% of the room depth from the window. This is illustrated in the sketch above. The target points are located on the longitudinal centerline of the room -- i.e., each point is equidistant from the two walls which are adjacent to the window-wall.

¹ Harvey Bryan and Robert Clear, "Calculating Interior Daylight Illumination with a Programmable Hand Calculator", JIES, July 1981, pp. 219-227.

2.3 Sky

CU tables are generated for five different sky brightness distributions, according to the ratio of vertical-to-horizontal illuminance produced by a particular distribution. The five V:H ratios and the corresponding distributions are:

<u>Vertical/Horizontal Illuminance</u>	<u>Sky Luminance Distribution</u>
0.75	$L = L_z \left(.301 + 1.273 \exp(-.6/\sin h) \right)$
1.00	$L = L_z$
1.25	$L = L_z \left[\frac{1 - \exp(-.6/\sin h)}{1 - \exp(-.6)} \right]$
1.50	$L = L_z \left[\frac{1 - \exp(-.26/\sin h)}{1 - \exp(-.26)} \right]$
1.75	$L = L_z \left[\frac{1 - \exp(-.13/\sin h)}{1 - \exp(-.13)} \right]$

where

L_z = zenith luminance

h = altitude above horizon of point in sky

Note that in each case the sky brightness (luminance) depends only upon the zenith luminance and the solar altitude -- the brightness is independent of solar azimuth angle.

2.4 Ground

The ground is assumed to be an infinite flat Lambertian surface of constant exitance. Although the ground is thought of as a plane and the sky is thought of as a hemisphere, for calculation purposes the ground and the uniform sky may be treated exactly alike.

2.5 Sun

The CU tables take into account the effect of the sun on venetian blinds surfaces. In all other cases the presence of direct sunlight is ignored. If there are no venetian blinds, it is assumed that no sunlight enters the room directly, regardless of the solar position. Likewise, if blinds are present, but the blinds opening angle and solar profile angle are such that sunlight can penetrate the blinds, this direct sunlight is ignored.

The solar profile angle is the elevation above the horizontal of the projection of a vector from the window to the sun onto the vertical plane which is normal to the window. CU values are generated

for the following 6 profile angles:

0° (sun is on the horizon)
 15°
 30°
 45°
 60°
 75°

At 90° profile angle, the sun would be directly overhead. For vertical blinds the angles above should be interpreted as azimuth angles, where 0° azimuth means that the projection of the vector from the window to the sun upon a horizontal plane is normal to the window, etc. Note that if the profile or azimuth angle is 90° no sunlight can fall upon the window.

2.6 Venetian Blinds

Venetian blinds can be either horizontal slats or vertical slats type. Tables are generated for each of the 5 following values of blinds reflectance:

10 %
 30 %
 50 %
 70 %
 90 %

Blinds slats are assumed to be perfectly flat Lambertian surfaces. Slat width is taken to be 1.15 times spacing between slats; slat width is presumed small when compared with room dimensions. The following 6 blinds opening angles are covered in the tables:

0° (fully open)
 15°
 30°
 45°
 60°
 75°

A blinds opening angle = 90° would mean fully closed blinds.

3. How to Use the CU Tables

The tables are computed to three decimal places and printed with an implied decimal point. I.e., a table entry 076 means a coefficient = .076 There are four different kinds of tables:

i) Illuminance CU Tables (T-1 thru T-54)

These constitute the great bulk of the package and are used in all cases, blinds or no blinds. The tables are indexed as follows:

D / H - Room depth / window height

W / H - Window width / window height

% D - Location of target point in room -- 10% means 10% of the way from the window to the back wall.

ii) Solar Blinds Multipliers (T-55 thru T-56)

These tables are indexed by solar profile angle and blinds reflectance. There are 12 such tables, one each for each combination of six blinds angles and two blinds surfaces (top or underside). The solar blinds multipliers may be thought of as yielding the final exitance on the blinds, given the vertical solar illuminance, profile angle, and blinds reflectance.

iii) Sky Blinds Multipliers (T-57)

These are indexed by blinds angle and blinds reflectance. There is one table for the underside of blinds, and one table for the top-side of blinds. The sky blinds multipliers may be thought of as yielding the final exitance on blinds, given the vertical illuminance due to the sky, blinds angle, and reflectance.

iv) Ground Blinds Multipliers (T-58)

These are indexed by blinds angle and blinds reflectance. There is one table for the underside of blinds, and one table for the top-side of blinds. These multipliers may be thought of as yielding the final exitance on blinds, given the vertical illuminance due to the sky, blinds angle, and reflectance.

3.1 No Blinds

If no blinds are present on the window, we proceed by computing these two quantities:

$$E_{\text{sky}} = \tau \times V_{\text{sky}} \times T_{\text{sky}}$$

$$E_{\text{grd}} = \tau \times V_{\text{grd}} \times T_{\text{grd}}$$

where E_{sky} = desired illuminance at a target point in the room due to the sky

E_{grd} = desired illuminance at the target point due to the ground

- τ = transmittance of the window glazing
- V_{sky} = vertical illuminance at the window due to the sky
- V_{grd} = vertical illuminance at the window due to the ground
- T_{sky} = table entry for the sky luminance distribution, room dimensions, and target point in question. The tables are those on pages T-1 thru T-5.
- T_{grd} = table entry for ground contribution. This is table on T-6.

EXAMPLE

Given: 40'L x 20'W x 10'H room reflectances 70/50/30
 One 10' high x 8' wide window is centered on the south wall. Transmittance of glazing = 82%.
 Sky is overcast.
 Solar elevation angle = 45° .
 Ground reflectance = 15%.

Find: Illuminance on the floor midway in the room.

1. From Figure 3a we have $V_{\text{sky}} = 625$ fc and $H_{\text{sky}} =$ horizontal illuminance due to the sky = 1580 fc
2. $V_{\text{grd}} = .5 \times .15 \times 1580 = 118.5$ fc
3. From table T-1 we have $E_{\text{sky}} = .82 \times 625 \times .078 = 40$ fc
4. From table T-6 we have $E_{\text{grd}} = .82 \times 118.5 \times .078 = 8$ fc

(It is coincidence that the coefficient is .078 in each case -- we are rounding each final result to the nearest footcandle)

5. Adding the sky and ground contribution together, we get

$$E_{\text{total}} = 48 \text{ fc}$$

6. The tables presume that the window occupies the entire wall; therefore we must adjust by a factor equal to the proportion of the wall which is occupied by window, or:

$$E_{\text{adjusted}} = 48 \times \frac{(8)(10)}{(20)(10)} = 19 \text{ fc}$$

3.2 Blinds are Present

When venetian blinds are present we must compute the following intermediate quantities:

$$E_{\text{sky-thru}} = \tau \times V_{\text{sky}} \times T_{\text{sky-thru}}$$

$$E_{\text{grd-thru}} = \tau \times V_{\text{grd}} \times T_{\text{grd-thru}}$$

$$E_{\text{sky-und}} = \tau \times V_{\text{sky}} \times M_{\text{sky-und}} \times T_{\text{und}}$$

$$E_{\text{grd-und}} = \tau \times V_{\text{grd}} \times M_{\text{grd-und}} \times T_{\text{und}}$$

$$E_{\text{sky-top}} = \tau \times V_{\text{sky}} \times M_{\text{sky-top}} \times T_{\text{top}}$$

$$E_{\text{grd-top}} = \tau \times V_{\text{grd}} \times M_{\text{grd-top}} \times T_{\text{top}}$$

$$E_{\text{sun-und}} = \tau \times V_{\text{sun}} \times M_{\text{sun-und}} \times T_{\text{und}}$$

$$E_{\text{sun-top}} = \tau \times V_{\text{sun}} \times M_{\text{sun-top}} \times T_{\text{top}}$$

where $E_{\text{sky-thru}}$ = illuminance due to sky light which passes thru the blinds

$E_{\text{grd-thru}}$ = illuminance due to ground light which passes thru the blinds

$E_{\text{sky-und}}$ = illuminance due to that portion of underside blinds exitance which is due to the sky

$E_{\text{grd-und}}$ = illuminance due to that portion of underside blinds exitance which is due to the ground

$E_{\text{sky-top}}$ = illuminance due to that portion of topside blinds exitance which is due to the sky

$E_{\text{grd-top}}$ = illuminance due to that portion of topside blinds exitance which is due to the ground

$E_{\text{sun-und}}$ = illuminance due to that portion of underside blinds exitance which is due to the sun

$E_{\text{sun-top}}$ = illuminance due to that portion of topside blinds exitance which is due to the sun

V_{sun} = vertical illuminance at the window due to the sun

$M_{\text{sky-und}}$ = sky blinds multiplier for blinds underside (T-57)

$M_{\text{grd-und}}$ = ground blinds multiplier for blinds underside (T-58)

$M_{\text{sky-top}}$ = sky blinds multiplier for blinds topside (T-57)

$M_{\text{grd-top}}$ = ground blinds multiplier for blinds topside (T-58)

- $M_{\text{sun-und}}$ = solar blinds multiplier for blinds underside (T-55,T-56)
 $M_{\text{sun-top}}$ = solar blinds multiplier for blinds topside (T-55,T-56)
 T_{und} = CU table entry for blinds underside (T-31 thru T-42)
 T_{top} = CU table entry for blinds topside (T-43 thru T-54)
 $T_{\text{sky-thru}}$ = CU table entry for sky-thru component (T-7 thru T-18)
 $T_{\text{grd-thru}}$ = CU table entry for ground-thru component
 (T-19 thru T-30)

EXAMPLE

Given: 40'L x 20'W x 10'H room, reflectances 70/50/30
 One 10' high x 8' wide window is centered on the south wall (south wall is 20' wide). Transmittance is .82
 The window is completely covered by venetian blinds.
 The blinds are set at 30° ; reflectance of blinds = 50%
 It is a clear summer day; solar elevation = 45° .
 The sun directly faces the window-wall, so that solar azimuth angle = 0° (therefore profile angle = 45°)
 Ground reflectance = 15%.

Find: Illuminance at the floor midway in the room.

1. From Figure 3b (0° azimuth curve) we have $V_{\text{sky}} = 1480$
2. From Figure 3e (0° azimuth curve) we have $V_{\text{sun}} = 5500$
3. From Figure 3b, horizontal illuminance on the ground due to the clear summer sky is 1440 fc; from Figure 3e the horizontal illuminance on the ground from direct sunlight is 5500 fc. These total 6940 fc, so the vertical illuminance at the window due to the ground is:

$$V_{\text{grd}} = (.5)(.15)(6940) = 520$$

4. From the tables we find these CU values:

$T_{\text{sky-thru}} = .014$	$T_{\text{grd-thru}} = .041$
$M_{\text{sky-und}} = .084$	$M_{\text{grd-und}} = .065$
$M_{\text{sky-top}} = .407$	$M_{\text{grd-top}} = .047$
$M_{\text{sun-und}} = .075$	$M_{\text{sun-top}} = .438$
$T_{\text{und}} = .054$	$T_{\text{top}} = .009$

5. Combining, we get:

$$\begin{array}{rcl}
 E_{\text{sky-thru}} & = & .82 \times 1480 \times .014 = 17 \\
 E_{\text{grd-thru}} & = & .82 \times 520 \times .041 = 17 \\
 E_{\text{sky-und}} & = & .82 \times 1480 \times .084 \times .054 = 6 \\
 E_{\text{grd-und}} & = & .82 \times 520 \times .065 \times .054 = 1 \\
 E_{\text{sky-top}} & = & .82 \times 1480 \times .407 \times .009 = 4 \\
 E_{\text{grd-top}} & = & .82 \times 520 \times .047 \times .009 = 0 \\
 E_{\text{sun-und}} & = & .82 \times 5500 \times .075 \times .054 = 18 \\
 E_{\text{sun-top}} & = & .82 \times 5500 \times .438 \times .009 = 18 \\
 & & \text{-----} \\
 & & 81
 \end{array}$$

6. Finally, we must adjust by the proportion of wall which the 8' wide window occupies, or

$$E = (8/20) \times 81 = 32 \text{ fc}$$

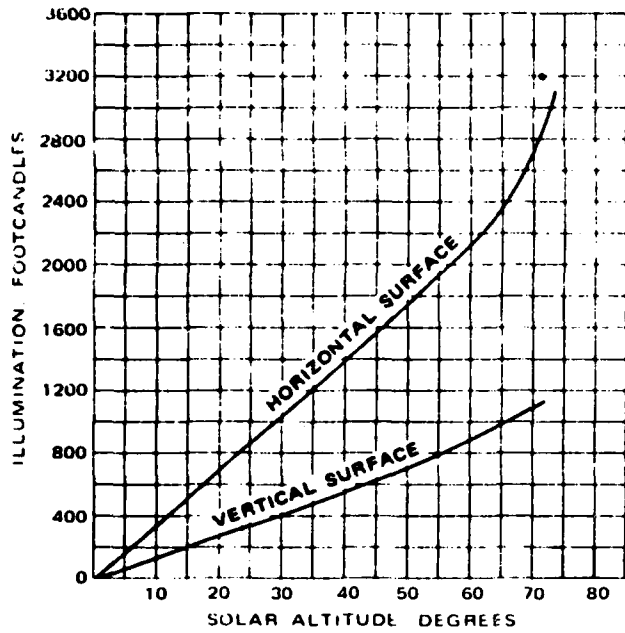


Figure 3a: Illuminance from an overcast sky (no sun)

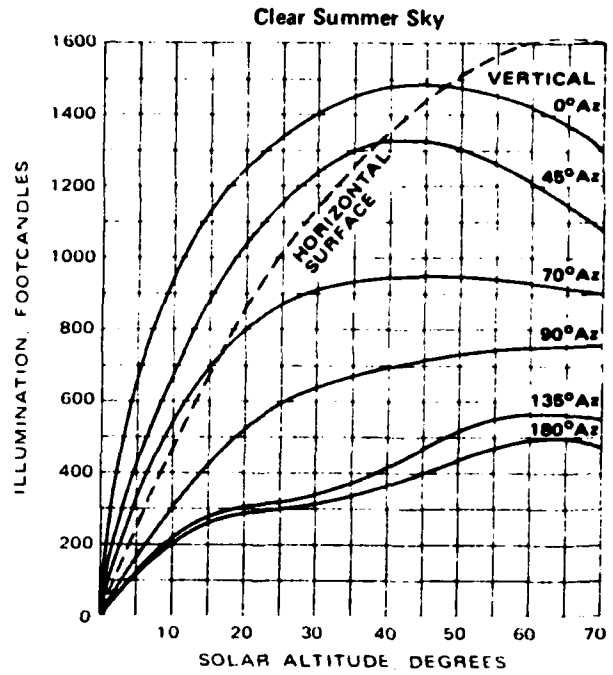


Figure 3b: Illuminance from a clear summer sky (no sun).

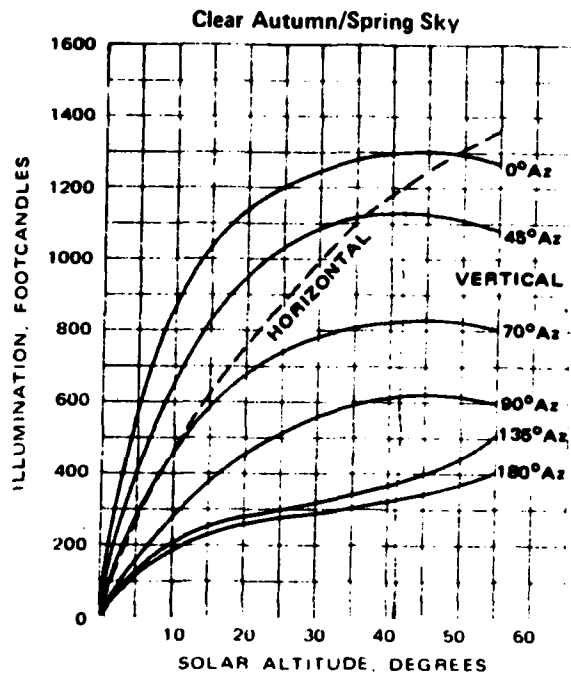


Figure 3c: Illuminance from a clear autumn/spring sky (no sun)

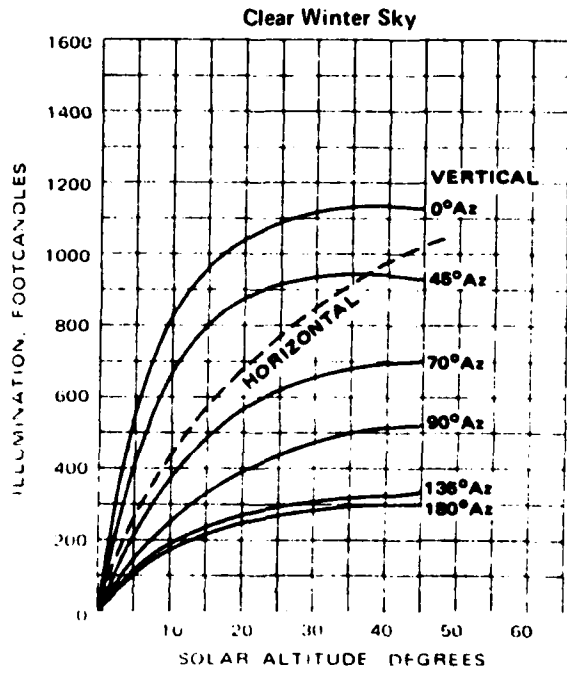


Figure 3d: Illuminance from a clear winter sky (no sun)

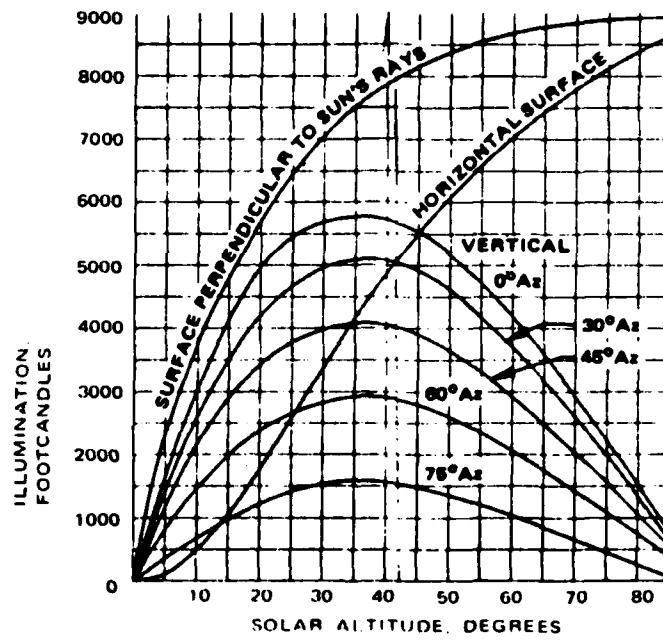


Figure 3e: Illuminance from the sun only (no sky)

4. Comparison with RP-5

IES Publication RP-5 presents an alternative method for predicting the effects of daylight. Figures 4a thru 4v compare results obtained from the CU tables presented here with those obtained from the RP-5 method. The following points regarding RP-5 calculations must be noted:

- 1) RP-5 assumes that the window begins 3' above the floor and runs to the ceiling. In order to achieve a window height of 10' a room height = 13' was used in the RP-5 calculations; this required interpolation between tabulated coefficients at heights 12' and 14'.
- 2) RP-5 tabulates coefficients only for wall reflectances 30% and 70%. Interpolation is therefore necessary to predict illuminance for 50% wall reflectance.
- 3) DAYCU2 computes coefficients for illuminance on the floor. RP-5 CU's give coefficients for a target plane 6" below the bottom of the window. Also, the DAYCU predictions are for an effective target plane reflectance = 30%; those from RP-5 are for effective target plane reflectance = 25-28%, depending on room dimensions (calculations from IES Handbook).
- 4) The room dimensions given in the comparisons presume that the W dimension corresponds to the window-wall. Note that this W dimension is the "length" dimension in RP-5; the L dimension in the comparison corresponds to "width" in RP-5.
- 5) The tables given in Appendix T are for ceiling reflectance 70%. The RP-5 figures are for ceiling reflectance 80%. Therefore for purposes of this comparison, abridged tables for 80% ceiling reflectance were generated; these abridged tables are included in this section following the comparison curves.

Figures 4a thru 4p are for rooms having no venetian blinds. The solid curve in each figure is a graph of the illuminance on the floor as predicted by the DAYCU2 tables. The vertical axis is illuminance in fc; the horizontal axis is distance (in feet) from the window. In each case the curve was hand-drawn from the predicted illuminance at the 5 target points treated in the tables. The heavy dots on each curve are the points from which the curves are constructed. For comparison purposes, RP-5 predicted values are plotted individually as + signs. Illuminance at the target points is computed assuming that the vertical illuminance on the window is 1000 fc. Transmittance of the window glazing is assumed to be 100%.

The Vertical/Horizontal illuminance ratios used to correspond to the RP-5 skies are:

Overcast sky:	0.75 V/H
Uniform sky:	1.00 V/H
Clear sky:	1.25 V/H

Figures 4q-4v compare predicted results when venetian blinds are present. All 6 figures are for the following conditions:

20' L x 20' W x 10' H	Room dimensions
0°	Solar azimuth angle (relative to window-wall)
45°	Solar altitude angle (therefore profile angle is also 45°)
Clear	Sky distribution (= 1.25 Vertical / Horizontal for DAYCU2)
5500 fc	Vertical illuminance from sun (RP-5)
1480 fc	" " " sky (RP-5)
1000 fc	" " " ground

The DAYCU2 curves were constructed using 50% blinds reflectance; the actual blinds reflectance from RP-5 is unknown.

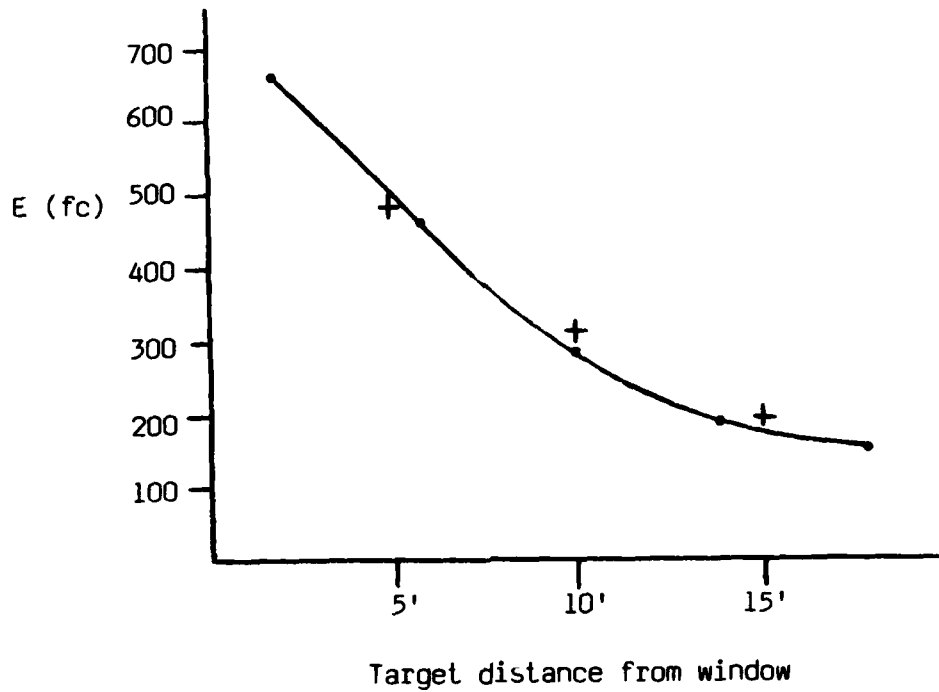


Figure 4a: 20'L x 20'W x 10'H room. Source: Uniform Sky

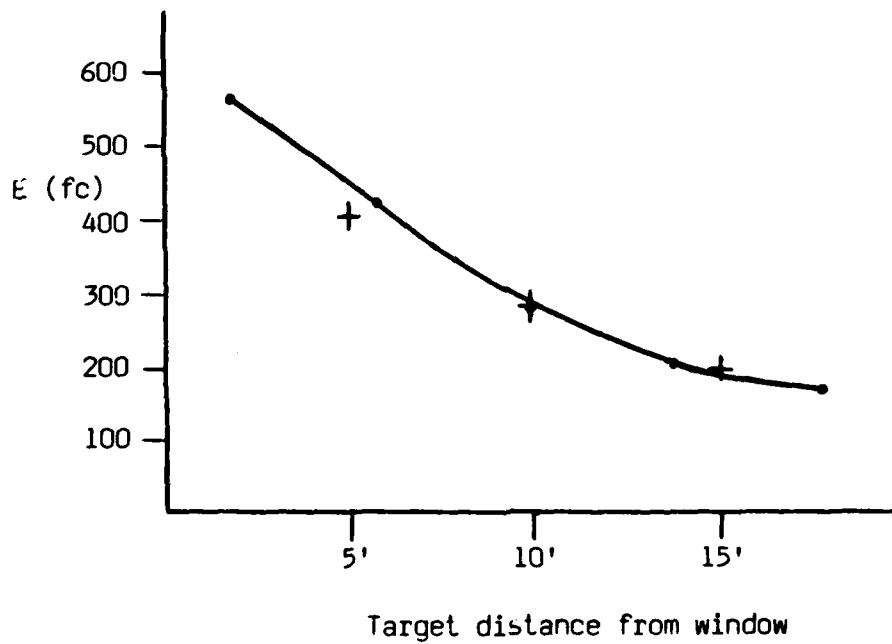


Figure 4b: 20'L x 20'W x 10'H room. Source: Clear sky

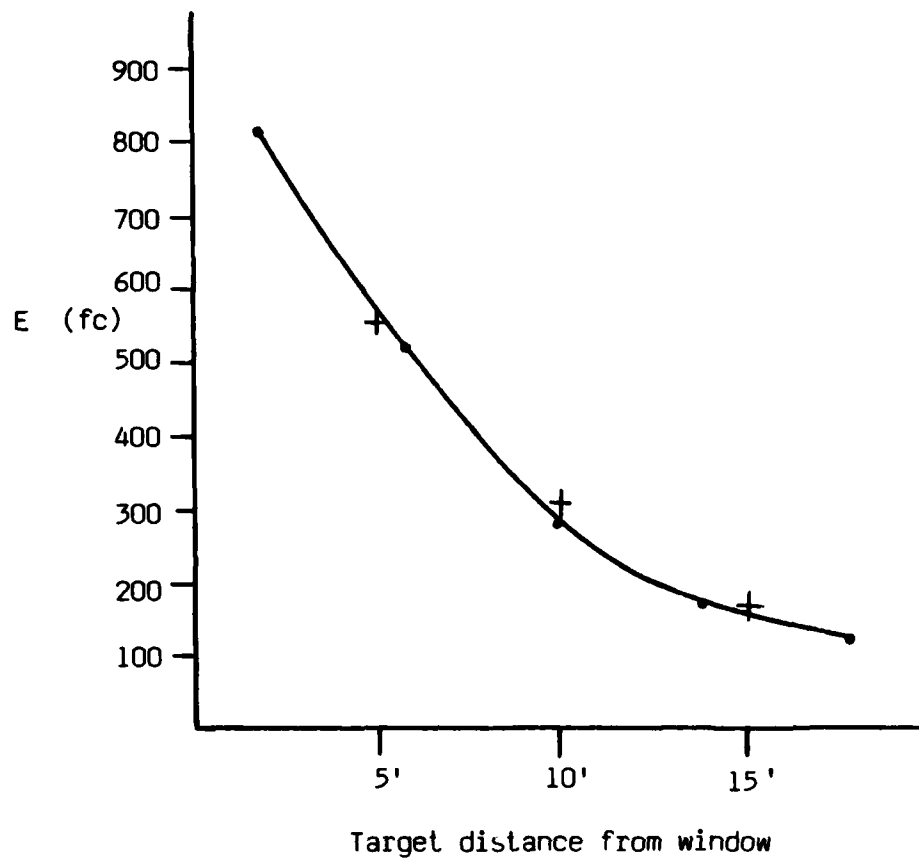


Figure 4c: 20'L x 20'W x 10'H room. Source: Overcast sky

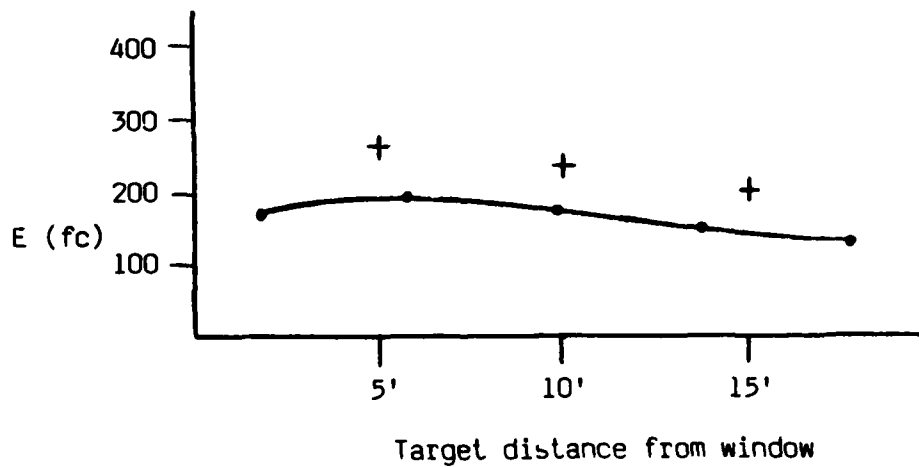


Figure 4d: 20'L x 20'W x 10'H room. Source: Ground

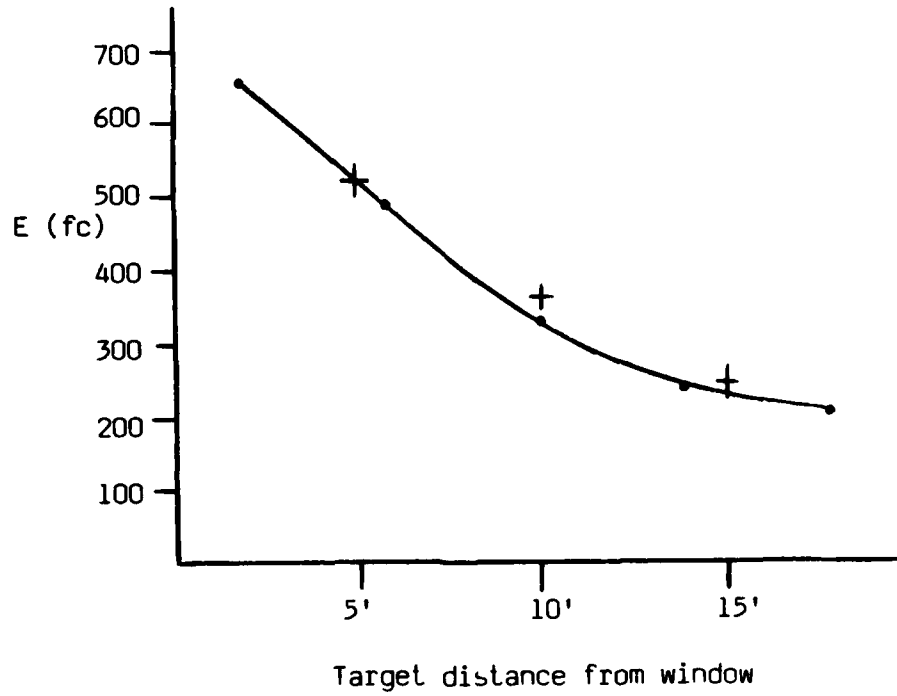


Figure 4e: 20'L x 40'W x 10'H room. Source: Uniform sky

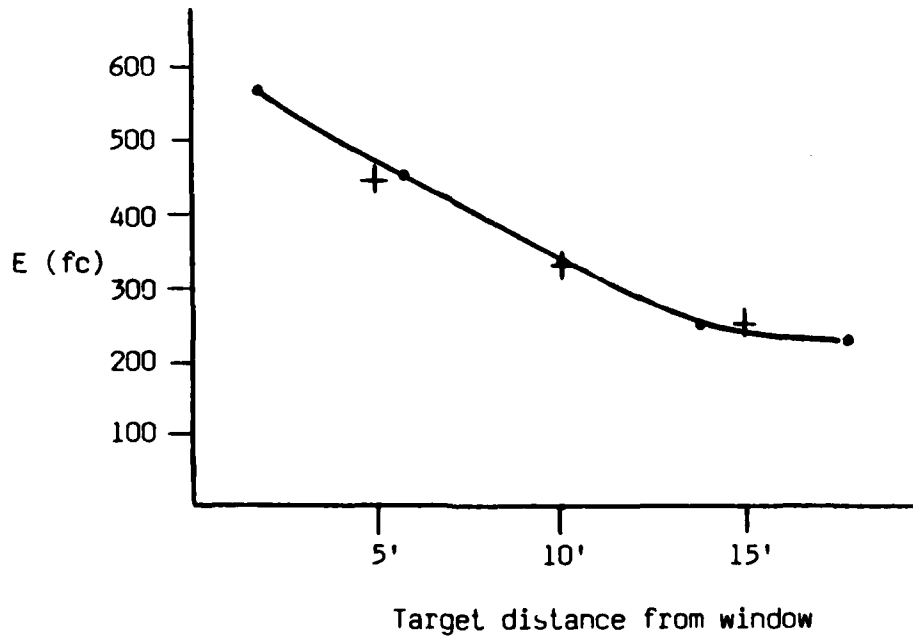


Figure 4f: 20'L x 40'W x 10'H room. Source: Clear sky

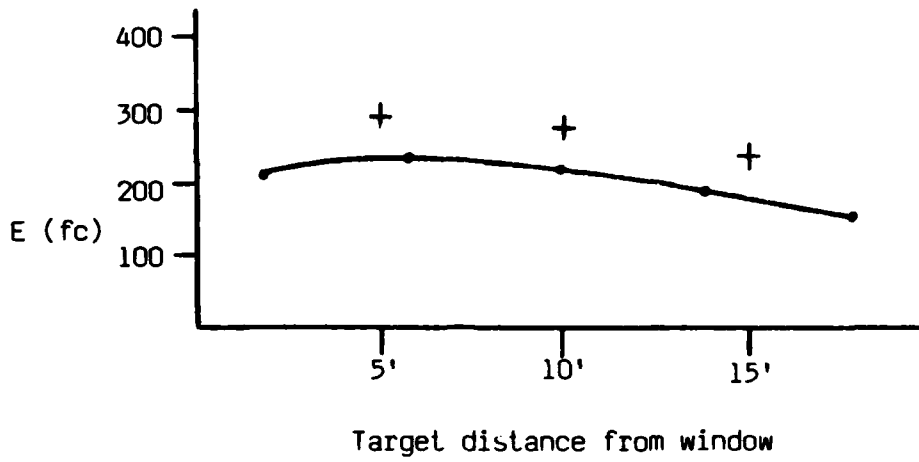


Figure 4g: 20'L x 40'W x 10'H room. Source: Ground

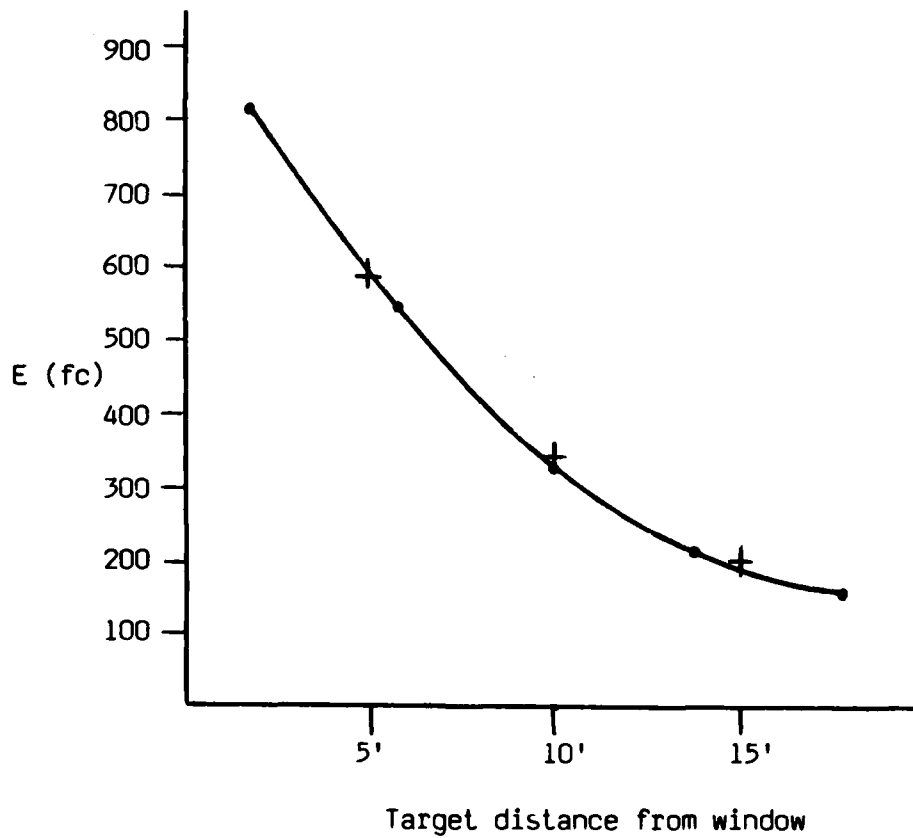


Figure 4h: 20'L x 40'W x 10'H room. Source: Overcast sky

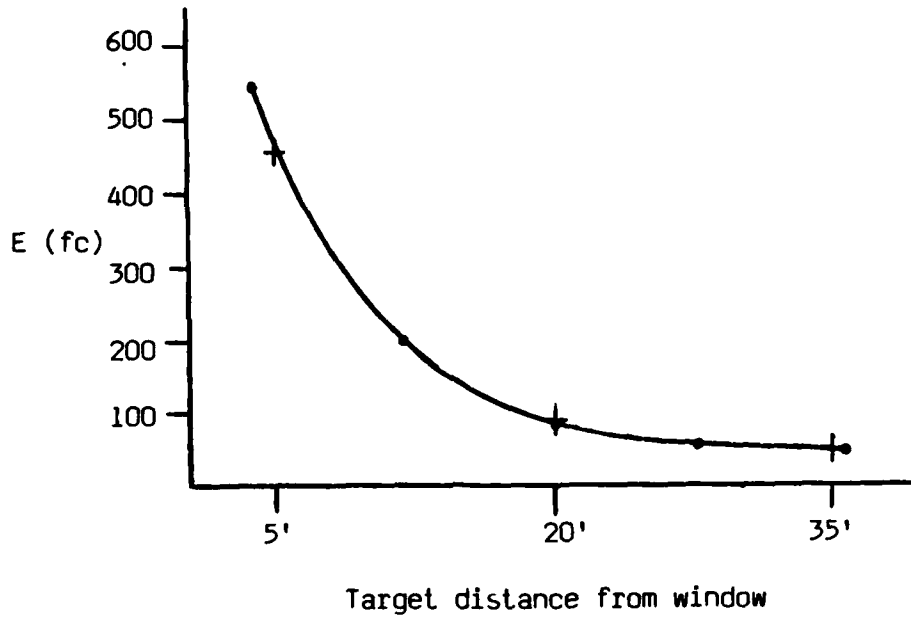


Figure 4i: 40'L x 20'W x 10'H room. Source: Uniform sky

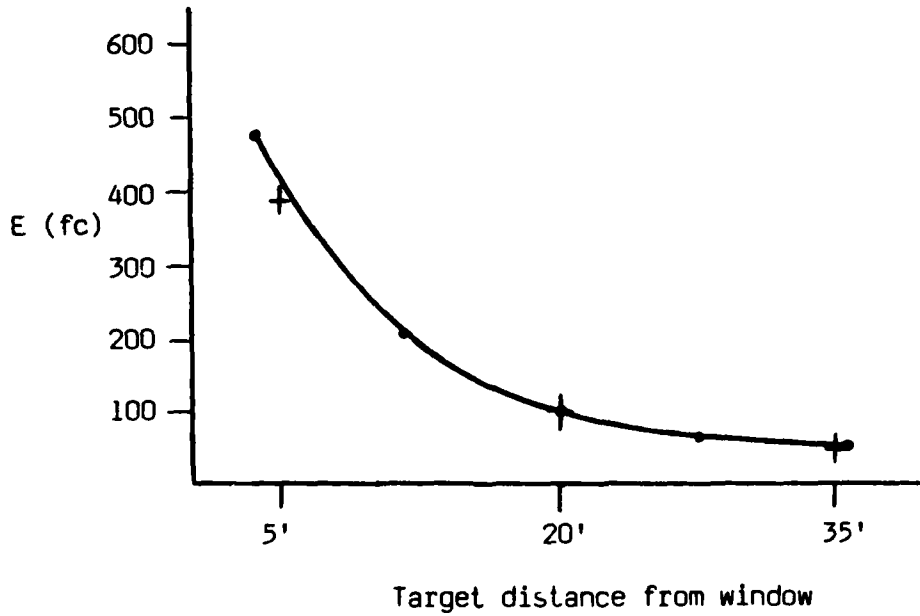


Figure 4j: 40'L x 20'W x 10'H room. Source: Clear sky

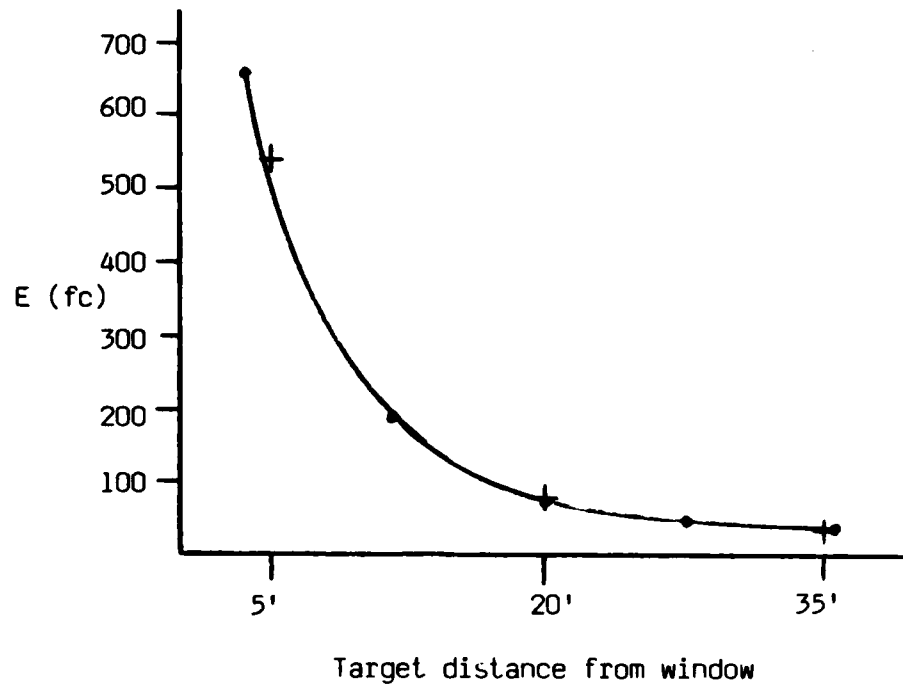


Figure 4k: 40'L x 20'W x 10'H room. Source: Overcast sky



Figure 4l: 40'L x 20'W x 10'H room. Source: Ground

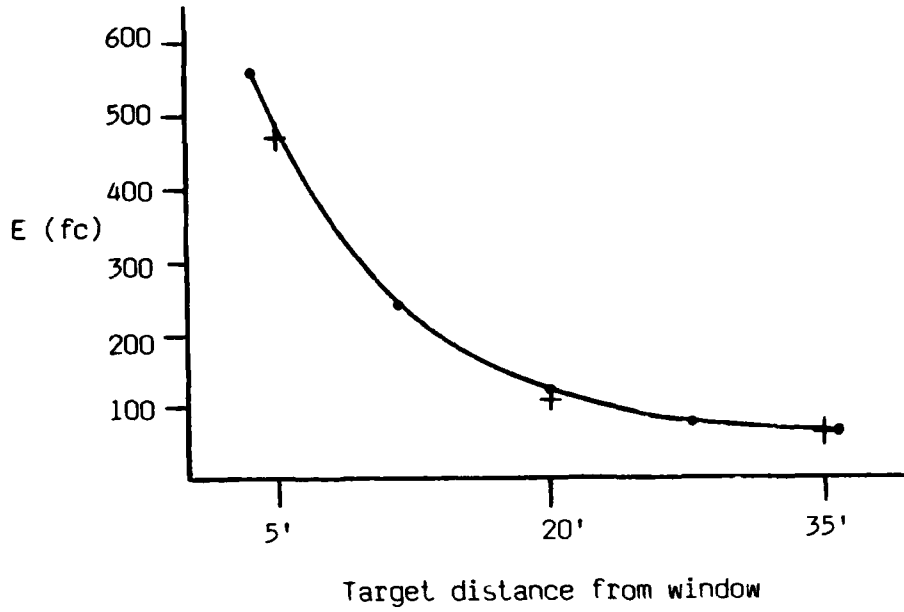


Figure 4m: 40'L x 40'W x 10'H room. Source: Uniform sky

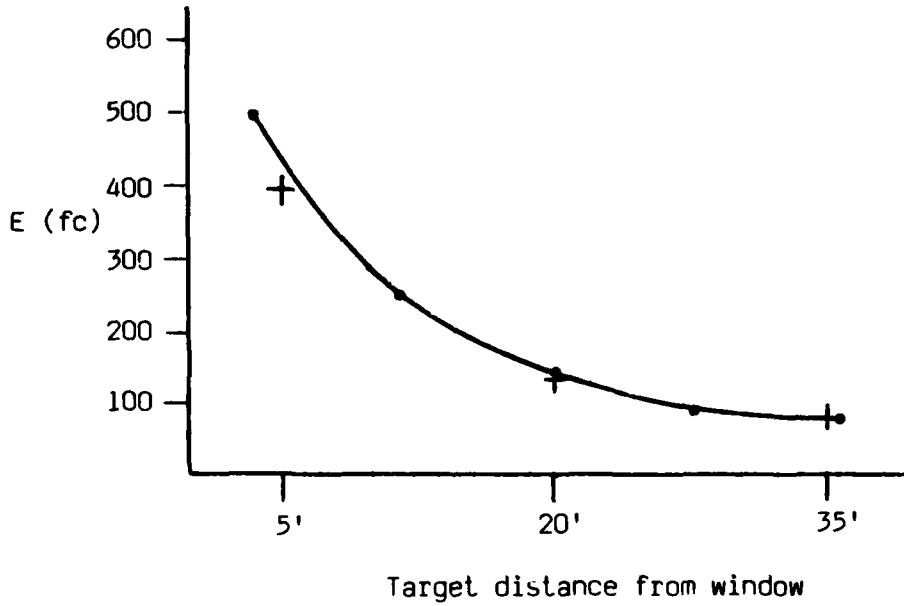


Figure 4n: 40'L x 40'W x 10'H room. Source: Clear sky

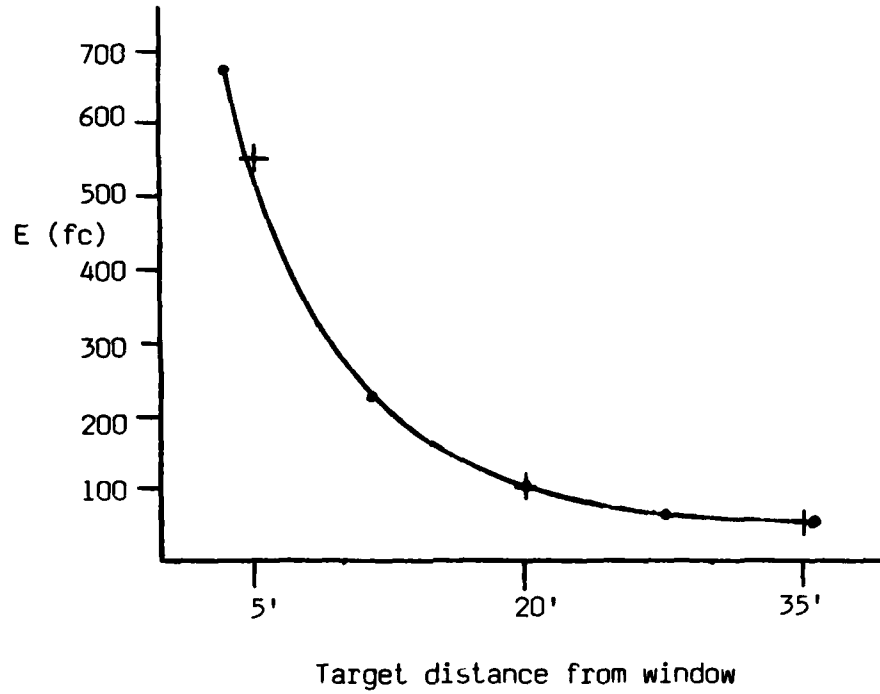


Figure 4o: 40'L x 40'W x 10'H room. Source: Overcast sky

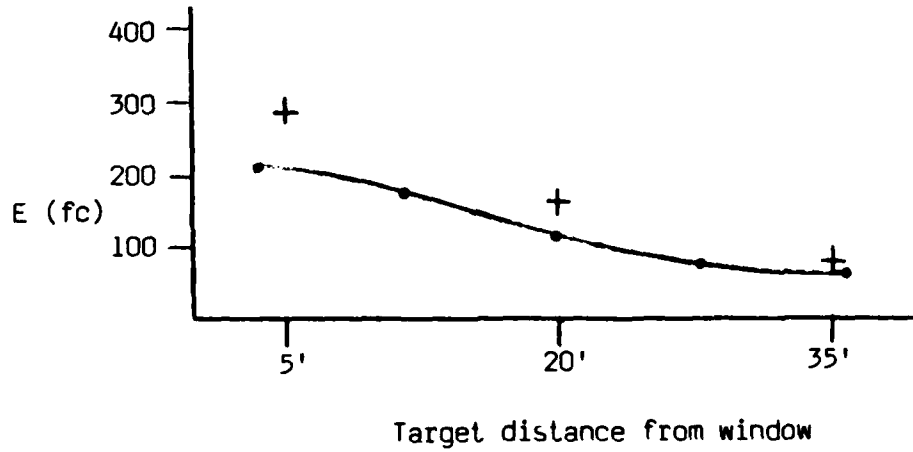


Figure 4p: 40'L x 40'W x 10'H room. Source: Ground

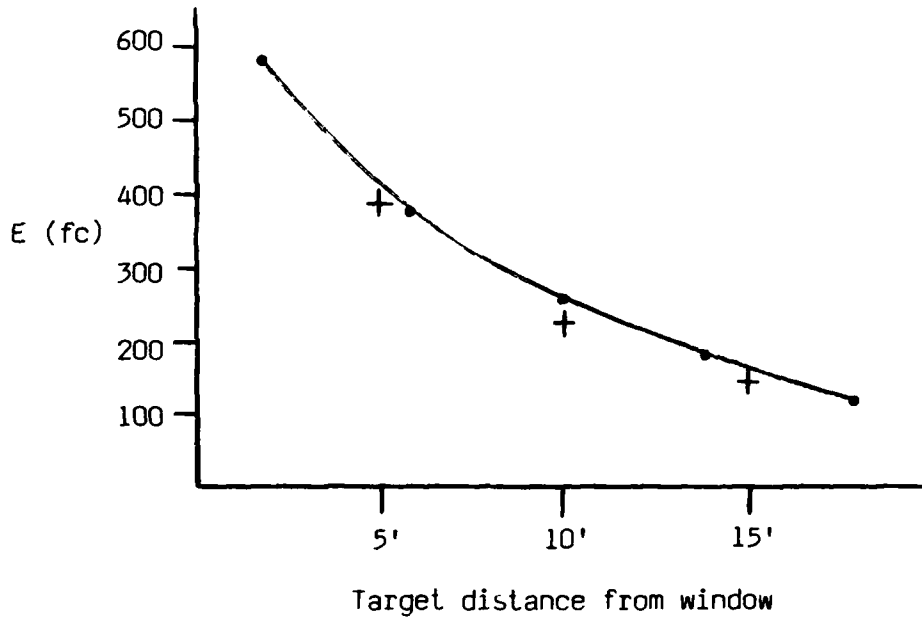


Figure 4q: Blinds setting = 30°. Source: Sun + sky

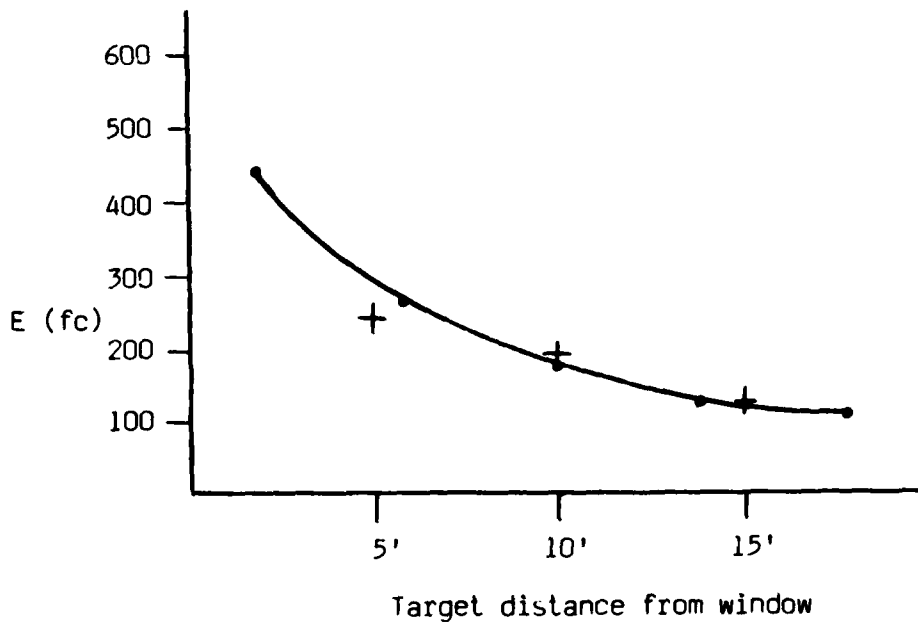


Figure 4r: Blinds setting = 45°. Source: Sun + sky

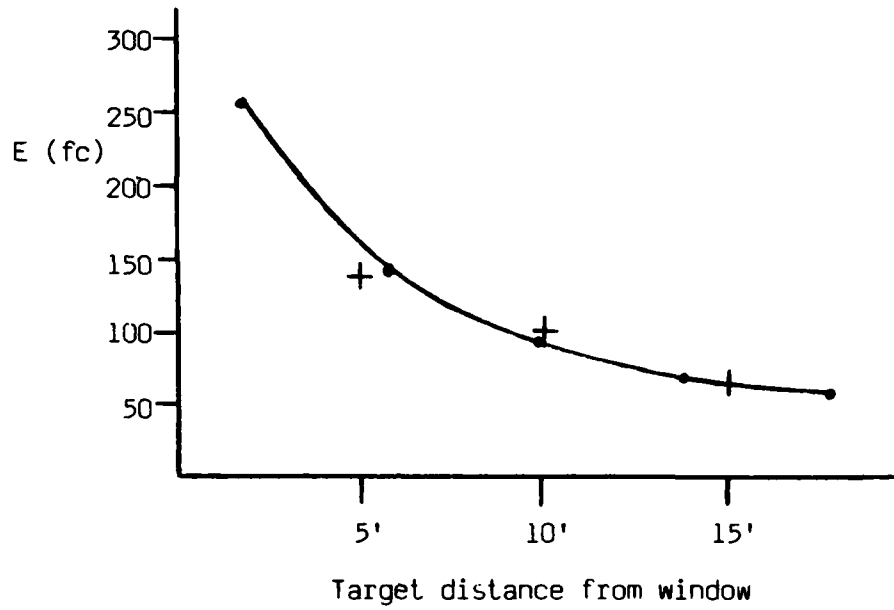


Figure 4s: Blinds setting = 60° . Source: Sun + sky

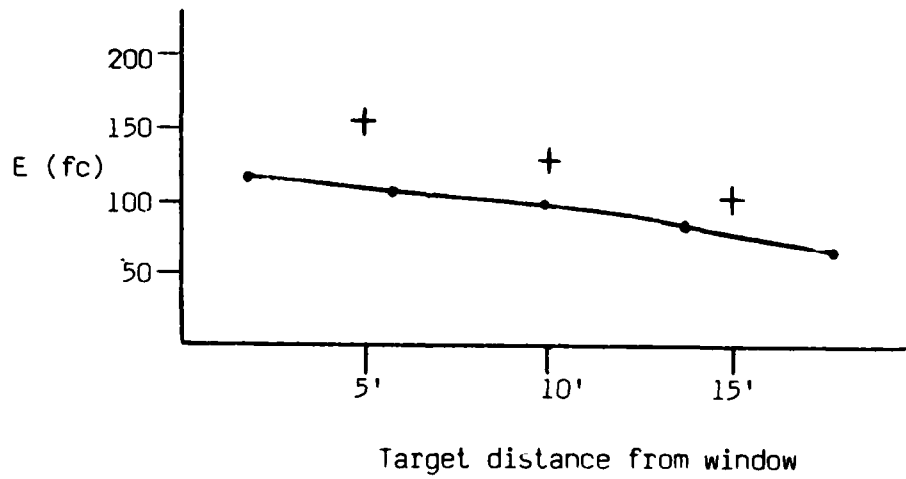


Figure 4t: Blinds setting = 30° . Source: Ground

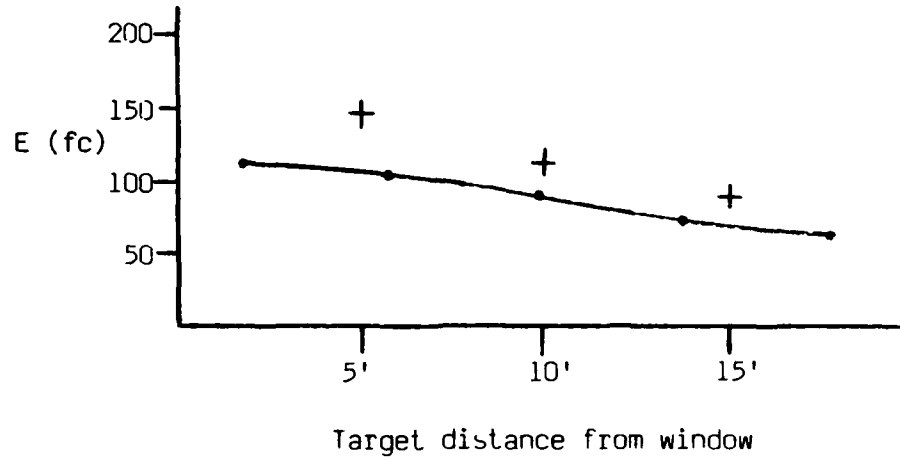


Figure 4u: Blinds setting = 45°. Source: Ground

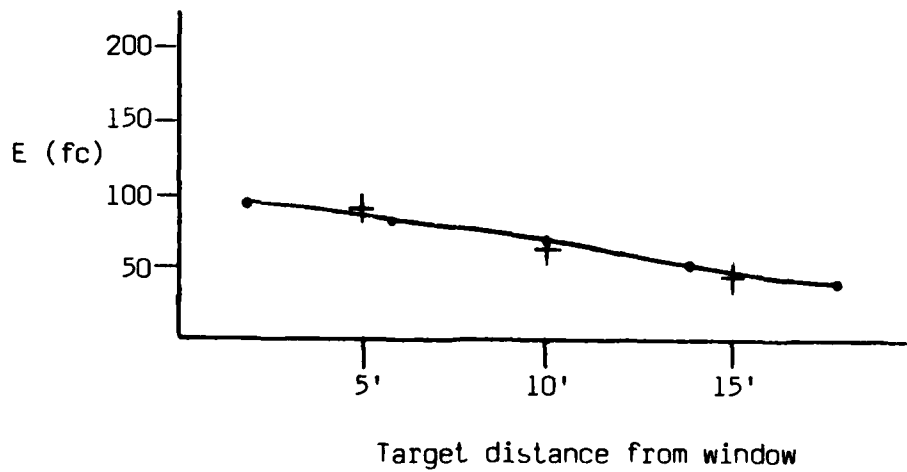


Figure 4v: Blinds setting = 60°. Source: Ground

5. DAYCU2 Computer Program

The DAYCU2 package is written in ANSI-standard FORTRAN-77 and has been implemented on the DEC VAX 11/780 minicomputer. The compiled binary code requires about 150k bytes of user memory for execution. The code consists of the three main programs DAYCU2, SUNMUL, and SKYMUL; approximately twenty additional subroutines are used. The entire source listing may be found in Appendix S.

5.1 Basic Equations

We obtain expressions for illuminance at any point in the room by starting with the inverse square law for illuminance from a point source:

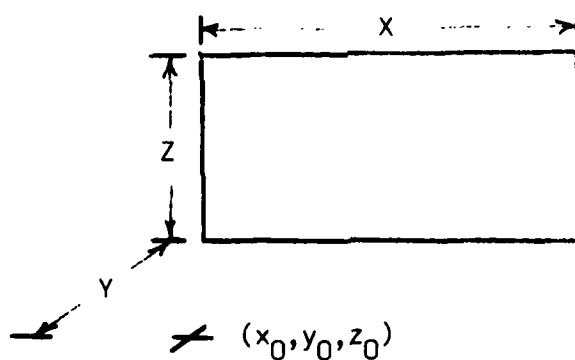
$$E = \frac{cd \cos\theta}{r^2}$$

where cd = candela

θ = angle between incident ray and a normal to the surface where illuminance is being measured

r = distance from point source to target point

E = desired illuminance value



If we treat each point on the window as a point source, we can write a double integral expression to yield the illuminance at any point in the room due to the window, provided we know the brightness evident anywhere on the window. Let (x_0, y_0, z_0) be the point in the room at which we want to calculate E . The "cd" factor will always be

$$\frac{L(x,z)}{\pi} \frac{Y}{r} \quad \text{where } L(x,z) \text{ is the brightness evident through point } (x,z) \text{ on the window.}$$

The "cos θ " factor will vary according to the room surface which the target point lies on. In addition we must account for transmission loss due to angle of incidence (see section 2.1) -- we may write this factor as $T(x,z)$. In general the expression for E is then

$$E = \int_{x_1}^{x_2} \int_{z_1}^{z_2} \frac{L(x,z)}{\pi} \frac{Y}{r} \frac{1}{r^2} \cos\theta T(x,z) dx dz$$

It is most convenient to perform a coordinate translation so that (x_0, y_0, z_0) becomes the origin for the integration -- this gives us these integration limits:

$$x_1 = -x_0 \quad x_2 = X - x_0 \quad z_1 = -z_0 \quad z_2 = Z - z_0$$

If we wish to keep the contribution due to the sky separate from that due to the ground (which we do wish), then we evaluate two double integrals, the first with z-limits $(-z_0, 0)$, the second with limits $(0, Z - z_0)$ -- these two evaluations give us the contribution from the ground and sky, respectively.

Whenever illuminance must be calculated, a 2-dimensional Simpson integration is used, with interval size chosen so that the maximum interval dimension does not exceed 0.2 times the distance from the target point to the window. In any case, however, the number of intervals cannot exceed 50 in the z-dimension, or 200 in the x-dimension.

The Simpson integrand is formed as follows:

a) $L(x, z)$ comes from the corresponding expression in 2.3, where

$$\sin h = \frac{z}{r}, \quad r = (x^2 + y^2 + z^2)^{\frac{1}{2}}$$

b) $T(x, z)$ comes from the expression in 2.1, with

$$\sin \psi = \frac{(x^2 + z^2)^{\frac{1}{2}}}{r}, \quad \cos \psi = \frac{y}{r}$$

c) The $\cos \theta$ term varies with target room surface, as follows:

<u>target surface</u>	<u>cos θ</u>
west or east wall	$\frac{ x }{r}$
south wall	$\frac{y}{r}$
floor or ceiling	$\frac{ z }{r}$

5.2 Handling Venetian Blinds

Following are the basic techniques used to handle venetian blinds in the program package:

1. From any point in the room at which it is necessary to compute illuminance from the window, the proportion of the exterior which is visible through the blinds is determined (Appendix D). This proportion is then used to factor the illuminance due to the blinds-free window.
2. The proportion of the exterior which is obscured by the blinds is presumed to be "replaced" by the diffuse brightness of the blinds. This process is carried out separately for both the top side of the blinds (exposed to sunlight) and the underside of the blinds (hidden from sunlight). In each case, after the final exitance of the blinds surface (topside or underside) has been determined, the total resultant flux is treated as being uniformly emitted from the entire window-wall.

Quantitatively, the effect is easily computed by simulating the blinds effect with that of the uniform sky or ground of the same brightness as the blinds and factoring by the proportion of the window which is obscured by the blinds side in question.

3. A flux transfer analysis is used to determine the exitance on each portion of the blinds (topside and underside). The analysis accounts for the reflectance of the blinds, the initial illuminance on the blinds from sky, ground, and sun, and the blinds opening angle. The exitance determined in this fashion is exclusive of any interreflections within the room.
4. For purposes of flux transfer analysis among the surfaces of the room, a constant blinds reflectance = 50% is assumed, and the reflectance of the window-wall is then

$$.5 \sin \gamma, \quad \text{where } \gamma \text{ is the blinds opening angle}$$

The above points should become clearer as the user goes through the step-by-step procedure in the next section and through the appendices.

5. Step-by-Step Procedure

This section outlines the logic flow of the program package. It may be thought of as a prose flowchart. When no blinds are present, each CU value in the table is intended to be multiplied by the vertical illuminance at the window. When blinds are present, the CU value is intended to be multiplied by the final exitance on either the underside or topside of the blinds. When DAYCU2 computes the tables, the vertical illuminance at the window is presumed to be 1000 fc; final exitance on blinds is presumed to be 1000 fl. Illuminance at each of the 5 room target points is then calculated -- these illuminance values, divided by 1000, are therefore the desired CU table entries. The procedure follows:

1. The room is assigned height = 10 feet. Length and width are then determined according to the ratios of length and width to ceiling height.
2. Each room surface (except the window-wall = north wall) is partitioned into rectangular zones of equal size. For the indirect (reflected) component calculation, each zone is treated as a diffuse light source of constant exitance. The zone sizes are chosen so that the longer dimension of any zone does not exceed 0.2 times the largest room dimension.
3. Each zone from step 2 is assigned unit exitance; its illuminance to each of the target points is computed (see Appendix B).
4. Illuminance from the sky and ground is computed at each of
 - a) every point on the room surfaces which lies at the center of a zone from step 2.
 - b) each of the 5 target points on the floor.

This illuminance is computed using 100% window transmittance and no blinds on the window. For each point, 6 values are saved:

- | | | |
|------|-------------------------------------|------------|
| i) | illuminance due to sky distribution | V/H = 0.75 |
| ii) | " | 1.00 |
| iii) | " | 1.25 |
| iv) | " | 1.50 |
| v) | " | 1.75 |
| vi) | illuminance due to the ground | |

Note that i) thru v) are computed assuming ground exitance = 0; vi) is computed assuming a completely black sky. These calculations employ the integral expressions discussed in section 5.1; zenith luminance and ground exitance values used are derived in Appendix G.

5. For the later blinds calculations, auxiliary tables are derived from those of step 4. These auxiliary tables give the illuminance

at each zone center and target point due to a uniform sky of unit luminance and due to a ground of unit exitance. One pair of tables accounts for transmission loss due to angle of incidence; the other pair does not. The former is used in computing the "through" component from sky or ground; the latter are used in computing the effect of blinds exitance.

6. The flux transfer coefficients for the room in question are computed. The resulting matrix equation may then be solved for the final average exitance on each room surface, provided the initial average illuminances on each surface are known. The flux transfer matrix equation may be written:

$$\begin{bmatrix}
 -1 & \rho_1^F_{12} & \rho_1^F_{13} & \rho_1^F_{14} & \rho_1^F_{15} & \rho_1^F_{16} \\
 \rho_2^F_{21} & -1 & \rho_2^F_{23} & \rho_2^F_{24} & \rho_2^F_{25} & \rho_2^F_{26} \\
 \rho_3^F_{31} & \rho_3^F_{32} & -1 & \rho_3^F_{34} & \rho_3^F_{35} & \rho_3^F_{36} \\
 \rho_4^F_{41} & \rho_4^F_{42} & \rho_4^F_{43} & -1 & \rho_4^F_{45} & \rho_4^F_{46} \\
 \rho_5^F_{51} & \rho_5^F_{52} & \rho_5^F_{53} & \rho_5^F_{54} & -1 & \rho_5^F_{56} \\
 \rho_6^F_{61} & \rho_6^F_{62} & \rho_6^F_{63} & \rho_6^F_{64} & \rho_6^F_{65} & -1
 \end{bmatrix}
 \begin{bmatrix}
 L_1 \\
 L_2 \\
 L_3 \\
 L_4 \\
 L_5 \\
 L_6
 \end{bmatrix}
 =
 \begin{bmatrix}
 -\rho_1 E_1 \\
 -\rho_2 E_2 \\
 -\rho_3 E_3 \\
 -\rho_4 E_4 \\
 -\rho_5 E_5 \\
 -\rho_6 E_6
 \end{bmatrix}$$

where L_i = final (equilibrium) exitance of surface i

ρ_i = reflectance of surface i

E_i = initial illuminance on surface i

F_{ij} = form factor from surface i to surface j . See Appendix C.

Note that the F_{ij} depend only on the room geometry and hence are completely determined at this point. The ρ_i are each fixed, except for ρ_2 , the reflectance of the window-wall. When no blinds are present, ρ_2 is assumed zero. Otherwise, ρ_2 varies with blinds reflectance and opening angle. Therefore at this point ρ_2 is set to 1, so that the actual row 2 of the matrix may be determined later simply by multiplying each entry in the row by the true value of ρ_2 .

7. The table values for the various sky distributions and the ground are computed -- windows are unobstructed. This is done by averaging the initial illuminances at the centers of zones (from step 4). Then the flux transfer analysis described in step 6 may be performed to yield the final average exitance on each room surface.

The individual zone brightnesses are then adjusted in a manner consistent with both the initial illuminance on each zone and the final average brightness on the room surface. Once this is done, the effect of the zones upon the target points may be calculated using the multipliers from step 3.

8. For a given blinds angle setting, the proportion of sky and ground which are visible thru the blinds from each zone center and target point are computed. For example, a sky value of .27 would mean that for the interior point in question (either a zone center or target point) .27 of the sky is visible from the point; the remaining .73 is obscured by the blinds. Appendix D discusses the determination of the visibility proportions.

At each blinds angle, the proportion of topside (exposed to the sun) and underside (hidden from sun) of blinds is calculated.

9. For each blinds setting and type (horizontal or vertical blinds), the following tables are calculated using the proportions determined in step 8:

Sky thru component
Ground thru component
Underside of Blinds component
Topside of Blinds component

For the sky and ground thru components, both sky and ground are presumed to produce 1000 fc vertical at the window. For the blinds tables, the exitance of both the topside and underside is assumed to be 1000 fl.

5.3 SUNMUL and SKYMUL

The solar blinds multipliers are calculated by the program SUNMUL according to the discussion in Appendix E.

The sky blinds multipliers and ground blinds multipliers are computed by the program SKYMUL according to the discussion in Appendix F.

6. Conclusions and Recommendations

It is felt that the work here has resulted in an extremely powerful tool for predicting the effect of daylight in interior spaces. The tables are easy to use, requiring only a few table lookups and simple arithmetic; at the same time the tables are reasonably compact while spanning a wide range of conditions.

The DAYCU2 package should prove itself to be a very versatile research tool, since with minor modification it can permit the analysis of hypotheses which might possibly condense the total information into fewer tables or even a series of analytic formulae. The package might also be used to generate tables for other daylighting conditions, such as wall reflectance other than 50%.

The following paragraphs discuss some recommendations and provisos regarding the use of the tables:

6.1 Venetian Blinds and Direct Sunlight

When a strong solar illuminance is present on the window, extra care is called for when applying the CU tables. Since the sun will produce the dominant illuminating effect within the room any tolerances in assumptions or application will magnify themselves in the predicted result.

In particular the user should be careful to ascertain the actual reflectance of the blinds. He should also be mindful of the presumption within the tables of perfectly flat blinds slats. If the slats show substantial curvature the CU tables' predictions are likely to be optimistic. Also, if the blinds surfaces are not predominantly diffusing, substantial deviation is likely between reality and predicted result.

Finally, it is worth stressing that the tables assume that no direct sunlight enters the room. Therefore the CU tables' predicted result for blinds opening angle = 0° and solar profile angle = 30° will be substantially divergent from reality since in this case sunlight can enter the room. Other combinations of opening angle and profile angle can also result in the entry of direct sunlight into the room.

6.2 Relationship of Blinds Reflectance to CU Values

In an environment involving venetian blinds, it seems that the illuminance at a target point would be proportional to the exitance of the blinds. This is approximately true, with a few provisos. First, the daylight entering the room between blinds slats must be accounted for separately. Secondly, and more subtly,

a change in blinds reflectance will influence the interreflection calculations among the room surfaces. Since some of this interreflected light will have originated as daylight passing between blinds slats, its effect will muddle the relationship between the exitance of the blinds and the illuminance at the target points.

If we subtract the effect of daylight entering between blinds slats and if we ignore the effect of the blinds reflectance on subsequent interreflections involving this directly-entering daylight, we may examine the following hypothesis:

"The illuminance E at a target point which is due only to flux reflected from blinds" is proportional to the exitance of the blinds."

To make use of this hypothesis we note from Appendix F that the exitance L on blinds is

$$L = \rho \left[\frac{E_1 + \rho E_2 F_{12}}{1 - \rho^2 F_{12}^2} \right]$$

If the illuminance is coming either from the sun or the sky, then $E_1 = 0$ and for given blinds opening angle the numerator is proportional to ρ^2 . For 100% blinds reflectance the denominator has the minimum value $1 - .4^2$ [approximately] = .84. For reflectance 70% the denominator has minimum value approx. $1 - .7^2 .4^2 = .92$. These minima are for opening angles of 0 degrees. For other opening angles the form factor F_{12} decreases, so that the denominator increases toward 1.

Since the denominator will be close to 1 in most cases of interest, we may state that the illuminance at the target points due to the exitance of the blinds will be approximately proportional to the square of the reflectance of the blinds, except for ground light, where E_1 is not zero.

6.3 Window Smaller than Entire Wall

In many if not most applications the window will not occupy the entire wall. In such cases the illuminance values predicted from the CU tables should be adjusted downward by the fraction of wall area which is occupied by window. For example, if the window is 5' x 8' and lies on a 30' x 10' wall, the proportion of wall area occupied by window is $(40/300) = 0.133...$. The predicted target point illuminances should be multiplied by 0.133... If more than one window lies on the wall then their cumulative area is used in determining the factor; only a single application of the CU tables is necessary.

For windows centered on the wall, the CU predictions should be pessimistic when compared to reality; when the windows tend toward room corners, the CU predictions should be optimistic.

6.4 Windows on More than One Wall

Where more than one wall has windows, the CU tables should be applied separately for each wall which has windows; the results should be added. The user should be aware that since the CU tables assume 50% reflectance on all walls except the window-wall, the CU prediction is likely to be optimistic in cases where more than one wall has windows. However, when venetian blinds are present the actual reflectances will be closer to 50%, so the table predictions should be more accurate.

A. Computing the Solar Profile Angle

The daylighting coefficient of utilization tables presented here require the knowledge of the solar profile angle if it is desired to use the tables for an application involving horizontal venetian blinds. If vertical venetian blinds are used, the user must know the solar azimuth angle. In practice the azimuth angle will be given or easily obtained; the profile angle is computed from the known values of azimuth angle and altitude angle.

The azimuth angle is that angle between the outward normal from the window-wall and the projection of the vector from the window-wall to the sun onto the ground. The elevation angle is the angle from the horizon to the sun. The profile angle for the horizontal blinds case is that angle between the outward normal from the window-wall and the projection of the vector from the window-wall to the sun upon the vertical plane containing the outward normal.

Let ϕ = solar azimuth angle, α = solar altitude angle
(= solar elevation angle)

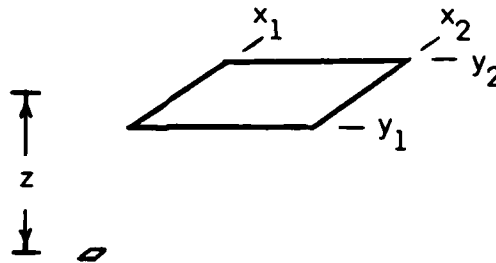
Then the profile angle β is given by

$$\beta = \tan^{-1} \left[\frac{\tan \alpha}{\cos \phi} \right]$$

B. Configuration Factors

The configuration factor C is the ratio of the illuminance at a given target point to the exitance of a Lambertian surface, provided the point is illuminated exclusively by the surface. Two cases are useful here: (1) the target point lies in a plane parallel to the surface, and (2) the target point lies in a plane normal to the surface.

B.1 Parallel Target Plane



The configuration factor C is given by

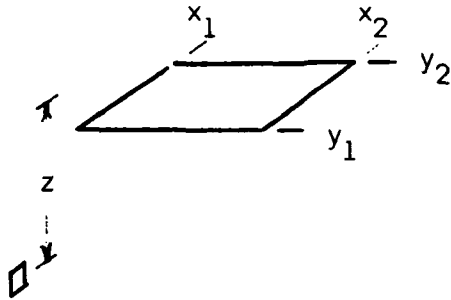
$$C = \int_{x_1}^{x_2} \int_{y_1}^{y_2} \frac{z^2}{\pi (x^2 + y^2 + z^2)^2} dx dy$$

$$= \frac{1}{2\pi} \sum_{i=1}^2 \sum_{j=1}^2 F(x_i, y_j) (-1)^{i+j}$$

where

$$F(x, y) = \frac{x}{\sqrt{x^2+z^2}} \tan^{-1} \frac{y}{\sqrt{x^2+z^2}} + \frac{y}{\sqrt{y^2+z^2}} \tan^{-1} \frac{x}{\sqrt{y^2+z^2}}$$

If the exitance of the surface is L fl, then the illuminance E is simply $E = LC$.

B.2 Normal Target Plane

The configuration factor C is given by

$$C = \int_{x_1}^{x_2} \int_{y_1}^{y_2} \frac{xz}{r^3} dx dy$$

$$= \frac{z}{2\pi} \sum_{i=1}^2 \sum_{j=1}^2 F(x_i, y_j) (-1)^{i+j}$$

where

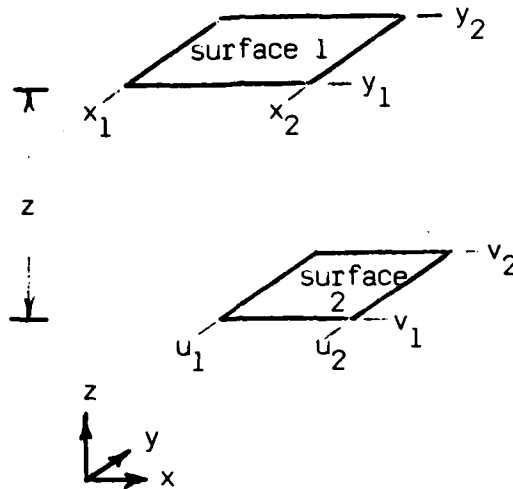
$$F(x, y) = \frac{-1}{\sqrt{x^2+z^2}} \tan^{-1} \frac{y}{\sqrt{x^2+z^2}}$$

If the exitance of the surface is L fl, then the illuminance E is simply $E = LC$.

C. Form Factors

The form factor from one surface to another is the proportion of flux leaving the first surface which is incident upon the second. The following treatments give the form factor F_{12} from surface 1 to surface 2 for the cases where the two surfaces are either parallel or normal:

C.1 Parallel Surfaces



$$F_{12} = \frac{z^2}{\pi A_1} \int_{u_1}^{u_2} \int_{v_1}^{v_2} \int_{x_1}^{x_2} \int_{y_1}^{y_2} \frac{du dv dx dy}{((x-u)^2 + (y-v)^2 + z^2)^2}$$

$$= \frac{z^2}{2\pi A_1} \sum_{i=1}^2 \sum_{j=1}^2 \sum_{k=1}^2 \sum_{m=1}^2 H(u_i, v_j, x_k, y_m) (-1)^{i+j+k+m}$$

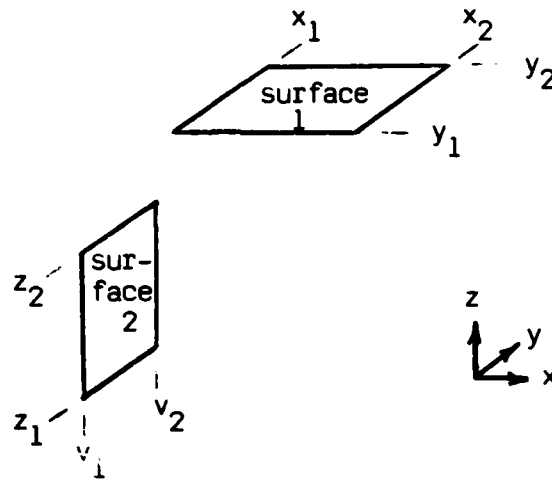
where

$$H(u_i, v_j, x_k, y_m) = b\sqrt{1+a^2} \tan^{-1} \frac{b}{\sqrt{1+a^2}} + a\sqrt{1+b^2} \tan^{-1} \frac{a}{\sqrt{1+b^2}} - \frac{1}{2} \ln(1+a^2+b^2)$$

$$a = \frac{1}{z} (x_k - u_i)$$

$$b = \frac{1}{z} (y_m - v_j)$$

$$A_1 = \text{area of surface 1}$$

C.2 Normal Surfaces

$$F_{12} = \frac{1}{\pi A_1} \int_{v_1}^{v_2} \int_{z_1}^{z_2} \int_{x_1}^{x_2} \int_{y_1}^{y_2} \frac{(x-\bar{x})(\bar{z}-z)}{((x-\bar{x})^2 + (y-v)^2 + (\bar{z}-z)^2)^2} dv dz dx dy$$

$$= \frac{1}{2\pi A_1} \sum_{i=1}^2 \sum_{j=1}^2 \sum_{k=1}^2 \sum_{m=1}^2 G(v_i, z_j, x_k, y_m) (-1)^{i+j+k+m}$$

where

$$G(v_i, z_j, x_k, y_m) = a\sqrt{c^2+b^2} \tan^{-1} \frac{a}{\sqrt{c^2+b^2}} + \frac{1}{2}(a^2-b^2-c^2)\ln(a^2+b^2+c^2)$$

$$a = y_m - v_i$$

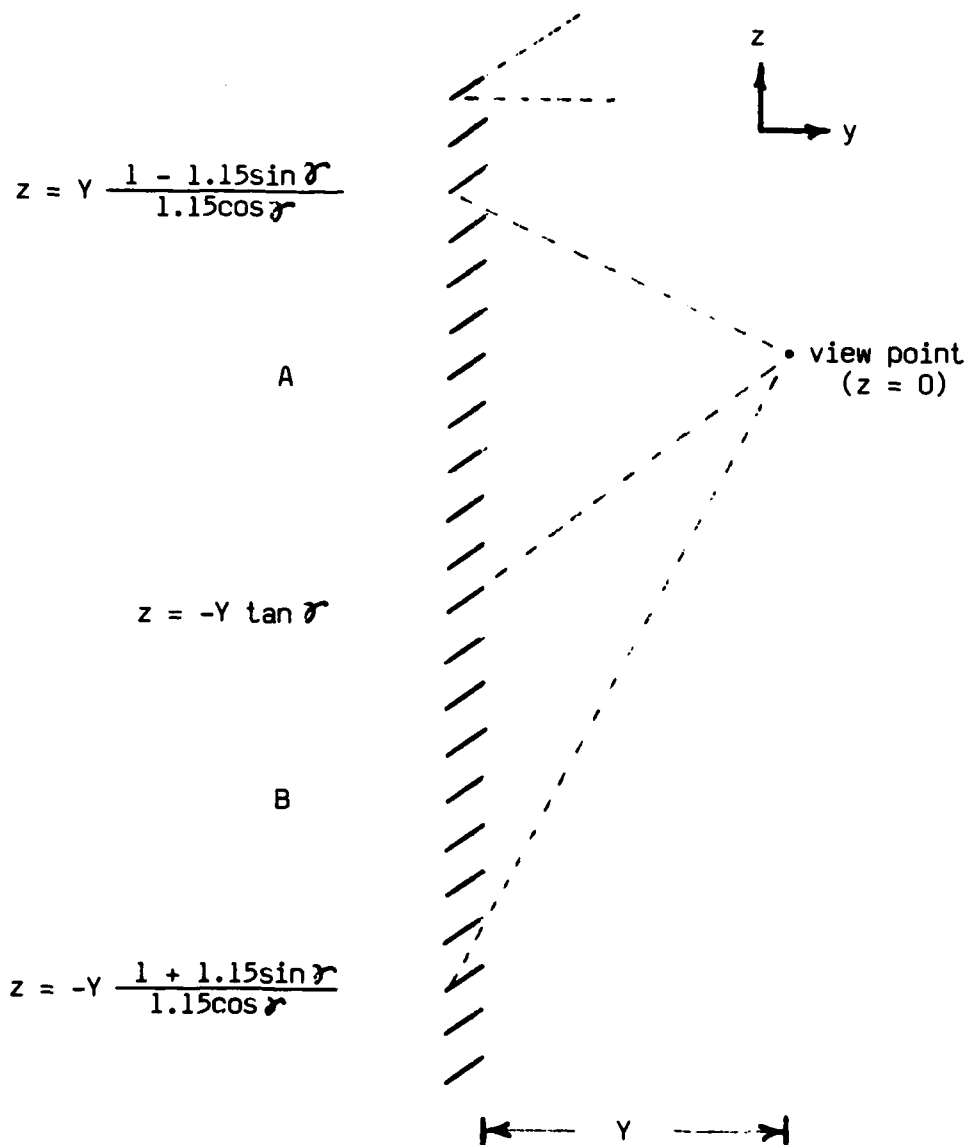
$$b = \bar{z} - z_j$$

$$c = x_k - \bar{x}$$

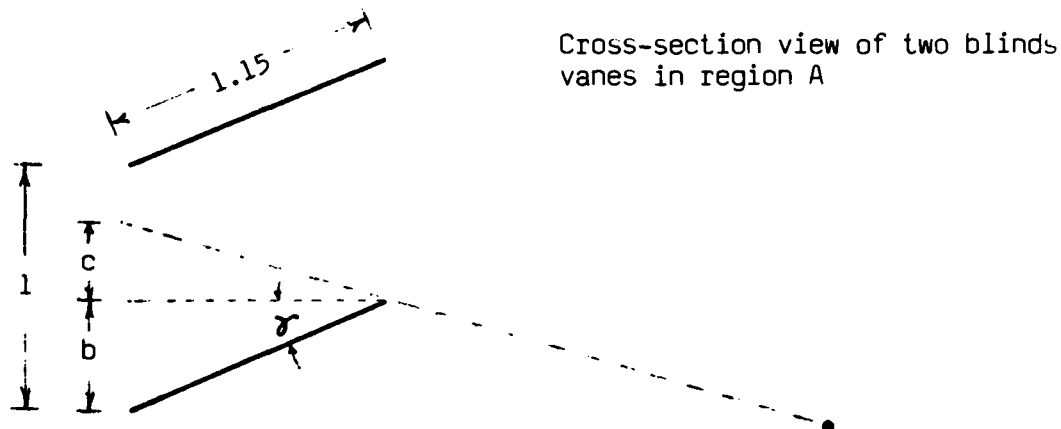
$$A_1 = \text{area of surface 1} = (x_2-x_1)(y_2-y_1)$$

$$\bar{x} = \text{x-coordinate of surface 2}$$

$$\bar{z} = \text{z-coordinate of surface 1}$$

D. Proportion of Sky and Ground Visible through Blinds

We need to know the proportion of the outside environment (sky and ground) which is visible through venetian blinds. In the sketch above let the view point have z-coordinate zero and let its distance from the blinds be Y. θ is the opening angle of the blinds. Divide the blinds into regions, A and B, and note that above region A and below region B, nothing outside is visible from the view point. Also note that the "topside" of the blinds are visible in region B, while the "underside" are visible in region A.



The sketch above graphically illustrates the view position into region A. We assume that the blinds have width equal to 1.15 times their spacing and that Y is large compared to the blinds width. The proportion of the exterior which is visible is then

$$1 - b - c = 1 - 1.15 \sin \gamma - 1.15 \frac{z}{Y} \cos \gamma$$

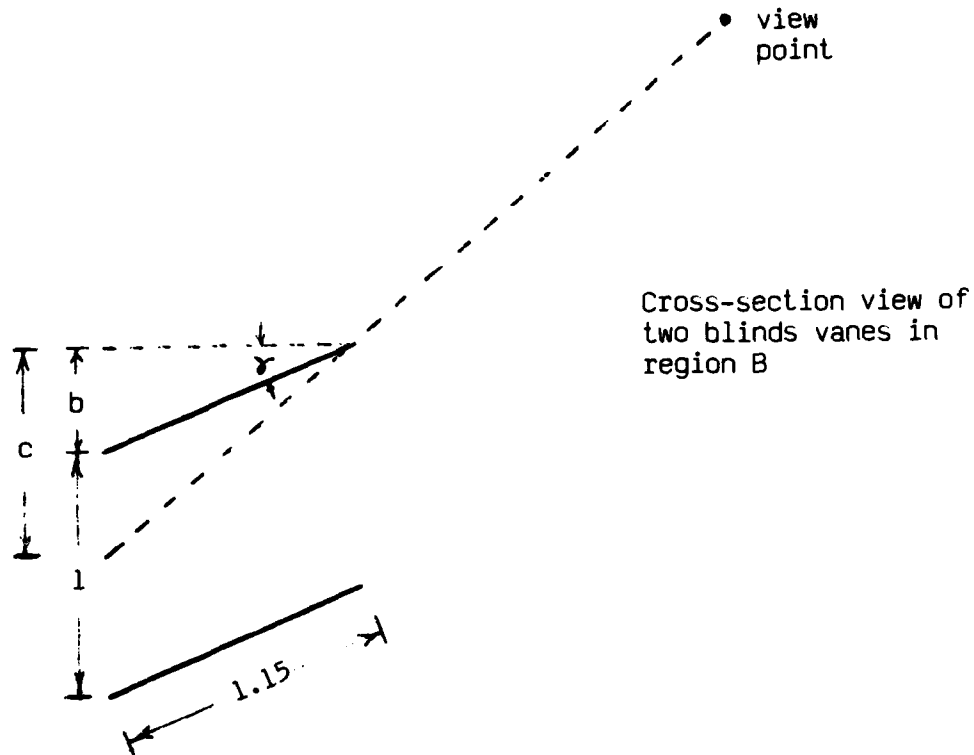
Over the entire portion of region A in question, then the proportion visible is

$$\begin{aligned} & \int_{z_1}^{z_2} (1 - 1.15 \sin \gamma - 1.15 \frac{z}{Y} \cos \gamma) dz \\ &= (1 - 1.15 \sin \gamma) (z_2 - z_1) - 1.15 \frac{\cos \gamma}{2Y} (z_2^2 - z_1^2) \end{aligned}$$

where z_1 and z_2 are the lower and upper limits of the subset of region A in question. In practice a proportion of sky visible is computed separately from a proportion of ground. For the sky we have $z_1 = 0$ and z_2 cannot exceed

$$Y \frac{(1 - 1.15 \sin \gamma)}{1.15 \cos \gamma}$$

For the ground we have $z_2 = 0$ and z_1 cannot exceed $-Y \tan \gamma$.



The sketch above illustrates the view position into region B. We again assume blinds width:spacing ratio = 1.15:1, and that Y is large compared to blinds width. The proportion of the exterior visible is

$$1 + b - c = 1 + 1.15 \sin \theta + 1.15 \frac{z}{Y} \cos \theta$$

Over the entire subset of region B in question, the proportion is

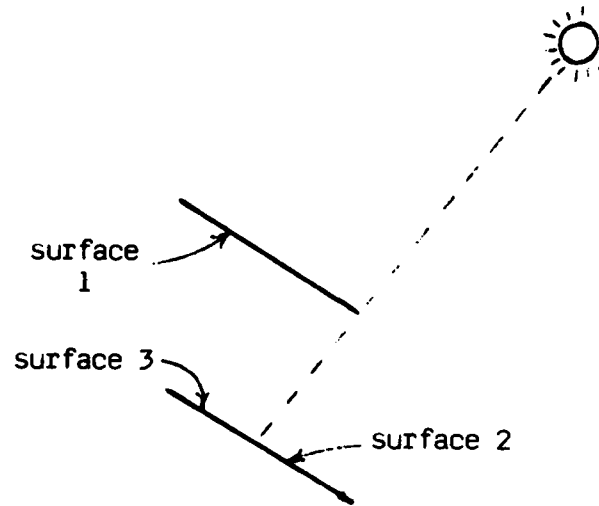
$$\int_{z_1}^{z_2} (1 + 1.15 \sin \theta + 1.15 \frac{z}{Y} \cos \theta) dz$$

$$= (1 + 1.15 \sin \theta) (z_2 - z_1) + 1.15 \frac{\cos \theta}{2Y} (z_2^2 - z_1^2)$$

where z_1 and z_2 are the lower and upper, respectively, limits of the subset of region B in question. Since only the ground may be visible through region B, z_1 can be no less than $-Y \left(\frac{1 + 1.15 \sin \theta}{1.15 \cos \theta} \right)$ and z_2 cannot exceed $-Y \tan \theta$.

E. Exitance on Blinds due to Sunlight

Blinds are treated as being of 1.15:1 width to spacing, and infinite length. We are interested in determining the exitance on the underside and topside of each vane.



Refer to the above cross-sectional view of 2 adjacent vanes. In general, the sunlight will only strike a portion of the lower vane. Therefore, the required exitances are determined by a three-surface flux-transfer analysis. Surface 2 is that portion of the lower vane which receives sunlight; surface 3 is the remaining portion of the lower vane. The flux transfer equations in matrix form are:

$$\begin{bmatrix} -1 & \rho^{F_{12}} & \rho^{F_{13}} \\ \rho^{F_{21}} & -1 & 0 \\ \rho^{F_{31}} & 0 & -1 \end{bmatrix} \begin{bmatrix} L_1 \\ L_2 \\ L_3 \end{bmatrix} = \begin{bmatrix} -\rho E_1 \\ -\rho E_2 \\ 0 \end{bmatrix}$$

We solve for each L_i using Cramer's Rule:

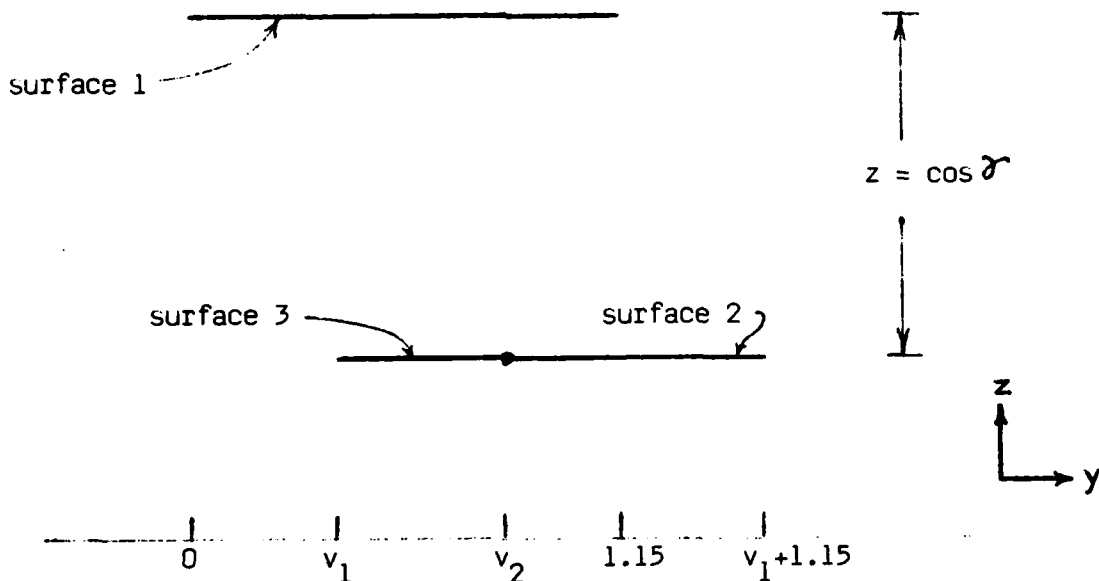
$$L_1 = \rho \left[\frac{E_1 + \rho^{F_{12}} E_2}{1 - \rho^{2F_{13}F_{31}} - \rho^{2F_{12}F_{21}}} \right]$$

$$L_2 = \rho \left[\frac{E_2 + \rho^{E_1 F_{21}} - \rho^{2E_2 F_{13} F_{31}}}{1 - \rho^{2F_{13}F_{31}} - \rho^{2F_{12}F_{21}}} \right]$$

$$L_3 = \rho^2 \left[\frac{E_1 F_{31} + E_2 F_{12} F_{31}}{1 - \rho^2 F_{13} F_{31} - \rho^2 F_{12} F_{21}} \right]$$

where ρ = reflectance of blinds
 F_{ij} = form factors
 L_i = final (equilibrium) exitance of the three surfaces
 E_i = initial illuminance on the surfaces from direct sunlight

It remains to determine the F_{ij} form factors. Refer to the figure below:

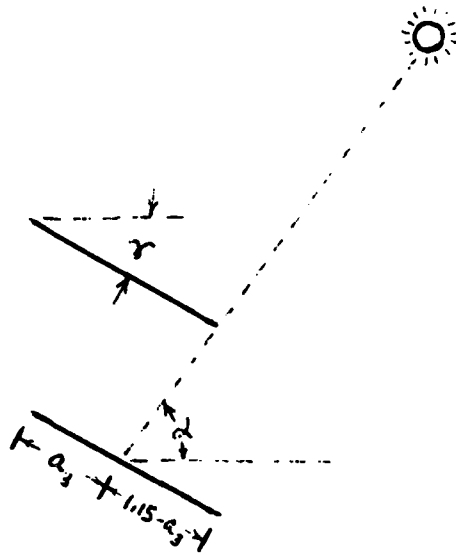


Determination of the form factors F_{12} and F_{13} are special cases of the general formulae which are given in section C.1. Here we have $y_1 = 0$ and $y_2 = 1.15$, with x_1 and u_1 running to negative infinity, and x_2 and u_2 running to positive infinity.

The v -limits are as shown in the sketch above; note that $v_1 = \sin \delta$ where δ is the blinds opening angle. Evaluating the general-case integral expression for parallel-surface form factors and taking the limits as the x and u limits tend to infinity, we get:

$$F_{13} = \frac{1}{2.3} \left[\sqrt{v_2^2 + z^2} - \sqrt{v_1^2 + z^2} - \sqrt{(1.15 - v_2)^2 + z^2} + \sqrt{(1.15 - v_1)^2 + z^2} \right]$$

The expression for F_{12} follows by changing the integration limits (v_1, v_2) to ($v_2, v_1 + 1.15$). The computation of v_2 is discussed on the following page.



To determine the quantity v_2 for the form factor calculation, we must compute the length a_3 as shown in the sketch above. γ is the opening angle of the blinds, α is the solar profile angle. After applying some trigonometry, we obtain:

$$a_3 = 1.15 - \frac{1}{\cos \gamma \tan \alpha + \sin \gamma}$$

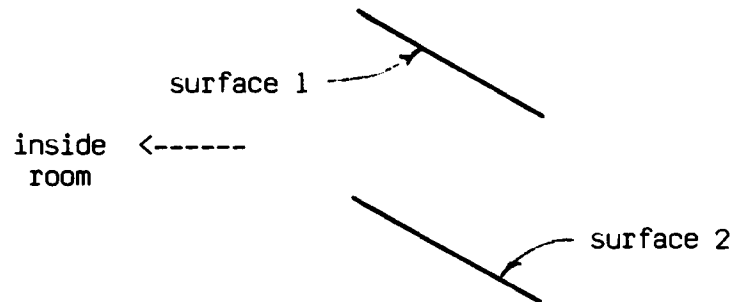
$$\text{and } v_2 = \sin \gamma + a_3$$

Finally, we must compute E_2 . Note that no sunlight reaches either surface 1 or 3; hence $E_1 = E_3 = 0$. To compute E_2 we let B be the vertical illuminance on the window from direct sunlight. Assigning unit area to the window, this means that B lumens fall on the window. The illuminance E_2 is then B divided by the area of blinds exposed to sunlight, or

$$E_2 = \frac{B}{1.15 - a_3} = B (\cos \gamma \tan \alpha + \sin \gamma)$$

The average final exitance on the topside of the blinds is

$$L_{\text{topside}} = (L_2(1.15 - a_3) + L_3 a_3) / 1.15$$

F. Exitance on Blinds due to Sky or Ground

Cross-section view of 2 adjacent blinds vanes

We seek to determine the equilibrium exitance on the side of the blinds visible from within the room. We accomplish this with a 2-surface flux-transfer analysis: surface 1 is the underside, surface 2 is the topside of two adjacent vanes. The matrix form of the flux transfer equations is:

$$\begin{bmatrix} -1 & \rho F_{12} \\ \rho F_{12} & -1 \end{bmatrix} \begin{bmatrix} L_1 \\ L_2 \end{bmatrix} = \begin{bmatrix} -\rho E_1 \\ -\rho E_2 \end{bmatrix}$$

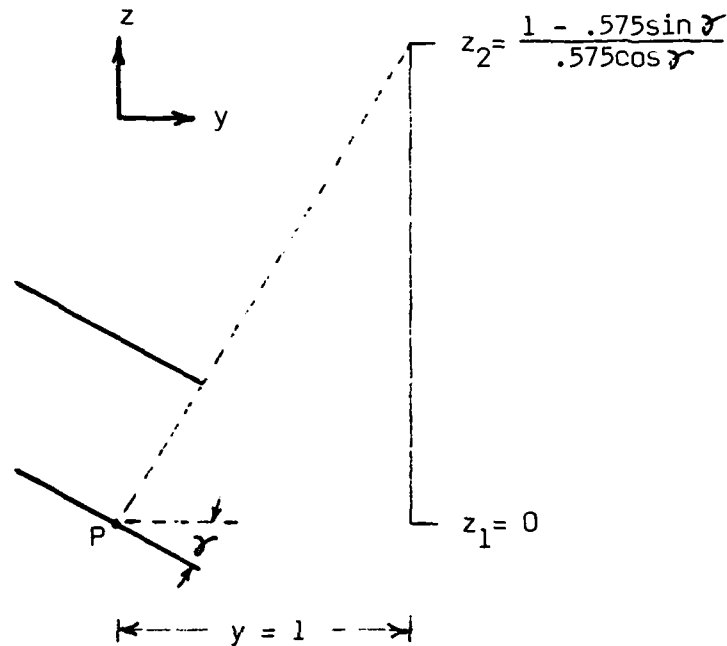
where ρ = blinds reflectance
 F_{12} = form factor from surface 1 to surface 2 (in this case we have $F_{12} = F_{21}$)
 L_i = final (equilibrium) exitance on surface i
 E_i = initial illuminance on surface i

We may solve for L_1 and L_2 using Cramer's Rule:

$$L_1 = \rho \frac{E_1 + \rho E_2 F_{12}}{1 - \rho^2 F_{12}^2} \quad L_2 = \rho \frac{E_2 + \rho E_1 F_{12}}{1 - \rho^2 F_{12}^2}$$

The form factor F_{12} is obtained from the expression for F_{13} in Appendix E -- setting $v_2 = v_1 + 1.15 = \sin \alpha + 1.15$ in that expression, we get

$$F_{12} = \frac{1}{2.3} \left\{ \sqrt{2.3225 - 2.3 \sin \alpha} + \sqrt{2.3225 + 2.3 \sin \alpha} - 2 \right\}$$

F.1 Initial Illuminance on Top of Blinds due to the Sky

To compute illuminance E_2 at point p due to the sky, we treat the sky as an infinite x - z plane at distance $y = 1$ from p . The plane's exitance L is the same as the uniform sky brightness. The limits of integration are $(-\infty, \infty)$ in the x -direction, and $(0, z_2)$ in the z -direction. Assign p the (x, y, z) coordinate location $(0, 0, 0)$; the illuminance at p from a point candlepower source at $(x, 1, z)$ on the infinite plane is

$$E = \frac{L}{\pi} \frac{1}{r} \frac{\sin \gamma + z \cos \gamma}{r} \frac{1}{r^2} \quad \text{where } r = \sqrt{x^2 + 1 + z^2}$$

Hence the illuminance E_2 from the entire infinite plane is

$$\begin{aligned} E_2 &= \frac{L}{\pi} \int_{-\infty}^{\infty} \int_0^{z_2} \frac{\sin \gamma + z \cos \gamma}{r^4} dx dz \\ &= \frac{L \sin \gamma}{\pi} \int_{-\infty}^{\infty} \int_0^{z_2} \frac{dx dz}{(x^2 + 1 + z^2)} + \frac{L \cos \gamma}{\pi} \int_{-\infty}^{\infty} \int_0^{z_2} \frac{z dx dz}{(x^2 + 1 + z^2)} \end{aligned}$$

These two double integrals are special cases of those integrals leading to the configuration factors; i.e.,

$$\frac{L \sin \delta}{\pi} \int_{-\alpha}^{\alpha} \int_0^{z_2} \frac{dx dz}{(x^2 + z^2 + 1)} = \frac{L \sin \delta}{2\pi} \left\{ \frac{x}{\sqrt{x^2+1}} \tan^{-1} \frac{z}{\sqrt{x^2+1}} + \frac{z}{\sqrt{z^2+1}} \tan^{-1} \frac{x}{\sqrt{z^2+1}} \right\} \Big|_{-\alpha}^{\alpha} \Big|_0^{z_2}$$

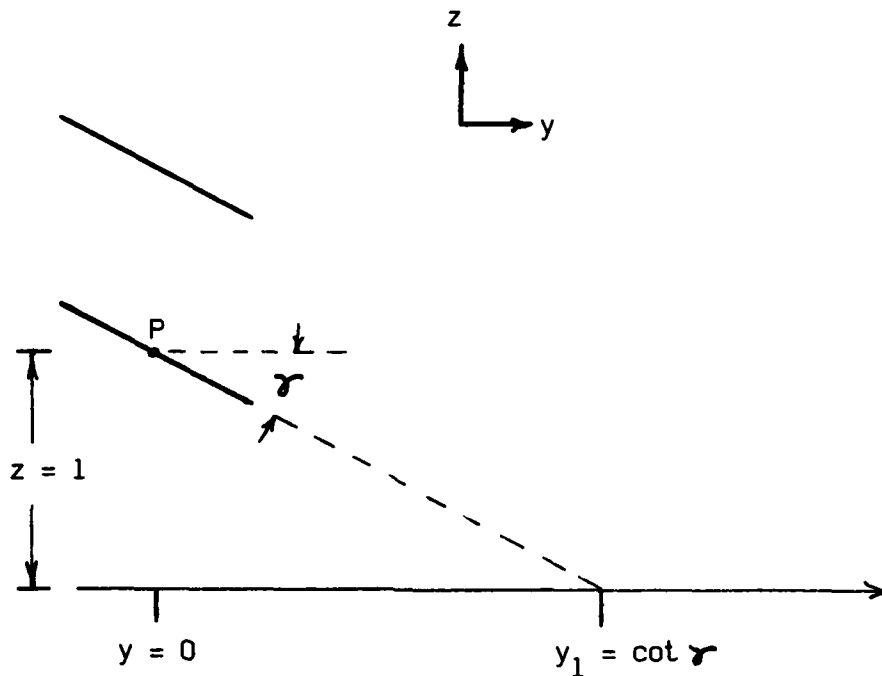
$$\frac{L \cos \delta}{\pi} \int_{-\alpha}^{\alpha} \int_0^{z_2} \frac{z dx dz}{(x^2 + z^2 + 1)} = \frac{L \cos \delta}{2\pi} \left\{ \frac{-1}{\sqrt{z^2+1}} \tan^{-1} \frac{x}{\sqrt{z^2+1}} \right\} \Big|_{-\alpha}^{\alpha} \Big|_0^{z_2}$$

and

$$E_2 = \frac{L \sin \delta}{2\pi} \left[\frac{\pi z_2}{\sqrt{z_2^2+1}} \right] + \frac{L \cos \delta}{2\pi} \left[\pi \left(1 - \frac{1}{\sqrt{z_2^2+1}} \right) \right]$$

$$\text{where } z_2 = \frac{(1 - .575 \sin \delta)}{.575 \cos \delta}$$

F.2 Initial Illuminance on Top of Blinds due to the Ground

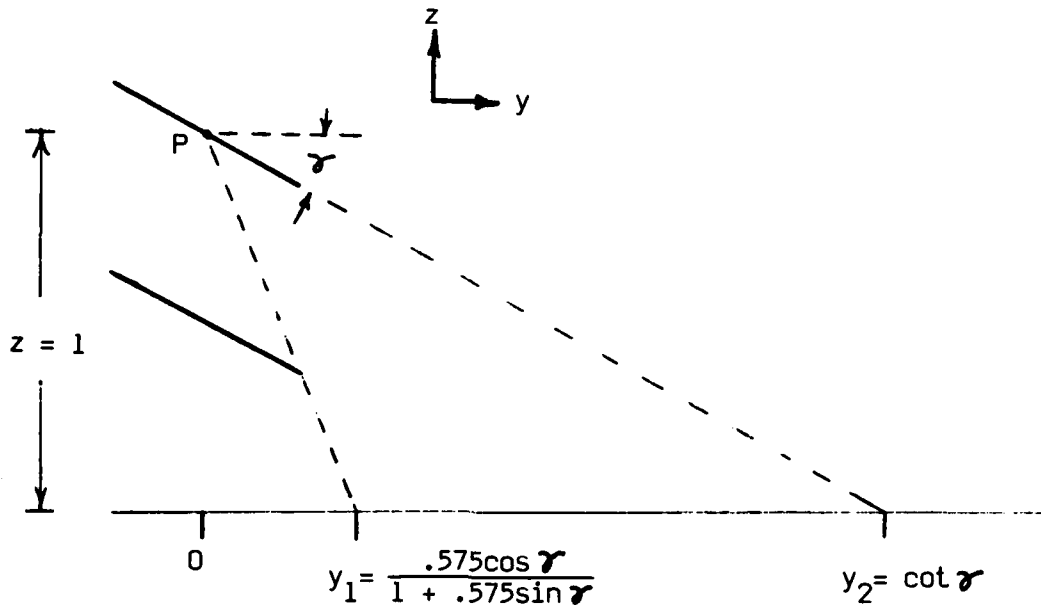


Here the ground is an infinite x-y plane of uniform exitance L . For convenience we assign the infinite plane a distance $z = 1$ from the target point p . Proceeding in similar fashion to the previous section, we obtain

$$\begin{aligned}
 E_2 &= \frac{L}{\pi} \int_{-\infty}^{\infty} \int_{y_1}^{\infty} \frac{1}{r} \frac{1}{r^2} \frac{y \sin \gamma - \cos \gamma}{r} dx dy \\
 &= \frac{L \sin \gamma}{\pi} \int_{-\infty}^{\infty} \int_{y_1}^{\infty} \frac{y dx dy}{(x^2 + y^2 + 1)^2} - \frac{L \cos \gamma}{\pi} \int_{-\infty}^{\infty} \int_{y_1}^{\infty} \frac{dx dy}{(x^2 + y^2 + 1)^2} \\
 &= \frac{L}{2} \left\{ \frac{\sin \gamma}{\sqrt{y_1^2 + 1}} - \cos \gamma \left(1 - \frac{y_1}{\sqrt{y_1^2 + 1}} \right) \right\}
 \end{aligned}$$

where $y_1 = \cot \gamma$

F.3 Initial Illuminance on Underside of Blinds due to the Ground



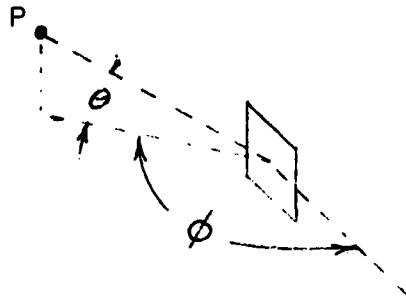
Again we treat the ground as an infinite x-y plane of uniform exitance L and at distance $z = 1$ from the target point p .

We have

$$\begin{aligned}
 E_2 &= \frac{L}{\pi} \int_{-\infty}^{\infty} \int_{y_1}^{y_2} \frac{1}{r} \frac{1}{r^2} \frac{\cos \delta - y \sin \delta}{r} dx dy \\
 &= \frac{L \cos \delta}{\pi} \int_{-\infty}^{\infty} \int_{y_1}^{y_2} \frac{dx dy}{(x^2 + y^2 + 1)^2} - \frac{L \sin \delta}{\pi} \int_{-\infty}^{\infty} \int_{y_1}^{y_2} \frac{y dx dy}{(x^2 + y^2 + 1)^2} \\
 &= \frac{L}{2} \left[\cos \delta \left(\frac{y_2}{\sqrt{y_2^2 + 1}} - \frac{y_1}{\sqrt{y_1^2 + 1}} \right) - \sin \delta \left(\frac{1}{\sqrt{y_1^2 + 1}} - \frac{1}{\sqrt{y_2^2 + 1}} \right) \right]
 \end{aligned}$$

$$\text{where } y_1 = \frac{.575 \cos \delta}{1 + .575 \sin \delta}$$

$$y_2 = \cot \delta$$

G. Zenith and Ground Brightness to Produce 1000 fc Vertical Illuminance

The calculations which involve the sky distributions require knowledge of the zenith luminance L_z ; calculations involving the ground require knowledge of the ground exitance L_g . The sketch above illustrates the coordinate system used to arrive at L_z and L_g . θ is the azimuth angle, θ is the elevation angle of the point p in the sky. Either the sky or ground may be treated as a quarter-sphere of unit radius. Therefore the vertical illuminance E is

$$E = \int_0^{\pi} \int_0^{\frac{\pi}{2}} \frac{L(\theta)}{\pi} \cos^2\theta \sin\theta \, d\theta \, d\theta$$

where $L(\theta)$ is the brightness of the sky at angle θ above the horizon. Using a 32-interval Simpson approximation for each different sky distribution, the following values of L_z were obtained:

<u>Vertical/Horizontal Illuminance</u>	<u>L_z (fL)</u>
0.75	3373.1
1.00	2000
1.25	1170.9
1.50	839.6
1.75	643.55

The ground may be treated in exactly the same way as the uniform sky, yielding

$$L_g = 2000 \text{ fL}$$

```

C-----
C GENERATE DAYLIGHT COEFFICIENT OF UTILIZATION TABLES
C
C      --- PROGRAM VARIABLES, ARRAYS ---
C A      - SCRATCH MATRIX FOR FLUX TRANSFER CALCULATIONS
C RFL     - FINAL EXITANCE ON UNDERSIDE OF BLINDS
C DIRECT(I,J) - DIRECT ILLUMINANCE ON TARGET PT I FROM SKY J
C E(I,J)   - CONFIGURATION FACTOR FROM ZONE I TO TARGET PT J
C E1GR     - ILLUMINANCE ON UNDERSIDE OF BLINDS FROM GROUND
C E1SKY(I) - ILLUMINANCE ON UNDERSIDE OF BLINDS FROM SKY I
C E1SUN(I) - ILLUMINANCE ON UNDERSIDE OF BLINDS FROM PROFILE I
C E2GR
C E2SKY    - SAME AS E1, ONLY FOR TOPSIDE OF BLINDS
C E2SUN
C F        - AUXILIARY TABLE FOR CONFIGURATION FACTOR CALX
C FF(I)    - FORM FACTORS BETWEEN BLINDS FOR BLINDS SETTING I
C FTM      - MATRIX OF COEFFICIENTS FOR FLUX TRANSFER SOLUTION
C F12,F13,F21,F31 - FORM FACTORS AMONG BLINDS FOR SUNLIGHT CALX
C IBTYPE   - 1 = HORIZONTAL BLINDS, 2 = VERTICAL BLINDS
C LENGTH   - ROOM DEPTHS
C LOWER(I) - ILLUMINANCE ON ZONE I FROM GROUND
C LZ(I)    - ZENITH LUMINANCE (FOR SKY I) TO GIVE 1000 FC VERTICAL
C NDIV     - ROOM DISCRETIZATION PARAMETERS
C OFILE    - OUTPUT FILE NAME
C PTRA(1)  - POINTS TO 1ST ELEMENT IN ARRAYS (E, UPPER, ETC.)
C          FOR ROOM SURFACE I
C PTRZ(I)  - POINTS TO LAST ELEMENT FOR ROOM SURFACE I
C PVISL(I) - FRACTION OF GROUND VISIBLE THRU BLINDS FROM ZONE I
C PVISU(I) - FRACTION OF SKY VISIBLE THRU BLINDS FROM ZONE I
C PVISUN(I) - FRACTION OF BLINDS UNDERSIDE NOT VISIBLE FROM ZONE I
C PVISTO(I) - FRACTION OF BLINDS TOPSIDE NOT VISIBLE FROM ZONE I
C RAT      - RATIO OF ILLUMINANCE (AT CENTER OF ROOM) FROM INFINITE-
C          WIDE WINDOW : 80'-WIDE WINDOW
C RHO      - ROOM SURFACE REFLECTANCES
C RHOB     - BLINDS REFLECTANCES
C ROOMD    - ROOM DIMENSIONS
C CU(I,J,K,L) - CU VALUE FOR TARGET PT I, WINDOW WIDTH J, ROOM
C          DEPTH K, CONFIGURATION L
C TEMP(I)  - TEMPORARILY SAVES CU VALUE AT TARGET PT I
C TPVIS(I) - FRACTION OF SKY VISIBLE THRU BLINDS FROM TARGET PT I
C TPVIST(I) - FRACTION OF BLINDS TOPSIDE NOT VISIBLE FROM TARGET PT I
C TPVISU(I) - FRACTION OF BLINDS UNDERSIDE NOT VISIBLE FROM TARG PT I
C UNITL(I) - CONFIGURATION FACTOR FROM GROUND TO ZONE I
C UNITU(I) - CONFIGURATION FACTOR FROM SKY TO ZONE I
C UNITTP(1) - CONFIGURATION FACTOR FROM SKY TO TARGET PT I
C UPPER(I,J) - ILLUMINANCE ON ZONE I FROM SKY J
C WIDTH    - ROOM (=WINDOW) WIDTHS
C XTP,YTP  - (X,Y) COORDS. OF OF TARGET POINT
C ZEROS    - 150 ZEROES
C

```

```

PROGRAM DAYCU2
REAL ROOMD(3),F(11,11),E(150,5),UPPER(150,7),LOWER(150)
& ,DIRECT(5,7),FF(6),FTM(6,6),A(6,6),RHO(6),RHOB(5)
& ,PVISL(150),PVISU(150),TPVIS(5),E1SKY(7),E2SKY(7),E1SUN(7)
& ,E2SUN(7),TEMP(5),UNITU(150),UNITL(150),UNITTP(5)
& ,FVISUN(150),FVISTO(150),TPVIST(5),TPVISU(5)
& ,CU(5,8,7,56),LENGTH(7),WIDTH(8),LZ(7),ZEROS(150)
& ,F12(6),F13(6),F21(6),F31(6)
INTEGER PTRX(6),PTRZ(6),ND(9(3),SKYDIS(56)
& ,DEBUG
CHARACTER OFILE*16,PAGE*20,DESC(2)*80
INCLUDE 'CSIMP.NAV'

```

```

DATA WIDTH/5.,10.,20.,30.,40.,60.,80.,10000./
& ,RHO/.5,1.,.5,.5,.3,.7/, ZEROS/150*0./
& ,LENGTH/10.,20.,30.,40.,60.,80.,100./
& ,FF/.4956,.4445,.4114,.3572,.2835,.1953/
& ,PHOB/0.,.3,.5,.7,.977/
& ,DEBUG/1/, LZ/3373.1,2000.,1170.9,839.6,643.55,3245.3,1131./
& ,SKYDIS/56*0/

```

```

OPEN(UNIT=1,FILE='SYS$INPUT',STATUS='UNKNOWN')
WRITE(1,1001)
1001 FORMAT(' FILE NAME FOR OUTPUT?')
READ(1,1002) OFILE
1002 FORMAT(A)
OPEN(UNIT=2,FILE=OFILE,STATUS='UNKNOWN')

```

C OUTERMOST LOOP IS ON ROOM DIMENSIONS

```

C
ROOMD(3) = 10.
WRITE(1,1003)
1003 FORMAT(' -ENTER WIDTH RANGE, LENGTH RANGE ')
READ(1,*) NW1,NW2,NL1,NL2
WRITE(1,1004)
1004 FORMAT(' -WHAT DISTRIBUTIONS ?')
READ(1,*) (SKYDIS(I),I=1,8)
WRITE(1,1005)
1005 FORMAT(' -ENTER 0 OR 1 FOR ANGLE OF INCIDENCE LOSS:')
READ(1,*) ITAU
WRITE(1,1006)
1006 FORMAT(' -UPPER, LOWER BLINDS ANGLE SETTINGS?')
READ(1,*) IBANG1,IBANG2
WRITE(1,1007)
1007 FORMAT(' -WHAT RANGE OF BLINDS TYPES?')
READ(1,*) IBTYP1,IBTYP2
DO 100 IWID=NW1,NW2
ROOMD(1) = AMIN1(WIDTH(IWID),80.)
DO 200 ILEN=NL1,NL2
ROOMD(2) = LENGTH(ILEN)

```

```

C
C RAT --- RATIO OF INFINITE WINDOW ILLUMINANCE TO 80' WIDE
C WINDOW ILLUMINANCE AT CENTER OF ROOM
C
      RAT = 1.
      IF(IWID.EQ.8) RAT = RATIO(.5*ROOMD(2))
C
C COMPUTE DISCRETIZATION PARAMETERS
C
      ZSIZE = 0.2 * AMAX1(ROOMD(1),ROOMD(2),ROOMD(3))
      DO 21 I=1,3
21  NDIV(I) = 1 + .999 * ROOMD(I) / ZSIZE
C
C COMPUTE POINTERS TO ZONE ARRAY
C
      PTRA(1) = 1
      PTRZ(1) = NDIV(2) * NDIV(3)
      PTRA(3) = 1 + PTRZ(1)
      PTRZ(3) = PTRA(3) + NDIV(2)*NDIV(3) - 1
      PTRA(4) = 1 + PTRZ(3)
      PTRZ(4) = PTRA(4) + NDIV(1)*NDIV(3) - 1
      PTRA(5) = PTRZ(4) + 1
      PTRZ(5) = PTRA(5) + NDIV(1)*NDIV(2) - 1
      PTRA(6) = PTRZ(5) + 1
      PTRZ(6) = PTRA(6) + NDIV(1)*NDIV(2) - 1
C
C LOOP THRU ZONES AND COMPUTE CONTRIBUTION OF EACH TO THE 5 TARGET PTS
C
      XTP = .5 * ROOMD(1)
      DO 42 IT=1,5
      YTP = (1.1 - .2*IT) * ROOMD(2)
C
C CEILING ZONES
C
      ZSQ = ROOMD(3) * ROOMD(3)
      DO 24 J=1,NDIV(1)+1
      X = (J-1.) * ROOMD(1) / NDIV(1) - XTP
      SQX = SQRT(X*X + ZSQ)
      DO 23 I=1,NDIV(2)+1
      Y = (I-1)*ROOMD(2) / NDIV(2) - YTP
      SQY = SQRT(Y*Y + ZSQ)
      F(I,J) = (X * ATAN(Y/SQX) / SQX + Y* ATAN(X/SQY) / SQY / 6.2832
23  CONTINUE
24  CONTINUE
C
C COMPUTE CONTRIBUTION FROM EACH ZONE
C
      L = -1
      DO 27 J=1,NDIV(1)
      DO 26 I=1,NDIV(2)

```

```

      YI = YI1
      YI1 = YI + ROOMD(2)/NDIV(2)
      L = L + 1
      E(L+PTRA(5),IT) = 0.
      E(L+PTRA(6),IT) = F(I,J) + F(I+1,J+1) - F(I,J+1) - F(I+1,J)
26  CONTINUE
27  CONTINUE
C
C NOW DO SOUTH WALL
C
      DO 30 I=1,NDIV(3) + 1
      SQZ = SQRT(YTP*YTP + ((I-1)*ROOMD(3)/NDIV(3))**2)
      DO 29 J=1,NDIV(1) + 1
      F(I,J) = -YTP * ATAN(((J-1)*ROOMD(1)/NDIV(1)-XTP)/SQZ) /
      * (SQZ * 6.2832)
29  CONTINUE
30  CONTINUE
C
C GET CONTRIBUTION FROM ZONES
C
      L = PTRA(4) - 1
      DO 33 J=1,NDIV(1)
      DO 32 I=1,NDIV(3)
      L = L + 1
      E(L,IT) = F(I,J) + F(I+1,J+1) - F(I,J+1) - F(I+1,J)
32  CONTINUE
33  CONTINUE
C
C FINALLY, DO EAST AND WEST WALLS TOGETHER
C
      DO 36 I=1,NDIV(3)+1
      SQZ = SQRT(XTP*XTP + ((I-1)*ROOMD(3)/NDIV(3))**2)
      DO 35 J=1,NDIV(2)+1
      F(I,J) = -XTP * ATAN(((J-1)*ROOMD(2)/NDIV(2) - YTP) / SQZ)
      * / (SQZ * 6.2832)
35  CONTINUE
36  CONTINUE
C
C CONTRIBUTION FROM ZONES
C
      L = -1
      DO 39 J=1,NDIV(2)
      DO 38 I=1,NDIV(3)
      L = L + 1
      E(L+PTRA(1),IT) = F(I,J) + F(I+1,J+1) - F(I,J+1) - F(I+1,J)
      E(L+PTRA(3),IT) = E(L+PTRA(1),IT)
38  CONTINUE
39  CONTINUE
42  CONTINUE
C

```

```

C COMPUTE ILLUMINANCE TO ALL POINTS IN ROOM
C UNITL,UNITU,UNITTP <-- UNIFORM SKY, WITHOUT INCIDENCE ANGLE LOSS
C FIRST, FLOOR AND CEILING
C

```

```

L = -1
DO 45 J=1,NDIV(1)
XTP = (J-.5) * ROOMD(1) / NDIV(1)
DO 44 I=1,NDIV(2)
YTP = (I-.5) * ROOMD(2) / NDIV(2)
L = L + 1
X1 = -AMIN1(XTP,40.*(ROOMD(2)-YTP))
X2 = AMIN1(ROOMD(1)-XTP,40.*(ROOMD(2)-YTP))
DO 43 ISKY=1,7
IF(SKYDIS(ISKY).NE.1) GOTO 43
UPPER(L+PTRA(5),ISKY) = RAT * RILLUM(X1,X2,0.,ROOMD(3)
& ,ROOMD(2)-YTP,5,ISKY,ITAU,TAU) * LZ(ISKY)
UPPER(L+PTRA(6),ISKY) = 0.
IF(ISKY.NE.2) GOTO 43
UNITU(L+PTRA(5)) = UPPER(L+PTRA(5),2) / (TAU * LZ(2))
UNITU(L+PTRA(6)) = 0.

```

```

43 CONTINUE
LOWER(L+PTRA(5)) = 0.
LOWER(L+PTRA(6)) = UPPER(L+PTRA(5),2)
UNITL(L+PTRA(5)) = 0.
UNITL(L+PTRA(6)) = UNITU(L+PTRA(5))
44 CONTINUE
45 CONTINUE

```

```

C
C NEXT WEST WALL (AND EAST WALL)
C

```

```

L = -1
DO 48 J=1,NDIV(2)
YTP = (J-.5) * ROOMD(2) / NDIV(2)
DO 47 I=1,NDIV(3)
ZTP = (I-.5) * ROOMD(3) / NDIV(3)
L = L + 1
X2 = AMIN1(ROOMD(1),40.*(ROOMD(2)-YTP))
DO 46 ISKY=1,7
IF(SKYDIS(ISKY).NE.1) GOTO 46
UPPER(L+PTRA(1),ISKY) = RAT * RILLUM(0.,X2,0.,ROOMD(3)-ZTP
& ,ROOMD(2)-YTP,1,ISKY,ITAU,TAU) * LZ(ISKY)
UPPER(L+PTRA(3),ISKY) = UPPER(L+PTRA(1),ISKY)
IF(ISKY.NE.2) GOTO 46
UNITU(L+PTRA(1)) = UPPER(L+PTRA(1),2) / (TAU * LZ(2))
UNITU(L+PTRA(3)) = UNITU(L+PTRA(1))
46 CONTINUE
LOWER(L+PTRA(1)) = RAT * RILLUM(0.,X2,0.,ZTP,ROOMD(2)-YTP
& ,1,2,ITAU,TAU) * LZ(2)
LOWER(L+PTRA(3)) = LOWER(L+PTRA(1))

```

```

        UNITL(L+PTRA(1)) = LOWER(L+PTRA(1)) / (TAU * LZ(2))
        UNITL(L+PTRA(3)) = UNITL(L+PTRA(1))
47  CONTINUE
48  CONTINUE
C
C  FINALLY, THE SOUTH WALL
C
        L = -1
        DO 51 J=1,NDIV(1)
            XTP = (J-.5) * ROOMD(1) / NDIV(1)
            DO 50 I=1,NDIV(3)
                ZTP = (I-.5) * ROOMD(3) / NDIV(3)
                L = L + 1
                X1 = -AMIN1(XTP,40.*ROOMD(2))
                X2 = AMIN1(ROOMD(1)-XTP,40.*ROOMD(2))
                DO 49 ISKY=1,7
                    IF(SKYDIS(ISKY).EQ.1) UPPER(L+PTRA(4),ISKY) = RAT *
& RILLUM(X1,X2,0.,ROOMD(3)-ZTP,ROOMD(2),4,ISKY,ITAU,TAU)*LZ(ISKY)
                    IF(ISKY.EQ.2) UNITU(L+PTRA(4))=UPPER(L+PTRA(4),2) / (TAU*LZ(2))
49  CONTINUE
                LOWER(L+PTRA(4)) = RAT * RILLUM(X1,X2,0.,ZTP,ROOMD(2),4,2,ITAU
& ,TAU) * LZ(2)
                UNITL(L+PTRA(4)) = LOWER(L+PTRA(4)) / (TAU * LZ(2))
50  CONTINUE
51  CONTINUE
C
C  COMPUTE DIRECT ILLUMINANCE FROM WINDOW TO TARGET PTS
C
        XTP = .5 * ROOMD(1)
        DO 55 I=1,5
            YTP = (.2*I - .1) * ROOMD(2)
            X2 = AMIN1(XTP,40.)
            DO 54 ISKY=1,7
                IF(SKYDIS(ISKY).EQ.1) DIRECT(I,ISKY) = RAT * RILLUM(-X2,X2
& ,0.,ROOMD(3),YTP,5,ISKY,ITAU,TAU) * LZ(ISKY)
                IF(ISKY.EQ.2) UNITTP(I) = DIRECT(I,2) / (TAU * LZ(2))
54  CONTINUE
55  CONTINUE
        WRITE(DEBUG,2013) ROOMD(1),ROOMD(2)
2013 FORMAT(' ROOM: ',F6.0,' X ',F6.0)
C
C  WRITE(DEBUG,2006) ((DIRECT(I,J),J=1,7),I=1,5)
C2006 FORMAT('/' DIRECT TO TARGET PTS:'/(1X,7F8.3))
C
C  COMPUTE THE FLUX TRANSFER MATRIX, LOOP THRU BLINDS TYPES
C
        CALL FTMATR(ROOMD,FTM)
        DO 57 I=1,6
            IF(I.EQ.2) GOTO 57
            DO 56 J=PTRA(I),PTRZ(I)

```



```

    PVISU(J) = 1.
    PVISL(J) = 1.
    IF(I.EQ.5) PVISL(J) = 0.
    IF(I.EQ.6) PVISU(J) = 0.
56 CONTINUE
57 CONTINUE
C
    DO 58 I=1,5
58 TFVIS(I) = 1.
C
C READ THE LABELS INTO SPACE USED FOR SIMPSON INTEGRATION
C
    OPEN(UNIT=3,FILE='LABELS.NAV',STATUS='OLD')
    DO 62 I=1,56
    READ(3,1010) ((RDESC(K,J,I),K=1,20),J=1,2)
1010 FORMAT(4X,20A4)
    62 CONTINUE
    CLOSE(UNIT=3)
C
C COMPUTE ENTRIES FOR SKY AND GROUND TABLES THRU UNOBSTRUCTED WINDOWS
C
    DO 85 ISKY=1,7
    IF(SKYDIS(ISKY).NE.1) GOTO 85
    CALL COMPE(FTM,A,PVISU,PVISL,TPVIS,-15.,UPPER(1,ISKY),ZEROS
& ,DIRECT(1,ISKY),0.,0.,RHO,CU(1,IWID,ILEN,ISKY)
& ,PTRA,PTRZ,UNITU,UNITL,UNITTP,E)
    85 CONTINUE
C
C NOW THE GROUND TABLE
C
    CALL COMPE(FTM,A,PVISU,PVISL,TPVIS,-1.,ZEROS,LOWER,ZEROS,0.,0.
& ,RHO,CU(1,IWID,ILEN,8),PTRA,PTRZ,UNITU,UNITL,UNITTP,E)
C
C LOOP ON BLINDS TYPE, THEN BLINDS ANGLE
C
    DO 100 IBTYPE=IRTP1,IBTYP2
    DO 98 IANG=IBANG1,IBANG2
    ANG = 15. * (IANG-1)
    WRITE(DEBUG,2007) ANG
    2007 FORMAT(' BLINDS ANGLE ',F5.0)
C
C COMPUTE % VISIBLE FROM EACH POINT IN ROOM
C
    CALL SKYVIS(ROOMD,NDIV,PTRA,PTRZ,PVISL,PVISU,TPVIS,IBTYPE
& ,ANG,PVISUN,PVISTO,TPVISU,TPVIST)
C
C GET THRU COMPONENT - SKY
C
    L = 8 + 6*(IBTYPE-1) + IANG
    CALL COMPE(FTM,A,PVISU,PVISL,TPVIS,ANG,UPPER(1,2),ZEROS

```

```

      & ,DIRECT(1,2),0.,.5,RHO,CU(1,IWID,ILEN,L),PTRA,PTRZ
      & ,UNITU,UNITL,UNITTP,E)
      SKYDIS(L) = 1
C
C THRU COMPONENT - GROUND
C
      L = 20 + 6*(IBTYPE-1) + IANG
      CALL COMPE(FTH,A,PVISU,PVISL,TPVIS,ANG,ZEROS,LOWER,ZEROS,0.
      & ,.5,RHO,CU(1,IWID,ILEN,L),PTRA,PTRZ,UNITU,UNITL,UNITTP,E)
      SKYDIS(L) = 1
C
C UNDERSIDE OF BLINDS
C
      L = 32 + 6*(IBTYPE-1) + IANG
      CALL COMPE(FTH,A,PVISUN,PVISUN,TPVISU,ANG,ZEROS,ZEROS,ZEROS
      & ,1000.,.5,RHO,CU(1,IWID,ILEN,L),PTRA,PTRZ,UNITU,UNITL,UNITTP,E)
      SKYDIS(L) = 1
C
C TOPSIDE OF BLINDS
C
      L = 44 + 6*(IBTYPE-1) + IANG
      CALL COMPE(FTH,A,PVISTO,PVISTO,TPVIST,ANG,ZEROS,ZEROS,ZEROS
      & ,1000.,.5,RHO,CU(1,IWID,ILEN,L),PTRA,PTRZ,UNITU,UNITL,UNITTP,E)
      SKYDIS(L) = 1
98  CONTINUE
100 CONTINUE
200 CONTINUE
C
      DO 210 I=1,56
      IF(SKYDIS(I).NE.1) GOTO 210
      PAGE = ' '
      WRITE(DESC(1),1008) (RDESC(J,1,I),J=1,20)
1008  FORMAT(20A4)
      WRITE(DESC(2),1008) (RDESC(J,2,I),J=1,20)
      CALL BFORMT(2,CU(1,1,1,I),PAGE,DESC,2)
210  CONTINUE
      STOP
      END
C-----
C COMPUTE RATIO OF INFINITE-WIDTH WINDOW ILLUMINANCE TO
C 80'-WIDE WINDOW ILLUMINANCE
C Y - Y-DISTANCE TO WINDOW
C
      FUNCTION RATIO(Y)
      SQYZ = SQRT(Y*Y + 100.)
      E80 = (ATAN(40./Y) - (Y/SQYZ)*ATAN(40./SQYZ)) / 3.14159
      RATIO = (.5 * (1.- Y/SQYZ)) / E80
      RETURN
      END
C-----

```

```

C THIS ROUTINE PRINTS OUT A "BASIC FORMAT" DAYLIGHT CU TABLE
C CU -- TABLE OF CU'S TO BE PRINTED
C DESC - N LINES OF DESCRIPTION TO BE CENTERED AT TOP
C PAGE - PAGE # TO BE PRINTED
C LU - OUTPUT DEVICE LOGICAL UNIT #
C

```

```

SUBROUTINE BFORMAT(LU,CU,PAGE,DESC,N)
REAL CU(5,8,7)
CHARACTER PAGE*20,DESC(N)*80,LINE*80,DH(7)*2,CH2*2

```

```

C
DATA DH/' 1',' 2',' 3',' 4',' 6',' 8','10'/
C

```

```

WRITE(LU,1001) PAGE
1001 FORMAT('1'//37X,A//)
C

```

```

DO 10 I=1,N
CALL CENTER(DESC(I),LINE,80)
WRITE(LU,1002) LINE(1:LASN8(LINE,80))
1002 FORMAT(2X,A)
10 CONTINUE
C

```

```

C TOP HEADER INFO
C

```

```

WRITE(LU,1003)
1003 FORMAT(/12X,59('--'))
& /12X,'1 ROOM DEPTH / 1',41X,'1'
& /12X,'1 WINDOW HEIGHT 1 WINDOW WIDTH / WINDOW HEIGHT '
& , ' W / H 1'
& /12X,'1',15X,'1',41X,'1'
& /12X,'1 D / H Z D 1 .5 1 2 3 4 6'
& , ' 8 INF 1'
& /12X,59('--') )
C

```

```

C OUTER LOOP ON ROOM DEPTH / WINDOW HEIGHT RATIO
C

```

```

DO 50 K=1,7
DO 40 I=1,5
CH2 = ' '
IF(I.EQ.3) CH2 = DH(K)
WRITE(LU,1004) CH2, 20*I-10, (NINT(CU(I,J,K)),J=1,8)
1004 FORMAT(12X,'1 ',A2,6X,I3,' 1',8I5.3,' 1')
40 CONTINUE
C

```

```

WRITE(LU,1005)
1005 FORMAT(12X,59('--'))
50 CONTINUE
RETURN
END

```

```

C-----
C CENTER STRING 'A' IN STRING 'B'

```

```

C
  SUBROUTINE CENTER(A,B,N)
  CHARACTER A*80,B*80
C
  L = 0
10  L = L + 1
  IF(A(L:L).EQ.' ' .AND. L.LT.N) GOTO 10
  M = LASNB(A,N)
  B = ' '
  I = (N - (M-L)) / 2
  B(I:I+M-L) = A(L:M)
  RETURN
  END
-----
C COMPUTE ILLUMINANCE AT EACH TARGET POINT
C AA - ORIGINAL FLUX XFER MATRIX
C A - MODIFIED FLUX XFER MATRIX
C PVISU - FRACTION OF UPPER WINDOW VISIBLE THRU BLINDS FROM ZONES
C PVISL - FRACTION OF LOWER WINDOW
C TPVIS - FRACTION OF WINDOW VISIBLE FROM TARGET PTS
C GAMMA - BLINDS OPENING ANGLE (NEGATIVE --> NO BLINDS)
C EUP - INITIAL E ON ZONES FROM SKY
C ELOW - INITIAL E ON ZONES FROM GROUND
C ETP - INITIAL E ON TARGET PTS FROM SKY
C BL - EXITANCE OF BLINDS
C KHOB - REFLECTANCE OF BLINDS
C B - RIGHT-HAND SIDE VECTOR
C RHO - REFLECTANCE OF ROOM SURFACES
C EANS - ILLUMINANCE AT TARGET PTS (ANSWERS)
C EUNU - ILLUM. ON ZONES FROM UNIFORM UPPER WINDOW
C EUNL - ILLUM. ON ZONES FROM UNIFORM GROUND (UNIT EXITANCE)
C FTPUN - ILLUM. ON TARGET PTS FROM UNIFORM WINDOW
C ZONTP - E ON TARGET PTS FROM ROOM SURFACE ZONES
C
  SUBROUTINE COMPE(AA,A,PVISU,PVISL,TPVIS,GAMMA,EUP,ELOW
& ,ETP,BL,RHOB,RHO,EANS,PTRA,PTRZ,EUNU,EUNL,ETPUN,ZONTP)
  REAL AA(6,6),A(6,6),PVISU(150),PVISL(150),TPVIS(5),EUP(150)
& ,ELOW(150),ETP(5),B(6),RHO(6),E(150),EUNU(150),ETPUN(5)
& ,EUNL(150)
& ,RHS(6),EANS(5),FLUM(6),ZONTP(150,5)
  INTEGER PTRA(6),PTRZ(6)
& ,DEBUG
  DATA DEBUG/1/
C
C COPY FLUX TRANSFER MATRIX, ADJUSTING ROW 2 FOR EFFECTIVE
C REFLECTANCE OF WINDOW-BLINDS
C
  SING = SIN(GAMMA/57.29578)
C
  RW = RHOB * SING
  RW = .5 * SING

```

```

      IF(GAMMA.LT,-0.01) RW = 0.
      RHO(2) = RW
      DO 12 J=1,6
      DO 11 I=1,6
11  A(I,J) = AA(I,J)
      A(2,J) = AA(2,J) * RW
12  CONTINUE
      A(2,2) = -1.
      RHS(2) = 0.
C
C COMPUTE AVG INITIAL E ON ROOM SURFACES
C
      DO 16 I=1,6
      IF(I.EQ.2) GOTO 16
      B(I) = 0.
      DO 14 J=PTRA(I),PTRZ(I)
      E(J) = EUP(J) * PVISU(J) + ELOW(J) * PVISL(J)
      * + EUNU(J) * BL * (1.-PVISU(J)) + EUNL(J) * BL * (1.-PVISL(J))
      B(I) = B(I) + E(J)
14  CONTINUE
      B(I) = B(I) / (PTRZ(I)-PTRA(I)+1)
      RHS(I) = -RHO(I) * B(I)
16  CONTINUE
C
C SOLVE THE FLUX TRANSFER MATRIX, THEN ADJUST FINAL ZONE EXITANCES
C
      CALL GJORDN(A,RHS,FLUM,6)
      DO 20 I=1,6
      IF(I.EQ.2) GOTO 20
      DO 18 J=PTRA(I),PTRZ(I)
      E(J) = RHO(I) * (E(J) + FLUM(I)/RHO(I) -B(I))
18  CONTINUE
20  CONTINUE
C
C ADD THE ZONE CONTRIBUTIONS TO THE TARGET PT ILLUMINANCES
C
      DO 25 K=1,5
      EANS(K) = ETP(K)*TPVIS(K) + ETPUN(K)*(FLUM(2) +BL*(1.-TPVIS(K)))
      DO 23 J=PTRA(1),PTRZ(6)
23  EANS(K) = EANS(K) + ZONTP(J,K) * E(J)
25  CONTINUE
C
      RETURN
      END
C-----
C RETURN THE (COS THETA / (PI * D**2) ) FACTOR FOR FORMATION
C OF THE SIMPSON INTEGRAND
C (X,Y,Z) - POINT ON NORTH WALL (=WINDOW WALL)
C D - DISTANCE TO (X,Y,Z)
C ISURF - SURFACE # (1=WEST WALL, ETC.)

```

```

C
  FUNCTION COSD2(X,Y,Z,D,ISURF)
C
  GOTO (10,20,10,20,50,50),ISURF
C
C WEST OR EAST WALL
C
  10 CONTINUE
  COSD2 = ABS(X) * Y / (D*D*D*D * 3.14159)
  RETURN
C
C SOUTH WALL
C
  20 CONTINUE
  COSD2 = Y * Y / (D*D*D*D * 3.14159)
  RETURN
C
C CEILING / FLOOR
C
  50 CONTINUE
  COSD2 = Z * Y / (D*D*D*D * 3.14159)
  RETURN
  END
-----
C
C COMPUTE NORMAL ILLUMINANCE ON TOP OF HORIZ. BLINDS DUE
C TO THE GROUND
C
  FUNCTION ETG(L,SING,COSG)
  REAL L
  ETG = 0.
  IF(SING.LT.0.01) RETURN
  Y1 = COSG/SING
  SQY1 = SQRT(1.+ Y1*Y1)
  ETG = .5 * L * (SING/SQY1 - COSG*(1.-Y1/SQY1))
  RETURN
  END
-----
C
C COMPUTE NORMAL ILLUMINANCE ON TOP OF HORIZ. BLINDS DUE
C TO THE UNIFORM SKY
C
  FUNCTION ETS(L,SING,COSG)
  REAL L
  Z = 10.**8.
  IF(COSG.GT.0.01) Z = (1.-.575*SING) / (.575*COSG)
  SQZ = SQRT(1.+ Z*Z)
  ETS = .5 * L * (SING*Z/SQZ + COSG*(1.-1./SQZ))
  RETURN
  END
-----
C
C COMPUTE NORMAL ILLUMINANCE ON UNDERSIDE OF HORIZ. BLINDS

```

```

C DUE TO THE GROUND
C SING,COSG - SINE,COSINE OF BLINDS TILT ANGLE
C L - EXITANCE OF GROUND
C
  FUNCTION EUG(L,SING,COSG)
  REAL L
  Y1 = .575 * COSG / (1.+ .575*SING)
  Y2 = 10.**8.
  IF(SING.GT.0.01) Y2 = COSG / SING
  SQY1 = SQRT(1. + Y1*Y1)
  SQY2 = SQRT(1. + Y2*Y2)
  EUG = 0.5 * L * ( COSG*(Y2/SQY2 - Y1/SQY1)
  * - SING * (1./SQY1 - 1./SQY2))
  RETURN
  END

```

```

C -----
C COMPUTE THE FLUX TRANSFER MATRIX
C

```

```

  SUBROUTINE FTMATR(ROOMD,A)
  REAL ROOMD(3),A(6,6),RHO(6)
  DATA RHO/.5,1.,.5,.5,.2,.8/
C
  A(1,2) = PERFF(ROOMD(1),ROOMD(3),ROOMD(2))
  A(1,5) = PERFF(ROOMD(1),ROOMD(2),ROOMD(3))
  A(1,3) = 1. - 2.* (A(1,2) + A(1,5))
  A(2,1) = (ROOMD(2) / ROOMD(1)) * A(1,2)
  A(2,5) = PERFF(ROOMD(2),ROOMD(1),ROOMD(3))
  A(2,4) = 1. - 2. * (A(2,1) + A(2,5))
  A(1,4) = A(1,2)
  A(1,6) = A(1,5)
  A(2,3) = A(2,1)
  A(2,6) = A(2,5)
  A(5,1) = (ROOMD(3)/ROOMD(1)) * A(1,5)
  A(5,2) = (ROOMD(3)/ROOMD(2)) * A(2,5)
  A(5,3) = A(5,1)
  A(5,4) = A(5,2)
  A(5,6) = 1. - 2. * (A(5,1) + A(5,2))
  DO 10 J=1,6
  A(3,J) = A(1,J)
  A(4,J) = A(2,J)
10  A(6,J) = A(5,J)
  A(3,1) = A(1,3)
  A(4,2) = A(2,4)
  A(6,5) = A(5,6)
C
  DO 20 I=1,6
  DO 18 J=1,6
18  A(I,J) = A(I,J) * RHO(I)
  A(I,I) = -1.
20  CONTINUE

```

```

RETURN
END

```

```

C-----
C FORM FACTOR FOR 2 PERPENDICULAR ADJACENT SURFACES
C SOURCE SURFACE IN Y-Z PLANE, RECEIVING SURFACE IN X-Y PLANE
C

```

```

FUNCTION PERFF(X,Y,Z)
X2 = X * X
Y2 = Y * Y
Z2 = Z * Z
TZ = .25 * (-Z2*LOG(Z2) + Z2)
TX = .25 * (-X2*LOG(X2) + X2)
TY = .25 * (-Y2*LOG(Y2) + Y2)
TXZ = .25 * (-(X2+Z2)*LOG(X2+Z2) + (X2+Z2))
TYZ = Y * Z * ATAN(Y/Z) + .5 * Y2 * LOG((Y2+Z2)/Y2)
&   -.25 * (Y2+Z2)*LOG(Y2+Z2) + .25 * (Y2+Z2)
TXY = Y * X * ATAN(Y/X) + .5 * Y2 * LOG((Y2+X2)/Y2)
&   -.25 * (Y2+X2)*LOG(Y2+X2) + .25 * (Y2+X2)
SQXZ = SQRT(X2+Z2)
TXYZ = Y * SQXZ * ATAN(Y/SQXZ) + .5 * Y2 *
&   LOG((X2+Y2+Z2)/Y2) - .25 * (X2+Y2+Z2) * LOG(X2+Y2+Z2)
&   + .25 * (X2+Y2+Z2)
PERFF = 2.*(TX + TY + TZ + TXYZ) - 2.*(TXZ+TYZ+TXY)
PERFF = -PERFF / (Y*Z*6.2831853)
RETURN
END

```

```

C-----
C SOLVE THE MATRIX EQUATION AX = B
C (A IS DIAGONALLY DOMINANT)
C

```

```

SUBROUTINE GJORDN(A,B,X,N)
REAL A(6,6),X(6),B(6)
C
DO 10 I=1,N
10 X(I) = B(I)
DO 25 I=1,N
R = 1. / A(I,I)
DO 12 J=1,N
12 A(I,J) = A(I,J) * R
X(I) = X(I) * R
C
DO 16 K=1,N
IF(K.EQ.I) GOTO 16
Q = A(K,I)
DO 15 J=1,N
15 A(K,J) = A(K,J) - Q*A(I,J)
X(K) = X(K) - Q*X(I)
16 CONTINUE
25 CONTINUE
RETURN

```



```

      END
C-----
C FIND LAST NON-BLANK IN STRING 'S'
C
      FUNCTION LASNB(S,N)
      CHARACTER S*80
C
      LASNB = N + 1
10  LASNB = LASNB - 1
      IF(S(LASNB:LASNB).EQ.' ' .AND. LASNB.GT.1) GOTO 10
      RETURN
      END
C-----
C COMPUTE ILLUMINANCE FROM THE WINDOW TO A POINT IN THE ROOM
C (X1,X2) - X-LIMITS OF WINDOW
C (Z1,Z2) - Z-LIMITS OF WINDOW
C ISURF - SURFACE POINT LIES ON
C ISKY - (1-7) IDENTIFIES SKY BRIGHTNESS DISTRIBUTION
C ITAU - 0 = IGNORE LOSSES DUE TO ANGLE OF INCIDENCE
C       1 = ACCOUNT FOR SUCH LOSSES
C ATAU - TRANSMISSION LOSS DUE TO ANGLE OF INCIDENCE
C
      FUNCTION RILLUM(X1,X2,Z1,Z2,Y,ISURF,ISKY,ITAU,ATAU)
      INCLUDE 'CSIMP.NAV'
C
C PARTITION WINDOW FOR SIMPSON INTEGRATION
C
      ZSIZE = 0.2 * Y
      NX = 1 + MIN1(199, .999*(X2-X1)/ZSIZE)
      NZ = 1 + MIN1(49, .999*(Z2-Z1)/ZSIZE)
      NX = NX + MOD(NX,2)
      NZ = NZ + MOD(NZ,2)
C
C COMPUTE TABULATED VALUES FOR SIMPSON INTEGRATION
C
      ATAU = 0.
      TAU = 1.
      DO 15 I=1,NZ+1
      Z = (I-1) * (Z2-Z1) / NZ + Z1
      DO 15 J=1,NX+1
      X = (J-1) * (X2-X1) / NX + X1
      D = SQRT(X*X + Y*Y + Z*Z)
      CTH = COSD2(X,Y,Z,D,ISURF)
      IF(ITAU.EQ.1) TAU = TLOSS(X,Y,Z,D)
      FS(I,J) = CTH * TAU * SKYBR(ISKY,X,Y,Z,D)
      ATAU = ATAU + TAU
15  CONTINUE
      ATAU = ATAU / ((NX+1)*(NZ+1))
C
C PERFORM SIMPSON INTEGRATION

```

```

C
  RILLUM = SIMP2(X2-X1,Z2-Z1,NX,NZ)
  RETURN
  END
C-----
C EVALUATE A 2-DIMENSIONAL INTEGRAL BY SIMPSON'S RULE
C DX - X-DISTANCE SPANNED BY COLUMNS
C DY - Y-DISTANCE SPANNED BY ROWS
C NX - # X INTERVALS (EVEN)
C NY - # Y INTERVALS (EVEN)
C F - FUNCTION VALUES
C
  FUNCTION SIMP2(DX,DY,NX,NY)
  REAL R(51)
  INCLUDE 'CSIMP.NAV'
C
C INTEGRATE EACH ROW
C
  DO 25 I=1,NY+1
  R(I) = FS(I,1) + FS(I,NX+1)
C
  DO 23 J=2,NX,2
  23 R(I) = R(I) + 4.* FS(I,J)
C
  DO 21 J=3,NX-1,2
  21 R(I) = R(I) + 2.* FS(I,J)
  25 CONTINUE
C
C NOW INTEGRATE THE INTEGRATED ROWS
C
  SIMP2 = R(1) + R(NY+1)
  DO 35 I=2,NY,2
  35 SIMP2 = SIMP2 + 4.* R(I)
C
  DO 38 I=3,NY-1,2
  38 SIMP2 = SIMP2 + 2.* R(I)
  SIMP2 = SIMP2 * DX * DY / (9.*NX*NY)
  RETURN
  END
C-----
C RETURN SKY BRIGHTNESS EVIDENT AT POINT (X,Y,Z) ON WINDOW
C WHICH IS IN X-Z PLANE
C D - DISTANCE TO (X,Y,Z)
C I - SKY DISTRIBUTION (1 --> V/H = 0.75, ETC.)
C ZENITH LUMINANCE IS ASSUMED = 1
C
  FUNCTION SKYBR(I,X,Y,Z,D)
  REAL C(5),DENOM(5)
C
  DATA C/0.,0.,-.6,-.26,-.13/, DENOM/0.,0.,.45119,.22895,.1219/

```

```

C
      GOTO (10,20,30,30,30,60,70),I
C
C V/H = 0.75 (OVERCAST SKY)
C
  10 CONTINUE
      SKYBR = 0.301
      IF(Z.GT.0.05) SKYBR = .301 + 1.273 * EXP(-.6*D/Z)
      RETURN
C
C V/H = 1.00 (UNIFORM SKY)
C
  20 CONTINUE
      SKYBR = 1.
      RETURN
C
C V/H = 1.25, 1.50, 1.75 (PARTLY CLOUDY TO CLEAR SKIES)
C
  30 CONTINUE
      TERM = 1.
      IF(Z.GT.0.05) TERM = 1. - EXP(C(I)*D/Z)
      SKYBR = TERM / DENOM(I)
      RETURN
C
C TRADITIONAL OVERCAST SKY --  $L = (LZ/3) * (1 + 2 \sin H)$ 
C
  60 CONTINUE
      SKYBR = (1. + 2.*Z/D) / 3.
      RETURN
C
C LATERALLY UNIFORM CLEAR SKY --  $L = 3 LZ / (1 + 2 \sin H)$ 
C
  70 CONTINUE
      SKYBR = 3./ (1. + 2.*Z/D)
      RETURN
      END
C-----
C FOR A GIVEN BLINDS ANGLE SETTING, DETERMINE THE PROPORTION OF
C SKY VISIBLE AT EACH POINT IN THE ROOM
C
      SUBROUTINE SKYVIS(ROOMD,NDIV,PTRA,PTRZ,PVISL,PVISU,TPVIS
& ,BLTYPE,GAMMA,PVISUN,PVISTO,TPVISU,TPVIST)
      REAL ROOMD(3),PVISU(150),PVISL(150),TPVIS(5)
& ,PVISUN(150),PVISTO(150),TPVISU(5),TPVIST(5)
      INTEGER NDIV(3),PTRA(6),PTRZ(6),BLTYPE
C
      SING = SIN(GAMMA/57.29578)
      COSG = COS(GAMMA/57.29578)
      TANG = SING / COSG
      IF(BLTYPE.EQ.2) GOTO 35

```

```

C
C HORIZONTAL BLINDS -- START WITH FLOOR + CEILING
C PV = FLOOR QV = CEILING
C
DO 15 I=1,NDIV(2)
  YP = (I-.5) * ROOMD(2) / NDIV(2)
  PV = VISIBL(ROOMD(2)-YP,0.,ROOMD(3),SING,COSG,TANG)
  QV = VISIBL(ROOMD(2)-YP,-ROOMD(3),0.,SING,COSG,TANG)
  ZT1 = -ROOMD(3)
  ZT2 = AMAX1(ZT1,-(ROOMD(2)-YP)*TANG)
  VTO = VISIBL(ROOMD(2)-YP,ZT1,ZT2,SING,COSG,TANG)
  ZU2 = 0.
  VUN = VISIBL(ROOMD(2)-YP,ZT2,ZU2,SING,COSG,TANG)
  RATIO = TSRAT(ZT2,ZT1,ROOMD(2)-YP)
  DO 14 J=1,NDIV(1)
    INC = (J-1)*NDIV(2) + I - 1
    PVISUN(PTRA(5)+INC) = 1.- PV
    PVISUN(PTRA(6)+INC) = (1.-VUN) * (ZU2-ZT2) / ROOMD(3)
    PVISTU(PTRA(5)+INC) = 0.
    PVISTO(PTRA(6)+INC) = (1.-VTO) * (ZT2-ZT1) * RATIO / ROOMD(3)
    PVISU(PTRA(5)+INC) = PV
    PVISL(PTRA(5)+INC) = 0.
    PVISL(PTRA(6)+INC) = QV
  14 PVISU(PTRA(6)+INC) = 0.
  15 CONTINUE
C
C NEXT, THE SOUTH WALL
C
DO 20 I=1,NDIV(3)
  ZP = (I-.5) * ROOMD(3) / NDIV(3)
  PV = VISIBL(ROOMD(2),0.,ROOMD(3)-ZP,SING,COSG,TANG)
  QV = VISIBL(ROOMD(2),-ZP,0.,SING,COSG,TANG)
  ZT1 = -ZP
  ZT2 = AMAX1(ZT1,-ROOMD(2)*TANG)
  VTO = VISIBL(ROOMD(2),ZT1,ZT2,SING,COSG,TANG)
  ZU2 = ROOMD(3)-ZP
  VUN = VISIBL(ROOMD(2),ZT2,ZU2,SING,COSG,TANG)
  RATIO = TSRAT(ZT2,ZT1,ROOMD(2))
  DO 19 J=1,NDIV(1)
    L = PTRA(4) + I - 1 + (J-1)*NDIV(3)
    PVISTO(L) = (1.-VTO) * (ZT2-ZT1) * RATIO / ROOMD(3)
    PVISUN(L) = (1.-VUN) * (ZU2-ZT2) / ROOMD(3)
    PVISL(L) = QV * ZP / ROOMD(3)
  19 PVISU(L) = PV * (ROOMD(3)-ZP) / ROOMD(3)
  20 CONTINUE
C
C EAST AND WEST WALLS
C
L = -1
DO 25 I=1,NDIV(2)

```

```

YP = (I-.5) * ROOMD(2) / NDIV(2)
DO 24 J=1,NDIV(3)
ZP = (J-.5) * ROOMD(3) / NDIV(3)
PV = VISIBL(ROOMD(2)-YP,0.,ROOMD(3)-ZP,SING,COSG,TANG)
QV = VISIBL(ROOMD(2)-YP,-ZP,0.,SING,COSG,TANG)
ZT1 = -ZP
ZT2 = AMAX1(ZT1,-(ROOMD(2)-YP)*TANG)
VTO = VISIBL(ROOMD(2)-YP,ZT1,ZT2,SING,COSG,TANG)
ZU2 = ROOMD(3)-ZP
VUN = VISIBL(ROOMD(2)-YP,ZT2,ZU2,SING,COSG,TANG)
RATIO = TSRAT(ZT2,ZT1,ROOMD(2)-YP)
L = L + 1
PVISTO(PTRA(1)+L) = (1.-VTO) * (ZT2-ZT1) * RATIO / ROOMD(3)
PVISTO(PTRA(3)+L) = PVISTO(PTRA(1)+L)
PVISUN(PTRA(1)+L) = (1.-VUN) * (ZU2-ZT2) / ROOMD(3)
PVISUN(PTRA(3)+L) = PVISUN(PTRA(1)+L)
PVISL(PTRA(1)+L) = QV * ZP / ROOMD(3)
PVISL(PTRA(3)+L) = QV * ZP / ROOMD(3)
PVISU(PTRA(1)+L) = PV * (ROOMD(3)-ZP) / ROOMD(3)
24 PVISU(PTRA(3)+L) = PV * (ROOMD(3)-ZP) / ROOMD(3)
25 CONTINUE
C
C FINALLY THE TARGET POINTS
C
DO 30 I=1,5
TPVIS(I) = VISIBL((.2*I-.1)*ROOMD(2),0.,ROOMD(3),SING,COSG,TANG)
TPVIST(I) = 0.
30 TPVISU(I) = 1. - TPVIS(I)
GOTO 60
C
C VERTICAL BLINDS -- FLOOR AND CEILING FIRST
C
35 CONTINUE
L = -1
DO 40 J=1,NDIV(1)
XP = (J-.5) * ROOMD(1) / NDIV(1)
DO 39 I=1,NDIV(2)
YP = (I-.5) * ROOMD(2) / NDIV(2)
PV = VISIBL(ROOMD(2)-YP,XP-ROOMD(1),XP,SING,COSG,TANG)
ZT1 = XP - ROOMD(1)
ZT2 = AMAX1(ZT1,-(ROOMD(2)-YP)*TANG)
VTO = VISIBL(ROOMD(2)-YP,ZT1,ZT2,SING,COSG,TANG)
ZU2 = XP
VUN = VISIBL(ROOMD(2)-YP,ZT2,ZU2,SING,COSG,TANG)
RATIO = TSRAT(ZT2,ZT1,ROOMD(2)-YP)
L = L + 1
PVISTO(PTRA(5)+L) = (1.-VTO) * (ZT2-ZT1) * RATIO / ROOMD(1)
PVISTO(PTRA(6)+L) = PVISTO(PTRA(5)+L)
PVISUN(PTRA(5)+L) = (1.-VUN) * (ZU2-ZT2) / ROOMD(1)
PVISUN(PTRA(6)+L) = PVISUN(PTRA(5)+L)

```

```

PVISU(PTRA(5)+L) = PV
PVISU(PTRA(6)+L) = 0.
PVISL(PTRA(5)+L) = 0.
39 PVISL(PTRA(6)+L) = PV
40 CONTINUE

```

```

C
C SOUTH WALL
C

```

```

L = -1
DO 45 J=1,NDIV(1)
XP = (J-.5) * ROOMD(1) / NDIV(1)
PV = VISIBL(ROOMD(2),XP-ROOMD(1),XP,SING,COSG,TANG)
ZT1 = XP - ROOMD(1)
ZT2 = AMAX1(ZT1,-ROOMD(2)*TANG)
VTO = VISIBL(ROOMD(2),ZT1,ZT2,SING,COSG,TANG)
ZU2 = XP
VUN = VISIBL(ROOMD(2),ZT2,ZU2,SING,COSG,TANG)
RATIO = TSRAT(ZT2,ZT1,ROOMD(2))
DO 44 I=1,NDIV(3)
L = L + 1
ZP = (I-.5)*ROOMD(3) / NDIV(3)
PVISTO(PTRA(4)+L) = (1.-VTO) * (ZT2-ZT1) * RATIO / ROOMD(1)
PVISUN(PTRA(4)+L) = (1.-VUN) * (ZU2-ZT2) / ROOMD(1)
PVISL(PTRA(4)+L) = PV * ZP / ROOMD(3)
44 PVISU(PTRA(4)+L) = PV * (ROOMD(3)-ZP) / ROOMD(3)
45 CONTINUE

```

```

C
C WEST, EAST WALLS (PV = WEST WALL, QV = EAST WALL)
C

```

```

L = -1
DO 50 J=1,NDIV(2)
YP = (J-.5) * ROOMD(2) / NDIV(2)
PV = VISIBL(ROOMD(2)-YP,-ROOMD(1),0.,SING,COSG,TANG)
QV = VISIBL(ROOMD(2)-YP,0.,ROOMD(1),SING,COSG,TANG)
ZT1W = -ROOMD(1)
ZT2W = AMAX1(ZT1W,-(ROOMD(2)-YP)*TANG)
VTWEST = VISIBL(ROOMD(2)-YP,ZT1W,ZT2W,SING,COSG,TANG)
RATIO = TSRAT(ZT2W,ZT1W,ROOMD(2)-YP)
ZU2W = 0.
VUWEST = VISIBL(ROOMD(2)-YP,ZT2W,ZU2W,SING,COSG,TANG)
VUEAST = VISIBL(ROOMD(2)-YP,0.,ROOMD(1),SING,COSG,TANG)
DO 49 I=1,NDIV(3)
L = L + 1
PVISTO(PTRA(1)+L) = (1.-VTWEST) * (ZT2W-ZT1W) * RATIO / ROOMD(1)
PVISUN(PTRA(1)+L) = (1.-VUWEST) * (ZU2W-ZT2W) / ROOMD(1)
PVISTO(PTRA(3)+L) = 0.
PVISUN(PTRA(3)+L) = 1. - VUEAST
PVISU(PTRA(1)+L) = PV * (ROOMD(3)-ZP) / ROOMD(3)
PVISU(PTRA(3)+L) = QV * (ROOMD(3)-ZP) / ROOMD(3)
PVISL(PTRA(1)+L) = PV * ZP / ROOMD(3)

```

```

49 PVISL(PTRA(3)+L) = QU * ZP / ROOMD(3)
50 CONTINUE
C
C FINALLY, THE TARGET POINTS
C
DO 55 I=1,5
Y = (.2*I - .1) * ROOMD(2)
TPVIS(I) = VISIBL(Y,-.5*ROOMD(1),.5*ROOMD(1),SING,COSG,TANG)
ZT1 = -.5*ROOMD(1)
ZT2 = AMAX1(ZT1,-Y*TANG)
VTO = VISIBL(Y,ZT1,ZT2,SING,COSG,TANG)
ZU2 = .5*ROOMD(1)
VUN = VISIBL(Y,ZT2,ZU2,SING,COSG,TANG)
TPVIST(I) = (1.-VTO) * (ZT2-ZT1) / ROOMD(1)
TPVISU(I) = (1.-VUN) * (ZU2-ZT2) / ROOMD(1)
55 CONTINUE
C
C COMPLEMENT THE TOPSIDE-UNDERSIDE PERCENTAGES
C
60 CONTINUE
DO 62 I=PTRA(1),PTRZ(6)
PVISUN(I) = 1.- PVISUN(I)
PVISTO(I) = 1.- PVISTO(I)
62 CONTINUE
C
DO 64 I=1,5
TPVIST(I) = 1.- TPVIST(I)
64 TPVISU(I) = 1.- TPVISU(I)
RETURN
END
C-----
C FORM RATIO USED TO ACCOUNT FOR THE FACT THAT TOPSIDE OF
C BLINDS ARE ONLY VISIBLE SOME DISTANCE AWAY
C
FUNCTION TSRAT(X1,X2,Z)
TSRAT = 0.
E1 = 2./Z - 2./SQRT(X1*X1+Z*Z)
E2 = 2./Z - 2./SQRT(X2*X2+Z*Z)
IF(E2.GT.0.001) TSRAT = (E2-E1) / E2
RETURN
END
C-----
C RETURN FORM FACTORS, INITIAL ILLUMINANCE FROM SUN ON BLINDS
C SING,COSG - SINE, COSINE OF BLINDS OPENING ANGLE
C TANA - TANGENT OF PROFILE ANGLE
C
SUBROUTINE SOLFF(SING,COSG,TANA,E1,E2,F12,F13
& ,F21,F31,FC)
F13 = 0.
F31 = 0.

```

```

F21 = F12
X = 1. - 1.15 *(SING + COSG*TANA)
E1 = 0.
E2 = FC / 1.15
IF(X.GT.0.) E2 = FC * (1.-X) / 1.15
IF(X.GT.0.) RETURN

```

C

```

A3 = 1.15 - 1./ (COSG*TANA + SING)
ZSQ = COSG * COSG
U1 = SING
U2 = U1 + A3
F13 = .43478 * (SQRT(U2*U2+ZSQ)
& -SQRT(U1*U1+ZSQ) -SQRT((1.15-U2)**2 +ZSQ)
& + SQRT((1.15-U1)**2 + ZSQ))

```

C

```

U1 = U2
U2 = SING + 1.15
F12 = .43478 * (SQRT(U2*U2+ZSQ) - SQRT(U1*U1+ZSQ)
& -SQRT((1.15-U2)**2 +ZSQ) + SQRT((1.15-U1)**2 + ZSQ))
IF(A3.GT.0.001) F31 = F13 / A3
F21 = F12 * 1.15 / (1.15-A3)
E2 = FC / (1.15-A3)
RETURN
END

```

C

```

-----
C FUNCTION GIVES LOSSES DUE TO INCIDENT ANGLE ON GLAZED
C WINDOW. FORMULA IS FROM RIVERO, AS GIVEN BY BRYAN
C (JIES, JULY 1981, PP. 219-227)
C X,Y,Z - LOCATION OF PT ON WINDOW, RELATIVE TO TARGET PT
C D - DISTANCE FROM TARGET PT TO PT ON WINDOW

```

C

```

FUNCTION TLOSS(X,Y,Z,D)
TLOSS = 1.018 * (Y/D) * (1.+ ( (X*X+Z*Z)**1.5 ) / (D*D*D) )
RETURN
END

```

C

```

-----
C RETURN PROPORTION OF OUTSIDE SKY VISIBLE THRU BLINDS
C Y - DISTANCE FROM WINDOW TO TARGET PT
C Z1,Z2 - Z-SPAN OF WINDOW
C SING,COSG,TANG - SINE,COSINE,TANGENT OF BLINDS OPENING ANGLE

```

C

```

FUNCTION VISIBL(Y,Z1,Z2,SING,COSG,TANG)
X1 = -Y * ( (1. + 1.15 * SING) / (1.15 * COSG) )
X2 = Y * ( (1. - 1.15 * SING) / (1.15 * COSG) )
VISIBL = 0.
IF(Z1.GE.X2 .OR. Z2.LE.X1 .OR. Z2.LE.Z1) RETURN
X0 = -Y * TANG
X1 = AMAX1(Z1,X1)
X2 = AMIN1(Z2,X2)
X0 = AMAX1(X1,AMIN1(X0,X2))

```



```

      VISIBL = (X2 - X1 + 1.15*SING * (2.*X0 -X1 -X2)
& + (1.15*COSG/(2.*Y)) * (2.*X0*X0 -X1*X1 -X2*X2) )
& / (Z2-Z1)
      RETURN
      END

C
C COMMON FOR SIMPSON INTEGRAND, LABEL STORAGE
C
      COMMON /CSIMP/ FS(51,201)
      REAL RDESC(20,2,56)
      EQUIVALENCE (FS,RDESC)

C
C -----
C THIS PROGRAM COMPUTES TABLES OF MULTIPLIERS FOR EACH BLINDS
C ANGLE
C
C           SOLAR COMPONENT
C
C
C CU(I,J,K,L) - CU VALUE FOR PROFILE ANGLE I, REFLECTANCE J,
C              BLINDS ANGLE K, SIDE OF BLINDS L
C RHOB - BLINDS REFLECTANCE
C PROFA - PROFILE ANGLE
C BLINDA - BLINDS ANGLE
C FF - FORM FACTORS FOR EACH BLINDS ANGLE
C
      PROGRAM SUNMUL
      REAL CU(6,5,6,2),RHOB(5),PROFA(6),BLINDA(6),FF(6),L1,L2,L3
      CHARACTER NAME*16

C
      DATA RHOB/.1,.3,.5,.7,.9/, PROFA/0.,15.,30.,45.,60.,75./
& ,BLINDA/0.,15.,30.,45.,60.,75./
& ,FF/.4556,.4445,.4114,.3572,.2835,.1953/

C
C OUTER LOOP ON BLINDS ANGLES
C
      DO 100 K=1,6
      SING = SIN(BLINDA(K)/57.29578)
      COSG = COS(BLINDA(K)/57.29578)

C
C NEXT LOOP ON PROFILE ANGLES -- GET INITIAL ILLUM., FORM FACTORS
C
      DO 90 J=1,6
      TANA = TAN(PROFA(J)/57.29578)
      FCLOST = TLOSS(0.,1.,TANA,SQRT(1.+TANA*TANA))
      F12 = FF(K)
      CALL SOLFF(SING,COSG,TANA,E1,E2,F12,F13,F21,F31,1000.*FCLOST)

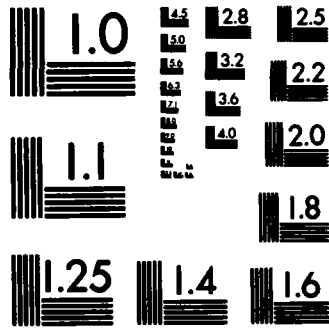
C
C SAVE WIDTH OF BRIGHT STRIP ON TOPSIDE (SURFACE 2)
C
      STRIP = 1.15

```

```

IF(J*K.NE.1) STRIP = 1. / (COSG*TANA + SING)
STRIP = AMAX1(0.,AMIN1(1.15,STRIP))
C
C LOOP ON REFLECTANCES, COMPUTE FINAL EXITANCES
C
DO 80 I=1,5
R = RHOB(I)
DENOM = 1. - R*R*(F13*F31 + F12*F21)
L1 = R * (E1 + R*F12*E2) / DENOM
L2 = R * (E2 + R*E1*F21 - R*R*E2*F13*F31) / DENOM
L3 = R*R * (E1*F31 + R*E2*F12*F31) / DENOM
CU(J,I,K,1) = L1
CU(J,I,K,2) = (STRIP*L2 + (1.15-STRIP)*L3) / 1.15
80 CONTINUE
90 CONTINUE
100 CONTINUE
C
C PRINT THE RESULTS
C
PRINT 1001
1001 FORMAT('/' -ENTER OUTPUT FILE NAME:')
ACCEPT 1002,NAME
1002 FORMAT(A)
OPEN(UNIT=2,FILE=NAME,STATUS='UNKNOWN')
C
DO 120 M=1,2
WRITE(2,1003)
1003 FORMAT('1'//29X,'SOLAR BLINDS MULTIPLIERS')
IF(M.EQ.1) WRITE(2,1004)
1004 FORMAT(/21X'-- UNDERSIDE, SURFACE HIDDEN FROM SUN --')
IF(M.EQ.2) WRITE(2,1005)
1005 FORMAT(/23X'-- TOPSIDE, SURFACE EXPOSED TO SUN --')
DO 110 K=1,5,2
WRITE(2,1006) NINT(BLINDA(K)),NINT(BLINDA(K+1))
& ,(NINT(PROFA(I)),(NINT(CU(I,J,K,M)),J=1,5)
& ,(NINT(CU(I,J,K+1,M)),J=1,5),I=1,6)
1006 FORMAT(///18X'BLINDS ANGLE = ',I3,' DEG '1'
& ,' BLINDS ANGLE = ',I3,' DEG'
& /8X'1-----1',26(' '),11',26(' '),1'
& /8X'1 SOLAR ',2('1 BLINDS REFLECTANCE 1')
& /8X'1PROFILE1',26X,11',26X,1'
& /8X'1 ANGLE ',2('1 10% 30% 50% 70% 90% 1')
& /8X'1-----1',26(' '),11',26(' '),1'
& / (8X,1',15,' 1',515.3,' 11',515.3,' 1') )
WRITE(2,1007)
1007 FORMAT(8X,1'-----1',26(' '),11',26(' '),1')
110 CONTINUE
120 CONTINUE
STOP
END

```

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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C-----
C THIS PROGRAM COMPUTES TABLES OF MULTIPLIERS FOR EACH BLINDS
C ANGLE
C
C          SKY COMPONENT  &  GROUND COMPONENT
C
C CU(I,J,L) - CU VALUE FOR BLINDS ANGLE I, REFLECTANCE J, BLINDS SIDE L
C RHOB - BLINDS REFLECTANCE
C BLINDA - BLINDS ANGLE
C FF - FORM FACTORS FOR EACH BLINDS ANGLE
C
C          PROGRAM SKYMUL
C          REAL CU(6,5,2), RHOB(5),BLINDA(6),FF(6),L1,L2
C          CHARACTER NAME*16
C
C          DATA RHOB/.1,.3,.5,.7,.9/
C          & ,BLINDA/0.,15.,30.,45.,60.,75./
C          & ,FF/.4556,.4445,.4114,.3572,.2835,.1953/
C
C OUTER LOOP ON BLINDS ANGLES
C
C          DO 100 K=1,6
C          SING = SIN(BLINDA(K)/57.29578)
C          COSG = COS(BLINDA(K)/57.29578)
C
C COMPUTE INITIAL ILLUMINANCES
C
C          Z2 = (1.-.575*SING) / (.575*COSG)
C          E1 = 0.
C          E2 = 1000.* SING * Z2 / SQRT(1.+Z2*Z2)
C          & + 1000. * COSG * (1. - 1./SQRT(1.+Z2*Z2))
C
C LOOP ON REFLECTANCES, COMPUTE FINAL EXITANCES
C
C          DO 80 I=1,5
C          CU(K,I,1) = RHOB(I) * (E1 + RHOB(I)*E2*FF(K))
C          & / (1. - RHOB(I)*RHOB(I)*FF(K)*FF(K))
C          CU(K,I,2) = RHOB(I) * (E2 + RHOB(I)*E1*FF(K))
C          & / (1. - RHOB(I)*RHOB(I)*FF(K)*FF(K))
C          80 CONTINUE
C          100 CONTINUE
C
C PRINT THE RESULTS
C
C          PRINT 1001
C          1001 FORMAT('/' -ENTER OUTPUT FILE NAME:')
C          ACCEPT 1002,NAME
C          1002 FORMAT(A)
C          OPEN(UNIT=2,FILE=NAME,STATUS='UNKNOWN')
C
C          WRITE(2,1003)

```

```

1003 FORMAT('1'/////30X,'SKY BLINDS MULTIPLIERS')
      DO 120 M=1,2
      IF(M.EQ.1) WRITE(2,1004)
1004 FORMAT(/////21X'-- UNDERSIDE, SURFACE HIDDEN FROM SUN --')
      IF(M.EQ.2) WRITE(2,1005)
1005 FORMAT(/////23X'-- TOPSIDE, SURFACE EXPOSED TO SUN --')
      WRITE(2,1006) (NINT(BLINDA(I)),(NINT(CU(I,J,M)),J=1,5),I=1,6)
1006 FORMAT(/18X'I-----I',26(' '),I'
      & /18X'I      I      BLINDS REFLECTANCE      I'
      & /18X'I BLINDS I',26X,I'
      & /18X'I ANGLE I 10% 30% 50% 70% 90% I'
      & /18X'I-----I',26(' '),I'
      & / (18X,I',I5,' I',5I5.3,' I') )
      WRITE(2,1007)
1007 FORMAT(18X,I'-----I',26(' '),I')
120 CONTINUE

C
C NOW DO GROUND MULTIPLIERS -- LOOP ON BLINDS ANGLES
C
      DO 200 K=1,6
      SING = SIN(BLINDA(K)/57.29578)
      COSG = COS(BLINDA(K)/57.29578)

C
C GET INITIAL ILLUMINANCES
C
      Y1 = .575 * COSG / (1. + .575 * SING)
      Y2 = 10.**6.
      IF(SING.GT.0.0001) Y2 = COSG / SING
      SY2 = SQRT(Y2*Y2+1.)
      SY1 = SQRT(Y1*Y1+1.)
      E1 = 500.* (COSG * (Y2/SY2 - Y1/SY1) - SING*(1./SY1 - 1./SY2))
      E2 = 500.* (SING/SY2 - COSG*(1.- Y2/SY2))

C
C LOOP ON REFLECTANCES
C
      DO 180 I=1,5
      CU(K,I,1) = RHOB(I) * (E1 + RHOB(I)*E2*FF(K))
      & / (1. - RHOB(I)*RHOB(I)*FF(K)*FF(K))
      CU(K,I,2) = RHOB(I) * (E2 + RHOB(I)*E1*FF(K))
      & / (1. - RHOB(I)*RHOB(I)*FF(K)*FF(K))
180 CONTINUE
200 CONTINUE

C
C PRINT THESE RESULTS
C
      WRITE(2,1008)
1008 FORMAT('1'/////28X'GROUND BLINDS MULTIPLIERS')
      DO 220 M=1,2
      IF(M.EQ.1) WRITE(2,1004)
      IF(M.EQ.2) WRITE(2,1005)

```

```

WRITE(2,1006) (NINT(BLINDA(I)),(NINT(CU(I,J,M)),J=1,5),I=1,6)
WRITE(2,1007)
220 CONTINUE
STOP
END
1 ILLUMINANCE FROM SKY -- V/H = 0.75
NO BLINDS
2 ILLUMINANCE FROM SKY -- V/H = 1.00 (UNIFORM SKY)
NO BLINDS
3 ILLUMINANCE FROM SKY -- V/H = 1.25
NO BLINDS
4 ILLUMINANCE FROM SKY -- V/H = 1.50
NO BLINDS
5 ILLUMINANCE FROM SKY -- V/H = 1.75
NO BLINDS
6 ILLUMINANCE FROM SKY --  $L = LZ * (1 + 2 \sin H) / 3$ 
NO BLINDS
7 ILLUMINANCE FROM SKY --  $L = 3LZ / (1 + 2 \sin H)$ 
NO BLINDS
8 ILLUMINANCE FROM GROUND
NO BLINDS
9 ILLUMINANCE FROM SKY -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 0
10 ILLUMINANCE FROM SKY -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 15
11 ILLUMINANCE FROM SKY -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 30
12 ILLUMINANCE FROM SKY -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 45
13 ILLUMINANCE FROM SKY -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 60
14 ILLUMINANCE FROM SKY -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 75
15 ILLUMINANCE FROM SKY -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 0
16 ILLUMINANCE FROM SKY -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 15
17 ILLUMINANCE FROM SKY -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 30
18 ILLUMINANCE FROM SKY -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 45
19 ILLUMINANCE FROM SKY -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 60
20 ILLUMINANCE FROM SKY -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 75
21 ILLUMINANCE FROM GROUND -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 0
22 ILLUMINANCE FROM GROUND -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 15
23 ILLUMINANCE FROM GROUND -- THRU COMPONENT

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- HORIZONTAL BLINDS, ANGLE = 30
24 ILLUMINANCE FROM GROUND -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 45
25 ILLUMINANCE FROM GROUND -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 60
26 ILLUMINANCE FROM GROUND -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 75
27 ILLUMINANCE FROM GROUND -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 0
28 ILLUMINANCE FROM GROUND -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 15
29 ILLUMINANCE FROM GROUND -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 30
30 ILLUMINANCE FROM GROUND -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 45
31 ILLUMINANCE FROM GROUND -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 60
32 ILLUMINANCE FROM GROUND -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 75
33 ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
HORIZONTAL BLINDS, ANGLE = 0
34 ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
HORIZONTAL BLINDS, ANGLE = 15
35 ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
HORIZONTAL BLINDS, ANGLE = 30
36 ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
HORIZONTAL BLINDS, ANGLE = 45
37 ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
HORIZONTAL BLINDS, ANGLE = 60
38 ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
HORIZONTAL BLINDS, ANGLE = 75
39 ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
VERTICAL BLINDS, ANGLE = 0
40 ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
VERTICAL BLINDS, ANGLE = 15
41 ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
VERTICAL BLINDS, ANGLE = 30
42 ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
VERTICAL BLINDS, ANGLE = 45
43 ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
VERTICAL BLINDS, ANGLE = 60
44 ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
VERTICAL BLINDS, ANGLE = 75
45 ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
HORIZONTAL BLINDS, ANGLE = 0
46 ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
HORIZONTAL BLINDS, ANGLE = 15
47 ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
HORIZONTAL BLINDS, ANGLE = 30
48 ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)

HORIZONTAL BLINDS, ANGLE = 45
 49 ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
 HORIZONTAL BLINDS, ANGLE = 60
 50 ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
 HORIZONTAL BLINDS, ANGLE = 75
 51 ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
 VERTICAL BLINDS, ANGLE = 0
 52 ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
 VERTICAL BLINDS, ANGLE = 15
 53 ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
 VERTICAL BLINDS, ANGLE = 30
 54 ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
 VERTICAL BLINDS, ANGLE = 45
 55 ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
 VERTICAL BLINDS, ANGLE = 60
 56 ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
 VERTICAL BLINDS, ANGLE = 75

C-----
 C USE 32-INTERVAL SIMPSON INTEGRATION TO DETERMINE VERTICAL
 C ILLUMINANCE FROM VARIOUS SKIES -- ASSUME UNIT ZENITH LUMINANCE
 C

PROGRAM EVERT
 REAL F(33)

DATA PI/3.1415927/

C
 OPEN(UNIT=1,FILE='SYS\$INPUT',STATUS='OLD')
 10 WRITE(1,1001)
 1001 FORMAT('/' -WHICH SKY (1-7) ?')
 READ(1,*) ISKY
 IF(ISKY.LE.0) STOP

C
 C COMPUTE SIMPSON INTEGRAND
 C

DO 20 I=1,32
 THETA = (I-1)*0.5* PI / 32.
 Z = TAN(THETA)
 F(I) = COS(THETA)**2. * SKYRR(ISKY,0.,1.,Z
 & ,SQRT(1.+Z*Z))
 20 CONTINUE
 F(33) = 0.
 WRITE(1,1002) (2./PI) * SIMPSN(.5*PI,32,F)
 1002 FORMAT(F10.6,' = VERTICAL ILLUMINANCE')
 GOTO 10
 END

C-----
 C SIMPSON INTEGRATION OVER N INTERVALS SPANNING 'X'
 C

FUNCTION SIMPSN(X,N,F)
 REAL F(33)

C

```
SIMPSN = F(1) + F(N+1)
DO 20 I=2,N,2
20 SIMPSN = SIMPSN + 4.* F(I)
DO 25 I=3,N-1,2
25 SIMPSN = SIMPSN + 2.* F(I)
SIMPSN = SIMPSN * X / (3.*N)
RETURN
END
```

ILLUMINANCE FROM SKY -- V/H = 0.75
NO BLINDS

ROOM DEPTH /		WINDOW WIDTH / WINDOW HEIGHT								W / H
WINDOW HEIGHT		.5	1	2	3	4	6	8	INF	
D / H	% D									
1	10	824	864	870	873	875	879	880	883	
	30	547	711	777	789	793	798	799	801	
	50	355	526	635	659	666	669	670	672	
	70	243	386	505	538	548	544	545	547	
	90	185	304	418	451	464	444	446	447	
2	10	667	781	809	812	813	815	816	824	
	30	269	416	519	544	551	556	557	563	
	50	122	204	287	319	331	339	341	345	
	70	068	116	173	201	214	223	226	229	
	90	050	084	127	151	164	167	171	172	
3	10	522	681	739	746	747	749	747	766	
	30	139	232	320	350	360	366	364	373	
	50	053	092	139	163	174	183	182	187	
	70	031	053	081	097	106	116	116	119	
	90	025	041	061	074	082	089	090	092	
4	10	405	576	658	670	673	675	674	707	
	30	075	134	197	224	235	243	243	255	
	50	028	050	078	094	104	112	114	119	
	70	018	031	048	059	065	073	074	078	
	90	016	026	040	048	053	059	061	064	
6	10	242	392	494	516	521	524	523	588	
	30	027	054	086	102	111	119	120	135	
	50	011	023	036	044	049	055	056	063	
	70	009	018	027	032	035	040	041	046	
	90	008	016	023	028	031	034	035	040	
8	10	147	257	352	380	387	391	392	482	
	30	012	026	043	054	060	067	070	086	
	50	006	013	021	026	029	033	035	043	
	70	005	011	017	021	023	026	027	034	
	90	004	010	015	019	021	023	025	030	
10	10	092	168	248	275	284	290	291	395	
	30	006	014	026	032	036	041	044	059	
	50	003	008	014	017	019	022	024	032	
	70	003	007	012	014	016	018	019	026	
	90	003	006	011	013	015	016	017	024	

ILLUMINANCE FROM SKY -- V/H = 1.00 (UNIFORM SKY)
NO BLINDS

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT								W / H
D / H	Z D	.5	1	2	3	4	6	8	INF	
1	10	671	704	711	715	717	726	726	728	
	30	458	595	654	668	672	682	683	685	
	50	313	462	563	589	598	607	608	610	
	70	227	362	478	515	527	530	532	534	
	90	186	306	424	465	481	468	471	472	
2	10	545	636	658	660	661	665	666	672	
	30	239	367	459	484	491	499	501	506	
	50	121	203	286	320	335	348	351	355	
	70	074	128	192	226	243	259	264	267	
	90	058	101	156	188	207	215	221	223	
3	10	431	561	607	613	614	616	615	631	
	30	133	223	306	337	348	357	357	366	
	50	058	103	155	183	197	211	213	218	
	70	037	063	098	119	132	147	150	154	
	90	030	051	079	098	110	122	126	129	
4	10	339	482	549	560	563	566	565	593	
	30	078	139	204	234	247	258	260	272	
	50	033	060	094	114	126	139	143	150	
	70	022	039	061	074	083	095	099	104	
	90	019	032	050	061	070	080	084	089	
6	10	211	343	433	453	458	461	461	518	
	30	033	065	103	123	135	145	148	167	
	50	015	029	047	057	064	073	077	086	
	70	011	021	033	040	045	051	054	060	
	90	010	019	028	034	038	044	046	052	
8	10	135	238	326	353	362	366	367	452	
	30	016	034	058	072	080	090	094	116	
	50	008	017	027	034	039	045	048	059	
	70	006	013	021	026	028	032	035	043	
	90	005	012	019	023	025	029	031	038	
10	10	090	165	244	272	283	290	291	395	
	30	009	020	036	045	052	060	064	087	
	50	005	010	019	023	026	030	033	044	
	70	004	009	015	018	020	023	025	033	
	90	003	008	014	016	018	020	022	030	

ILLUMINANCE FROM SKY -- V/H = 1.25
NO BLINDS

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT						W / H	
D / H	Z D	.5	1	2	3	4	6	8	INF
1	10	578	607	614	619	621	633	634	635
	30	405	525	580	594	599	612	614	615
	50	287	423	519	547	556	569	571	573
	70	218	347	461	501	515	522	525	526
	90	186	307	428	473	491	483	486	487
2	10	472	549	566	569	570	574	575	581
	30	221	337	422	447	456	465	467	472
	50	120	202	285	321	337	353	357	361
	70	078	136	204	242	261	281	287	290
	90	064	112	174	211	233	244	251	253
3	10	377	488	527	533	534	536	536	549
	30	130	217	298	329	341	352	353	362
	50	062	110	165	195	211	228	231	237
	70	040	070	109	132	147	166	171	175
	90	033	057	090	112	127	142	148	152
4	10	300	424	484	494	497	499	499	524
	30	080	143	209	240	255	267	269	283
	50	036	066	104	126	140	156	160	168
	70	024	043	068	083	094	109	115	120
	90	021	036	056	070	080	092	099	103
6	10	193	314	395	415	420	423	423	476
	30	036	071	113	136	149	161	165	186
	50	017	033	053	065	074	084	089	100
	70	012	024	037	045	050	058	061	069
	90	011	021	031	038	043	049	053	060
8	10	128	226	310	337	346	351	352	433
	30	019	039	066	082	092	104	109	134
	50	009	019	031	040	045	052	056	069
	70	007	015	023	029	032	037	040	049
	90	006	013	021	025	028	032	035	043
10	10	088	164	241	270	282	290	291	396
	30	011	024	043	054	062	071	076	103
	50	005	012	022	026	030	035	038	052
	70	004	010	017	020	023	026	028	038
	90	004	009	016	018	020	023	025	034

ILLUMINANCE FROM SKY -- V/H = 1.50
NO BLINDS

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT								W / H
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	503	528	536	541	544	557	558	559	
	30	359	464	514	528	534	549	550	552	
	50	261	384	471	499	508	524	526	527	
	70	204	325	432	470	485	497	499	500	
	90	179	295	412	456	475	474	477	478	
2	10	412	477	490	492	493	498	499	505	
	30	201	304	379	402	410	422	424	429	
	50	115	192	269	304	320	339	343	347	
	70	078	136	204	241	261	286	292	295	
	90	066	117	183	221	246	262	271	273	
3	10	331	426	458	461	462	465	465	477	
	30	121	202	275	304	316	327	329	337	
	50	062	109	164	193	209	228	232	238	
	70	041	073	114	138	154	176	183	188	
	90	035	062	099	123	141	159	169	173	
4	10	265	372	422	430	433	435	435	456	
	30	077	137	199	229	243	256	259	272	
	50	037	069	107	130	144	161	167	175	
	70	026	046	073	089	101	119	126	132	
	90	022	039	063	078	090	106	114	120	
6	10	173	281	351	368	373	375	375	422	
	30	037	073	115	137	151	164	168	189	
	50	018	036	058	071	080	092	098	110	
	70	013	026	040	049	056	064	069	078	
	90	012	023	035	043	048	057	062	070	
8	10	117	207	282	305	314	319	320	393	
	30	020	042	071	087	098	111	116	143	
	50	010	021	035	044	050	058	063	078	
	70	007	016	026	032	036	041	045	055	
	90	007	014	023	028	031	036	040	049	
10	10	082	153	224	250	262	269	271	368	
	30	012	026	047	059	068	078	084	114	
	50	006	014	024	030	034	040	044	060	
	70	005	011	019	022	025	029	032	043	
	90	004	010	017	020	023	026	028	038	

ILLUMINANCE FROM SKY -- V/H = 1.75
NO BLINDS

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	435	457	465	471	474	486	488	489	
	30	317	407	452	466	471	486	488	489	
	50	234	343	422	447	456	472	475	476	
	70	187	297	395	430	445	458	461	462	
	90	168	276	384	426	444	447	450	451	
2	10	357	412	422	424	424	430	431	436	
	30	180	271	335	356	363	375	378	381	
	50	106	177	246	278	293	313	318	321	
	70	074	130	194	229	249	274	282	284	
	90	065	116	181	219	244	264	273	276	
3	10	288	369	394	397	397	400	401	411	
	30	110	183	247	272	282	294	296	304	
	50	058	104	154	181	196	215	221	226	
	70	040	072	112	136	152	176	184	188	
	90	035	063	101	126	144	166	177	182	
4	10	232	324	365	371	373	375	375	394	
	30	071	127	183	209	222	235	238	250	
	50	036	067	104	125	139	157	163	171	
	70	025	046	072	089	101	119	127	134	
	90	022	041	065	082	095	114	124	130	
6	10	153	247	307	320	324	326	327	367	
	30	035	070	109	130	143	155	160	180	
	50	018	036	058	071	080	091	098	110	
	70	013	026	041	051	058	067	073	082	
	90	012	023	037	046	052	062	069	078	
8	10	104	184	249	269	276	281	282	346	
	30	020	042	070	086	096	109	115	141	
	50	010	022	036	046	052	060	066	081	
	70	008	017	027	033	038	044	048	059	
	90	007	015	024	030	034	040	044	054	
10	10	074	138	201	223	233	240	242	328	
	30	012	027	048	059	067	078	084	114	
	50	006	014	026	032	036	043	047	064	
	70	005	011	020	024	027	031	034	046	
	90	004	010	018	022	024	028	031	042	

ILLUMINANCE FROM GROUND
NO BLINDS

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT						W / H	
D / H	% D	.5	1	2	3	4	6	8	INF
1	10	105	137	177	197	207	208	210	211
	30	116	157	203	225	235	241	243	244
	50	110	165	217	241	252	267	269	270
	70	101	162	217	243	253	283	285	286
	90	091	146	199	230	239	290	292	293
2	10	095	124	160	178	186	186	189	191
	30	082	132	179	201	212	219	222	225
	50	062	113	165	189	202	214	218	220
	70	051	093	141	165	179	194	198	200
	90	045	079	118	140	153	179	183	185
3	10	088	120	157	175	183	185	163	167
	30	059	107	154	176	187	198	193	198
	50	039	074	114	134	146	157	166	170
	70	031	055	085	101	111	122	127	130
	90	028	047	070	083	092	107	113	115
4	10	073	113	154	174	183	187	176	184
	30	040	082	127	148	159	170	177	185
	50	025	049	078	094	103	113	117	123
	70	020	036	054	065	071	079	083	087
	90	019	032	046	054	060	069	073	076
6	10	056	106	143	164	175	184	173	194
	30	021	050	081	098	107	117	123	138
	50	013	027	041	049	054	060	064	072
	70	011	021	029	033	035	039	041	046
	90	011	020	026	030	032	035	037	042
8	10	036	082	122	143	156	166	170	208
	30	011	029	050	062	070	078	082	101
	50	007	016	024	028	031	035	038	046
	70	006	013	018	020	021	023	025	030
	90	006	013	017	019	020	022	023	028
10	10	024	061	109	120	131	144	147	200
	30	006	017	034	040	046	053	056	076
	50	004	010	016	018	020	023	024	033
	70	004	009	013	014	015	016	016	022
	90	004	009	013	013	014	015	016	021

ILLUMINANCE FROM SKY -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 0

ROOM DEPTH /		WINDOW WIDTH / WINDOW HEIGHT								W / H
WINDOW HEIGHT		.5	1	2	3	4	6	8	INF	
D / H	Z U									
1	10	036	041	046	048	050	054	055	055	
	30	061	084	097	101	103	108	108	108	
	50	065	102	129	137	140	144	144	145	
	70	062	106	146	159	164	163	164	165	
	90	061	109	158	175	182	172	173	174	
2	10	051	061	066	067	069	070	071	072	
	30	058	093	121	129	132	136	136	138	
	50	044	077	115	131	139	145	147	148	
	70	031	059	095	114	125	133	136	137	
	90	025	048	082	102	115	115	119	120	
3	10	058	077	085	087	088	089	090	092	
	30	046	080	115	128	134	138	140	144	
	50	026	050	080	098	108	116	120	123	
	70	016	030	052	066	075	085	090	092	
	90	011	023	041	053	062	068	073	075	
4	10	060	086	099	102	103	104	105	110	
	30	035	063	097	114	122	128	130	137	
	50	016	031	052	066	075	084	088	092	
	70	009	018	031	041	047	056	061	063	
	90	007	013	024	032	038	043	048	050	
6	10	055	090	115	120	122	123	124	140	
	30	018	035	059	073	082	090	093	105	
	50	007	014	025	033	039	046	050	056	
	70	004	009	016	020	024	029	032	036	
	90	003	007	012	016	018	022	026	029	
8	10	047	082	114	124	127	129	130	159	
	30	010	020	036	046	053	061	064	079	
	50	004	008	015	020	023	028	031	039	
	70	003	006	010	013	015	018	020	025	
	90	002	005	008	011	012	015	016	020	
10	10	038	070	105	118	123	127	127	173	
	30	006	012	023	030	036	042	046	062	
	50	002	005	010	013	016	019	022	030	
	70	002	004	008	009	011	013	015	020	
	90	001	004	007	008	009	011	012	017	

ILLUMINANCE FROM SKY -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 15

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT						W / H	
D / H	% D	.5	1	2	3	4	6	8	INF
1	10	019	023	027	030	031	037	040	040
	30	032	044	052	054	056	061	061	062
	50	034	053	068	073	074	078	079	079
	70	032	055	076	084	086	089	089	089
	90	032	057	082	091	095	093	094	094
2	10	026	032	035	037	038	040	041	041
	30	030	048	063	068	070	072	073	074
	50	023	041	060	069	073	077	078	079
	70	017	032	052	063	068	073	075	075
	90	014	028	049	060	068	068	071	071
3	10	030	040	045	046	047	048	049	050
	30	024	041	060	067	070	072	074	075
	50	014	027	044	054	059	064	066	068
	70	009	018	031	040	045	051	054	056
	90	007	014	025	033	039	043	046	047
4	10	031	044	052	053	054	055	056	059
	30	018	033	051	059	064	067	068	071
	50	009	018	031	039	045	050	052	055
	70	005	011	019	025	029	035	038	040
	90	004	008	015	020	024	028	031	032
6	10	028	046	059	062	063	064	065	073
	30	010	020	034	043	048	052	054	061
	50	004	009	016	021	024	029	031	035
	70	003	005	010	013	015	018	020	023
	90	002	004	007	010	012	014	016	018
8	10	024	043	059	064	066	067	067	083
	30	006	012	022	028	032	037	039	048
	50	002	005	009	012	015	018	020	024
	70	002	003	006	008	009	011	013	016
	90	001	003	005	006	007	009	010	013
10	10	020	037	054	061	064	065	066	089
	30	004	008	014	019	022	026	029	039
	50	001	003	006	008	010	012	014	019
	70	001	002	004	006	007	008	009	012
	90	001	002	004	005	006	007	007	010

ILLUMINANCE FROM SKY -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 30

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT						W / H	
D / H	% D	.5	1	2	3	4	6	8	INF
1	10	008	010	013	014	015	019	021	021
	30	013	019	022	023	024	026	027	027
	50	014	022	029	031	031	033	034	034
	70	013	023	032	035	036	037	038	038
	90	013	023	034	038	040	039	040	040
2	10	011	014	015	016	017	018	019	019
	30	012	020	026	029	029	031	031	032
	50	009	017	025	029	031	033	033	034
	70	007	013	022	027	029	032	032	033
	90	006	012	021	027	030	031	032	032
3	10	012	017	019	019	020	021	021	022
	30	010	017	025	028	029	030	031	032
	50	006	011	019	023	025	027	028	029
	70	004	008	014	018	020	023	025	025
	90	003	007	012	016	019	021	023	023
4	10	013	018	022	022	023	023	024	025
	30	007	014	021	025	026	028	028	030
	50	004	008	014	017	019	022	023	024
	70	003	005	009	012	014	017	018	019
	90	002	004	008	010	012	014	016	017
6	10	012	019	024	026	026	027	027	030
	30	004	009	014	018	020	022	023	026
	50	002	004	008	010	012	014	015	017
	70	001	003	005	006	008	009	010	012
	90	001	002	004	005	006	007	008	009
8	10	010	017	024	026	027	028	028	034
	30	003	006	010	013	015	017	018	022
	50	001	003	005	006	007	009	010	013
	70	001	002	003	004	005	006	007	008
	90	001	001	002	003	004	005	005	006
10	10	008	015	022	025	026	027	027	037
	30	002	004	007	009	011	013	014	019
	50	001	002	003	004	005	006	007	010
	70	000	001	002	003	003	004	005	006
	90	000	001	002	002	003	003	004	005

ILLUMINANCE FROM SKY -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 45

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT					W / H			
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	002	003	003	004	004	005	006	006	
	30	003	005	005	006	006	007	007	007	
	50	003	005	007	007	008	008	008	008	
	70	003	005	008	008	009	009	009	009	
	90	003	006	008	009	010	009	010	010	
2	10	003	003	004	004	004	005	005	005	
	30	003	005	006	007	007	008	008	008	
	50	002	004	006	007	007	008	008	008	
	70	002	003	005	006	007	008	008	008	
	90	001	003	005	006	007	008	008	008	
3	10	003	004	005	005	005	005	005	006	
	30	002	004	006	007	007	007	008	008	
	50	001	003	005	005	006	007	007	007	
	70	001	002	003	004	005	006	006	006	
	90	001	002	003	004	005	006	006	006	
4	10	003	004	005	005	006	006	006	006	
	30	002	003	005	006	006	007	007	007	
	50	001	002	003	004	005	005	006	006	
	70	001	001	002	003	004	004	005	005	
	90	001	001	002	003	003	004	005	005	
6	10	003	005	006	006	006	006	007	007	
	30	001	002	004	004	005	005	006	006	
	50	001	001	002	003	003	004	004	004	
	70	000	001	001	002	002	003	003	003	
	90	000	001	001	002	002	002	003	003	
8	10	002	004	006	006	007	007	007	008	
	30	001	001	002	003	004	004	004	005	
	50	000	001	001	002	002	003	003	004	
	70	000	000	001	001	001	002	002	003	
	90	000	000	001	001	001	001	002	002	
10	10	002	004	005	006	006	006	007	009	
	30	000	001	002	002	003	003	004	005	
	50	000	000	001	001	002	002	002	003	
	70	000	000	001	001	001	001	001	002	
	90	000	000	001	001	001	001	001	002	

ILLUMINANCE FROM SKY -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 0

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT						W / H	
D / H	% D	.5	1	2	3	4	6	8	INF
1	10	109	065	038	028	022	015	012	012
	30	199	145	088	062	048	032	024	024
	50	171	174	118	085	065	044	033	033
	70	130	172	132	098	076	049	037	037
	90	109	162	143	106	083	051	039	039
2	10	169	107	060	043	033	023	018	018
	30	142	164	113	083	065	045	034	034
	50	073	110	107	084	068	048	036	037
	70	041	069	086	075	063	045	035	035
	90	029	052	074	072	062	042	033	033
3	10	196	138	080	056	043	030	023	023
	30	086	123	108	083	066	046	035	036
	50	035	058	074	066	055	041	032	033
	70	019	032	046	049	044	034	028	028
	90	013	023	035	040	041	031	025	026
4	10	188	155	094	066	051	035	027	028
	30	052	082	092	074	060	043	033	035
	50	019	033	047	049	043	033	027	028
	70	010	018	027	031	031	026	022	023
	90	008	013	020	024	026	023	020	021
6	10	145	164	110	079	061	041	031	035
	30	024	041	055	054	046	034	027	030
	50	009	016	023	026	026	023	019	021
	70	006	010	013	015	016	016	014	016
	90	005	008	010	011	012	013	012	014
8	10	101	139	109	081	063	043	033	040
	30	012	022	033	036	034	027	022	026
	50	005	009	013	015	016	016	014	017
	70	003	006	008	009	010	010	010	012
	90	003	005	007	007	008	008	008	010
10	10	071	107	101	077	061	042	032	044
	30	007	014	021	024	025	021	017	024
	50	003	006	009	010	011	011	010	014
	70	002	004	006	007	007	007	007	009
	90	002	004	005	005	006	006	006	007

ILLUMINANCE FROM SKY -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 15

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	114	069	043	032	026	019	015	015	
	30	192	150	092	066	051	035	026	027	
	50	155	177	122	089	069	046	035	035	
	70	113	161	137	102	079	052	039	039	
	90	092	148	148	110	087	054	041	041	
2	10	174	111	063	045	036	025	020	020	
	30	126	158	117	086	067	047	036	036	
	50	060	100	109	087	070	050	038	038	
	70	033	060	081	077	065	047	036	036	
	90	023	045	068	070	064	043	034	034	
3	10	190	142	083	058	045	031	024	025	
	30	072	113	112	086	068	048	037	038	
	50	028	050	069	067	057	042	033	034	
	70	015	027	042	046	044	036	029	029	
	90	011	019	032	037	039	032	026	027	
4	10	173	160	098	069	053	037	028	030	
	30	042	073	089	076	062	045	034	036	
	50	015	028	043	046	044	034	027	029	
	70	008	015	024	028	029	027	022	023	
	90	006	011	018	022	024	022	020	021	
6	10	129	159	114	081	063	043	033	037	
	30	019	035	051	052	047	035	028	031	
	50	007	013	020	024	025	023	019	022	
	70	005	009	012	014	015	015	014	016	
	90	004	007	009	010	011	012	012	013	
8	10	087	128	113	084	065	045	034	042	
	30	009	019	029	033	033	028	022	027	
	50	004	008	011	014	015	015	014	017	
	70	003	006	007	009	009	010	009	011	
	90	002	005	006	007	007	007	007	009	
10	10	058	097	103	080	063	044	033	045	
	30	005	011	019	022	023	022	018	025	
	50	002	005	008	009	010	011	010	014	
	70	002	004	006	006	006	007	007	009	
	90	002	003	005	005	005	005	005	007	

ILLUMINANCE FROM SKY -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 30

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	Z D	.5	1	2	3	4	6	8	INF	
1	10	125	076	050	039	032	024	020	020	
	30	166	164	102	074	058	040	031	031	
	50	104	166	135	099	077	052	040	040	
	70	072	130	148	114	089	058	044	044	
	90	057	106	146	123	097	061	046	046	
2	10	183	122	070	051	040	029	023	023	
	30	081	137	129	095	075	052	040	041	
	50	038	068	102	096	078	055	043	043	
	70	021	039	066	075	071	052	040	041	
	90	015	029	050	061	064	048	038	038	
3	10	165	158	092	065	050	036	028	029	
	30	045	080	111	095	076	053	041	042	
	50	018	033	055	063	061	047	037	038	
	70	010	018	030	038	041	039	032	032	
	90	007	013	022	028	033	032	029	030	
4	10	131	168	108	076	059	041	032	033	
	30	026	048	077	080	069	049	038	040	
	50	010	018	030	039	042	038	030	032	
	70	006	010	017	021	025	026	024	026	
	90	004	008	013	016	018	020	020	021	
6	10	083	139	126	090	070	048	037	041	
	30	012	023	037	046	047	039	031	035	
	50	005	010	014	018	020	022	021	023	
	70	003	007	009	010	011	013	014	015	
	90	003	006	007	008	009	010	010	012	
8	10	054	097	118	093	072	050	038	047	
	30	006	012	020	026	029	029	024	030	
	50	002	006	008	010	011	013	013	017	
	70	002	004	006	007	007	008	008	010	
	90	002	004	005	006	006	006	006	008	
10	10	036	066	097	088	070	049	037	050	
	30	003	007	013	016	019	021	019	026	
	50	001	003	006	007	008	009	009	012	
	70	001	003	005	005	005	005	005	007	
	90	001	002	004	004	004	004	004	006	

ILLUMINANCE FROM SKY -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 45

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	150	088	058	048	041	033	027	027	
	30	106	176	121	089	071	050	039	039	
	50	054	122	157	119	094	065	049	050	
	70	035	077	142	135	109	072	055	055	
	90	027	058	118	133	118	074	057	057	
2	10	162	147	083	060	049	036	029	029	
	30	040	088	140	114	090	064	049	050	
	50	018	037	076	096	091	067	052	052	
	70	010	020	041	060	068	062	049	049	
	90	008	015	029	042	053	053	046	046	
3	10	107	172	110	077	060	043	034	035	
	30	022	044	090	102	091	064	050	051	
	50	009	017	033	048	057	055	044	045	
	70	005	010	018	024	031	038	037	037	
	90	004	008	013	017	022	027	029	030	
4	10	072	149	131	092	071	050	038	040	
	30	012	025	051	071	074	059	046	048	
	50	005	010	018	025	032	038	036	037	
	70	003	006	010	014	016	022	024	025	
	90	002	005	008	010	012	015	017	018	
6	10	041	090	137	109	084	058	044	050	
	30	006	012	022	031	039	042	037	041	
	50	002	006	009	011	013	017	020	022	
	70	002	004	006	007	008	009	011	012	
	90	002	004	005	006	006	007	008	009	
8	10	025	054	105	108	088	060	046	056	
	30	003	006	012	016	020	026	027	033	
	50	001	003	006	007	008	009	011	013	
	70	001	003	004	005	005	006	006	008	
	90	001	002	004	004	004	005	005	006	
10	10	016	034	072	089	083	059	045	061	
	30	001	004	007	010	012	016	018	025	
	50	001	002	004	005	005	006	007	009	
	70	001	002	004	004	004	004	004	006	
	90	000	001	003	003	004	004	003	005	

ILLUMINANCE FROM SKY -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 60

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT					W / H			
D / H	Z D	.5	1	2	3	4	6	8	INF	
1	10	176	117	072	061	055	047	040	041	
	30	048	128	161	119	096	070	055	055	
	50	020	059	142	153	127	090	070	070	
	70	011	034	089	132	137	101	077	078	
	90	008	024	063	100	123	104	080	080	
2	10	090	173	113	080	064	049	040	040	
	30	014	041	103	133	122	087	068	068	
	50	005	015	039	064	084	088	071	072	
	70	003	008	020	033	045	062	063	063	
	90	003	006	014	022	030	041	049	049	
3	10	049	127	152	106	082	059	047	048	
	30	006	019	047	076	094	088	068	070	
	50	002	007	016	026	035	052	054	056	
	70	002	005	009	014	018	026	033	034	
	90	001	004	007	010	013	017	021	022	
4	10	029	083	155	127	098	068	053	055	
	30	003	010	025	041	056	070	063	066	
	50	001	004	009	014	018	027	037	036	
	70	001	003	006	008	010	014	017	018	
	90	001	003	005	006	008	010	012	012	
6	10	013	042	102	129	117	080	061	069	
	30	001	004	011	016	022	032	039	044	
	50	001	002	005	007	008	011	013	015	
	70	001	002	005	005	006	007	008	009	
	90	000	002	004	005	005	005	006	006	
8	10	006	022	059	093	104	084	064	079	
	30	000	002	006	009	011	016	021	025	
	50	000	001	003	005	005	006	007	009	
	70	000	001	003	004	004	005	005	006	
	90	000	001	003	004	004	004	004	005	
10	10	003	012	035	059	077	079	063	085	
	30	000	001	003	005	007	009	012	016	
	50	000	001	002	003	004	004	005	006	
	70	000	001	002	003	003	003	003	005	
	90	000	001	002	003	003	003	003	004	

ILLUMINANCE FROM SKY -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 75

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT					W / H			
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	082	175	118	090	078	073	068	068	
	30	009	041	119	169	161	121	099	099	
	50	002	014	053	094	133	151	126	126	
	70	002	007	029	055	079	122	130	130	
	90	002	004	019	037	054	083	107	107	
2	10	023	081	170	145	113	083	067	068	
	30	001	009	035	064	093	129	121	122	
	50	001	003	011	023	035	058	078	079	
	70	001	003	006	012	018	030	040	040	
	90	001	002	005	008	012	019	025	026	
3	10	008	041	115	161	151	106	083	085	
	30	000	003	014	027	041	068	089	092	
	50	000	002	006	009	014	023	032	033	
	70	000	002	004	006	008	013	017	018	
	90	000	001	004	005	007	009	012	012	
4	10	003	022	073	124	149	126	097	102	
	30	000	001	007	014	021	036	050	052	
	50	000	001	004	006	008	012	017	017	
	70	000	001	003	005	006	008	010	010	
	90	000	001	003	004	005	006	008	008	
6	10	000	007	033	061	089	123	114	128	
	30	000	001	003	006	009	013	019	021	
	50	000	000	002	004	005	006	007	008	
	70	000	000	002	004	004	005	006	006	
	90	000	000	002	003	004	004	005	005	
8	10	000	002	016	032	049	082	098	121	
	30	000	000	001	003	004	007	009	011	
	50	000	000	001	002	003	004	005	006	
	70	000	000	001	002	003	004	004	005	
	90	000	000	001	002	003	004	004	005	
10	10	000	001	007	018	028	050	070	095	
	30	000	000	001	001	002	004	006	008	
	50	000	000	000	001	002	003	003	005	
	70	000	000	000	001	002	003	003	004	
	90	000	000	000	001	002	003	003	004	

ILLUMINANCE FROM GROUND -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 0

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT						W / H	
D / H	Z D	.5	1	2	3	4	6	8	INF
1	10	013	023	036	043	046	053	054	054
	30	017	029	043	051	054	062	063	063
	50	018	033	049	056	060	070	070	071
	70	018	034	050	058	061	076	076	077
	90	016	030	044	053	056	080	081	081
2	10	013	022	034	041	045	051	052	052
	30	015	029	045	054	059	063	065	066
	50	014	030	050	060	066	070	072	073
	70	012	028	049	060	067	072	074	075
	90	010	024	042	052	058	071	073	074
3	10	014	023	035	041	045	050	057	058
	30	013	027	044	053	059	063	070	072
	50	010	023	042	052	059	063	067	068
	70	008	019	035	045	051	056	059	060
	90	007	015	028	036	042	050	055	056
4	10	014	024	037	043	047	052	057	059
	30	010	024	042	052	057	061	065	068
	50	007	017	033	042	047	053	055	058
	70	006	013	024	031	036	040	044	046
	90	005	011	019	025	028	033	037	039
6	10	015	029	041	048	053	056	061	068
	30	007	018	032	041	047	052	055	061
	50	004	010	019	024	028	033	036	041
	70	004	008	012	015	018	021	024	027
	90	003	007	010	013	015	017	020	022
8	10	012	028	043	052	057	062	063	077
	30	005	012	023	030	035	041	043	053
	50	003	007	012	015	018	021	023	028
	70	002	005	008	010	011	013	014	018
	90	002	005	007	009	009	011	012	015
10	10	010	025	047	052	058	064	066	089
	30	003	008	018	022	026	031	033	045
	50	002	005	008	010	012	014	016	021
	70	002	004	006	007	008	009	010	013
	90	002	004	006	006	007	008	009	012

ILLUMINANCE FROM GROUND -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 15

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	022	040	063	076	084	100	106	107	
	30	025	045	068	080	086	099	101	102	
	50	027	050	075	086	092	106	107	108	
	70	026	050	075	087	092	111	113	113	
	90	023	044	066	078	083	115	116	116	
2	10	020	035	053	064	072	081	085	086	
	30	021	043	067	079	087	093	095	096	
	50	019	043	072	086	095	098	100	101	
	70	017	039	068	083	092	096	099	100	
	90	014	032	056	069	077	091	094	095	
3	10	022	035	053	062	069	078	091	093	
	30	018	039	064	077	084	090	104	107	
	50	014	032	057	071	080	085	093	096	
	70	011	025	045	057	065	071	076	078	
	90	009	020	035	044	051	059	066	068	
4	10	020	036	055	065	070	078	087	092	
	30	014	034	059	072	079	085	092	097	
	50	010	023	043	054	061	068	072	075	
	70	008	016	029	038	043	049	053	056	
	90	007	013	023	029	033	038	042	045	
6	10	022	044	062	072	078	084	092	104	
	30	010	024	043	055	062	069	074	083	
	50	006	013	023	029	034	040	044	050	
	70	005	010	015	018	021	024	027	031	
	90	005	009	013	015	017	019	022	024	
8	10	017	041	065	078	086	093	095	117	
	30	006	016	030	039	045	052	055	068	
	50	004	008	014	018	020	024	026	032	
	70	003	007	010	012	013	015	016	020	
	90	003	006	009	010	011	012	013	016	
10	10	013	036	069	078	086	096	098	134	
	30	004	010	022	028	032	038	041	056	
	50	002	006	010	012	014	016	017	024	
	70	002	005	008	008	009	010	011	015	
	90	002	005	007	008	008	009	010	013	

ILLUMINANCE FROM GROUND -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 30

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	Z D	.5	1	2	3	4	6	8	INF	
1	10	030	053	084	104	116	140	152	152	
	30	031	056	084	100	108	124	128	129	
	50	032	060	090	106	113	127	130	130	
	70	031	059	089	105	111	129	131	132	
	90	027	052	078	093	099	128	130	131	
2	10	025	043	066	080	089	105	111	112	
	30	025	050	078	092	099	112	114	116	
	50	022	048	079	095	103	110	112	114	
	70	018	041	070	086	095	100	103	104	
	90	015	033	056	069	077	089	092	093	
3	10	026	043	064	076	084	098	117	121	
	30	021	044	072	087	094	103	127	131	
	50	015	034	059	073	081	087	106	109	
	70	012	024	043	054	061	067	077	079	
	90	010	019	032	040	046	053	062	063	
4	10	024	044	066	078	084	096	113	119	
	30	016	037	063	077	085	092	108	114	
	50	010	023	041	052	058	065	072	075	
	70	008	016	027	033	038	043	048	051	
	90	007	013	021	025	029	033	037	039	
6	10	025	053	077	091	098	105	116	131	
	30	010	026	044	056	063	070	079	089	
	50	006	013	021	026	030	035	039	044	
	70	005	010	014	017	018	021	024	027	
	90	005	009	013	014	015	017	019	022	
8	10	019	047	078	095	105	114	116	144	
	30	006	016	029	038	044	050	053	065	
	50	004	008	013	016	018	021	022	028	
	70	003	007	010	011	012	013	014	017	
	90	003	007	009	010	011	012	012	015	
10	10	013	037	074	085	095	106	109	148	
	30	003	010	020	025	029	034	036	050	
	50	002	005	009	010	012	013	014	020	
	70	002	005	007	008	008	009	010	013	
	90	002	005	007	007	008	008	009	012	

ILLUMINANCE FROM GROUND -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 45

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	034	060	094	114	127	176	194	195	
	30	033	059	089	103	112	147	153	154	
	50	033	061	092	106	113	146	150	151	
	70	031	059	090	103	110	144	147	147	
	90	028	053	080	093	098	138	141	141	
2	10	027	047	071	084	096	127	134	135	
	30	026	051	078	090	099	126	129	131	
	50	021	045	073	086	093	114	117	118	
	70	017	036	060	072	080	094	096	097	
	90	014	029	046	056	063	077	080	080	
3	10	026	046	068	079	092	116	118	121	
	30	020	042	068	081	089	110	123	126	
	50	014	029	050	060	068	080	097	100	
	70	011	021	034	041	047	055	064	066	
	90	009	017	025	031	035	042	048	049	
4	10	025	049	075	087	093	112	120	126	
	30	016	035	059	070	077	091	107	113	
	50	010	020	034	041	046	054	061	064	
	70	008	014	022	026	029	033	038	040	
	90	007	012	017	020	022	026	029	030	
6	10	023	054	083	100	109	116	113	128	
	30	009	023	040	050	056	061	070	078	
	50	005	011	017	021	023	027	029	033	
	70	004	009	012	013	015	016	017	020	
	90	004	008	011	012	013	014	015	017	
8	10	015	041	071	088	098	106	109	134	
	30	005	013	023	030	035	039	041	051	
	50	003	006	010	012	013	015	016	020	
	70	002	005	007	008	009	010	010	013	
	90	002	005	007	008	008	009	009	012	
10	10	010	028	058	067	075	083	086	117	
	30	002	007	014	017	020	024	025	034	
	50	002	004	006	007	008	009	009	013	
	70	001	003	005	005	006	006	006	009	
	90	001	003	005	005	006	006	006	008	

ILLUMINANCE FROM GROUND -- THRU COMPONENT
HORIZONTAL BLINDS, ANGLE = 60

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							
D / H	% D	.5	1	2	3	4	6	8	INF
1	10	034	057	086	110	121	165	183	184
	30	031	054	078	095	102	132	139	139
	50	030	053	078	093	098	129	133	134
	70	027	050	074	087	092	125	128	128
	90	024	044	065	077	082	117	120	120
2	10	026	045	064	080	103	114	121	122
	30	023	043	064	077	097	110	112	114
	50	018	035	054	065	080	094	096	097
	70	014	026	041	050	061	071	073	074
	90	012	021	031	038	047	055	056	057
3	10	027	049	072	083	099	103	069	071
	30	020	038	059	069	083	092	071	073
	50	013	024	037	043	052	059	054	056
	70	010	017	024	028	033	037	034	035
	90	009	014	019	021	025	027	024	025
4	10	025	050	078	091	097	100	078	082
	30	015	031	051	060	065	072	067	071
	50	008	016	025	030	032	036	035	037
	70	007	012	016	018	020	021	020	021
	90	006	010	014	015	016	016	015	016
6	10	015	037	059	072	079	084	066	074
	30	006	015	025	031	035	038	038	043
	50	003	007	010	012	013	015	014	016
	70	003	005	007	008	008	009	008	009
	90	003	005	007	007	008	008	007	008
8	10	008	022	039	048	054	058	060	074
	30	002	006	012	015	017	019	020	025
	50	001	003	005	005	006	007	007	009
	70	001	003	004	004	004	004	005	006
	90	001	003	004	004	004	004	004	005
10	10	004	013	028	032	036	041	042	057
	30	001	003	006	008	009	010	011	015
	50	001	002	003	003	003	004	004	005
	70	001	001	002	002	002	003	003	004
	90	001	001	002	002	002	003	003	004

ILLUMINANCE FROM GROUND -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 0

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT						W / H	
D / H	Z D	.5	1	2	3	4	6	8	INF
1	10	028	031	028	024	019	015	011	011
	30	035	038	034	028	023	017	013	013
	50	038	043	038	031	025	019	014	014
	70	037	044	039	032	026	020	015	015
	90	033	039	034	028	023	021	016	016
2	10	028	031	029	025	022	016	013	013
	30	031	039	038	033	028	021	016	016
	50	027	040	042	037	032	023	018	018
	70	023	036	041	038	033	024	019	019
	90	019	029	034	032	028	024	019	019
3	10	032	032	030	026	022	017	015	015
	30	028	036	038	034	029	022	018	019
	50	020	030	035	033	030	022	018	019
	70	015	023	029	029	028	021	017	018
	90	013	018	023	024	023	020	017	017
4	10	032	034	032	027	023	018	015	015
	30	022	032	036	033	029	022	018	018
	50	014	022	028	027	025	020	016	017
	70	010	015	020	021	021	017	014	015
	90	009	013	016	017	017	015	013	014
6	10	026	041	036	031	026	019	016	018
	30	012	024	027	027	025	020	016	018
	50	007	012	015	016	016	014	012	014
	70	006	009	010	011	011	010	010	011
	90	005	008	008	009	009	009	009	010
8	10	020	039	037	033	028	021	017	020
	30	007	015	020	020	020	017	014	017
	50	004	008	009	010	011	010	009	011
	70	004	006	006	007	007	007	006	008
	90	003	006	006	006	006	006	006	007
10	10	015	033	043	033	029	022	017	023
	30	004	010	016	015	014	014	012	016
	50	003	005	007	007	007	007	007	009
	70	002	004	005	005	005	005	004	006
	90	002	004	005	004	004	004	004	005

ILLUMINANCE FROM GROUND -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 30

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	Z D	.5	1	2	3	4	6	8	INF	
1	10	030	037	040	037	032	027	022	022	
	30	032	039	040	036	030	024	019	019	
	50	032	042	043	038	032	025	019	019	
	70	030	041	043	038	032	025	020	020	
	90	026	037	038	034	028	026	020	020	
2	10	026	031	033	031	028	023	019	019	
	30	025	035	039	037	033	025	020	020	
	50	020	033	041	039	036	027	022	022	
	70	016	028	037	038	036	028	022	022	
	90	014	023	030	032	031	028	022	022	
3	10	028	031	032	029	027	022	019	020	
	30	021	031	037	035	032	025	022	022	
	50	014	023	031	033	031	025	021	022	
	70	011	017	024	026	027	023	020	020	
	90	009	013	018	021	022	021	019	020	
4	10	026	031	033	030	027	021	018	019	
	30	015	025	033	033	031	024	020	021	
	50	009	016	023	025	025	022	019	019	
	70	007	011	016	018	018	017	016	017	
	90	007	009	012	014	014	015	014	015	
6	10	017	036	035	033	029	022	019	021	
	30	007	017	023	025	025	022	018	020	
	50	004	009	012	013	014	014	013	015	
	70	003	007	007	008	009	009	009	011	
	90	003	006	006	007	007	007	008	009	
8	10	012	029	035	034	031	024	019	024	
	30	004	010	015	018	018	017	015	019	
	50	002	005	007	008	009	009	009	011	
	70	002	004	005	005	005	005	006	007	
	90	002	004	004	005	004	004	005	006	
10	10	008	022	041	032	030	025	020	027	
	30	002	006	012	012	013	013	012	017	
	50	001	003	005	005	006	006	006	008	
	70	001	003	004	004	004	004	004	005	
	90	001	003	004	003	003	003	003	004	

ILLUMINANCE FROM GROUND -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 45

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT						W / H	
D / H	% D	.5	1	2	3	4	6	8	INF
1	10	027	036	045	045	042	037	031	032
	30	027	036	043	042	038	031	025	025
	50	025	037	045	043	039	031	025	025
	70	023	036	044	043	038	032	025	025
	90	019	032	039	039	034	032	025	025
2	10	024	029	034	034	033	029	025	025
	30	020	030	038	038	037	030	025	025
	50	015	026	037	039	039	032	026	027
	70	012	021	032	035	037	032	027	027
	90	010	016	025	029	030	031	026	027
3	10	023	028	032	032	030	026	024	025
	30	014	025	034	036	035	029	026	027
	50	009	017	026	030	031	028	025	025
	70	007	012	018	022	024	024	022	023
	90	007	010	014	016	018	020	021	021
4	10	018	029	034	033	030	025	022	024
	30	009	020	029	032	032	028	024	025
	50	006	011	018	021	023	023	021	022
	70	005	008	012	014	015	016	016	017
	90	004	007	009	010	011	012	013	014
6	10	009	025	033	035	033	026	022	025
	30	004	011	018	022	023	023	020	023
	50	002	005	008	010	012	013	014	015
	70	002	004	006	006	007	008	008	009
	90	002	004	005	005	005	006	006	007
8	10	006	018	033	033	035	028	023	028
	30	002	006	012	014	016	017	016	020
	50	001	003	005	006	007	008	008	010
	70	001	003	004	004	004	004	005	006
	90	001	003	004	004	004	004	004	004
10	10	004	012	031	031	030	028	023	032
	30	001	003	008	009	011	012	012	016
	50	001	002	004	004	004	005	005	007
	70	001	002	003	003	003	003	003	004
	90	001	002	003	003	003	002	002	003

ILLUMINANCE FROM GROUND -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 60

ROOM DEPTH /		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	Z D	.5	1	2	3	4	6	8	INF	
1	10	023	032	046	053	054	053	047	047	
	30	021	030	041	046	046	043	035	036	
	50	018	030	042	047	047	043	035	035	
	70	015	027	040	045	046	044	035	035	
	90	013	024	035	041	041	044	035	035	
2	10	021	026	033	036	038	038	034	034	
	30	015	024	034	038	039	038	033	033	
	50	010	018	030	035	038	037	034	034	
	70	008	014	024	029	033	034	033	033	
	90	007	011	018	023	026	031	031	031	
3	10	014	026	033	034	035	033	032	033	
	30	007	019	029	033	035	034	033	034	
	50	004	012	019	024	028	029	029	030	
	70	004	008	013	016	019	022	023	024	
	90	003	007	010	012	014	017	019	020	
4	10	009	024	035	036	035	032	029	031	
	30	004	014	024	028	030	030	029	030	
	50	002	008	013	016	019	021	022	023	
	70	002	006	008	010	011	013	015	016	
	90	002	005	007	008	008	010	011	012	
6	10	003	013	033	039	039	033	030	033	
	30	001	005	015	018	020	022	022	025	
	50	001	003	006	007	009	010	012	014	
	70	001	002	004	005	005	006	007	007	
	90	001	002	004	004	004	005	005	005	
8	10	002	007	026	034	040	036	030	037	
	30	000	002	008	011	013	015	016	019	
	50	000	001	003	004	005	006	006	008	
	70	000	001	003	003	003	003	004	004	
	90	000	001	003	003	003	003	003	004	
10	10	001	004	016	028	031	036	031	042	
	30	000	001	004	007	008	010	011	015	
	50	000	001	002	003	003	003	004	005	
	70	000	001	002	002	002	002	002	003	
	90	000	001	002	002	002	002	002	003	

ILLUMINANCE FROM GROUND -- THRU COMPONENT
VERTICAL BLINDS, ANGLE = 75

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT								W / H
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	018	023	038	052	059	080	080	080	
	30	015	020	033	044	048	063	059	060	
	50	011	019	031	042	046	061	058	058	
	70	009	016	029	038	043	060	057	057	
	90	008	014	025	034	038	057	055	055	
2	10	008	020	029	036	043	050	049	049	
	30	005	016	026	033	040	048	045	046	
	50	003	011	019	026	032	042	040	041	
	70	003	008	014	019	024	032	033	033	
	90	002	007	011	015	019	025	027	027	
3	10	004	013	029	035	041	045	045	047	
	30	002	009	021	027	033	041	046	048	
	50	001	005	012	016	020	026	035	036	
	70	001	004	008	010	013	016	022	022	
	90	001	003	007	008	010	012	015	016	
4	10	002	009	025	035	040	043	044	047	
	30	001	005	015	022	026	032	038	040	
	50	000	002	008	011	012	016	020	021	
	70	000	002	005	007	007	009	011	012	
	90	000	002	005	006	006	007	008	009	
6	10	000	003	014	026	035	043	043	049	
	30	000	001	006	011	015	019	024	027	
	50	000	001	002	004	006	007	009	010	
	70	000	000	002	003	004	004	005	005	
	90	000	000	002	003	004	004	004	005	
8	10	000	001	008	017	024	036	042	052	
	30	000	000	002	005	008	012	013	017	
	50	000	000	001	002	003	004	004	005	
	70	000	000	001	002	002	003	003	004	
	90	000	000	001	002	002	003	003	003	
10	10	000	000	003	011	017	026	034	046	
	30	000	000	001	002	004	007	008	011	
	50	000	000	000	001	002	002	003	004	
	70	000	000	000	001	001	002	002	003	
	90	000	000	000	001	001	002	002	003	

ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
HORIZONTAL BLINDS, ANGLE = 0

ROOM DEPTH /		WINDOW WIDTH / WINDOW HEIGHT								W / H
WINDOW HEIGHT										
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	685	813	1025	1230	1430	1802	2161	2167	
	30	255	334	401	458	518	621	730	732	
	50	141	205	253	282	313	356	411	412	
	70	090	139	180	199	218	234	265	266	
	90	068	107	142	155	169	166	186	187	
2	10	359	447	552	647	738	914	1086	1097	
	30	097	147	192	215	233	268	307	310	
	50	039	065	093	106	112	122	137	138	
	70	022	036	054	062	066	069	077	078	
	90	017	027	040	047	050	049	055	056	
3	10	228	307	379	439	494	602	702	720	
	30	043	072	101	116	124	139	149	153	
	50	015	026	040	048	052	056	055	056	
	70	010	016	025	031	034	036	033	034	
	90	009	013	020	025	027	029	026	026	
4	10	155	225	283	324	362	435	503	528	
	30	020	036	054	064	070	078	083	087	
	50	008	013	021	027	031	034	034	036	
	70	006	010	015	019	022	025	024	025	
	90	005	009	013	016	019	021	020	021	
6	10	077	128	173	196	215	252	287	322	
	30	006	012	020	025	028	032	033	037	
	50	003	006	009	012	014	017	017	019	
	70	002	005	008	010	011	014	014	016	
	90	002	005	007	009	010	013	012	014	
8	10	042	075	108	124	135	155	174	214	
	30	002	005	009	012	014	016	018	022	
	50	001	003	005	007	008	009	011	013	
	70	001	003	004	006	007	008	010	012	
	90	001	002	004	005	006	008	009	011	
10	10	024	044	068	079	086	097	108	147	
	30	001	003	005	006	008	009	010	014	
	50	001	002	003	004	005	006	007	009	
	70	001	001	003	004	004	005	006	008	
	90	001	001	003	003	004	005	005	007	

ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
HORIZONTAL BLINDS, ANGLE = 15

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	711	849	1073	1289	1501	1891	2271	2277	
	30	280	370	449	515	582	700	823	826	
	50	164	242	304	342	379	436	502	504	
	70	112	177	233	261	286	313	355	356	
	90	089	144	198	220	241	244	274	275	
2	10	381	477	589	691	789	977	1161	1173	
	30	115	177	232	261	284	329	376	380	
	50	053	089	129	149	159	177	198	200	
	70	032	055	084	100	107	117	130	131	
	90	025	042	066	079	086	091	101	102	
3	10	249	336	415	480	541	660	768	788	
	30	057	096	136	156	168	190	206	211	
	50	023	041	064	078	085	094	096	099	
	70	015	026	041	052	057	064	063	065	
	90	012	021	034	043	047	053	052	053	
4	10	175	254	319	365	408	490	567	594	
	30	031	055	083	098	108	121	130	136	
	50	012	023	037	046	052	060	061	064	
	70	009	015	025	032	037	043	044	046	
	90	008	013	021	027	032	037	038	040	
6	10	094	156	209	236	259	303	344	387	
	30	011	023	037	045	051	058	061	068	
	50	005	010	017	022	025	031	032	036	
	70	004	008	013	017	019	024	025	028	
	90	004	007	012	015	017	021	022	025	
8	10	056	099	141	161	175	201	226	278	
	30	005	011	019	024	028	033	036	044	
	50	003	006	010	013	015	018	021	025	
	70	002	005	008	010	012	015	017	021	
	90	002	004	007	009	011	013	015	019	
10	10	035	064	098	113	123	139	155	210	
	30	003	006	012	015	017	020	023	031	
	50	001	003	006	008	010	012	013	018	
	70	001	003	006	007	008	010	011	015	
	90	001	003	005	006	007	009	010	014	

ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
HORIZONTAL BLINDS, ANGLE = 30

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	735	883	1124	1352	1577	1998	2406	2414	
	30	302	403	494	569	645	784	923	926	
	50	184	276	352	397	441	518	598	600	
	70	131	210	282	318	350	395	449	451	
	90	107	177	246	278	305	327	368	370	
2	10	399	502	623	732	836	1037	1233	1246	
	30	130	203	268	303	331	384	440	445	
	50	065	111	163	189	204	229	256	259	
	70	041	073	114	137	149	166	184	186	
	90	033	059	094	114	126	138	153	154	
3	10	266	360	446	516	582	710	827	848	
	30	069	117	166	192	208	236	256	263	
	50	030	056	088	107	118	133	139	142	
	70	020	036	059	075	084	096	098	101	
	90	017	030	049	062	070	081	083	085	
4	10	191	277	349	399	447	537	621	651	
	30	039	072	109	129	142	160	173	181	
	50	017	032	054	067	077	088	093	098	
	70	012	022	037	047	055	064	067	071	
	90	010	019	031	040	046	055	058	061	
6	10	108	179	238	269	296	346	393	442	
	30	016	033	055	067	075	086	092	103	
	50	008	016	026	034	039	047	050	056	
	70	006	012	019	024	028	035	037	042	
	90	005	011	017	021	025	031	033	037	
8	10	067	120	169	193	210	241	271	333	
	30	008	018	031	039	045	052	057	071	
	50	004	009	015	020	023	028	032	039	
	70	003	007	012	015	017	021	024	030	
	90	003	007	011	014	016	019	022	027	
10	10	044	082	124	143	155	175	195	265	
	30	004	010	019	025	029	034	038	051	
	50	002	006	010	013	015	018	021	028	
	70	002	005	009	010	012	014	016	022	
	90	002	005	008	010	011	013	015	020	

ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
HORIZONTAL BLINDS, ANGLE = 45

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT					W / H			
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	757	918	1177	1422	1664	2119	2562	2570	
	30	321	434	539	624	709	868	1026	1029	
	50	202	307	397	452	504	598	693	695	
	70	147	240	327	372	411	474	541	543	
	90	122	205	289	330	363	407	459	461	
2	10	414	525	656	773	883	1098	1307	1321	
	30	143	226	301	342	375	438	502	507	
	50	075	131	194	226	246	279	313	316	
	70	049	090	143	172	189	213	236	239	
	90	040	074	119	147	163	183	202	205	
3	10	280	381	474	550	621	759	882	905	
	30	078	135	194	225	245	279	306	314	
	50	037	069	110	135	149	169	180	184	
	70	025	046	077	097	109	126	131	135	
	90	021	038	064	081	093	108	114	117	
4	10	203	297	376	431	483	581	671	705	
	30	046	086	132	157	173	197	214	225	
	50	021	042	070	087	100	115	123	129	
	70	015	028	048	061	071	084	090	094	
	90	013	024	040	052	061	073	078	082	
6	10	120	199	265	300	330	386	438	493	
	30	021	043	071	087	098	113	121	136	
	50	010	021	035	045	052	062	067	075	
	70	008	016	025	032	037	045	049	055	
	90	007	014	022	028	032	040	043	048	
8	10	076	137	194	222	242	278	313	385	
	30	011	024	041	053	060	071	078	096	
	50	005	012	021	026	031	037	042	052	
	70	005	010	016	020	023	028	032	039	
	90	004	009	014	018	021	025	029	035	
10	10	050	097	148	170	186	210	234	318	
	30	006	014	027	034	040	048	053	072	
	50	003	008	014	017	020	025	028	038	
	70	003	007	011	014	016	019	021	029	
	90	003	006	011	013	014	017	020	027	

ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
HORIZONTAL BLINDS, ANGLE = 60

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	779	955	1235	1498	1758	2252	2735	2744	
	30	339	465	585	681	777	958	1135	1138	
	50	219	337	442	507	568	681	791	794	
	70	163	269	371	426	472	555	636	637	
	90	136	230	328	380	420	485	550	551	
2	10	428	547	690	815	933	1165	1388	1404	
	30	155	247	334	383	420	496	569	575	
	50	084	149	224	263	287	331	372	376	
	70	057	105	168	204	225	258	287	290	
	90	047	086	141	174	194	223	247	250	
3	10	292	400	503	585	662	812	942	967	
	30	087	152	221	258	281	326	361	371	
	50	043	081	130	160	177	204	224	229	
	70	029	055	091	116	130	153	163	167	
	90	025	046	076	097	111	131	140	144	
4	10	214	315	403	464	520	629	728	765	
	30	052	099	154	183	204	234	261	274	
	50	025	049	083	104	119	139	151	159	
	70	018	034	057	073	085	101	110	115	
	90	016	029	048	062	072	088	095	100	
6	10	129	218	292	333	368	432	487	549	
	30	024	051	085	105	119	138	151	170	
	50	012	025	042	054	062	075	081	092	
	70	010	019	031	038	044	054	058	066	
	90	009	018	027	034	039	048	052	058	
8	10	083	152	218	252	276	318	358	442	
	30	013	029	050	064	074	087	096	119	
	50	007	015	025	032	037	045	051	062	
	70	006	012	019	024	027	033	038	046	
	90	005	011	018	022	025	030	034	042	
10	10	055	108	167	193	212	242	269	367	
	30	007	017	033	041	048	058	064	088	
	50	004	009	017	021	024	029	033	045	
	70	003	008	014	016	019	022	025	034	
	90	003	008	013	015	017	020	023	032	

ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
HORIZONTAL BLINDS, ANGLE = 75

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	808	1000	1306	1593	1875	2399	2926	2936	
	30	362	503	641	754	862	1059	1258	1262	
	50	239	373	496	575	647	775	903	906	
	70	181	301	420	489	545	644	741	743	
	90	152	259	372	436	484	569	648	650	
2	10	446	577	734	874	1006	1244	1486	1502	
	30	169	273	374	434	483	565	650	657	
	50	094	169	256	305	338	390	440	445	
	70	065	121	193	236	264	304	340	343	
	90	054	099	161	199	225	259	289	292	
3	10	308	427	545	638	723	878	989	1015	
	30	097	172	254	299	330	382	405	415	
	50	049	093	151	186	208	240	257	264	
	70	035	064	106	133	151	176	185	190	
	90	030	054	087	111	127	150	156	160	
4	10	226	338	441	512	576	690	778	818	
	30	059	113	178	215	240	277	303	318	
	50	029	057	096	121	138	161	173	182	
	70	021	040	066	084	097	115	123	129	
	90	019	034	056	071	082	099	106	111	
6	10	137	234	318	366	406	478	527	594	
	30	027	058	097	120	137	159	174	195	
	50	014	029	047	060	070	084	090	102	
	70	011	022	034	043	049	060	064	072	
	90	010	020	031	038	043	053	057	064	
8	10	087	162	235	274	301	349	393	485	
	30	014	032	056	072	083	098	108	133	
	50	007	016	027	035	040	049	055	068	
	70	006	013	021	026	030	036	041	050	
	90	006	013	019	024	027	033	037	046	
10	10	057	114	180	208	230	262	292	399	
	30	008	019	036	045	053	064	071	096	
	50	004	010	018	022	026	031	036	048	
	70	004	009	015	018	020	024	027	037	
	90	004	008	014	016	019	022	025	034	

ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
VERTICAL BLINDS, ANGLE = 0

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	325	436	580	701	823	1017	1221	1225	
	30	109	196	274	326	379	443	525	526	
	50	063	129	202	242	282	322	377	378	
	70	046	095	162	199	233	266	310	311	
	90	038	077	136	172	202	233	271	272	
2	10	151	238	333	402	459	560	668	675	
	30	038	086	154	190	213	249	291	294	
	50	020	047	094	123	141	167	194	196	
	70	015	033	064	088	103	125	145	147	
	90	013	027	051	069	083	102	120	121	
3	10	082	161	238	293	332	403	451	463	
	30	018	046	093	124	142	170	178	183	
	50	009	023	048	068	082	100	109	112	
	70	008	017	032	045	054	069	075	076	
	90	007	014	026	036	043	055	060	062	
4	10	048	115	184	228	265	320	359	377	
	30	009	027	058	082	099	122	135	142	
	50	005	013	028	040	051	065	072	076	
	70	004	010	019	027	033	043	048	051	
	90	004	009	017	022	028	035	040	042	
6	10	020	061	119	152	178	219	243	273	
	30	003	011	027	039	050	065	075	084	
	50	002	006	013	018	023	031	035	040	
	70	002	005	010	013	016	021	024	027	
	90	002	005	009	012	014	019	021	023	
8	10	010	033	079	106	125	155	180	221	
	30	001	005	014	021	027	037	044	054	
	50	001	003	007	010	012	017	021	025	
	70	001	003	006	008	010	012	015	019	
	90	001	003	006	008	009	011	014	017	
10	10	005	019	053	075	090	112	130	177	
	30	001	003	008	012	016	022	027	037	
	50	000	002	004	006	008	010	013	017	
	70	000	002	004	005	006	008	010	013	
	90	000	002	004	005	006	008	009	012	

ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
VERTICAL BLINDS, ANGLE = 15

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	374	477	621	745	873	1075	1294	1298	
	30	158	238	311	360	413	478	564	565	
	50	099	172	239	275	313	352	409	410	
	70	075	135	199	232	263	294	338	339	
	90	064	113	173	205	232	259	297	298	
2	10	196	273	362	429	485	587	698	706	
	30	066	122	183	215	236	269	311	315	
	50	037	072	121	147	163	185	211	214	
	70	027	050	087	110	123	141	161	162	
	90	023	041	070	090	102	118	134	136	
3	10	125	195	264	315	354	424	471	483	
	30	036	071	118	145	161	186	193	198	
	50	019	037	066	086	097	114	121	124	
	70	014	026	045	059	068	080	085	087	
	90	012	022	037	048	055	067	070	072	
4	10	085	149	209	249	284	337	376	394	
	30	021	044	079	100	116	135	147	154	
	50	011	022	040	053	063	075	081	085	
	70	008	016	027	035	043	052	056	058	
	90	007	014	023	030	036	044	047	049	
6	10	046	095	144	173	195	234	256	288	
	30	009	021	039	052	062	075	083	093	
	50	005	011	019	025	030	037	041	046	
	70	004	009	014	018	021	026	028	032	
	90	004	008	013	016	018	023	025	028	
8	10	027	060	102	125	141	168	191	235	
	30	004	011	021	029	036	044	050	062	
	50	002	006	011	014	017	021	025	030	
	70	002	005	008	011	012	015	018	022	
	90	002	005	008	010	011	014	016	020	
10	10	017	039	075	092	105	124	141	191	
	30	002	006	013	018	022	028	032	044	
	50	001	004	007	009	010	013	015	021	
	70	001	003	006	007	008	010	012	016	
	90	001	003	006	007	008	009	011	015	

ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
VERTICAL BLINDS, ANGLE = 30

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT						W / H	
D / H	% D	.5	1	2	3	4	6	8	INF
1	10	427	524	667	794	927	1137	1372	1376
	30	209	284	350	396	449	514	604	606
	50	146	219	279	310	347	384	442	444
	70	112	181	239	267	295	323	368	369
	90	095	157	212	239	263	287	324	325
2	10	243	310	392	458	514	616	730	738
	30	101	159	214	243	261	291	333	336
	50	057	102	149	172	185	204	229	232
	70	040	072	112	133	144	159	176	178
	90	033	059	093	112	122	135	149	151
3	10	171	231	292	340	376	445	491	503
	30	058	101	144	168	181	203	208	213
	50	029	055	086	104	114	127	133	136
	70	021	037	060	074	082	093	095	097
	90	018	031	049	062	069	079	080	082
4	10	128	184	236	272	304	356	393	413
	30	035	066	101	119	132	149	159	167
	50	017	033	054	066	075	086	090	095
	70	013	023	037	046	053	061	063	067
	90	011	020	031	039	045	052	055	057
6	10	079	129	170	194	214	250	270	304
	30	016	033	054	066	074	085	091	103
	50	008	016	026	033	037	044	047	053
	70	006	012	019	023	026	031	033	037
	90	006	011	017	020	023	028	030	033
8	10	050	091	126	145	158	182	203	250
	30	008	018	031	039	045	052	057	070
	50	004	009	015	019	022	026	029	035
	70	004	007	011	014	016	019	021	026
	90	003	007	010	013	014	017	019	024
10	10	033	065	098	110	121	136	151	205
	30	004	011	020	025	029	034	037	050
	50	003	006	010	012	014	017	019	025
	70	002	005	008	009	011	012	014	019
	90	002	005	008	009	010	012	013	018

ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
VERTICAL BLINDS, ANGLE = 45

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							
D / H	Z D	.5	1	2	3	4	6	8	INF
1	10	489	578	720	848	986	1204	1453	1458
	30	268	337	395	438	490	555	649	651
	50	189	272	325	351	385	419	479	480
	70	147	230	286	307	332	356	400	402
	90	124	200	259	279	299	319	354	355
2	10	299	353	428	491	546	648	765	773
	30	134	202	251	274	289	316	357	360
	50	076	130	182	202	211	227	249	252
	70	052	093	139	159	168	179	195	197
	90	043	076	116	137	145	155	166	168
3	10	223	273	324	368	402	469	514	527
	30	078	130	175	194	204	222	225	231
	50	039	071	107	126	133	144	147	151
	70	027	048	075	091	098	107	107	110
	90	023	040	062	076	084	092	092	094
4	10	171	226	267	298	328	377	412	433
	30	048	086	126	142	152	165	173	182
	50	023	043	068	082	090	098	101	106
	70	017	029	046	056	063	071	072	076
	90	015	025	038	047	054	062	064	067
6	10	108	169	201	219	235	268	286	322
	30	022	044	069	081	088	097	101	114
	50	011	021	033	041	046	052	054	061
	70	009	016	023	028	032	037	039	043
	90	008	015	021	025	028	033	035	039
8	10	070	122	155	169	178	198	217	268
	30	011	024	040	049	055	061	064	079
	50	006	012	019	024	027	031	034	041
	70	005	010	014	017	019	022	025	030
	90	005	009	013	016	017	020	023	028
10	10	046	088	125	132	139	151	163	222
	30	006	015	026	032	036	041	043	058
	50	004	008	013	015	017	020	022	030
	70	003	007	010	012	013	015	016	022
	90	003	006	010	011	012	014	015	021

ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
 VERTICAL BLINDS, ANGLE = 60

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	576	649	787	916	1058	1281	1541	1546	
	30	323	409	456	494	544	606	701	703	
	50	225	329	387	407	437	466	524	526	
	70	174	274	346	363	383	401	442	444	
	90	148	237	313	335	349	362	394	395	
2	10	371	414	476	536	588	689	807	816	
	30	159	242	301	318	328	351	389	393	
	50	091	155	218	241	247	258	277	280	
	70	063	110	165	190	200	208	220	222	
	90	052	090	137	161	173	182	191	193	
3	10	272	334	369	407	438	502	544	558	
	30	093	155	211	231	237	250	249	256	
	50	048	084	127	149	158	166	167	171	
	70	033	057	088	106	116	125	124	128	
	90	029	047	072	089	098	109	109	111	
4	10	206	279	312	336	362	406	440	462	
	30	057	103	150	170	180	188	193	203	
	50	028	051	080	096	106	115	116	122	
	70	021	035	054	066	074	083	085	089	
	90	018	030	045	055	063	072	074	078	
6	10	129	206	244	255	267	294	309	348	
	30	026	053	082	097	105	114	116	130	
	50	013	026	039	048	054	061	063	071	
	70	010	019	027	033	037	043	045	050	
	90	010	018	024	029	032	038	040	045	
8	10	083	147	191	202	207	221	238	293	
	30	013	029	048	059	065	072	075	093	
	50	007	015	023	028	031	036	039	048	
	70	006	012	017	020	022	026	028	035	
	90	006	011	016	018	020	023	026	032	
10	10	055	105	154	161	166	172	182	248	
	30	008	018	032	038	042	048	051	069	
	50	004	009	016	018	020	023	026	035	
	70	004	008	013	014	015	017	019	025	
	90	003	008	012	013	014	016	017	023	

ILLUMINANCE FROM UNDERSIDE OF BLINDS (HIDDEN FROM SUN)
VERTICAL BLINDS, ANGLE = 75

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT						W / H	
D / H	% D	.5	1	2	3	4	6	8	INF
1	10	731	782	902	1031	1176	1406	1672	1678
	30	371	494	569	599	645	703	795	797
	50	254	382	476	510	537	560	611	613
	70	195	313	412	450	477	492	526	527
	90	165	269	367	406	432	451	475	476
2	10	439	525	573	622	670	767	883	893
	30	179	279	363	395	407	422	454	459
	50	102	175	253	287	302	318	335	338
	70	071	124	189	222	237	254	269	272
	90	059	102	156	187	202	219	232	235
3	10	309	409	465	490	514	570	606	622
	30	102	176	247	279	293	308	302	310
	50	053	096	146	174	187	202	206	211
	70	037	065	101	122	135	149	151	155
	90	032	054	083	101	113	127	129	133
4	10	228	331	396	418	435	470	497	523
	30	062	116	174	201	217	232	237	248
	50	031	058	092	111	124	137	141	148
	70	023	040	062	076	085	096	100	105
	90	020	035	052	063	072	083	087	091
6	10	139	233	299	324	336	353	361	407
	30	027	059	094	113	124	137	142	160
	50	014	029	045	055	062	071	075	084
	70	011	022	032	038	043	049	052	058
	90	011	020	029	034	037	044	046	052
8	10	087	162	226	251	264	276	286	353
	30	014	032	055	068	076	086	091	112
	50	007	016	026	032	036	042	046	056
	70	006	013	020	024	026	030	033	040
	90	006	013	018	022	023	027	030	036
10	10	058	114	176	195	207	220	225	307
	30	008	019	035	043	049	057	061	082
	50	004	010	018	021	024	027	030	040
	70	004	009	014	016	018	020	022	030
	90	004	008	014	015	017	018	020	027

ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
HORIZONTAL BLINDS, ANGLE = 0

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT						W / H	
R / H	Z D	.5	1	2	3	4	6	8	INF
1	10	059	092	118	124	142	112	128	129
	30	062	099	127	135	155	128	146	147
	50	057	095	126	137	156	137	157	158
	70	052	086	117	129	147	139	160	160
	90	046	075	102	114	130	135	155	155
2	10	041	068	104	117	117	107	123	124
	30	036	065	101	117	122	120	138	140
	50	027	050	080	094	101	106	122	123
	70	021	037	059	071	076	082	094	095
	90	019	030	046	054	058	064	073	073
3	10	032	056	086	107	110	109	078	080
	30	022	044	072	090	097	106	090	092
	50	014	027	044	055	061	068	069	071
	70	011	019	029	036	039	042	042	043
	90	010	016	023	028	030	031	029	030
4	10	024	046	074	093	106	111	095	100
	30	014	029	050	064	074	084	087	091
	50	008	015	025	032	037	042	044	046
	70	007	011	016	020	022	025	025	026
	90	006	010	014	016	018	020	019	020
6	10	016	035	055	069	080	096	085	095
	30	006	014	024	031	037	045	049	055
	50	003	007	010	012	014	017	018	020
	70	003	005	007	008	009	011	010	012
	90	003	005	007	007	008	010	009	010
8	10	009	022	039	050	058	069	078	096
	30	002	006	012	016	019	023	026	032
	50	001	003	005	006	007	008	009	011
	70	001	003	004	004	005	005	006	007
	90	001	003	004	004	005	005	006	007
10	10	005	014	029	035	041	048	055	074
	30	001	003	006	008	010	012	014	019
	50	001	002	003	003	003	004	004	006
	70	001	002	002	003	003	003	003	005
	90	001	002	002	003	003	003	003	005

ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
VERTICAL BLINDS, ANGLE = 0

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	325	436	580	701	823	1017	1221	1225	
	30	109	196	274	326	379	443	525	526	
	50	063	129	202	242	282	322	377	378	
	70	046	095	162	199	233	266	310	311	
	90	038	077	136	172	202	233	271	272	
2	10	151	238	333	402	459	560	668	675	
	30	038	086	154	190	213	249	291	294	
	50	020	047	094	123	141	167	194	196	
	70	015	033	064	088	103	125	145	147	
	90	013	027	051	069	083	102	120	121	
3	10	082	161	238	292	332	403	451	463	
	30	018	046	093	124	142	170	178	183	
	50	009	023	048	068	081	100	109	112	
	70	008	017	032	045	054	069	075	076	
	90	007	014	026	036	043	055	060	062	
4	10	048	115	184	228	265	320	359	377	
	30	009	027	058	082	099	122	135	142	
	50	005	013	028	040	051	065	072	076	
	70	004	010	019	027	033	043	048	051	
	90	004	009	017	022	028	035	040	042	
6	10	020	061	119	152	178	219	243	273	
	30	003	011	027	039	050	065	075	084	
	50	002	006	013	018	023	031	035	040	
	70	002	005	010	013	016	021	024	027	
	90	002	005	009	012	014	019	021	023	
8	10	010	033	079	106	125	155	180	221	
	30	001	005	014	021	027	037	044	054	
	50	001	003	007	010	012	017	021	025	
	70	001	003	006	008	010	012	015	018	
	90	001	003	006	007	009	011	014	017	
10	10	005	019	053	075	090	112	130	177	
	30	001	003	008	012	016	022	027	037	
	50	000	002	004	006	008	010	013	017	
	70	000	002	004	005	006	008	010	013	
	90	000	002	004	005	006	008	009	012	

ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
VERTICAL BLINDS, ANGLE = 15

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							
D / H	% D	.5	1	2	3	4	6	8	INF
1	10	282	409	566	697	828	1034	1255	1259
	30	069	158	248	306	366	437	526	527
	50	038	091	171	218	263	309	370	371
	70	028	065	129	172	211	250	299	300
	90	025	052	101	144	179	216	258	259
2	10	103	205	311	385	446	553	667	674
	30	020	055	125	166	193	233	279	282
	50	012	030	068	100	121	150	181	182
	70	010	021	046	067	084	108	132	133
	90	009	018	036	051	064	086	106	108
3	10	042	125	213	272	315	391	442	453
	30	008	026	066	101	122	154	165	169
	50	005	014	033	051	065	086	097	100
	70	004	011	023	033	041	057	064	066
	90	004	010	019	027	032	044	050	051
4	10	019	078	157	206	246	305	347	364
	30	003	015	039	062	082	107	122	128
	50	002	008	019	029	038	054	063	066
	70	002	007	014	020	025	035	040	042
	90	002	006	012	017	021	028	032	033
6	10	004	031	092	130	158	203	229	258
	30	001	005	016	027	037	054	065	073
	50	001	003	008	012	016	024	029	032
	70	001	003	007	010	012	017	019	022
	90	001	003	007	009	011	015	016	019
8	10	001	013	053	084	106	139	166	205
	30	000	002	008	013	018	029	037	045
	50	000	001	004	007	009	013	016	020
	70	000	001	004	006	007	010	012	015
	90	000	001	004	006	007	009	011	014
10	10	000	005	028	055	073	098	118	161
	30	000	001	004	007	010	016	021	029
	50	000	001	002	004	005	008	010	013
	70	000	001	002	004	005	006	008	011
	90	000	001	002	004	005	006	007	010

ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
VERTICAL BLINDS, ANGLE = 30

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	223	369	536	672	810	1026	1259	1263	
	30	036	108	208	271	334	411	506	507	
	50	023	055	127	178	227	278	343	344	
	70	019	041	085	131	173	216	269	269	
	90	017	035	064	101	140	181	226	227	
2	10	050	161	278	356	420	531	649	656	
	30	011	030	086	132	161	205	253	255	
	50	007	018	043	069	091	123	155	156	
	70	006	014	030	045	058	083	108	109	
	90	005	012	025	034	043	062	083	084	
3	10	013	079	178	242	288	367	422	432	
	30	003	014	039	071	094	128	142	146	
	50	002	008	020	033	044	066	078	080	
	70	002	007	015	023	028	040	048	049	
	90	002	006	013	019	023	030	035	036	
4	10	003	038	122	176	218	280	325	341	
	30	001	008	022	039	058	085	102	107	
	50	001	004	012	018	025	038	048	050	
	70	001	004	009	014	018	024	029	030	
	90	001	004	008	012	016	020	022	024	
6	10	000	009	058	100	131	179	208	234	
	30	000	002	009	016	023	039	050	056	
	50	000	001	005	008	011	016	020	023	
	70	000	001	004	007	009	012	014	016	
	90	000	001	004	006	008	011	012	014	
8	10	000	002	026	057	081	117	146	180	
	30	000	000	004	007	011	018	026	032	
	50	000	000	003	004	006	009	011	014	
	70	000	000	002	004	005	007	009	011	
	90	000	000	002	004	005	007	009	011	
10	10	000	001	009	031	051	079	100	136	
	30	000	000	001	004	006	010	014	019	
	50	000	000	001	002	003	005	007	009	
	70	000	000	001	002	003	005	006	008	
	90	000	000	001	002	003	005	006	008	

ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
VERTICAL BLINDS, ANGLE = 45

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT								W / H
D / H	Z D	.5	1	2	3	4	6	8	INF	
1	10	139	310	488	626	764	984	1220	1224	
	30	019	052	153	220	283	364	459	461	
	50	013	030	071	124	172	228	293	294	
	70	011	025	045	076	118	164	217	217	
	90	010	022	036	054	085	128	174	174	
2	10	011	100	231	313	379	494	612	618	
	30	004	015	043	085	117	164	212	214	
	50	003	010	024	037	053	085	117	118	
	70	002	008	019	026	033	051	074	075	
	90	002	007	016	022	025	035	053	053	
3	10	001	029	131	199	248	330	389	399	
	30	001	007	019	036	056	093	110	112	
	50	000	004	012	019	024	039	052	053	
	70	000	003	009	014	017	024	028	029	
	90	000	003	008	012	015	019	020	020	
4	10	000	008	074	133	178	244	292	306	
	30	000	003	011	019	030	055	073	077	
	50	000	002	006	011	015	022	029	030	
	70	000	001	005	009	012	015	017	018	
	90	000	001	005	008	010	013	014	015	
6	10	000	001	021	060	094	145	177	199	
	30	000	000	004	008	012	021	031	035	
	50	000	000	002	005	006	010	012	013	
	70	000	000	002	004	005	008	009	010	
	90	000	000	002	004	005	008	008	009	
8	10	000	000	005	024	048	087	117	144	
	30	000	000	001	004	006	009	014	018	
	50	000	000	001	002	003	005	007	009	
	70	000	000	001	002	003	005	006	008	
	90	000	000	001	002	003	004	006	007	
10	10	000	000	001	009	024	052	075	102	
	30	000	000	000	002	003	005	007	010	
	50	000	000	000	001	002	003	004	006	
	70	000	000	000	001	002	003	004	005	
	90	000	000	000	001	002	003	004	005	

ILLUMINANCE FROM TOPSIDE OF BLINDS (EXPOSED TO SUN)
VERTICAL BLINDS, ANGLE = 60

ROOM DEPTH / WINDOW HEIGHT		WINDOW WIDTH / WINDOW HEIGHT							W / H	
D / H	% D	.5	1	2	3	4	6	8	INF	
1	10	032	212	412	553	687	904	1133	1136	
	30	007	017	070	144	207	291	382	383	
	50	005	014	023	050	096	153	216	217	
	70	004	012	020	027	049	091	141	141	
	90	004	011	018	022	033	057	100	100	
2	10	001	023	156	247	316	435	550	556	
	30	000	005	015	029	054	105	153	154	
	50	000	004	011	016	019	036	065	066	
	70	000	003	009	013	015	020	033	034	
	90	000	003	008	011	013	016	023	023	
3	10	000	002	056	133	187	273	339	348	
	30	000	001	007	013	018	043	064	066	
	50	000	001	005	009	011	015	020	021	
	70	000	001	004	007	008	011	012	012	
	90	000	001	003	006	007	010	009	009	
4	10	000	000	016	068	117	188	241	253	
	30	000	000	004	007	011	021	034	036	
	50	000	000	002	005	007	010	012	012	
	70	000	000	002	004	006	008	008	009	
	90	000	000	002	003	005	007	007	008	
6	10	000	000	001	013	039	094	131	147	
	30	000	000	001	002	004	008	011	013	
	50	000	000	000	002	003	005	005	006	
	70	000	000	000	001	002	004	005	005	
	90	000	000	000	001	002	004	004	005	
8	10	000	000	000	002	010	043	075	092	
	30	000	000	000	001	002	004	006	007	
	50	000	000	000	000	001	002	003	004	
	70	000	000	000	000	001	002	003	004	
	90	000	000	000	000	001	002	003	004	
10	10	000	000	000	000	002	016	040	054	
	30	000	000	000	000	001	002	003	004	
	50	000	000	000	000	000	001	002	003	
	70	000	000	000	000	000	001	002	002	
	90	000	000	000	000	000	001	002	002	

SOLAR BLINDS MULTIPLIERS

-- UNDERSIDE, SURFACE HIDDEN FROM SUN --

BLINDS ANGLE = 0 DEG						BLINDS ANGLE = 15 DEG				
SOLAR PROFILE ANGLE	BLINDS REFLECTANCE					BLINDS REFLECTANCE				
	10%	30%	50%	70%	90%	10%	30%	50%	70%	90%
0	000	000	000	000	000	001	011	031	064	113
15	001	011	032	067	119	002	021	061	125	222
30	003	024	069	142	254	004	033	095	195	347
45	004	036	103	214	382	004	033	094	193	343
60	003	030	087	180	320	003	025	073	150	264
75	002	017	048	099	175	001	013	038	078	137

BLINDS ANGLE = 30 DEG						BLINDS ANGLE = 45 DEG				
SOLAR PROFILE ANGLE	BLINDS REFLECTANCE					BLINDS REFLECTANCE				
	10%	30%	50%	70%	90%	10%	30%	50%	70%	90%
0	002	019	055	112	197	003	023	066	134	232
15	003	028	079	161	283	003	028	078	159	275
30	003	031	088	180	315	003	023	065	133	230
45	003	026	075	154	269	002	019	053	108	187
60	002	019	055	113	197	001	013	037	076	131
75	001	010	027	056	097	001	006	017	035	061

BLINDS ANGLE = 60 DEG						BLINDS ANGLE = 75 DEG				
SOLAR PROFILE ANGLE	BLINDS REFLECTANCE					BLINDS REFLECTANCE				
	10%	30%	50%	70%	90%	10%	30%	50%	70%	90%
0	003	023	064	127	217	001	011	031	062	105
15	002	018	051	103	176	001	009	024	048	082
30	002	015	041	083	142	001	007	019	037	063
45	001	011	032	065	111	001	005	014	028	047
60	001	008	021	043	073	000	003	009	017	029
75	000	003	009	018	031	000	001	003	006	011

SOLAR BLINDS MULTIPLIERS

--- TOPSIDE, SURFACE EXPOSED TO SUN ---

BLINDS ANGLE = 0 DEG						BLINDS ANGLE = 15 DEG				
SOLAR PROFILE ANGLE	BLINDS REFLECTANCE					BLINDS REFLECTANCE				
	10%	30%	50%	70%	90%	10%	30%	50%	70%	90%
0	000	000	000	000	000	026	080	139	204	282
15	027	082	141	209	290	052	158	272	401	555
30	057	175	302	446	620	081	247	426	628	868
45	085	259	447	660	917	085	258	444	651	894
60	073	223	384	565	780	073	222	380	554	754
75	044	133	228	333	456	044	132	225	327	441

BLINDS ANGLE = 30 DEG						BLINDS ANGLE = 45 DEG				
SOLAR PROFILE ANGLE	BLINDS REFLECTANCE					BLINDS REFLECTANCE				
	10%	30%	50%	70%	90%	10%	30%	50%	70%	90%
0	051	155	266	389	531	072	218	372	537	723
15	073	223	382	559	764	087	264	449	648	871
30	086	262	449	654	890	086	261	442	635	847
45	085	257	438	635	856	085	256	432	618	818
60	073	221	375	541	724	073	220	371	528	695
75	044	132	223	319	424	044	131	221	313	409

BLINDS ANGLE = 60 DEG						BLINDS ANGLE = 75 DEG				
SOLAR PROFILE ANGLE	BLINDS REFLECTANCE					BLINDS REFLECTANCE				
	10%	30%	50%	70%	90%	10%	30%	50%	70%	90%
0	088	266	450	642	849	089	266	446	628	814
15	087	262	442	629	826	087	261	437	615	796
30	086	260	437	619	810	086	259	433	608	786
45	085	255	428	605	788	085	254	425	596	770
60	073	220	368	519	674	073	219	366	513	662
75	044	131	219	308	399	044	131	218	306	394

SKY BLINDS MULTIPLIERS

-- UNDERSIDE, SURFACE HIDDEN FROM SUN --

BLINDS ANGLE	BLINDS REFLECTANCE				
	10%	30%	50%	70%	90%
0	002	021	060	125	222
15	003	027	077	158	281
30	003	029	084	171	301
45	003	029	082	166	287
60	003	026	073	145	246
75	002	019	054	107	178

-- TOPSIDE, SURFACE EXPOSED TO SUN --

BLINDS ANGLE	BLINDS REFLECTANCE				
	10%	30%	50%	70%	90%
0	050	153	264	391	543
15	066	200	344	508	702
30	078	238	407	595	813
45	089	270	460	665	894
60	100	303	512	731	966
75	109	329	552	779	1015

GROUND BLINDS MULTIPLIERS

-- UNDERSIDE, SURFACE HIDDEN FROM SUN --

BLINDS ANGLE	BLINDS REFLECTANCE				
	10%	30%	50%	70%	90%
0	025	077	132	195	271
15	017	054	093	138	193
30	011	036	065	099	141
45	007	024	046	074	110
60	003	015	032	056	088
75	001	009	022	041	067

-- TOPSIDE, SURFACE EXPOSED TO SUN --

BLINDS ANGLE	BLINDS REFLECTANCE				
	10%	30%	50%	70%	90%
0	001	010	030	062	111
15	002	012	029	055	093
30	007	025	047	075	113
45	015	046	081	121	167
60	025	076	130	186	247
75	037	112	187	265	345

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