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ZONE METHOD AS A NEW TECHNIQUE OF 3-DIMENSIONAL ILLUMINATION FOR INTERIOR & EXTERIOR LIGHTING DESIGN*

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ABSTRACT:

This paper introduces the zone method as a new tool for lighting design. This method is an intermediate way between Lumen method and the modern computer lighting design programs. It is very simple accurate satisfy designers needs and can be used manually. The zone method photometric report (ZMPR) & test rooms specification have been demonstrated.

KEYWORDS: Zone, Illumination, Interior, Exterior, Lighting

METHODE DE LA ZONE COMME UNE NOUVELLE TECHNIQUE DE L'ECLAIREMENT 3-DIMENSIONS CONCEPTION DE L'ECLAIRAGE INTERIEUR ET EXTERIEUR

RÉSUMÉ:

Cet article présente la méthode de la zone comme un nouvel outil pour la conception d'éclairage. Cette méthode est une voie intermédiaire entre la méthode de Lumen et les programmes informatiques modernes d'éclairage design. Il est très simple précision satisfaire les besoins des concepteurs et peut être utilisé manuellement. Le rapport méthode de la zone photométrique (ZMPR) et test de spécification de chambres ont été démontrés.

MOTS CLÉS: Zone, Illumination, Intérieur, Extérieur, Eclairage

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1. INTRODUCTION

Lighting design is one of the most important factors, the installation and decoration designers take it into consideration, when designing a new project. This design depends on the method of calculation. For many years Lumen Method was the main method used to calculate illumination, due to its simplicity [1,2]. This method has some disadvantages. Therefore lighting designers are looking for a new technique to calculate illumination.

These disadvantages are:-

1) The light source uses as a considered point source and only the light reaches a surface on a direct path from the light source, the calculation depends on the "Lambert's Cosine Law" and "Lumen method".
2) The calculation was performed using one type of source (Point source) not considering other types.
3) The design was done without any consideration of daylight zone method must integrate natural lighting with industrial lighting sources.
4) The control of lighting was not taken as an important point design (occupation needs – switches – occupancy sensors and dimmers).
5) Lumen method calculations were performed without taking appears after furnishing the place.
6) The light source was considered without its accessories.

Computer programs used to design lighting system are divided to:

a) advanced lighting design programs, as Lighting Analysts AGI32 and Lighting technologies[3,4,5,6] Lumen Micro, it depends on high advanced mathematic method, very expensive and gives a lot of unused results.

b) Simple lighting design programs, like Philips program and El-Sweedy program, depends on simple method gives non-accurate result

In addition, these programs assume that the interior place must be in a square shape which is far away from the actual designed places.

The main objective of the present work is to design a new, simple, accurate, manual and cheap method (Zone method) to calculate the three dimensional illumination in interior & exterior places. Beside the method a new form for the photometric report is introduced that called "Zone method photometric report" or "Egyptian photometric report" and the description of the testing room is introduced, which made the luminaire used like any electrical instrument like, cables,……etc

2. ZONE METHOD DESCRIPTION

This method tries to find an intermediate way between Lumen method and computer lighting design programs, reformulates the photometric report data in new form and suggests a new technique to obtain the photometric data.

To explain zone method form of the photometric report (ZMPR) based on that every lighting source at definite height drops light on its exact area. This area varies with the height of the lighting source and the surrounding reflectance.

2.1 Zone method Photometric Report

The Zone Method Photometric Report (ZMPR) is divided into two parts, first part is Luminaire Description (ZMPL) and consequently the second new part is photometric data (ZMPD).

2.1.1 Zone method photometric luminaire description (ZMPL)

ZMPL include the main information about the luminaire like description of the luminaire, image of the luminaire, wattage, etc. In addition, lamp color, lamp dimensions, dissipated temperature, Ballast information are added to ZMPL as shown in Table (1). This concept is very important to introduce the cover page of zone method. for more details see Table (I-1) in appendix I

Table (1): The meaning of data in ZMPL

Data	*Meaning*
ZMPR-NO	Number of zone method photometric report
TEST	Test report number and laboratory
NMBER OF LAMPS	No. of lamps in Luminaire
LUMEN PER LAMP	Lumen per one lamp
INPUT WATTS	Watts of lamp
DISTRIBUTION	The type of the distribution of lamp lumens
HIEGHT	Height of the Luminaire
MANUFACT	Contains information about manufacture
LUMCAT	Luminaire catalog number
OTHERS	Contains any additional data about luminaire

2.1.2 Zone method photometric data (ZMPD)

ZMPD include the photometric data, as each luminaire at an exact height of the source (h_s) and average surrounding reflectance (ρ_{av}) drops the light at an area (A_s). The average illuminance (E_{av}), the maximum illuminance (E_{max}) and the minimum illuminance (E_{min}) can be obtained directly from the ZMPD as shown in Table (2).
In Table (2) The ZMPD contains the following**:**
room with dimensions (0.5×0.5 m^2). Each test

i) average surrounding reflectance (ρ_{av}):-

The average surrounding reflectance (ρ_{av}) is the average value of the reflectance of the four sides and top and bottom surrounded the lighting source. This average value varies between 0 &1.

ii) Luminaire height (h_s)

It is the distance between the luminaire and the illuminated surface. As any interior location height value of this height varies between 0.5 to 10 m

iii) Average illuminance (E_{av})

Is the average illuminance value of the illuminance readings at all points in the testing grid matrix. This value calculated at every height and every reflectance.

iv) Maximum illuminance (E_{max})

Is the maximum illuminance value of the illuminance readings at all points in the testing grid matrix. This value calculated at every height and every reflectance.

v) Minimum illuminance (E_{min})

Is the minimum illuminance value of the illuminance readings at all points in the testing grid matrix. This value calculated at every height and every reflectance.

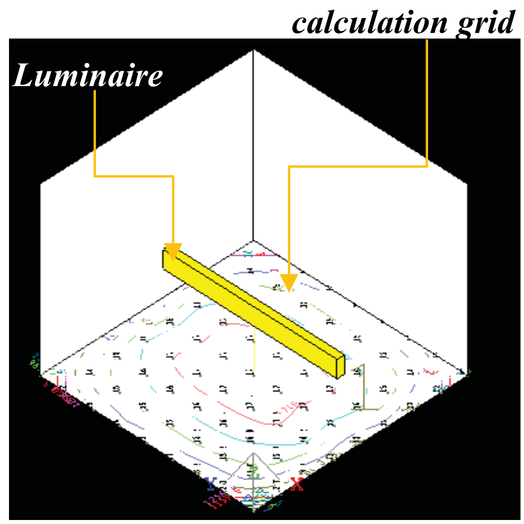
Table (2): Part of the zone method photometric report shows the photometric data

Hieght	pav Room no.	Area m2	0.55 Eav	Emin	Emax
hs =5.5	11	30.25	18	13	21
	12	36	16	11	19
	13	42.25	14	10	17
	14	49	13	9	16
	15	56.25	12	7	15
	16	64	11	7	14
	17	72.25	10	6	14
	18	81	9	5	13
	19	90.25	9	5	13
	20	100	0	0	0
hs =6	12	36	15	11	18
	13	42.25	14	9	16
	14	49	12	8	15
	15	56.25	11	7	14
	16	64	10	7	13
	17	72.25	10	6	12
	18	81	9	5	12
	19	90.25	8	5	11
	20	100	0	0	0

3. ZONE METHOD TESTING ROOMS CONSTRUCTION

There are 20 rooms for testing. Its area is in Table (I-1) in Appendix I (Fig.(1)). As the dimensions of the luminaire used is 1.2m length so we start with room test has dimension 1.5 × 1.5 m which is the suitable value. However if the report for luminaire has dimensions 20 × 20 cm the test.

In Table (3) the minimum number of points and room has a testing Grid, the dimensions of these grids described (see Appendix I, Table(I-1)).



Fig(1): Test rooms configuration

Research has shown ([7]) that the relationship between room dimensions and the number of measuring points required to calculate the average illuminance and give an error of less than 10% in a rectangular room with a regular array of luminaries at spacing no greater than 1.5-1.0 can be tabulated in terms of room index (RI) as shown below, where the room index is given by

RI = (Area of ceiling and floor/ Area of walls between the luminaries and the working plane)

$$RI = (2l \times W) / H (l + w)$$

Therefore RI = w/2H for a square room where l = room length & w = room width

H= luminaire mounting height above the working plane.

Table (3): Room index & number of measuring points required to calculate the average

RI	*Numbers of points*
Below 1	9
1 and below 2	16
2 and below 3	25
3 and above	36

This CU = 0.55. Note that this is for an effective floor reflectance of 40%, while the actual effective more can be used. The points should be laid out as a grid with half spacing at the walls. It is obvious that this grid must not coincide with the grid of the luminaries, since this would place each reading directly beneath a luminaire which would give large errors. In that case, the next higher number of points of measurement should be used ([1]).

The installation should have run for 100 hours from new before the measurements are taken and this initial comparison of the calculated and measured average values should use a calculated value that does not include the maintenance factor ([1]).

4. PROPOSED EXPERIMENTS

The purpose of these experiments is to apply zone method and compare it with lumen method and lumen micro methods. by creating test room, this room used as drawing office, which contains four desks. Its Dimensions are 8.5 m width (W), 10 m Length (L) and 3 m height (h). The working plane at 0.6 The Reflectances of room are Ceiling 80%, Walls 80%, floor 40% .The tables used in lumen method and Zone method are in Appendices.

4.1 Case1:-Lumen method

Firstly: to calculate cavity ratios as follows, or look up in table of cavity ratios . It is found that

Ceiling-cavity ratio (CCR) $= 5h_{RC}(L+W)/LW = RCR \times (h_{CC}/h_{RC})$ **…………….(1)**

CCR= 0 (recessed units are used)

Room-cavity ratio (RCR) $= 5h_{RC}(L+W)/LW$ **…………(2)**

RCR = (5) (8) (8.5+10) / (8.5) (10) = 2.7

Floor-cavity ratio (FCR) $= 5h_{FC}(L+W)/LW = RCR\times (h_{FC}/h_{RC})$ **…………………...(3)**

FCR = (5) (0.6) (8.5+10) / (8.5) (10) = 0.65

Secondly: look up effective cavity reflectances for ceiling and floor cavities. ρ_{CC} for the ceiling will be 80%, while ρ_{FC} for the floor cavity will be 42%.

Thirdly: With the room-cavity ratio RCR known, it is now possible to find the coefficient of utilization for the luminaire in a room having a RCR of 2.7 and effective reflectances as follows:

ρ_{CC} = 80% ρ_w = *66%* ρ_{FC} = 40%

In Lumen method, the design of lighting system depends on that the illumination at every point in reflectance of the floor ρ_{FC} is 42%. To correct for this, locate the appropriate multiplier for the RCR already (2.7). It is 0.95 and is found by interpolating between the numbers for 80 ρ_{CC} and between RCRs of 4.0 and 5.0. Then CU final = 0.55 * 0.95 = 0.52

Fourthly: Estimate the number of luminaries used:

Number of luminaries =

(llumination * area) / (lamp lumens * coefficient of utilization * LLF)

N= (400 × 8.5 × 10) / (3150 × 0.52 ×

0.6) = 35 luminaire

Finally: Distribute in a matrix (6 × 6) as shown in Fig.(2):

The length of the luminaire is 1.2 m and the width is 0.3 m.

So the distance in X-axis = (10-(6× 1.2))/6 = 0.5m

So the distance in Yaxis = (8.5 – (6× 0.3))/6 = 1.2 m

E_{min} = 286 Lux and E_{max} = 955 Lux .On each disk E_{max} = 815 Lux & E_{min}= 759 Lux & E_{av} = 854 Lux and is twice the wanted Lux

Finally: try 5 × 4 matrix for lighting the room

Using the same steps, the result the average during whole room is E_{av} =437 Lux and E_{min} = 150 Lux and E_{max} = 533 Lux. On each disk E_{max} = 507 Lux & E_{min}= 492 Lux & E_{max} = 526 Lux and is twice the wanted Lux.

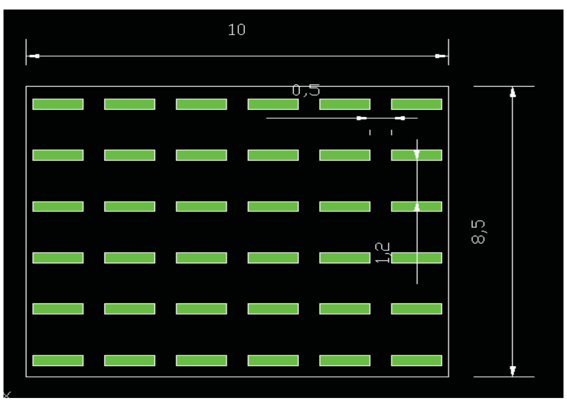


Fig. (2) Luminaries distribute on whole room using luman method to have 400 lux on working plane

the room take the same value. In the studied room all the points have 400 Lux. to achieve that need to use 36 luminaire, use one type of luminaries only, and to determine the utilization factor varies for each luminaire. Another drawback of that method that the designer needs to use the following tables beside the reflectance table:

1. Cavity ratio.
2. Percent effective ceiling or floor-cavity reflectance for various Reflectances.
3. Multiplying factors for percentage of effective floor-cavity reflectance.
4. Coefficients of utilization and luminance coefficients of the Luminaire.
5. Room position multipliers (for all room-cavity ratios and for all points)

Case 2: Lumen micro 2000

Firstly: Define the room and put the furniture as shown in Fig. (3).

Secondly: select luminaries attend to use in your project & them to room & arrange them.

Thirdly: add calculation grids at whole room & at desks

Fourthly: calculate the output of the design.

Fifthly: view the results as shown in Fig.(4) and see if the design achieves the required illumination value on desks.

The average during whole room is E_{av} =791 Lux,

needs more time, accurate input data luminaire to 20) and with high accuracy but program of lumen micro2000 is too expensive, designer have to use try and error until achieve the desired value.

The results using lumen micro2000 are E_{max}=533 lux.on each disk E_{max}=507 lux& Emin492 Lux & E_{max}=526 lux

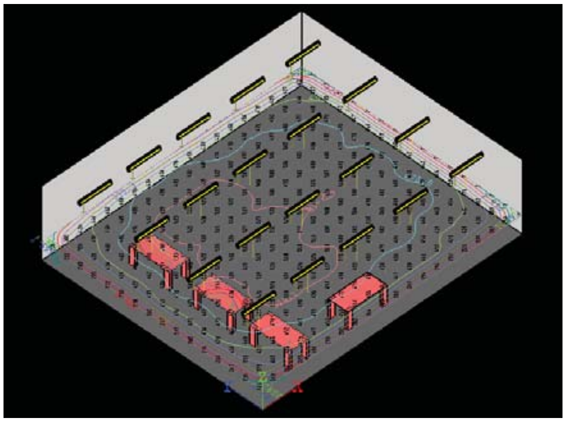


Fig. (3) : 4× 5 Matrix of Luminaries distribution to design lighting in whole room using Lumen Micro2000

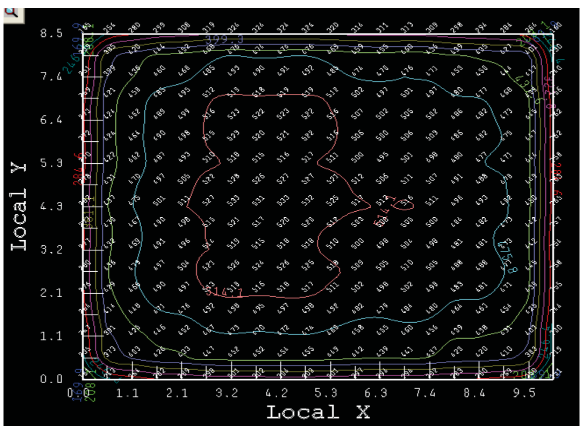


Fig. (4): The lighting contour distribution on the whole room grid for luminaire distribution (5×4)

Finally: For the drawing desks, another type of luminaire installed over every drawing desk (local lighting) which gives the remaining 100 lux**.**

In Zone method the design is manually, use one new table beside reflectance table, use different types in luminaire, design depends on the height of luminaire, reduce the number of luminaries from 36 to 24(20+4) ,reduce consumed power, reduce cost, use short time, suitable for modern decoration and let designers use luminaries like any other electrical instrument.

Case (3) proposed zone method

Using Zone method as the ZMPR for the desired in the present work in case 3 luminaire to be used in Appendix II.

Firstly:calculate the average reflectance ρ_{av} = (0.8 + (4× 0.8)) / 5 = 4/5 = 0.8

Secondly: The previous selected 400 lux as average value for whole room, 300 lux is taken only as average illuminance for the whole room and another 100 lux fall on the 4 drawing desk

Thirdly: From the ZMPR at ρ_{av} = 0.8 & h_s = 2 m and E_{av} = 300 lux the luminaire falling area is 4 m^2.

So Number of luminaires = A_r / A_s = (10 × 8.5) / 4 = 21 luminaire. ………..(4)

Fourthly: Distribute in a matrix (5 × 4) as shown in Fig.(5). From the ZMPD the length of the luminaire is 1.2g m and the width is 0.3 m.

So the distance in X-axis = (10-(5× 1.2))/5 = 0.8 m

So the distance in Yaxis = (8.5 – (4× 0.3))/4 = 1.825m

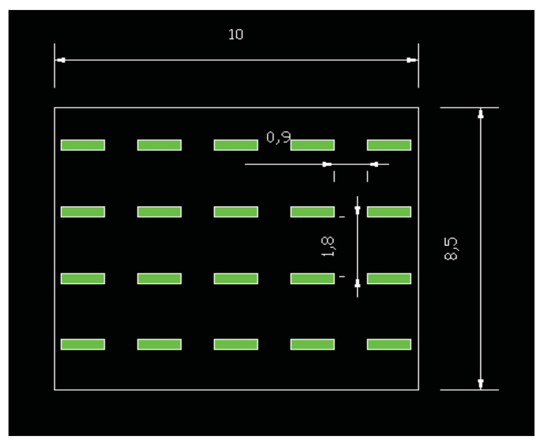


Fig. (5): Luminaries distribution on whole room using zone method

In Lumenmicro 2000, the design achieved the desired illumination values, reduces the number of luminaries used, reduces electrical power used in lighting compared with lumen method.

Final results to 3 cases:

The final results to the three cases are shown in table 4.

Table (4): Final results of the three cases

Case	Case1 36 luminaires (lumen method)	Case 2' 36 luminaires Lumenmicro 2000	Case 2' 20 luminaires Lumenmicr o2000	Case 3 Zone method 20 luminaires
E_{max}	-	955	533	334
E_{min}	-	286	507	187
E_{av}	400	791	150	300
E_{desk}	-	526	437	100

5. CONCLUSION

From previous discussion it can be concluded that:

1. The research introduced a new lighting design method that called "zone method", allows designers to use it manually, simple, accurate and reduce power and cost used in lighting design.
2. The new formulation and construction of the zone method photometric report.
3. The applying of this method on one of luminaries and evaluate the zone method photometric report of this luminaire.
4. Applying the zone method The research success to apply the method on the lighting design of a drawing room and compared it with lumen method and lumen micro 2000, shows that the high accuracy of this method like designing using lumen micro2000

REFERENCES:

1. Robert Bean, "Lighting Interior and Exterior", Architectural press, 2004.

2.Members of the staff of the N.V. Philips' Gloeilampenfabrieken, "Lighting manual", Lighting Design and Engineering Center, 1974.

3. CIE,"Lighting of indoor work places", 2001.

4. CIE 52-1982, "Technical Report: Calculations for interior lighting (Applied method)", 1982

5. CIE 40-1978, "Technical Report: Calculations for interior lighting (Basic method)", 1978.

6. James Avro, Kenneth Torrance and Brain smith, " A Framework for the Analysis of Error in Global Illumination Algorithms", Program of Computer Graphics, Cornell University

7. James Casey, "Three dimensional illuminance: a tool for lighting design", Barllett school of architecture, September 1998.

8. Donald G.Fink, H.Wayne Beaty,"Standard Handbook for Electrical Engineers", 11th Edition (chapter 22), MC GrawHill.

9. John L.Fetters, "The handbook of Lighting Surveys & Audit", CRC Press, 1997.

10.Donald G.Fink and Joh M.carroll,"Standard Handbook for Electrical Engineers", 10th Edition (chapter 16), MC GrawHill.

11. Terrell, Clifford and John H.watt, "American Electricians Handbook", 9th Edition (chapter. 10), MC GrawHill.

13.J.R.Coaton and A.M.Marsden, "Lamps and Lighting", 4th Edition, Arnold and contributors, 1997.

14. Lumen Micro2000, www.lighting-technologies.com

Appendix I: Test rooms specifications

Table (I-1): Test rooms geometries

Room No	Area(m^2)	Dimensions(m)	Testing grid		
			Matrix	Rows spacing(m)	Columns spacing(m)
1	*0.25*	*0.5 × 0.5*	*4 × 4*	*0.17*	*0.17*
2	*1*	*1 × 1*	*5 × 5*	*0.25*	*0.25*
3	*2.25*	*1.5 × 1.5*	*9 × 9*	*0.187*	*0.187*
4	*4*	*2 × 2*	*9 × 9*	*0.25*	*0.25*
5	*6.25*	*2.5 × 2.5*	*9 × 9*	*0.312*	*0.312*
6	*9*	*3 × 3*	*9 × 9*	*0.375*	*0.375*
7	*12.25*	*3.5 × 3.5*	*9 × 9*	*0.4375*	*0.4375*
8	*16*	*4 × 4*	*9 × 9*	*0.5*	*0.5*
9	*20.25*	*4.5 × 4.5*	*9 × 9*	*0.5625*	*0.5625*
10	*25*	*5 × 5*	*10 × 10*	*0.5556*	*0.5556*
11	*30.25*	*5.5 × 5.5*	*11 × 11*	*0.55*	*0.55*
12	*36*	*6 × 6*	*12 × 13*	*0.5442*	*0.5*
13	*42.25*	*6.5 × 6.5*	*13 × 13*	*0.54*	*0.54*
14	*49*	*7 × 7*	*14 × 14*	*0.54*	*0.54*
15	*56.25*	*7.5 × 7.5*	*15 × 15*	*0.54*	*0.54*
16	*64*	*8 × 8*	*16 × 16*	*0.53*	*0.53*
17	*72.25*	*8.5 × 8.5*	*17 × 17*	*0.53*	*0.53*
18	*81*	*9 × 9*	*18 × 18*	*0.53*	*0.53*
19	*90.25*	*9.5 × 9.5*	*20 × 20*	*0.5*	*0.5*
20	*100*	*10 × 10*	*20 × 20*	*0.53*	*0.53*

Table (I-2): Cavity Ratios

Room dimensions		Cavity depth																		
Width	Length	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	9.0	10	11	12	14	16	20	25	30
8	8	1.2	1.9	2.5	3.1	3.7	4.4	5.0	6.2	7.5	8.8	10.0	12.5	12.5	.....	.....	.....	.....	.....	.....	......
	10	1.1	1.7	2.2	2.8	3.4	3.9	4.5	5.6	6.7	7.9	9.0	11.3	11.3	12.4	.....	.....	.....	.....	.....	......
	14	1.0	1.5	2.0	2.5	3.0	3.4	3.9	4.9	5.9	6.9	7.8	9.7	9.7	10.7	11.7	.....	.....	.....	.....	......
	20	0.9	1.3	1.7	2.2	2.6	3.1	3.5	4.4	5.2	6.1	7.0	8.8	8.8	9.6	10.5	12.2	.....	.....	.....	......
	30	0.8	1.2	1.6	2.0	2.4	2.8	3.2	4.0	4.7	5.5	6.3	7.9	7.9	8.7	9.5	11.0	.....	.....	.....	......
	40	0.7	1.1	1.5	1.9	2.3	2.6	3.0	3.7	4.5	5.3	5.9	7.4	7.4	8.1	8.8	10.3	11.8	.....	.....	......
10	10	1.0	1.5	2.0	2.5	3.0	3.5	4.0	5.0	6.0	7.0	8.0	10.0	10.0	11.0	12.0	......	......	......	......	......
	14	0.9	1.3	1.7	2.1	2.6	3.0	3.4	4.3	5.1	6.0	6.9	8.6	8.6	9.5	10.4	12.0	....	......	......	......
	20	0.7	1.1	1.5	1.9	2.3	2.6	3.0	3.7	4.5	5.3	6.0	7.5	7.5	8.3	9.0	10.5	12.0	......	......	......
	30	0.7	1.0	1.3	1.7	2.0	2.3	2.7	3.3	4.0	4.7	5.3	6.6	6.6	7.3	8.0	9.4	10.6	......	......	......
	40	0.6	0.9	1.2	1.6	1.9	2.2	2.5	3.1	3.7	4.4	5.0	6.2	6.2	6.9	7.5	8.7	10.0	12.5	......	......
	60	0.6	0.9	1.2	1.5	1.7	2.0	2.3	2.9	3.5	4.1	4.7	5.9	5.9	6.5	7.1	8.2	9.4	11.7	......	......
12	12	0.8	1.2	1.7	2.1	2.5	2.9	2.3	4.2	5.0	5.8	6.7	8.4	8.4	9.2	10.0	11.7	......	......	......	......
	16	0.7	1.1	1.5	1.8	2.2	2.5	2.9	3.6	4.4	5.1	5.8	7.2	7.2	8.0	8.7	10.2	11.6	......	......	......
	24	0.6	0.9	1.2	1.6	1.9	2.2	2.5	3.1	3.7	4.4	5.0	6.2	6.2	6.9	7.5	8.7	10.0	12.5	......	......
	36	0.6	0.8	1.1	1.4	1.7	1.9	2.2	2.8	3.3	3.9	4.4	5.5	5.5	6.0	6.6	7.8	8.8	11.0	......	......
	50	0.5	0.8	1.0	1.3	1.5	1.8	2.1	2.6	3.1	3.6	4.1	5.1	5.1	5.6	6.2	7.2	8.2	10.2	......	......
	70	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.4	2.9	3.4	3.9	4.9	4.9	5.4	5.8	6.8	7.8	9.7	12.2	......
14	14	0.7	1.1	1.4	1.8	2.1	2.5	2.9	3.6	4.3	5.0	5.7	7.1	7.1	7.8	8.5	10.0	11.4	......	......	......
	20	0.6	0.9	1.2	1.5	1.8	2.1	2.4	3.0	3.6	4.2	4.9	6.1	6.1	6.7	7.3	8.6	9.8	12.3	......	......
	30	0.5	0.8	1.0	1.3	1.6	1.8	2.1	2.6	3.1	3.7	4.2	5.2	5.2	5.8	6.3	7.3	8.4	10.5	......	......
	42	0.5	0.7	1.0	1.2	1.4	1.7	1.9	2.4	2.9	3.3	3.8	4.7	4.7	5.2	5.7	6.7	7.6	9.5	11.9	......
	60	0.4	0.7	0.9	1.1	1.3	1.5	1.8	2.2	2.6	3.1	3.5	4.4	4.4	4.8	5.2	6.1	7.0	8.8	10.9	......
	90	0.4	0.6	0.8	1.0	1.2	1.4	1.6	2.0	2.5	2.9	3.3	4.1	4.1	4.5	5.0	5.8	6.6	8.3	10.3	12.4
17	17	0.6	0.9	1.2	1.5	1.8	2.1	2.3	2.9	3.5	4.1	4.7	5.9	5.9	6.5	7.0	8.2	9.4	11.7	......	......
	25	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.5	3.0	3.5	4.0	5.0	5.0	5.5	6.0	7.0	8.0	10.0	12.5	......
	35	0.4	0.7	0.9	1.1	1.3	1.5	1.7	2.2	2.6	3.1	3.5	4.4	4.4	4.8	5.2	6.1	7.0	8.7	10.9	......
	50	0.4	0.6	0.8	1.0	1.2	1.4	1.6	2.0	2.4	2.8	3.1	3.9	3.9	4.3	4.5	5.4	6.2	7.7	9.7	11.6
	80	0.4	0.5	0.7	0.9	1.1	1.2	1.4	1.8	2.1	2.5	2.9	3.6	3.6	4.0	4.3	5.1	5.8	7.2	9.0	10.9
	120	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.7	2.0	2.3	2.7	3.4	3.4	3.7	4.0	4.7	5.4	6.7	8.4	10.1
20	20	0.5	0.7	1.0	1.2	1.5	1.7	2.0	2.5	3.0	3.5	4.0	5.0	5.0	5.5	6.0	7.0	8.0	10.0	12.5	......
	30	0.4	0.6	0.8	1.0	1.2	1.5	1.7	2.1	2.5	2.9	3.3	4.1	4.1	4.5	4.9	5.8	6.6	8.2	10.3	12.4
	45	0.4	0.5	0.7	0.9	1.1	1.3	1.4	1.8	2.2	2.5	2.9	3.6	3.6	4.0	4.3	5.1	5.8	7.2	9.1	10.9
	60	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.7	2.0	2.3	2.7	3.4	3.4	3.7	4.0	4.7	5.4	6.7	8.4	10.1
	90	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.5	1.8	2.1	2.4	3.0	3.0	3.3	3.6	4.2	4.8	6.0	7.5	9.0
	150	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.4	1.7	2.0	2.3	2.9	2.9	3.2	3.4	4.0	4.6	5.7	7.2	8.6
24	24	0.4	0.6	0.8	1.0	1.2	1.5	1.7	2.1	2.5	2.9	3.3	4.1	4.1	4.5	5.0	5.8	6.7	8.2	10.3	12.4
	32	0.4	0.5	0.7	0.9	1.1	1.3	1.5	1.8	2.2	2.6	2.9	3.6	3.6	4.0	4.3	5.1	5.8	7.2	9.0	11.0
	50	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.5	1.8	2.2	2.5	3.1	3.1	3.4	3.7	4.4	5.0	6.2	7.8	9.4
	70	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.4	1.7	2.0	2.2	2.8	2.8	3.0	3.3	3.8	4.4	5.5	6.9	8.2
	100	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.3	1.6	1.8	2.1	2.6	2.6	2.9	3.1	3.7	4.2	5.2	6.5	7.9
	160	0.2	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.7	1.9	2.4	2.4	2.6	2.8	3.3	3.8	4.7	5.9	7.1
30	30	0.3	0.5	0.7	0.8	1.0	1.2	1.3	1.7	2.0	2.3	2.7	3.3	3.3	3.7	4.0	4.7	5.4	6.7	8.4	10.0
	45	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.4	1.7	1.9	2.2	2.7	2.7	3.0	3.3	3.8	4.4	5.5	6.9	8.2
	60	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.5	1.7	2.0	2.5	2.5	2.7	3.0	3.5	4.0	5.0	6.2	7.4
	90	0.2	0.3	0.4	0.6	0.7	0.8	0.9	1.1	1.3	1.6	1.8	2.2	2.2	2.5	2.7	3.1	3.6	4.5	5.6	6.7
	150	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	2.0	2.0	2.2	2.4	2.8	3.2	4.0	5.0	5.9
	200	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.3	1.5	1.9	1.9	2.0	2.2	2.6	3.0	3.7	4.7	5.6
36	36	0.3	0.4	0.6	0.7	0.8	1.0	1.1	1.4	1.7	1.9	2.2	2.8	2.8	3.0	3.3	3.9	4.4	5.5	6.9	8.3
	50	0.2	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.7	1.9	2.5	2.5	2.6	2.9	3.3	3.8	4.8	5.9	7.2
	75	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	2.0	2.0	2.3	2.5	2.9	3.3	4.1	5.1	6.1
	100	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.1	1.3	1.5	1.9	1.9	2.1	2.3	2.6	3.0	3.8	4.7	5.7
	150	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.4	1.7	1.7	1.9	2.1	2.4	2.8	3.5	4.3	5.2
	200	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.1	1.3	1.6	1.6	1.8	2.0	2.3	2.6	3.3	4.1	4.9
42	42	0.2	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	1.9	2.4	2.4	2.6	2.8	3.3	3.8	4.7	5.9	7.1
	60	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	2.0	2.0	2.2	2.4	2.8	3.2	4.0	5.0	6.0
	60	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.4	1.7	1.7	1.9	2.1	2.4	2.8	3.5	4.4	5.2
	140	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.8	0.9	1.1	1.2	1.5	1.5	1.7	1.9	2.2	2.5	3.1	3.9	4.6
	200	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.9	1.0	1.1	1.4	1.4	1.6	1.7	2.0	2.3	2.9	3.6	4.3
	300	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.7	0.8	0.9	1.1	1.4	1.4	1.5	1.7	1.9	2.2	2.8	3.5	4.2
50	50	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	2.0	2.0	2.2	2.4	2.8	3.2	4.0	5.0	6.0
	70	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.4	1.7	1.7	1.9	2.0	2.4	2.7	3.4	4.3	5.1
	100	0.1	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.5	1.5	1.6	1.8	2.1	2.4	3.0	3.7	4.5
	150	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.7	0.8	0.9	1.1	1.3	1.3	1.5	1.6	1.9	2.1	2.7	3.3	4.0
	300	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.1	1.1	1.3	1.4	1.6	1.9	2.3	2.9	3.5
60	60	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.3	1.7	1.7	1.8	2.0	2.3	2.7	3.3	4.2	5.0
	100	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.7	0.8	0.9	1.1	1.3	1.3	1.5	1.6	1.9	2.1	2.7	3.3	4.0
	150	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.2	1.2	1.3	1.4	1.6	1.9	2.3	2.9	3.5
	300	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.0	1.1	1.2	1.4	1.6	2.0	2.5	3.0
75	75	0.1	0.2	0.3	0.3	0.4	0.5	0.5	0.7	0.8	0.9	1.1	1.3	1.3	1.5	1.6	1.9	2.1	2.7	3.3	4.0
	120	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.8	0.9	1.1	1.1	1.2	1.3	1.5	1.7	2.2	2.7	3.3
	200	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.7	0.9	0.9	1.0	1.1	1.3	1.5	1.8	2.3	2.7
	300	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.8	0.9	1.0	1.2	1.3	1.7	2.1	2.5
100	100	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.0	1.1	1.2	1.4	1.6	2.0	2.5	3.0
	200	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.7	0.7	0.8	0.9	1.0	1.2	1.5	1.9	2.2
	300	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.7	0.7	0.7	0.8	0.9	1.1	1.3	1.7	2.0
150	150	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.7	0.7	0.7	0.8	0.9	1.1	1.3	1.7	2.0
	300	......	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.8	1.0	1.2	1.5
200	200	......	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.8	1.0	1.2	1.5
	300	......	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.8	1.0	1.2
300	300	......	......	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.8
500	500	......	......	.....	.....	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.6

Table (I-3): Percent Effective Ceiling or Floor Cavity Reflectance at Various Reflectance Combinations

Ceiling or floor reflectance	90				80				70			50			30				10		
%Wall reflectance	90	70	50	30	80	70	50	30	70	50	30	70	50	30	65	50	30	10	50	30	10
CCR OR FCR From 0 to 0.5																					
0	90	90	90	90	80	80	80	80	70	70	70	50	50	50	30	30	30	30	10	10	10
0.1	90	89	88	87	79	79	78	78	69	69	68	59	49	48	30	30	29	29	10	10	10
0.2	89	88	86	85	79	78	77	76	68	67	66	49	48	47	30	29	29	28	10	10	9
0.3	89	87	85	83	78	77	75	74	68	66	64	49	47	46	30	29	28	27	10	10	9
0.4	88	86	83	81	78	76	74	72	67	65	63	48	46	45	30	29	27	26	11	10	9
0.5	88	85	81	78	77	75	73	70	66	64	61	48	46	44	29	28	27	25	11	10	9
CCR OR FCR From 0.6 to 1																					
0.6	88	84	80	76	77	75	71	68	65	62	59	47	45	43	29	28	26	25	11	10	9
0.7	88	83	78	74	76	74	70	66	65	61	58	47	44	42	29	28	26	24	11	10	8
0.8	87	82	77	73	75	73	69	65	64	60	56	47	43	41	29	27	25	23	11	10	8
0.9	87	81	76	71	75	72	68	63	63	59	55	46	43	40	29	27	25	22	11	9	8
1	86	80	74	69	74	71	66	61	63	58	53	46	42	39	29	27	24	22	11	9	8
CCR OR FCR From 1.1 to 1.5																					
1.1	86	79	73	67	74	71	65	60	62	57	52	46	41	38	29	26	24	21	11	9	8
1.2	86	78	72	65	73	70	64	58	61	56	50	45	41	37	29	26	23	20	12	9	7
1.3	85	78	70	64	73	69	63	57	61	55	49	45	40	36	29	26	23	20	12	9	7
1.4	85	77	69	62	72	68	62	55	60	54	48	45	40	35	28	26	22	19	12	9	7
1.5	85	76	68	61	72	68	61	54	59	53	47	44	39	34	28	25	22	18	12	9	7
CCR OR FCR From 1.6 to 2																					
1.6	85	75	66	59	71	67	60	53	59	53	45	44	39	33	28	25	21	18	12	9	7
1.7	84	74	65	58	71	66	59	52	58	51	44	44	38	32	28	25	21	17	12	9	7
1.8	84	73	64	56	70	65	58	50	57	50	43	43	37	32	28	25	21	17	12	9	6
1.9	84	73	63	55	70	65	57	49	57	49	42	43	37	31	28	25	20	16	12	9	6
2	83	72	62	53	69	64	56	48	56	48	41	43	37	30	28	24	20	16	12	9	6
CCR OR FCR From 2.1 to 2.5																					
2.1	83	71	61	52	69	63	55	47	56	47	40	43	36	29	28	24	20	16	13	9	6
2.2	83	70	60	51	68	63	54	45	55	46	39	42	36	29	28	24	19	15	13	9	6
2.3	83	69	59	50	68	62	53	44	54	46	38	42	35	28	28	24	19	15	13	9	6
2.4	82	68	58	48	67	61	52	43	54	45	37	42	35	27	28	24	19	14	13	9	6
2.5	82	68	57	47	67	61	51	42	53	44	36	41	34	27	27	23	18	14	13	9	6
CCR OR FCR From 2.6 to 3																					
2.6	82	67	56	46	66	60	50	41	53	43	35	41	34	26	27	23	18	13	13	9	5
2.7	82	66	55	45	66	60	49	40	52	43	34	41	33	26	27	23	18	13	13	9	5
2.8	81	66	54	44	66	59	48	39	52	42	33	41	33	25	27	23	18	13	13	9	5
2.9	81	65	53	43	65	58	48	38	51	41	33	40	33	25	27	23	17	12	13	9	5
3	81	64	52	42	65	58	47	38	51	40	32	40	32	24	27	22	17	12	13	8	5
CCR OR FCR From 3.1 to 3.5																					
3.1	80	64	51	41	64	57	46	37	50	40	31	40	32	24	27	22	17	12	13	8	5
3.2	80	63	50	40	64	57	45	36	50	39	30	40	31	23	27	22	16	11	13	8	5
3.3	80	62	49	39	64	56	44	35	49	39	30	39	31	23	27	22	16	11	13	8	5
3.4	80	62	48	38	63	56	44	34	49	38	29	39	31	22	27	22	16	11	13	8	5
3.5	79	61	48	37	63	55	43	33	48	38	29	39	30	22	26	22	16	11	13	8	5
CCR OR FCR From 3.6 to 4																					
3.6	79	60	47	36	62	54	42	33	48	37	28	39	30	21	26	21	15	10	13	8	5
3.7	79	60	46	35	62	54	42	32	48	37	27	38	30	21	26	21	15	10	13	8	4
3.8	79	59	45	35	62	53	41	31	47	36	27	38	29	21	26	21	15	10	13	8	4
3.9	78	59	45	34	61	53	40	30	47	36	26	38	29	20	26	21	15	10	13	8	4
4	78	58	44	33	61	52	40	30	46	35	26	38	29	20	26	21	15	9	13	8	4
CCR OR FCR From 4.1 to 4.5																					
4.1	78	57	43	32	60	52	39	29	46	35	25	37	28	20	26	21	14	9	13	8	4
4.2	78	57	43	32	60	51	39	29	46	34	25	37	28	19	26	20	14	9	13	8	4
4.3	78	56	42	31	60	51	38	28	45	34	25	37	28	19	26	20	14	9	13	8	4
4.4	77	56	41	30	59	51	38	28	45	34	24	37	27	19	26	20	14	8	13	8	4
4.5	77	55	41	30	59	50	37	27	45	33	24	37	27	19	25	20	14	8	14	8	4
CCR OR FCR From 4.6 to 5																					
4.6	77	55	40	29	59	50	37	26	44	33	24	36	27	18	25	20	14	8	14	8	4
4.7	77	54	40	29	58	49	36	26	44	33	23	36	26	18	25	20	13	8	14	8	4
4.8	76	54	39	28	58	49	36	25	44	32	23	36	26	18	25	19	13	8	14	8	4
4.9	76	53	38	28	58	49	35	25	44	32	23	36	26	18	25	19	13	7	14	8	4
5	76	53	38	27	57	48	35	25	43	32	22	36	26	17	25	19	13	7	14	8	4

Table (I – 4)
Multiplying Factors for 10 % Effective Floor – Cavity Reflectance

Effective Ceiling cavity reflectance, pcc	80				70				50			30			10		
%Wall reflectance,pw	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
Room cavity ratio																	
1	0.923	0.929	0.935	0.940	0.933	0.939	0.943	0.948	0.956	0.960	0.963	0.973	0.976	0.979	0.989	0.991	0.993
2	0.931	0.942	0.950	0.958	0.940	0.949	0.957	0.963	0.962	0.968	0.974	0.976	0.980	0.985	0.988	0.991	0.995
3	0.939	0.951	0.961	0.969	0.945	0.957	0.966	0.973	0.967	0.975	0.981	0.978	0.983	0.988	0.988	0.992	0.996
4	0.944	0.958	0.969	0.978	0.950	0.963	0.973	0.980	0.972	0.980	0.986	0.980	0.986	0.991	0.987	0.992	0.996
5	0.949	0.964	0.976	0.983	0.954	0.968	0.978	0.985	0.975	0.983	0.989	0.981	0.988	0.993	0.987	0.992	0.997
6	0.953	0.969	0.980	0.986	0.958	0.972	0.982	0.989	0.977	0.985	0.992	0.982	0.989	0.995	0.987	0.993	0.997
7	0.957	0.973	0.983	0.991	0.961	0.975	0.985	0.991	0.979	0.987	0.994	0.983	0.990	0.996	0.987	0.993	0.998
8	0.960	0.976	0.986	0.993	0.963	0.977	0.987	0.993	0.981	0.988	0.995	0.984	0.991	0.997	0.987	0.994	0.998
9	0.963	0.978	0.987	0.994	0.965	0.979	0.989	0.994	0.983	0.990	0.996	0.985	0.992	0.998	0.988	0.994	0.999
10	0.965	0.980	0.989	0.995	0.967	0.981	0.990	0.995	0.984	0.991	0.997	0.986	0.993	0.998	0.988	0.994	0.999

Table (I – 5)
Multiplying Factors for 10 % Effective Floor – Cavity Reflectance

Appendix I Table(I-5) Multiplying Factors for 10% Effective Floor-Cavity Reflectance																	
Effective Ceiling cavity reflectance, pcc	80				70				50			30			10		
%Wall reflectance,pw	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10
Room cavity ratio																	
1	1.092	1.092	1.075	1.068	1.077	1.070	1.064	1.059	1.049	1.044	1.040	1.028	1.026	1.023	1.012	1.010	1.008
2	1.079	1.066	1.055	1.047	1.068	1.057	1.048	1.039	1.041	1.033	1.027	1.026	1.021	1.017	1.013	1.010	1.006
3	1.070	1.054	1.042	1.033	1.061	1.048	1.037	1.028	1.034	1.027	1.020	1.024	1.017	1.012	1.014	1.009	1.005
4	1.062	1.045	1.033	1.024	1.055	1.040	1.029	1.021	1.030	1.022	1.015	1.022	1.015	1.010	1.014	1.009	1.004
5	1.056	1.038	1.026	1.018	1.050	1.034	1.024	1.051	1.027	1.018	1.012	1.020	1.013	1.008	1.014	1.009	1.004
6	1.052	1.033	1.021	1.014	1.047	1.030	1.020	1.012	1.024	1.015	1.009	1.019	1.012	1.006	1.014	1.008	1.003
7	1.047	1.029	1.018	1.011	1.043	1.026	1.017	1.009	1.022	1.013	1.007	1.018	1.010	1.005	1.014	1.008	1.003
8	1.044	1.026	1.015	1.009	1.040	1.024	1.015	1.007	1.020	1.012	1.006	1.017	1.009	1.004	1.013	1.007	1.003
9	1.040	1.024	1.014	1.007	1.037	1.022	1.014	1.006	1.019	1.011	1.005	1.016	1.009	1.004	1.013	1.007	1.002
10	1.037	1.022	1.012	1.006	1.034	1.020	1.012	1.005	1.017	1.010	1.004	1.015	1.009	1.003	1.013	1.007	1.002

Table (I- 6)
Coefficients of Utilization

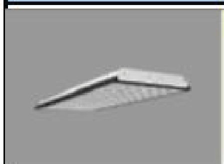
ρCC*	80				70				50			30			10			0
Pw**	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
RCR***	Ceiling cavity luminance coefficients for 205 effective floor-cavity reflectance (ρFC=20)																	
0	.83	.83	.83	.83	.78	.78	.78	.78	.70	.70	.70	.63	.63	.63	.56	.56	.56	.52
1	.72	.67	.63	.59	.68	.64	.60	.56	.57	.54	.51	.50	.48	.45	.44	.42	.40	.37
2	.64	.57	.51	.46	.60	.54	.48	.44	.48	.43	.40	.42	.39	.35	.37	.34	.32	.29
3	.58	.49	.42	.37	.54	.46	.40	.35	.41	.36	.32	.36	.32	.29	.32	.28	.26	.23
4	.53	.43	.36	.30	.49	.41	.34	.29	.36	.31	.26	.32	.27	.24	.28	.24	.21	.19
5	.48	.38	.31	.26	.45	.36	.29	.24	.32	.26	.22	.28	.24	.20	.25	.21	.18	.16
6	.44	.34	.27	.22	.41	.32	.26	.21	.29	.23	.19	.25	.21	.17	.22	.18	.15	.13
7	.41	.30	.24	.19	.38	.29	.23	.18	.26	.20	.17	.23	.18	.15	.20	.16	.14	.12
8	.38	.28	.21	.17	.35	.26	.20	.16	.23	.18	.15	.21	.16	.13	.18	.15	.12	.10
9	.35	.25	.19	.15	0.3	.24	.18	.14	.21	.16	.13	.19	.15	.12	.17	.13	.11	.09
10	.33	.23	.17	.13	.31	.22	.16	.13	.20	.15	.12	.18	.13	.11	.16	.12	.10	.08

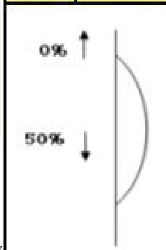
*ρCC = Percent effective ceiling-cavity reflectance.
**ρW = Percent wall reflectance.
***RCR = room-cavity ratio

Table (I- 7)
Coefficients of Utilization and Luminance Coefficients of a Generic Troffer

a. Coefficients of utilization

Typical distribution and lamp lumens %

Typical luminaire	Maint. Cat	Max S/MH guide****
 4 lamp, 2-ft wide troffer with 45 plastic louver- multiply by 1.05 for 2 lamps and 0.95 for 6 lamp	IV	1.0



ρCC*	80			70			50			30			10			0
Pw**	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	0
RCR***	Ceiling cavity luminance coefficients for 205 effective floor-cavity reflectance (ρFC=20)															
0	.59	.59	.59	.58	.58	.58	.55	.55	.55	.53	.53	.53	.51	.51	.51	.50
1	.54	.52	.50	.52	.51	.49	.50	.49	.48	.48	.47	.46	.47	.46	.45	.44
2	.48	.45	.43	.47	.44	.42	.45	.43	.41	.44	.42	.40	.42	.41	.39	.39
3	.43	.40	.37	.42	.39	.37	.41	.38	.36	.40	.37	.36	.39	.37	.35	.34
4	.39	.35	.32	.38	.35	.32	.37	.34	.32	.36	.33	.31	.35	.33	.31	.30
5	.35	.31	.28	.35	.31	.28	.34	.30	.28	.33	.30	.28	.32	.29	.27	.26
6	.32	.28	.25	.32	.28	.25	.31	.27	.25	.30	.27	.25	.29	.26	.24	.23
7	.29	.25	.22	.29	.25	.22	.28	.25	.22	.27	.24	.22	.27	.24	.22	.21
8	.26	.22	.20	.26	.22	.20	.25	.22	.20	.25	.22	.19	.24	.21	.19	.18
9	.24	.20	.17	.24	.20	.17	.23	.20	.17	.23	.19	.17	.22	.19	.17	.16
10	.22	.18	.16	.22	.18	.16	.21	.18	.16	.21	.18	.15	.20	.17	.15	.15

b. Luminance coefficients

ρCC	80			70			50			30			10		
Pw	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10
RCR	Ceiling cavity luminance coefficients***** for 20% effective floor-cavity reflectance (ρFC=20)														
0	.09	.09	.09	.08	.08	.08	.05	.05	.05	.03	.03	.03	.01	.01	.01
1	.09	.08	.07	.08	.07	.06	.05	.05	.04	.03	.03	.02	.01	.01	.01
2	.08	.07	.05	.07	.06	.05	.05	.04	.03	.03	.02	.02	.01	.01	.01
3	.08	.06	.04	.07	.05	.03	.05	.03	.02	.03	.02	.01	.01	.01	.00
4	.07	.05	.03	.06	.04	.03	.04	.03	.02	.03	.02	.01	.01	.01	.00
5	.07	.04	.03	.06	.04	.02	.04	.03	.01	.02	.02	.01	.01	.01	.00
6	.07	.04	.02	.06	.04	.02	.04	.02	.01	.02	.01	.01	.01	.00	.00
7	.06	.04	.02	.06	.03	.02	.04	.02	.01	.02	.01	.01	.01	.00	.00
8	.06	.03	.02	.05	.03	.01	.04	.02	.01	.02	.01	.01	.01	.00	.00
9	.06	.03	.01	.05	.03	.01	.04	.02	.01	.02	.01	.00	.01	.00	.00
10	.06	.03	.01	.05	.03	.01	.03	.02	.01	.02	.01	.00	.01	.00	.00

ρCC	80			70			50			30			10			WDRC
Pw	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	
RCR	WALL LUMINANCE COEFFICIENTS FOR 20% EFFECTIVE FLOOR-CAVITY REFLECTANCE (ρFC=20)															
0																
1	.13	.07	.02	.12	.07	.02	.12	.07	.02	.11	.06	.02	.10	.06	.02	.15
2	.12	.07	.02	.12	.06	.02	.11	.06	.02	.11	.06	.02	.10	.06	.02	.14
3	.11	.06	.02	.11	.06	.02	.11	.06	.02	.10	.06	.02	.10	.05	.02	.13
4	.11	.06	.02	.10	.05	.02	.10	.05	.02	.10	.06	.02	.09	.05	.02	.13
5	.10	.05	.01	.10	.05	.01	.10	.05	.01	.09	.05	.01	.09	.05	.01	.12
6	.10	.05	.01	.09	.05	.01	.09	.05	.01	.09	.05	.01	.08	.04	.01	.11
7	.09	.04	.01	.09	.04	.01	.09	.04	.01	.08	.04	.01	.08	.04	.01	.10
8	.09	.04	.01	.08	.04	.01	.08	.04	.01	.08	.04	.01	.08	.04	.01	.10
9	.08	.04	.01	.08	.04	.01	.08	.04	.01	.08	.04	.01	.07	.04	.01	.09
10	.08	.04	.01	.08	.04	.01	.07	.04	.01	.07	.04	.01	.07	.04	.01	.09

*pCC = Percent effective ceiling-cavity reflectance.

**pW = Percent wall reflectance.

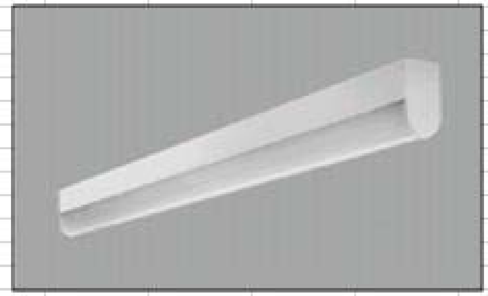
***RCR = room-cavity ratio

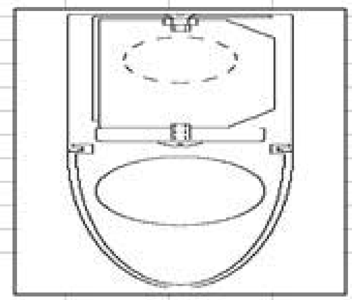
****Maximum S/MH guide---ratio of maximum luminaire spacing to mounting or ceiling height above work plane

*****Although it is recommended that luminance coefficients and wall direct radiation coefficients be published to three decimal places only two are shown here. Three decimal-place data should be obtained from manufacturers of actual luminaires used

Appendix II: Zone Method Photometric Report No-ZMPRF001

ZMPR-No	Report number (ZMPR-EHRC)
TEST	ABC1234 ABC Laboratories
NUMBER OF LAMPS	1
LUMEN PER LAMP	3150
INPUT WATTS	50.4
DISTRIBUTION	Semi-Direct
MANUFACT	GE Lighting INC
LUMCAT	Wide beam fluorescent , used without tilt
LAMPCAT	Fluorescent lamp 50 watt
BALLASTCAT	Global 16G6031
BALLASTST	50 W 277 V MH
MAINCAT	4
LUMINAIRE	Semi-Direct - Quadrilateral fuluorescent used in interior lighing
Lamp	Fluorescent lamp
Lamp Colour	White
Lamp Dimensions	1.2 m Length & 0.3m Width & 0.15m thickness
dispated temperature	………………
OTHERS	This luminaire is useful as a semi-direct applications





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	pav		0.05			0.1			0.15			0.2			0.25		
Hieght	Room no.	Area m2	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax
hs = 0.5	3	2.25	274	89	527	283	93	536	294	97	547	306	103	559	320	110	573
	4	4	185	40	591	188	41	524	195	44	530	201	48	535	209	52	542
	5	6.25	129	17	519	131	19	521	135	22	524	138	25	527	143	28	530
	6	9	93	6	518	95	8	519	97	10	521	100	12	523	103	14	525
	7	12.25	71	3	518	72	4	519	74	5	520	76	6	521	78	8	523
	8	16	56	2	518	56	2	518	58	3	519	59	4	520	60	5	521
	9	20.25	44	1	517	45	1	518	46	2	518	47	3	519	48	3	520
	10	25	39	0.8	448	40	1	448	41	2	449	41	2	449	42	3	450
	11	30.25	32	1	517	32	1	518	33	1	518	33	2	518	34	3	519
	12	36	28	1	487	28	1	287	28	1	487	29	1	488	30	2	488
	13	42.25	24	1	517	24	1	517	25	1	517	25	1	518	26	2	518
	14	49	22	0	445	22	0	445	22	0	445	23	1	445	23	1	446
	15	56.25	19	0	517	19	0	517	19	1	517	19	1	517	20	1	518
	16	64	17	0	447	17	0	447	18	0	447	18	1	447	18	1	448
	17	72.25	15	0	517	15	0	517	15	0	517	16	1	517	16	1	517
	18	81	14	0	454	14	0	455	14	0	455	15	0	455	15	1	455
	19	90.25	12	0	487	12	0	487	12	0	488	13	0	488	13	1	488
	20	100	12	0	450	12	0	450	12	0	450	12	0	450	12	1	450
hs = 1	3	2.25	150	89	209	157	92	219	167	96	230	177	101	242	189	107	257
	4	4	118	52	206	122	53	210	127	56	216	133	59	222	140	62	230
	5	6.25	91	27	201	94	29	204	97	31	207	101	32	211	106	35	215
	6	9	71	19	201	73	20	203	76	22	205	78	24	208	82	27	210
	7	12.25	57	10	201	59	12	202	60	13	203	62	14	205	65	16	20
	8	16	47	6	200	48	7	201	49	8	202	50	9	203	52	10	205
	9	20.25	38	4	200	39	4	201	40	5	201	41	5	202	42	6	203
	10	25	33	3	183	34	3	184	35	4	184	35	4	185	36	5	186
	11	30.25	29	1	200	29	2	200	30	2	201	30	3	201	31	3	202
	12	36	25	1	186	25	1	187	26	2	187	27	2	187	27	2	188
	13	42.25	22	1	200	22	1	200	23	1	200	23	2	201	24	2	201
	14	49	19	1	183	20	1	184	20	1	184	20	1	184	21	2	185
	15	56.25	17	0	200	18	1	200	18	1	200	18	1	200	19	1	201
	16	64	16	0	184	16	1	184	16	1	184	16	1	184	17	1	184
	17	72.25	14	0	200	14	0	200	14	1	200	15	1	200	15	1	200
	18	81	13	0	185	13	0	185	13	0	185	13	1	185	14	1	185
	19	90.25	12	0	186	12	0	187	12	0	187	12	1	187	12	1	187
	20	100	11	0	184	11	0	184	11	0	184	11	1	184	11	1	185
hs =1.5	3	2.25	91	67	112	98	71	121	107	76	132	117	81	145	128	87	158
	4	4	76	47	107	79	48	111	84	51	117	89	53	123	96	57	130
	5	6.25	63	29	104	66	30	107	69	32	110	73	34	114	77	36	119
	6	9	53	22	104	55	23	105	57	25	108	60	26	110	63	28	114
	7	12.25	45	16	103	46	17	104	48	18	106	50	19	107	52	20	110
	8	16	38	10	102	39	11	103	40	12	104	42	13	106	43	15	107
	9	20.25	32	7	102	33	7	103	34	8	103	35	9	104	36	10	106
	10	25	28	5	96	29	6	96	30	6	97	30	7	98	31	8	99
	11	30.25	24	3	102	25	3	102	26	4	103	26	5	103	27	5	104
	12	36	22	2	97	22	2	97	23	3	97	23	3	98	24	4	99
	13	42.25	19	2	101	20	2	102	20	2	102	21	2	102	21	3	103
	14	49	17	1	95	18	2	96	18	2	96	18	2	96	19	2	97
	15	56.25	16	1	96	16	1	97	16	1	97	16	1	97	17	2	97
	16	64	14	1	95	14	1	96	15	1	96	15	1	96	15	2	96
	17	72.25	13	1	101	13	1	101	13	1	102	14	1	102	14	1	102
	18	81	12	0	96	12	1	96	12	1	96	12	1	96	13	1	97
	19	90.25	11	0	97	11	0	97	11	1	97	11	1	97	12	1	97
	20	100	10	0		10	0	96	10	1	96	10	1	96	11	1	96

	pav		0.3			0.35			0.4			0.45			0.5		
Hieght	Room no.	Area m2	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax
hs = 0.5	3	2.25	336	118	589	355	127	608	376	139	629	399	151	625	428	167	682
	4	4	218	56	550	228	62	560	240	68	570	252	75	582	268	84	596
	5	6.25	148	31	535	154	34	540	161	38	546	169	43	553	179	48	562
	6	9	106	17	528	110	21	531	115	25	636	120	29	540	126	35	545
	7	12.25	80	10	525	83	12	527	86	15	530	90	18	533	94	22	537
	8	16	62	6	523	64	8	524	67	10	526	69	12	529	73	15	532
	9	20.25	49	4	521	51	6	522	53	7	524	55	9	526	57	11	528
	10	25	43	4	451	45	5	452	46	6	453	48	7	455	50	9	457
	11	30.25	35	3	519	37	4	521	39	6	522	40	7	524	42	9	526
	12	36	30	2	489	31	3	489	32	4	490	33	5	491	35	6	492
	13	42.25	26	2	519	27	3	519	27	3	520	29	4	521	30	5	522
	14	49	24	1	446	24	2	447	25	3	447	26	3	448	27	4	449
	15	56.25	20	2	518	21	2	519	21	2	519	22	3	520	23	4	520
	16	64	19	1	448	19	1	448	20	2	449	20	2	449	21	3	450
	17	72.25	16	1	518	17	1	518	17	2	518	18	2	519	18	3	520
	18	81	15	1	456	16	1	456	16	1	456	16	2	456	17	2	457
	19	90.25	13	1	488	14	1	488	14	1	489	14	2	489	15	2	490
	20	100	12	1	450	13	1	451	13	1	451	14	2	451	14	2	452
hs = 1	3	2.25	203	114	273	220	123	292	239	134	314	260	145	337	288	160	367
	4	4	148	66	239	158	71	249	169	77	261	181	84	274	196	93	290
	5	6.25	111	37	221	117	41	227	124	44	234	132	49	242	141	54	251
	6	9	85	29	214	89	32	218	94	36	222	99	40	227	106	45	234
	7	12.25	67	18	209	70	21	212	74	24	215	77	27	218	82	32	223
	8	16	54	12	206	56	13	208	59	16	211	62	18	213	65	21	217
	9	20.25	44	8	205	46	9	206	48	11	208	50	13	210	52	15	212
	10	25	38	6	187	39	7	188	41	9	190	42	10	191	44	12	193
	11	30.25	32	4	203	33	5	204	34	6	205	36	7	206	37	9	208
	12	36	28	3	189	29	4	189	30	5	190	31	6	191	33	7	193
	13	42.25	24	2	202	25	3	202	26	4	203	27	4	204	28	6	205
	14	49	21	2	185	22	3	186	23	3	186	24	4	187	25	5	188
	15	56.25	19	2	201	20	2	202	20	3	202	21	3	203	22	4	204
	16	64	17	1	185	17	2	185	18	2	186	19	3	186	20	4	187
	17	72.25	15	1	201	16	1	201	16	1	201	17	2	202	17	3	203
	18	81	14	1	186	14	1	186	15	2	187	15	2	187	16	3	188
	19	90.25	13	1	187	13	1	187	13	1	188	14	2	188	14	2	189
	20	100	12	1	185	12	1	185	12	1	185	13	2	186	13	2	186
hs =1.5	3	2.25	141	95	174	157	104	192	174	114	212	196	127	237	223	142	266
	4	4	103	61	139	112	65	149	122	71	160	133	77	173	148	86	188
	5	6.25	82	38	125	87	42	131	94	45	138	101	49	146	111	55	156
	6	9	66	31	117	70	34	121	75	37	126	80	41	131	87	46	138
	7	12.25	55	22	112	58	24	115	61	27	119	65	30	122	70	34	127
	8	16	45	16	109	47	18	111	50	20	114	53	22	116	57	25	120
	9	20.25	38	12	107	39	13	108	41	15	111	44	17	113	46	19	115
	10	25	33	9	100	34	10	101	36	12	103	38	13	104	40	15	107
	11	30.25	28	6	105	29	7	106	31	8	107	32	9	108	34	11	110
	12	36	25	4	99	26	5	100	27	6	101	28	7	102	30	9	104
	13	42.25	22	3	104	23	4	104	24	5	105	25	6	106	26	7	107
	14	49	19	3	97	20	4	98	21	4	99	22	5	99	23	6	100
	15	56.25	17	2	98	18	2	98	19	3	99	19	4	100	20	4	101
	16	64	16	2	97	16	2	97	17	3	98	17	3	98	18	4	99
	17	72.25	14	2	102	15	2	103	15	2	103	15	3	104	16	3	104
	18	81	13	1	97	13	2	97	14	2	98	14	2	98	15	3	99
	19	90.25	12	1	97	12	1	98	13	2	98	13	2	99	14	3	99
	20	100	11	1	96	11	1	97	12	2	97	12	2	97	12	3	98

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	pav		0.55			0.6			0.65			0.7			0.75			0.8			0.85			0.9			0.95			1		
Hieght	Room no.	Area m2	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax
	3	2.25	463	186	717	505	210	760	556	240	813	614	274	872	692	320	952	790	378	1052	913	452	1178	1068	546	1338	1274	655	1522	1512	816	1795
	4	4	287	95	615	311	109	638	339	126	665	372	145	697	415	171	740	469	204	793	537	246	861	624	299	948	724	361	108	872	452	1196
	5	6.25	190	55	573	204	64	586	222	74	603	242	86	622	268	102	647	301	122	680	343	148	721	396	181	774	457	219	835	547	275	925
	6	9	134	42	552	143	51	561	155	62	572	168	74	585	185	89	601	207	108	623	235	131	650	271	161	685	312	196	726	372	248	786
	7	12.25	100	27	542	107	33	548	115	40	556	124	49	565	137	61	577	153	75	592	173	92	612	199	114	637	229	138	666	273	175	709
	8	16	77	18	536	82	23	540	88	28	546	95	35	553	105	44	562	117	55	574	132	68	588	152	85	607	174	103	629	208	131	662
	9	20.25	60	14	531	64	17	535	69	21	539	74	26	544	82	33	552	91	42	561	103	53	572	118	65	587	135	80	604	161	102	629
	10	25	52	11	459	56	14	462	60	18	466	64	22	470	70	27	476	78	34	484	87	42	493	100	52	505	114	64	519	135	82	540
hs = 0.5	11	30.25	45	11	528	48	14	531	52	17	531	52	17	535	57	22	540	63	28	546	71	34	553	80	43	563	92	53	574	109	67	591
	12	36	37	7	494	39	9	496	41	12	499	44	14	502	49	18	506	54	23	511	61	29	517	69	36	525	79	44	535	93	56	549
	13	42.25	31	6	523	33	8	525	35	10	527	38	12	529	42	15	533	46	20	537	52	24	543	59	30	549	67	37	558	79	47	570
	14	49	28	5	450	30	7	452	32	8	453	34	11	456	37	13	459	41	17	462	45	21	467	52	26	473	59	32	480	69	41	491
	15	56.25	24	5	522	25	6	523	27	7	524	29	9	526	32	12	529	35	15	532	39	18	536	44	22	541	51	28	547	60	35	556
	16	64	22	4	451	23	5	452	25	6	453	26	8	455	29	10	457	32	13	460	35	16	464	40	20	468	45	24	474	53	31	482
	17	72.25	19	4	520	21	6	521	21	6	523	23	7	524	25	9	526	27	11	528	31	14	532	35	17	536	40	21	540	47	27	547
	18	81	18	3	458	19	4	459	20	5	460	21	6	461	23	8	463	25	10	465	28	12	468	32	15	472	36	19	476	42	24	482
	19	90.25	16	3	490	16	4	491	18	5	492	19	6	493	20	7	495	22	9	497	25	11	499	28	14	503	32	17	506	38	22	512
	20	100	15	3	452	15	3	453	16	4	454	17	5	455	19	6	457	21	8	458	23	10	461	26	12	464	30	15	467	35	20	472
	3	2.25	320	179	403	361	202	447	410	232	500	467	265	560	543	310	640	639	368	741	760	441	686	927	543	1043	1092	643	1215	1356	804	1489
	4	4	215	103	310	237	106	333	265	133	362	297	152	395	339	177	439	393	210	495	461	251	564	546	304	652	646	365	754	793	456	904
	5	6.25	153	51	263	167	69	278	185	79	295	205	91	315	231	107	342	265	128	376	307	154	419	361	186	473	423	225	537	515	282	630
	6	9	114	51	241	124	59	251	136	69	263	149	80	276	167	95	294	190	114	316	219	138	345	255	169	381	297	204	423	360	257	486
	7	12.25	88	36	228	95	42	235	104	49	244	114	57	253	127	68	266	145	83	283	165	99	302	191	121	328	222	146	359	267	184	403
	8	16	70	25	221	75	30	226	81	36	231	89	42	239	99	50	248	111	61	260	128	74	276	147	90	295	170	109	318	204	138	351
	9	20.25	56	18	215	60	22	219	65	26	224	70	32	230	78	39	237	87	47	246	99	57	258	115	70	273	132	85	291	159	107	317
	10	25	47	4	196	50	17	199	55	21	203	60	25	207	65	30	213	73	37	221	83	45	231	95	55	243	110	67	258	131	85	279
hs = 1	11	30.25	40	10	210	42	13	212	46	16	215	49	19	219	54	24	224	61	30	230	69	37	238	79	45	248	90	55	259	108	70	276
	12	36	34	8	194	37	10	196	39	13	199	43	16	202	47	20	207	52	24	211	59	30	218	68	37	226	78	46	236	92	57	250
	13	42.25	30	7	207	32	9	208	34	11	210	37	13	213	40	16	216	45	20	221	50	25	226	57	32	233	66	39	242	78	49	254
	14	49	26	6	189	28	8	191	30	9	193	32	12	195	35	15	198	39	18	202	44	22	207	50	27	213	57	33	220	68	42	231
	15	56.25	23	5	205	24	6	206	26	8	208	28	9	209	31	12	212	34	15	215	38	19	219	44	23	225	50	29	231	59	36	240
	16	64	21	4	188	22	6	189	23	7	191	25	9	192	27	11	194	30	13	127	34	16	201	39	20	206	44	25	211	52	32	219
	17	72.25	18	4	203	19	5	204	21	6	206	22	7	207	24	9	209	26	11	211	30	14	215	34	18	219	39	22	220	46	28	231
	18	81	17	3	188	18	4	189	19	5	190	20	7	192	22	8	193	24	10	196	27	13	199	31	16	202	35	20	207	42	25	213
	19	90.25	15	3	189	16	4	190	17	5	191	18	6	192	20	7	194	22	9	196	25	11	199	28	14	202	32	17	206	38	22	211
	20	100	14	3	187	15	4	188	16	5	186	17	6	190	18	7	191	20	8	193	22	10	195	25	13	198	29	16	202	34	20	207
	3	2.25	252	160	298	293	184	342	339	212	392	395	245	450	469	291	529	555	343	619	682	421	752	821	505	897	993	611	1077	1229	755	1322
	4	4	165	96	207	187	109	230	214	125	259	245	144	291	286	169	334	338	201	388	405	242	457	489	294	544	487	354	644	587	354	644
	5	6.25	122	61	168	136	69	182	153	79	200	172	91	220	199	107	247	232	127	281	273	153	324	326	185	379	388	223	442	479	279	536
	6	9	94	52	146	104	60	156	116	69	168	129	80	181	147	95	200	170	114	223	199	138	252	235	168	289	278	204	332	340	256	396
	7	12.25	75	38	133	83	44	140	91	51	148	101	59	158	114	69	171	131	83	188	152	100	209	179	122	235	210	148	266	256	186	312
	8	16	61	29	124	66	33	129	73	38	136	80	52	153	91	52	153	103	63	165	119	76	181	163	112	224	198	141	258	198	141	258
	9	20.25	50	22	119	54	25	123	59	29	128	65	34	133	72	41	141	82	49	150	94	59	163	110	72	178	128	87	196	154	109	223
	10	25	43	17	109	46	20	112	50	23	116	55	27	121	61	32	127	69	39	135	79	47	145	92	57	158	106	70	172	128	88	194
hs =1.5	11	30.25	36	13	112	39	15	115	42	19	118	46	22	122	51	26	127	57	31	133	65	38	141	76	47	151	88	57	163	105	72	180
	12	36	32	10	105	34	12	108	37	15	110	40	18	113	44	22	117	50	26	123	57	32	129	65	39	138	75	47	148	90	59	163
	13	42.25	27	8	109	29	10	111	32	12	113	34	15	115	38	18	119	43	22	123	48	27	129	56	33	136	64	40	144	77	50	157
	14	49	24	7	102	26	9	103	28	11	105	30	13	108	33	15	111	37	18	114	42	23	119	48	28	126	55	4	133	66	43	144
	15	56.25	22	5	102	23	7	103	25	8	105	27	10	107	29	13	109	33	16	113	37	19	117	42	24	122	49	29	128	58	37	138
	16	64	19	5	100	20	6	101	22	8	103	24	9	104	26	11	107	29	14	110	33	17	113	38	21	118	43	26	123	51	32	131
	17	72.25	17	4	105	18	5	106	20	6	108	21	8	109	23	10	111	26	12	114	29	15	117	33	18	121	38	23	126	45	29	133
	18	81	16	4	99	17	5	100	18	6	101	19	7	103	21	9	105	23	11	107	26	13	110	30	16	114	34	20	118	41	25	124
	19	90.25	14	3	100	15	4	101	16	5	102	18	6	103	19	8	104	21	9	106	24	12	109	27	15	112	31	18	116	37	23	122
	20	100	13	3	98	14	4	99	15	5	100	16	6	101	18	7	103	19	9	105	22	11	107	25	13	110	29	16	113	34	20	119

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Hieght	ρav		0.05			0.1			0.15			0.2			0.25			0.3			0.35			0.4			0.45			0.5		
	Room no.	Area m2	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax
hs =2	4	4	52	37	65	55	39	70	60	44	81	65	48	89	71	48	89	78	52	97	86	57	107	96	62	118	106	69	129	120	77	145
	5	6.25	46	27	63	47	28	66	50	29	69	54	31	73	58	33	78	62	36	83	67	39	89	74	42	96	81	46	104	90	52	113
	6	9	40	22	62	41	23	64	43	24	67	46	25	69	49	27	73	52	29	76	56	32	80	60	36	85	65	39	90	71	44	97
	7	12.25	35	16	62	36	17	63	37	18	65	39	19	67	41	21	69	44	22	72	47	24	75	50	27	78	54	30	82	59	33	87
	8	16	30	12	61	31	13	62	32	14	63	34	15	65	36	16	67	37	17	69	40	19	71	42	21	73	45	23	76	49	25	80
	9	20.25	26	9	61	27	10	62	28	11	63	29	11	64	30	12	65	32	13	66	3	15	68	36	16	70	38	18	72	41	20	75
	10	25	23	7	58	24	8	59	25	8	59	26	9	60	27	10	61	28	11	63	30	12	64	31	13	66	33	14	67	35	16	70
	11	30.25	21	5	61	21	5	61	22	6	62	23	6	62	24	7	63	25	8	64	26	9	65	27	10	66	29	11	68	31	13	70
	12	36	19	4	59	19	4	59	20	4	59	21	5	60	21	5	61	22	6	61	23	7	62	24	8	63	25	9	64	27	10	66
	13	42.25	17	3	60	17	3	61	18	3	61	18	4	62	19	4	62	20	5	63	20	5	63	21	6	64	22	7	65	24	8	66
	14	49	15	2	58	16	2	58	16	3	58	16	3	59	17	3	59	18	4	60	18	5	60	19	5	61	20	6	62	21	7	63
	15	56.25	14	1	58	14	1	58	14	2	59	15	2	59	15	2	59	16	3	60	16	3	60	17	4	61	18	4	62	19	5	63
	16	64	13	1	58	13	1	58	13	2	58	13	2	58	14	2	59	14	3	59	15	3	60	15	4	60	16	4	61	17	5	62
	17	72.25	12	1	60	12	1	60	12	1	61	12	1	61	13	2	61	13	2	61	13	2	62	14	3	62	15	3	63	15	4	64
	18	81	11	1	58	11	1	58	11	1	58	11	1	58	12	1	59	12	2	59	12	2	59	13	2	60	13	3	60	14	4	61
	19	90.25	10	1	58	10	1	58	10	1	59	10	1	59	11	1	59	11	1	59	11	2	60	12	2	60	12	2	60	13	3	61
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =2.5	5	6.25	34	23	43	36	24	45	38	25	49	41	27	52	45	29	57	49	31	62	54	34	68	60	30	75	67	41	82	75	46	91
	6	9	30	19	24	32	20	44	34	22	46	36	23	49	38	25	52	42	27	55	45	30	59	60	33	64	54	36	69	60	41	76
	7	12.25	35	16	62	36	17	63	37	18	65	39	19	67	41	21	69	44	22	72	47	24	75	50	27	78	54	30	82	59	33	87
	8	16	24	12	41	25	13	42	26	14	43	28	14	44	29	15	46	31	17	48	33	18	50	36	20	53	29	22	56	42	25	60
	9	20.25	22	10	40	22	10	41	23	11	42	24	12	43	26	12	45	27	13	46	29	15	48	31	16	50	33	18	52	36	20	55
	10	25	20	8	39	20	8	40	21	9	40	22	9	41	23	10	42	24	11	44	26	12	45	27	13	47	29	14	49	31	16	51
	11	30.25	18	6	40	18	6	41	19	7	41	20	8	43	21	8	43	22	9	44	23	10	45	24	11	46	26	12	48	27	13	49
	12	36	16	5	39	17	5	39	17	5	40	18	6	41	19	7	41	19	7	42	21	8	43	22	9	44	23	10	45	24	11	47
	13	42.25	15	4	40	15	4	40	16	4	41	16	5	41	17	5	42	17	6	42	18	7	43	19	7	44	20	8	45	22	9	46
	14	49	13	3	39	14	3	39	14	4	39	15	4	40	15	4	40	16	5	41	16	5	41	17	6	42	18	7	43	18	8	44
	15	56.25	12	2	39	13	2	39	13	2	39	13	3	39	14	3	40	14	3	40	15	4	41	16	4	42	16	5	42	17	6	43
	16	64	11	2	38	12	2	39	12	2	39	12	3	39	13	3	40	13	3	40	14	4	40	14	4	41	15	5	42	16	6	42
	17	72.25	10	1	40	11	2	40	11	2	40	11	2	40	12	2	41	12	3	41	12	3	41	13	3	42	14	4	42	14	5	43
	18	81	10	1	38	10	1	39	10	1	39	10	2	39	11	2	39	11	2	40	11	3	40	12	3	40	12	3	41	13	4	42
	19	90.25	9	1	39	9	1	39	9	1	39	10	1	39	10	2	39	10	2	40	11	2	40	11	2	40	11	3	41	12	3	41
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =3	6	9	23	17	30	25	18	32	27	19	34	29	20	37	32	23	40	34	24	43	37	26	47	41	29	51	46	32	56	51	37	62
	7	12.25	22	14	30	23	15	31	24	16	33	26	17	34	28	18	37	30	19	39	33	21	42	36	24	46	39	26	50	44	30	54
	8	16	20	12	29	20	12	30	22	13	31	23	14	33	24	15	35	26	16	37	28	17	39	31	19	42	33	21	44	37	24	48
	9	20.25	18	10	29	19	10	30	19	11	31	20	11	32	22	12	33	23	13	35	25	14	36	27	16	38	29	17	41	31	19	44
	10	25	16	8	28	17	8	29	18	9	29	19	9	30	20	10	31	21	11	33	22	12	34	24	13	36	26	14	38	28	16	40
	11	30.25	15	7	28	16	7	29	16	7	30	17	8	30	18	8	31	19	9	32	20	10	33	21	11	35	23	12	36	24	13	38
	12	36	14	5	28	14	6	28	15	6	29	15	6	29	16	7	30	17	8	31	18	8	32	19	9	33	20	10	34	22	11	36
	13	42.25	13	4	28	13	5	29	14	5	29	14	5	30	15	6	30	15	6	31	16	7	32	17	8	33	18	8	34	20	9	35
	14	49	12	4	27	12	4	28	13	4	28	13	5	29	13	5	29	14	5	30	15	6	30	16	7	31	16	7	32	18	8	33
	15	56.25	11	2	27	11	3	28	12	3	28	12	3	28	12	4	29	13	4	29	13	4	30	14	5	31	15	6	31	16	6	32
	16	64	10	2	27	10	3	28	10	3	28	11	3	28	11	3	29	12	4	29	12	4	29	13	5	30	14	5	31	15	6	32
	17	72.25	9	2	28	10	2	28	10	2	28	10	2	29	11	3	29	11	3	29	11	3	30	12	4	30	13	4	31	13	5	32
	18	81	9	2	27	9	2	28	9	2	28	9	2	28	10	2	28	10	3	29	10	3	29	11	3	29	12	4	30	12	5	31
	19	90.25	8	1	28	8	1	28	9	2	28	9	2	28	9	2	28	9	2	29	10	2	29	10	3	29	11	3	30	11	4	30
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Hieght	pav Room no.	Area m2	0.55 Eav	0.55 Emin	0.55 Emax	0.6 Eav	0.6 Emin	0.6 Emax	0.65 Eav	0.65 Emin	0.65 Emax	0.7 Eav	0.7 Emin	0.7 Emax	0.75 Eav	0.75 Emin	0.75 Emax	0.8 Eav	0.8 Emin	0.8 Emax	0.85 Eav	0.85 Emin	0.85 Emax	0.9 Eav	0.9 Emin	0.9 Emax	0.95 Eav	0.95 Emin	0.95 Emax	1 Eav	1 Emin	1 Emax
hs =2	4	4	137	87	163	157	99	184	182	115	211	211	132	241	251	156	282	300	187	334	363	226	399	442	275	481	535	332	576	672	417	717
	5	6.25	101	58	125	114	65	139	131	76	157	150	88	177	175	103	203	208	123	237	249	148	280	301	181	334	362	218	397	452	274	490
	6	9	79	50	105	88	57	115	100	67	127	113	77	141	131	92	159	153	111	182	182	134	211	218	164	248	260	200	291	322	252	354
	7	12.25	64	37	93	71	43	100	80	50	108	90	58	118	103	68	132	120	82	148	141	99	170	167	121	196	198	147	228	224	185	274
	8	16	53	29	84	58	33	90	65	38	96	72	44	104	82	52	113	95	63	126	111	76	142	131	92	162	155	112	186	190	141	220
	9	20.25	44	23	79	48	26	83	53	30	88	59	35	93	67	41	101	76	49	111	89	59	123	104	73	139	122	88	157	149	110	184
	10	25	38	18	72	41	21	76	46	24	80	50	28	84	57	33	91	65	40	99	75	48	109	88	58	122	102	70	136	124	89	158
	11	30.25	33	15	72	35	17	74	39	20	78	43	23	81	48	27	86	54	32	93	62	39	101	73	48	111	85	58	123	103	73	141
	12	36	29	12	68	31	14	70	34	16	73	37	19	76	42	22	80	47	27	85	54	32	92	63	40	101	73	48	111	88	60	126
	13	42.25	25	10	68	27	11	70	30	14	72	32	16	75	36	19	78	41	23	83	46	27	88	54	34	96	62	41	104	75	51	117
	14	49	22	8	64	24	10	66	26	12	68	28	13	70	31	16	73	35	19	77	40	23	82	47	29	89	54	35	96	65	44	107
	15	56.25	20	6	64	21	8	65	23	9	67	25	11	69	28	13	71	31	16	75	36	20	79	41	24	85	47	30	91	57	37	100
	16	64	18	6	62	19	7	64	21	8	65	23	10	67	25	12	69	28	14	72	32	18	76	36	22	81	42	26	86	50	33	94
	17	72.25	16	5	64	17	6	65	19	7	67	20	8	68	22	10	70	25	13	73	28	15	76	32	19	80	37	23	85	45	29	92
	18	81	15	4	62	16	5	62	17	6	64	18	8	65	20	8	67	23	11	60	25	14	72	29	17	76	34	20	80	40	26	87
	19	90.25	14	4	62	14	4	62	16	5	63	17	6	65	18	8	66	21	10	68	23	12	71	27	15	74	31	18	78	37	23	84
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =2.5	5	6.25	85	52	102	98	60	116	113	70	132	131	80	151	155	95	176	185	114	207	224	138	248	272	167	297	329	203	357	414	255	444
	6	9	68	47	84	77	54	93	88	63	105	101	74	119	119	88	137	141	107	160	169	130	188	204	160	225	246	195	267	307	247	330
	7	12.25	64	37	93	71	43	100	80	50	108	90	58	118	103	68	132	120	82	148	141	99	170	167	121	196	198	147	228	224	185	274
	8	16	46	28	64	52	32	69	58	37	76	65	43	83	75	51	93	88	61	106	104	74	122	124	91	142	147	110	166	182	139	202
	9	20.25	39	22	58	43	26	63	48	30	68	54	34	74	61	41	81	71	49	91	83	59	104	99	72	119	117	87	138	144	110	165
	10	25	34	18	54	37	21	57	42	24	61	46	28	66	53	33	72	61	40	80	71	48	91	83	58	103	98	71	118	120	89	140
	11	30.25	30	15	52	32	17	54	36	20	58	39	23	61	45	27	67	51	33	73	59	39	81	70	48	91	82	58	104	100	73	122
	12	36	26	13	49	29	14	51	31	17	54	35	19	57	39	23	61	45	27	67	52	33	73	60	40	82	71	48	93	86	61	108
	13	42.25	23	11	48	25	12	50	28	14	52	30	16	55	34	19	58	39	23	63	44	28	69	52	34	76	60	41	84	73	52	97
	14	49	21	9	45	22	10	47	24	12	49	27	14	51	30	16	55	34	20	59	39	24	64	45	29	70	52	35	77	63	44	88
	15	56.25	19	7	45	20	8	46	22	10	48	24	11	50	26	14	52	30	16	56	34	20	60	40	25	66	46	30	72	56	38	82
	16	64	17	7	44	18	8	45	19	9	46	21	10	48	24	12	50	27	15	53	30	18	57	35	22	62	41	27	67	49	33	75
	17	72.25	15	5	44	16	6	45	18	8	46	19	9	48	21	11	50	24	13	53	27	16	56	32	19	60	36	23	65	44	30	72
	18	81	14	5	42	15	6	43	16	7	44	17	8	46	19	10	48	22	12	50	25	14	53	28	17	57	33	21	61	39	26	68
	19	90.25	13	4	42	14	5	43	15	6	44	16	7	45	18	8	47	20	10	49	23	12	52	26	15	55	30	19	59	36	23	65
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =3	6	9	58	42	70	67	49	79	76	57	89	89	67	102	105	80	119	126	98	141	151	119	166	184	146	200	222	178	239	278	221	297
	7	12.25	49	34	60	56	39	67	64	46	76	73	53	85	86	64	98	103	77	115	123	94	136	149	116	162	180	141	194	225	178	244
	8	16	41	27	52	46	31	58	52	36	64	60	42	72	70	50	82	82	60	94	98	73	110	118	89	130	141	109	156	175	137	195
	9	20.25	35	22	47	39	25	51	44	29	56	49	34	62	57	40	70	66	48	80	79	58	92	94	71	108	112	86	126	139	109	154
	10	25	31	18	43	34	21	46	38	2	50	43	28	55	49	33	62	57	39	70	67	47	80	80	58	93	94	70	108	116	88	130
	11	30.25	27	15	40	29	17	43	33	20	46	36	23	50	42	27	55	48	32	62	56	39	70	67	48	81	79	58	93	96	73	111
	12	36	23	13	38	26	14	40	29	17	43	32	19	46	37	23	50	42	27	56	49	33	63	58	40	72	68	49	83	83	61	97
	13	42.25	21	11	36	23	12	38	26	14	41	28	16	43	32	19	47	37	23	52	42	28	57	50	34	65	58	41	73	71	52	86
	14	49	19	9	35	21	10	36	23	12	38	25	14	41	28	17	44	32	20	48	37	24	53	43	29	59	51	35	67	62	44	78
	15	56.25	17	7	34	19	9	35	20	10	37	22	12	39	25	14	42	29	17	45	33	20	50	38	25	55	45	30	62	54	38	71
	16	64	16	7	33	17	8	34	18	9	35	20	11	27	23	13	39	26	15	42	29	18	46	34	22	51	40	27	57	48	34	65
	17	72.25	14	6	33	15	7	34	17	8	35	18	9	36	20	11	39	23	13	41	26	16	44	31	20	49	36	24	54	43	30	61
	18	81	13	5	31	14	6	32	15	7	34	17	8	35	19	10	37	21	12	39	24	14	42	28	17	46	32	21	50	39	26	57
	19	90.25	12	4	31	13	5	32	14	6	33	15	7	34	17	9	36	19	10	38	22	13	41	25	15	44	29	19	48	35	24	54
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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	ρav		0.05			0.1			0.15			0.2			0.25			0.3			0.35			0.4			0.45			0.5		
Hieght	Room no.	Area m2	Esv	Emin	Emax	Esv	Emin	Emax	Esv	Emin	Emax	Esv	Emin	Emax	Esv	Emin	Emax	Esv	Emin	Emax	Esv	Emin	Emax	Esv	Emin	Emax	Esv	Emin	Emax	Esv	Emin	Emax
hs =5.5	11	30.25	7	5	9	8	5	10	8	6	10	9	6	11	10	7	12	10	7	13	11	8	14	13	9	16	14	10	17	16	11	19
	12	36	7	5	9	7	5	9	8	5	10	8	5	11	9	6	11	10	6	12	11	7	13	12	8	14	13	9	16	14	10	17
	13	42.25	6	4	9	7	4	9	7	5	10	8	5	10	8	5	11	9	6	12	10	6	13	11	7	13	12	8	15	13	9	16
	14	49	6	4	9	7	4	9	7	4	10	7	4	10	8	5	11	8	5	11	9	6	12	10	6	13	11	7	14	12	8	15
	15	56.25	6	3	9	6	3	9	7	3	9	7	4	10	7	4	10	8	4	11	8	5	11	9	5	12	10	6	13	11	6	14
	16	64	6	3	9	6	3	9	6	3	9	7	4	10	7	4	10	7	4	10	8	4	11	8	5	12	9	5	12	10	6	13
	17	72.25	5	3	9	6	3	9	6	3	9	6	3	10	7	3	10	7	4	10	7	4	11	8	4	11	8	5	12	9	5	13
	18	81	5	2	9	5	3	9	6	3	9	6	3	9	6	3	10	7	3	10	7	4	10	7	4	11	8	4	12	9	5	12
	19	90.25	5	2	9	5	2	9	5	2	9	6	3	9	6	3	10	6	3	9	7	3	10	7	4	11	7	4	11	8	4	12
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =6	12	36	6	4	8	6	4	8	7	5	9	7	5	9	8	5	10	9	6	11	10	7	12	11	7	13	12	8	15	13	9	16
	13	42.25	6	4	8	6	4	8	7	4	8	7	5	9	8	5	10	8	5	10	9	6	11	10	7	12	11	7	13	12	8	15
	14	49	6	4	7	6	4	8	6	4	8	7	4	9	7	4	9	8	5	10	8	5	11	9	6	11	10	7	12	11	7	14
	15	56.25	5	3	7	6	3	8	6	3	8	6	4	8	7	4	9	7	4	10	8	5	10	8	5	11	9	6	12	10	6	13
	16	64	5	3	7	5	3	7	6	3	8	6	3	8	6	4	9	7	4	9	7	4	10	8	5	10	8	5	11	9	6	12
	17	72.25	5	3	7	5	3	7	5	3	8	6	3	8	6	3	9	6	4	9	7	4	9	7	4	10	8	5	11	9	5	11
	18	81	5	2	7	5	3	8	5	3	8	5	3	8	6	3	8	6	3	9	6	4	9	7	4	10	7	4	10	8	5	11
	19	90.25	5	2	7	5	2	7	5	2	8	5	3	8	5	3	8	6	3	9	6	3	9	7	4	9	7	4	10	8	4	10
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =6.5	13	42.25	5	4	7	6	4	7	6	4	8	6	4	8	7	5	9	8	5	10	8	6	10	9	6	11	10	7	12	12	8	14
	14	49	5	3	6	5	3	6	5	3	6	5	4	7	6	4	7	6	4	8	7	5	9	8	5	10	9	6	10	10	7	12
	15	56.25	5	3	6	5	3	7	5	3	7	6	3	7	6	4	8	7	4	8	7	4	9	8	5	10	9	5	11	9	6	12
	16	64	5	3	6	5	3	7	5	3	7	5	3	7	6	4	8	6	4	8	7	4	9	7	5	9	8	5	10	9	6	11
	17	72.25	4	3	6	5	3	7	5	3	7	5	3	7	5	3	8	6	3	8	6	4	8	7	4	9	7	5	10	8	5	10
	18	81	4	2	6	4	2	6	5	3	7	5	3	7	5	3	7	6	3	8	6	3	8	6	4	9	7	4	9	8	5	10
	19	90.25	4	2	6	4	2	6	4	2	7	5	3	7	5	3	7	5	3	8	6	3	8	6	3	8	7	4	9	7	4	9
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =7	14	49	4	3	6	5	3	6	5	3	6	5	4	7	6	4	7	6	4	8	7	5	9	8	5	10	9	6	10	10	7	12
	15	56.25	4	3	6	5	3	6	5	3	6	5	3	7	6	4	7	6	4	8	7	4	8	7	5	9	8	5	10	10	6	11
	16	64	4	3	6	4	3	6	5	3	6	5	3	6	5	3	7	6	4	7	6	4	8	7	4	9	7	5	9	8	6	10
	17	72.25	4	2	6	4	3	6	4	3	6	5	3	6	5	3	7	5	3	7	6	4	8	6	4	8	7	4	9	8	5	10
	18	81	4	2	5	4	2	6	4	3	6	5	3	6	5	3	7	5	3	7	6	3	7	6	4	8	7	4	8	7	5	9
	19	90.25	4	2	5	4	2	6	4	2	6	4	2	6	5	3	6	5	3	7	5	3	7	6	3	8	6	4	8	7	4	9
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =7.5	15	56.25	4	3	5	4	3	5	4	3	6	5	3	6	5	3	7	6	4	7	6	4	8	7	5	8	8	5	9	8	6	10
	16	64	4	3	5	4	3	5	4	3	5	5	3	6	5	3	6	5	4	7	6	4	7	6	4	8	7	5	9	8	5	9
	17	72.25	4	2	5	4	2	5	4	3	5	4	3	6	5	3	6	5	3	6	5	4	7	6	4	8	7	4	8	7	5	9
	18	81	4	2	5	4	2	5	4	2	5	4	3	6	4	3	6	5	3	6	5	3	7	6	4	7	6	4	8	7	4	8
	19	90.25	3	2	5	4	2	5	4	2	5	4	2	5	4	3	6	5	3	6	5	3	6	5	3	7	6	4	7	6	4	8
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =8	16	64	3	2	4	4	3	5	4	3	5	4	3	5	5	3	6	5	3	6	6	4	7	6	4	7	7	5	8	8	5	9
	17	72.25	3	2	4	4	2	5	4	3	5	4	3	5	4	3	5	5	3	6	5	3	6	6	4	7	6	4	8	7	5	8
	18	81	3	2	4	3	2	4	4	2	5	4	2	5	4	3	5	4	3	6	5	3	6	5	4	7	6	4	7	6	4	8
	19	90.25	3	2	4	3	2	4	4	2	5	4	2	5	4	2	5	4	3	6	5	3	6	5	3	6	6	4	7	6	4	7
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =8.5	17	72.25	3	2	4	3	2	4	3	2	4	4	3	5	4	3	5	4	3	5	5	3	6	5	4	7	6	4	7	6	5	8
	18	81	3	2	4	3	2	4	3	2	4	4	2	5	4	3	5	4	3	5	5	3	6	5	3	6	6	4	7	6	4	7
	19	90.25	3	2	4	3	2	4	3	2	4	3	2	4	4	2	5	4	3	5	4	3	5	5	3	6	5	3	6	6	4	7
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =9	18	81	3	2	4	3	2	4	3	2	4	4	2	5	4	3	5	4	3	5	5	3	6	5	3	6	6	4	7	6	4	7
	19	90.25	3	2	3	3	2	4	3	2	4	3	2	4	4	2	4	4	3	5	4	3	5	5	3	6	5	3	6	6	4	7
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =9.5	19	90.25	3	2	3	3	2	3	3	2	4	3	2	4	3	2	4	4	2	5	4	3	5	5	3	6	5	3	6	5	4	6
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =10	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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pav			0.55			0.6			0.65			0.7			0.75			0.8			0.85			0.9			0.95			1		
Hieght	Room no.	Area m2	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax	Eav	Emin	Emax
hs =5.5	11	30.25	18	13	21	20	15	24	23	16	26	27	20	31	32	24	36	38	29	42	45	35	50	55	43	60	66	53	71	83	67	89
	12	36	16	11	19	18	13	21	21	15	24	24	18	28	28	21	32	34	25	37	40	31	44	49	38	53	59	46	65	74	58	82
	13	42.25	14	10	17	16	11	19	19	13	22	21	15	25	25	18	28	29	22	33	35	27	39	42	33	46	51	40	55	63	50	68
	14	49	13	9	16	15	10	18	17	11	20	19	13	22	22	16	26	2	19	30	31	23	35	37	28	41	44	34	48	55	43	60
	15	56.25	12	7	15	13	8	17	15	9	18	17	11	21	20	14	23	23	16	27	27	20	31	33	25	37	39	30	43	49	38	53
	16	64	11	7	14	12	8	16	14	9	17	15	10	19	18	12	21	21	15	24	25	18	28	29	22	33	35	26	39	43	33	47
	17	72.25	10	6	14	11	7	15	13	8	16	14	9	18	16	11	20	19	13	23	22	16	26	26	19	30	31	24	35	39	30	46
	18	81	9	5	13	10	6	14	12	7	15	13	8	17	13	8	17	17	12	21	20	14	24	24	17	28	28	21	32	35	26	39
	19	90.25	9	5	13	10	6	13	11	7	15	12	8	16	14	9	18	16	11	20	19	13	22	22	16	26	26	19	30	32	24	36
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =6	12	36	15	11	18	17	14	20	20	15	23	23	17	26	27	20	31	33	25	36	39	30	43	48	37	52	58	45	64	72	57	81
	13	42.25	14	9	16	15	11	18	18	13	21	20	15	23	24	18	27	28	21	32	34	26	37	41	32	45	50	39	54	62	50	66
	14	49	12	8	15	14	10	17	16	11	19	18	13	21	21	16	24	25	19	28	30	23	33	36	28	40	43	34	47	54	43	58
	15	56.25	11	7	14	13	8	15	14	10	17	16	11	19	19	14	22	22	16	25	27	20	30	32	24	35	38	30	42	48	37	52
	16	64	10	7	13	12	8	14	13	9	16	15	10	18	18	12	20	20	15	23	24	18	27	29	22	32	34	26	37	42	33	46
	17	72.25	10	6	12	11	7	13	12	8	15	14	9	16	16	11	19	18	13	21	22	13	25	26	19	29	31	23	34	38	29	41
	18	81	9	5	12	10	6	13	11	7	14	12	8	15	14	10	17	17	12	20	20	14	23	23	17	27	28	21	31	34	26	38
	19	90.25	8	5	11	9	6	12	10	6	13	12	7	15	13	9	16	15	11	18	18	13	21	22	16	25	26	19	29	32	24	35
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =6.5	13	42.25	13	9	15	15	11	17	17	13	20	20	15	23	23	18	26	28	21	31	34	26	37	41	32	44	49	39	53	62	49	66
	14	49	11	8	13	12	9	15	14	10	16	16	12	19	21	15	23	24	18	27	29	22	32	35	28	39	43	34	46	53	43	57
	15	56.25	11	7	13	12	8	14	14	10	16	16	11	18	18	13	21	22	16	24	26	20	29	31	24	34	38	29	41	47	37	50
	16	64	10	6	12	11	7	13	12	9	15	14	10	17	17	12	19	20	14	22	23	17	26	28	21	31	34	26	36	42	33	45
	17	72.25	9	6	11	10	7	12	11	8	14	13	9	15	15	11	17	18	13	20	21	16	24	25	19	28	30	23	33	37	29	40
	18	81	8	5	11	9	6	12	11	7	13	12	8	14	14	10	16	18	12	19	19	14	22	23	17	26	27	21	30	34	26	37
	19	90.25	8	5	10	8	6	11	10	6	12	11	7	14	13	9	15	15	10	17	18	13	20	21	15	24	25	19	28	31	24	34
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =7	14	49	11	8	13	12	9	15	14	10	16	16	12	19	19	14	22	23	17	26	26	21	30	33	26	36	40	32	43	50	40	54
	15	56.25	10	7	12	11	8	14	13	9	15	15	11	17	18	13	20	21	16	24	25	19	28	31	24	34	37	29	40	46	37	49
	16	64	9	6	11	10	7	12	12	9	14	14	10	16	16	12	18	19	14	21	23	17	25	27	21	30	33	26	35	41	33	44
	17	72.25	9	6	10	10	7	12	11	8	13	12	9	15	15	11	17	17	13	19	20	15	23	25	19	27	30	23	32	37	29	39
	18	81	8	5	10	9	6	11	10	7	12	11	8	14	13	10	15	16	11	18	19	14	21	22	17	25	27	21	29	33	26	36
	19	90.25	7	5	9	8	5	10	9	6	11	11	7	13	12	9	14	15	10	17	17	13	19	21	15	23	25	19	27	31	23	33
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =7.5	15	56.25	10	7	11	11	8	13	13	9	15	14	11	17	17	13	19	20	15	23	24	19	27	30	23	32	36	28	39	45	36	48
	16	64	9	6	11	10	7	12	12	8	13	13	10	15	16	12	18	19	14	21	22	17	24	27	21	29	33	26	35	41	32	43
	17	72.25	8	6	10	9	6	11	11	8	12	12	8	14	14	10	16	17	13	19	20	15	22	24	19	26	29	23	31	36	29	39
	18	81	8	5	9	9	6	10	10	7	11	11	8	13	13	9	15	15	11	17	18	14	20	22	17	24	26	20	28	33	26	35
	19	90.25	7	5	9	8	5	10	9	6	11	10	7	12	12	9	14	14	10	16	17	12	19	20	15	22	24	18	26	30	23	32
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =8	16	64	9	6	10	10	7	11	11	8	13	13	10	15	15	11	17	18	14	20	22	17	24	27	21	29	32	25	34	40	32	42
	17	72.25	8	6	9	9	6	10	10	7	12	12	9	13	14	10	16	16	12	18	20	15	22	24	19	26	29	23	31	36	29	38
	18	81	7	5	9	8	6	10	9	7	11	11	8	12	13	9	14	15	11	17	18	14	20	22	17	23	26	20	28	32	26	35
	19	90.25	7	5	8	8	5	9	9	6	10	10	7	12	12	8	13	14	10	15	16	12	18	20	15	22	24	18	26	30	23	32
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =8.5	17	72.25	7	5	8	8	6	10	10	7	11	11	8	13	13	10	15	16	12	17	19	15	21	23	18	25	27	22	29	34	27	36
	18	81	7	5	8	8	6	9	9	7	11	11	8	12	12	9	14	15	11	16	18	14	19	21	17	23	26	20	27	32	26	34
	19	90.25	7	4	8	7	5	9	9	6	10	10	7	11	11	8	13	14	10	15	16	12	18	20	15	21	24	18	25	29	23	31
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =9	18	81	7	5	8	8	6	9	9	7	11	11	8	12	12	9	13	14	11	16	17	13	18	21	16	22	25	19	26	31	25	33
	19	90.25	6	4	7	7	5	8	8	6	9	10	7	11	11	8	12	13	10	15	16	12	17	19	15	21	23	18	25	29	23	31
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =9.5	19	90.25	6	4	7	7	5	8	8	6	9	9	7	10	11	8	12	13	10	14	16	12	17	19	15	20	23	18	24	29	23	30
	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
hs =10	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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