Reference List

[1] E.G Pita, "Air Conditioning Principles and Systems," 4th ed, M 97, Connaught Circus, New Delhi, Jay Print Pack Private Limited, 2006,pp 102- 245

[2] Prof N Wickramarachchi, Lighting Design section 2, Illumination Levels and Colour, MSc/PG Dip in EElectrical Installations, Department of Electrical Engineering, University of Morauwa, Moratuwa. (2010)

[3] Prof Lanka Udawaththa, BMS Design, Human Comfort in BMS Designs, MSc/PG Dip in EElectrical Installations, Department of Electrical Engineering, University of Moratuwa, Moratuwa. (2010)

[4] Eng Chandana Dalugoda, Air Conditioning & Ventilation, Introduction to Air Conditioning, MSc/PG Dip in EElectrical Installations, Department of Electrical Engineering, University of Moratuwa, Moratuwa. (2011)

[5] Sri Lanka Sustainable Energy Authority, "Code of practice for energy efficient buildings in SriLanka," http://www.energy.gov.lk/pdf/Building%20CODE.pdf, [25 June 2014]

[6] DIALLight. Building, Software,Download, http://www.dial.de/DIAL/en/dialux- international-download.html [13 February 2013]

[7] Skeptical Science, "Why it's urgent we act now on climate change" http://www.skepticalscience.com/print.php?r=349 [1 August 2014]

[8] Organization for Green Peace (2014)," Global warming and climate change" http://www.greenpeace.org/usa/en/campaigns/global-warming-and-energy/, [4 August 2014]

[9] IPCC WGI AR5 (Report), Chapter 2 http://www.climatechange2013.org/images/report/WG1AR5_Chapter02_FINAL.pdf, [3 August 2014]

[10] Skeptical **S**cience, Projected global surface warming from 2000 to 2100 in various IPCC scenarios http://www.skepticalscience.com/monckton-myth-10-warming-in-the-pipeline.html [7 August 2014]

[11] World Meteorological Organization, Causes of Climate Change, http://www.wmo.int/pages/themes/climate/causes_of_climate_change.php , [15 August 2014]

[12] Amount of CO2 released when making and using product, http://www.co2list.org/files/carbon.htm [20 August 2014]

[13] IPCC WGII AR5 (Report), Chapter 19, http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap19_FGDall.pdf [20 August 2014]

[14] Organization for Time for change, What is Carbon footprint – definition http://timeforchange.org/what-is-a-carbon-footprint-definition [25 August 2014]

[15] Carbon Planet, Introduction to Carbon Credits, http://www.carbonplanet.com/introduction_to_carbon_credits [25 August 2014]

[16] Efficient Windows Collaborative, Window Technologies: Low-E Coatings, http://efficientwindows.org/lowe.php [30 August 2014]

[17] European Commission, EUR 24283 – Energy – efficient Buildings PPP Multi – annual Roadmap and longer term strategy,

http://ec.europa.eu/research/industrial_technologies/pdf/ppp-energy-efficient-building-strategic-multiannual-roadmap-info-day_en.pdf [1 June 2014]

[18] New Mexico Solar Energy Association, Passive solar design, http://www.nmsea.org/Passive_Solar/Passive_Solar_Design.htm [5 November 2014]

[19] Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report (AR5), http://www.ipcc.ch/ [10 November 2014]

[20] United Nations Framework Convention on Climate Change, Kyoto Protocol, http://unfccc.int/kyoto_protocol/items/2830.php [15 November 2014]

[21] Energy.gov, Energy efficient windows, http://energy.gov/energysaver/articles/energy-efficient-windows [20 November 2014]

[22] Union of Concerned Scientists, Causes of Sea Level Rise, http://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/Causes-of-Sea-Level-Rise.pdf [15 December 2014]

[23] United States Environmental Protection Agency, Climate Impacts on Coastal Area,http://www.epa.gov/climatechange/impacts-adaptation/coasts.html [15 December 2014]

[24] National Resources Canada, Improving Window Energy efficiency http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/energystar/IWEE_EN.pdf [13 June 2014]

Appendix A: Sample Calculations of Dialux Software

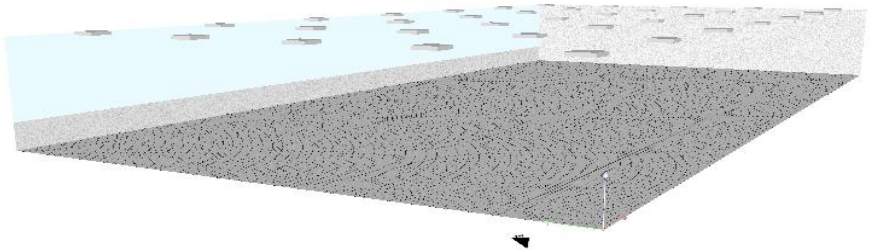


Figure A.1: 3D Arrengment of luminaire in selected building model

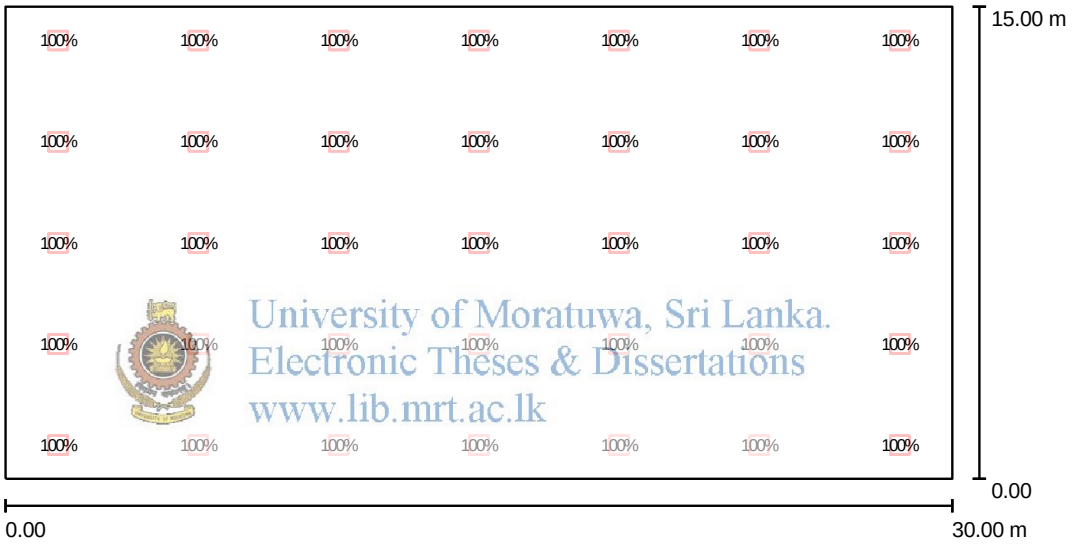


Figure A.2 : Luminaire arrangement and illumination level W/W ratio at 0%

Daylight parameters:
Location: Sri Jaywardanapura, Longitude: 80.13°, Latitude: 6.10°,
North deviation: 245.0°
Date: 21.03.2011, Time:09:00:00 (+5 hours difference to GMT)
Reference sky type: Clear sky

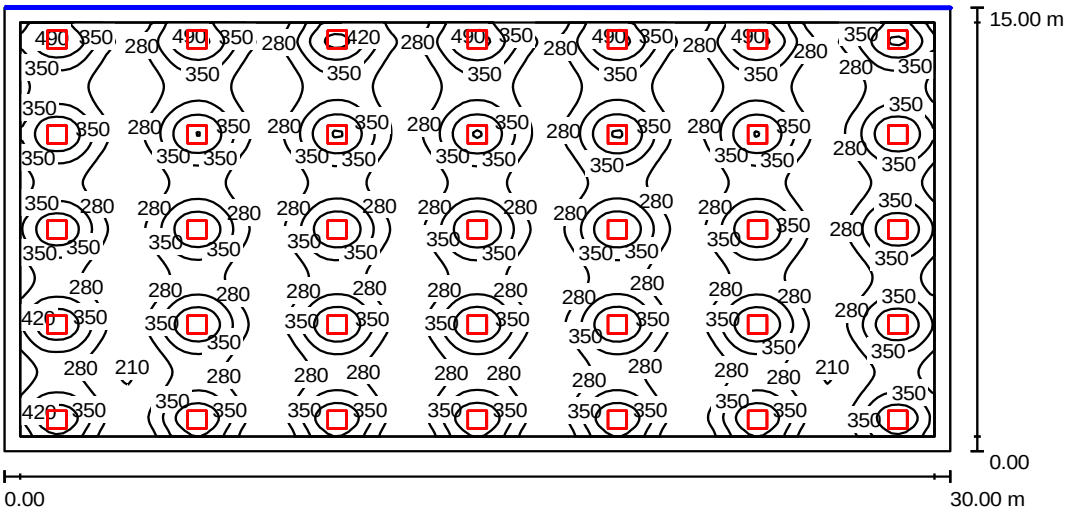


Figure A.3- Isoline arrangement

Photometric results

Total Luminous Flux:	178850 lm
Total Load:	3675.0 W
Light loss factor:	0.67
Boundary Zone:	0.500 m

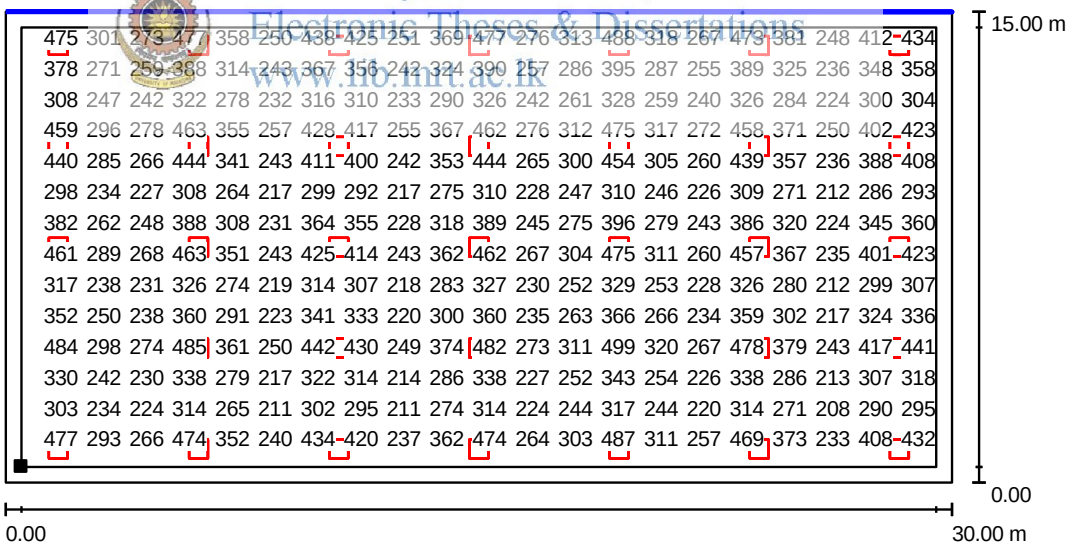


Figure A.4: Luminaire arrangement and Value Chart W/W ratio at 0%

Values in Lux, Scale 1 : 215

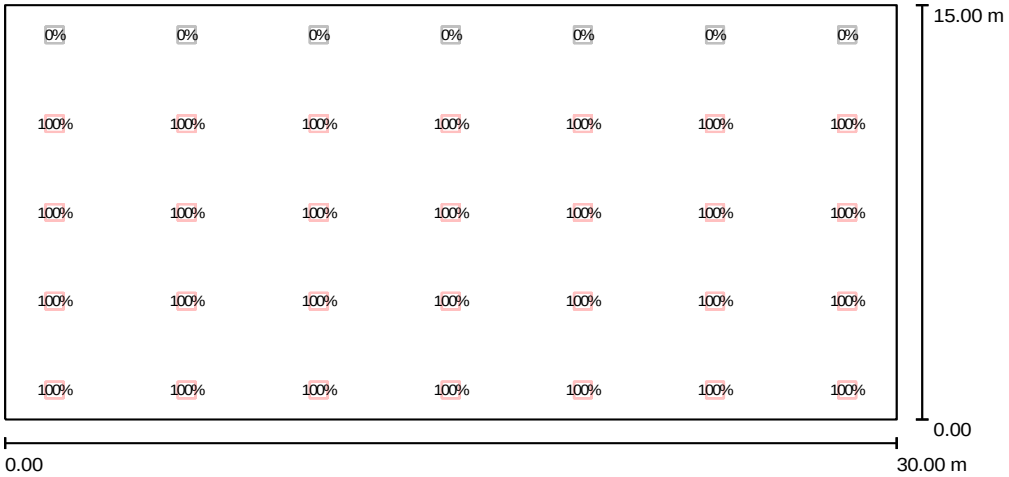


Figure A.5: Luminaire arrangement and illumination level W/W ratio at 5%
Scale 1 : 215

Daylight parameters:
Location: Sri Jaywardanapura, Longitude: 80.13°, Latitude: 6.10°,
North deviation: 245.0°
Date: 21.03.2011, Time:09:00:00 (+5 hours difference to GMT)
Reference sky type: Clear sky

Figure A.6: Luminaire arrangement and Isolines W/W ratio at 5%

Photometric results
Total Luminous Flux: 143080 lm
Total Load: 2940 W
Light loss factor: 0.67
Boundary Zone: 0.500 m

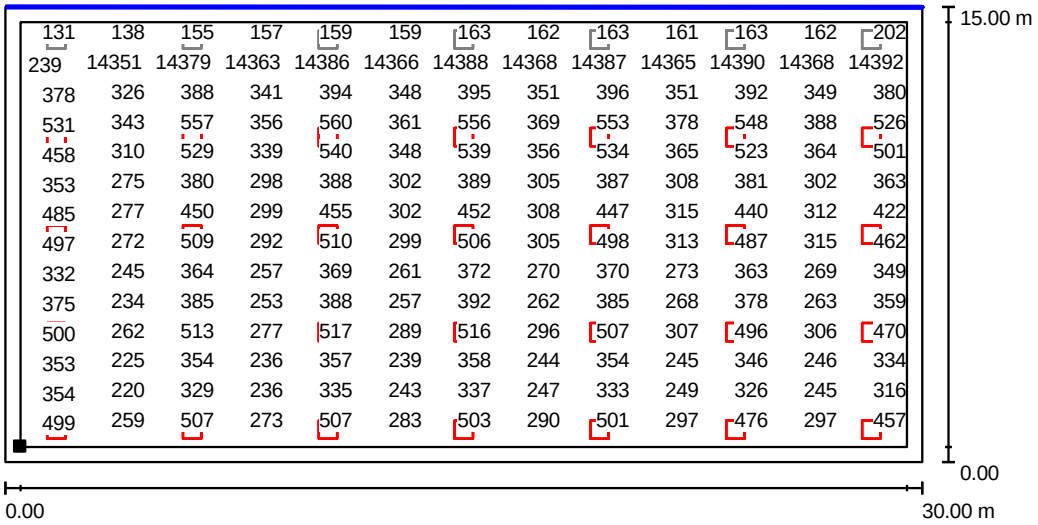


Figure A.7: Luminaire arrangement and Value Chart W/W ratio at 5%

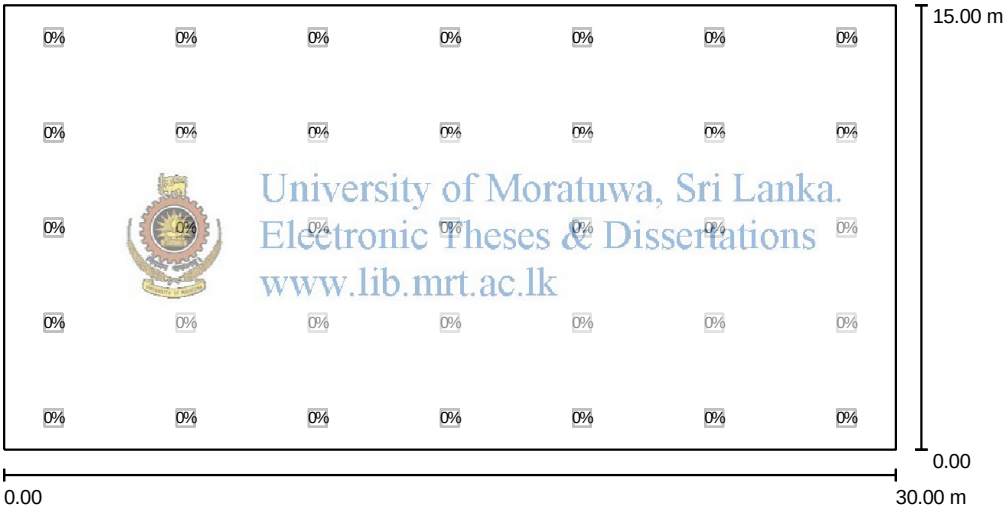


Figure A.8: Luminaire arrangement and illumination level W/W ratio at 75%

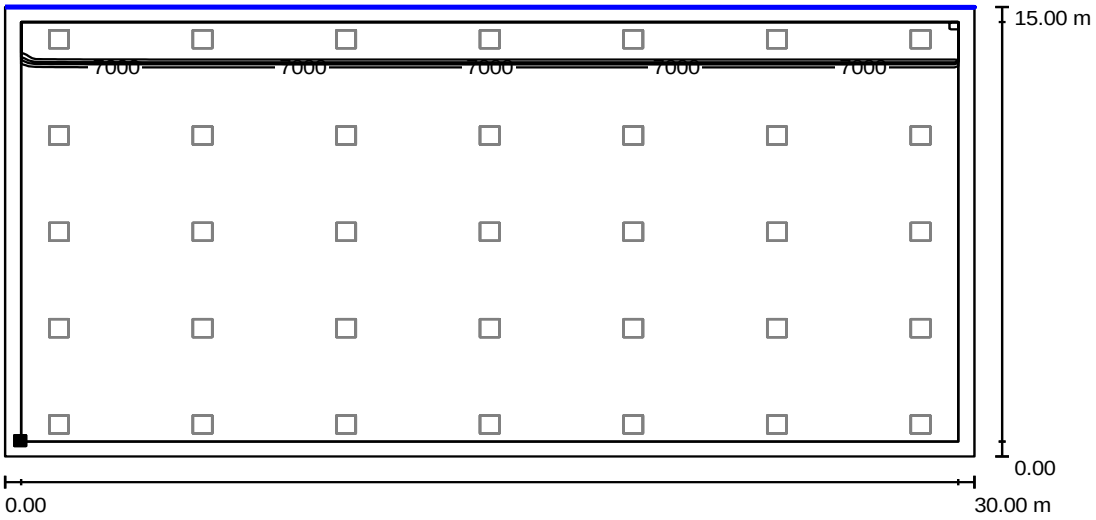
Scale 1 : 215

Daylight parameters:

Location: Sri Jaywardanapura, Longitude: 80.13°, Latitude: 6.10°, North deviation: 245.0°

Date: 21.03.2011, Time:09:00:00 (+5 hours difference to GMT)

Reference sky type: Clear sky



Values in Lux, Scale 1:21

Figure A 9: Luminaire arrangement and Isoline arrangement W/W ratio at 75%

Photometric results

Total Luminous Flux:	0 lm
Total Load:	0.0 W
Light loss factor:	0.67
Boundary Zone:	0.500 m

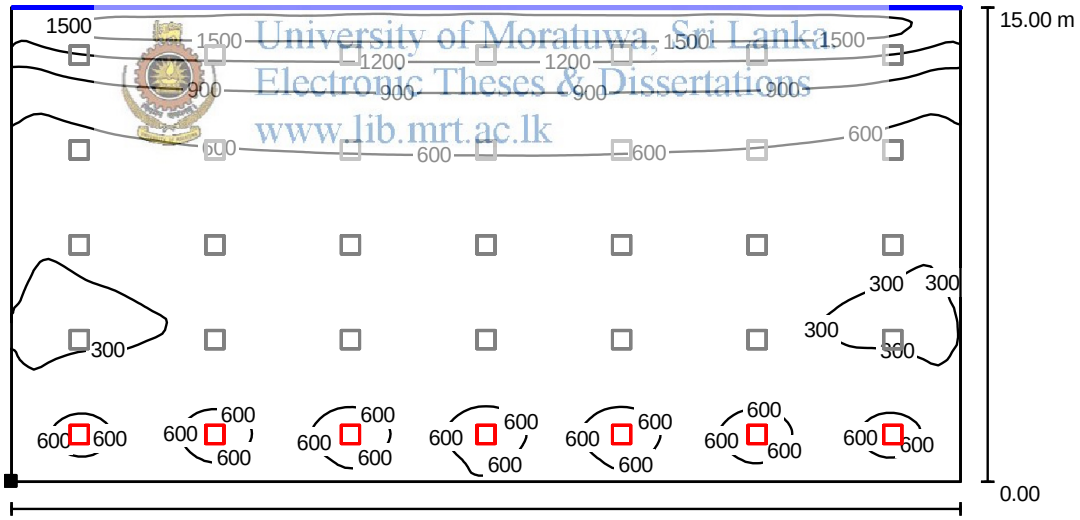


Figure A.10: Luminaire arrangement and illumination level W/W ratio at 65%

Scale 1 : 215

Daylight parameters:

Location: Sri Jaywardanapura, Longitude: 80.13°, Latitude: 6.10°, North deviation: 245.0°

Date: 21.06.2011, Time:15:00:00 (+5 hours difference to GMT)

Reference sky type: Clear sky

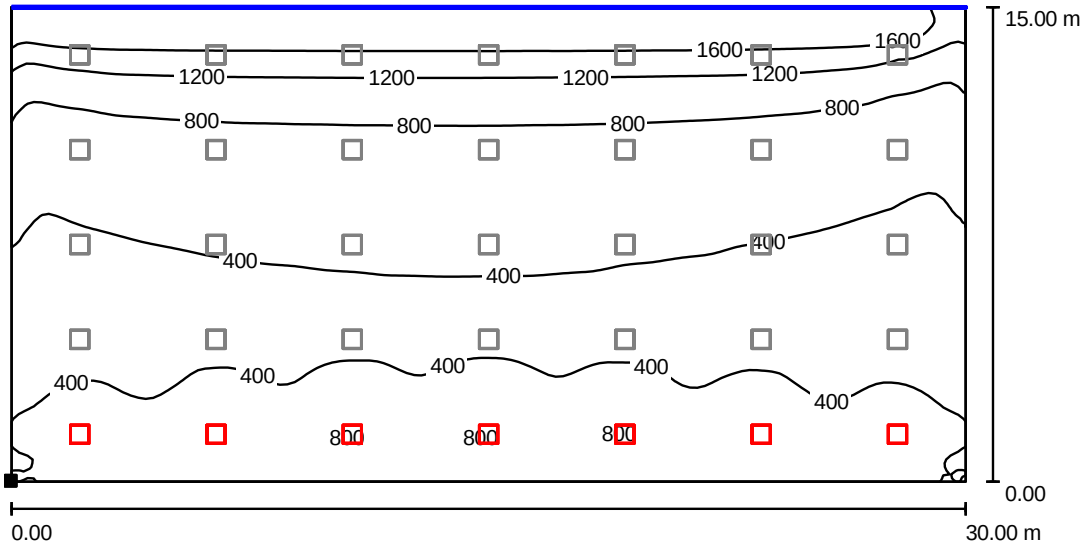


Figure A.11: Luminaire arrangement and illumination level W/W ratio at 65%

Scale 1 : 215

Daylight parameters:

Location: Sri Jaywardanapura, Longitude: 80.13°, Latitude: 6.10°, North deviation: 245.0°

Date: 21.12.2011, Time:15:00:00 (+5 hours difference to GMT)

Reference sky type: Clear sky

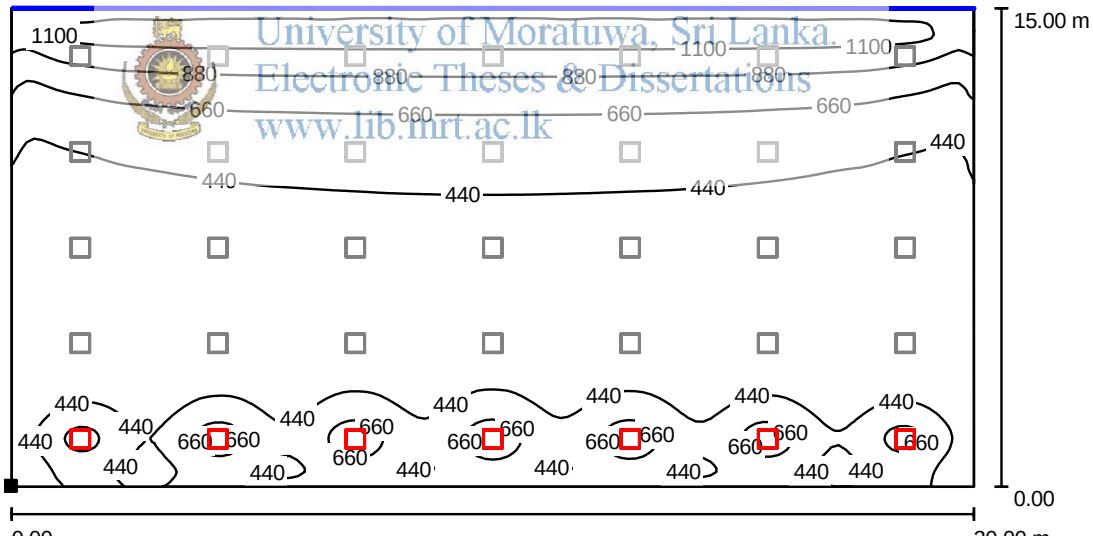


Figure A.12: Luminaire arrangement and illumination level W/W ratio at 65%

Scale 1 : 215

Daylight parameters:

Location: Sri Jaywardanapura, Longitude: 80.13°, Latitude: 6.10°, North deviation: 245.0°

Date: 21.06.2011, Time:15:00:00 (+5 hours difference to GMT)

Reference sky type: Clear sky

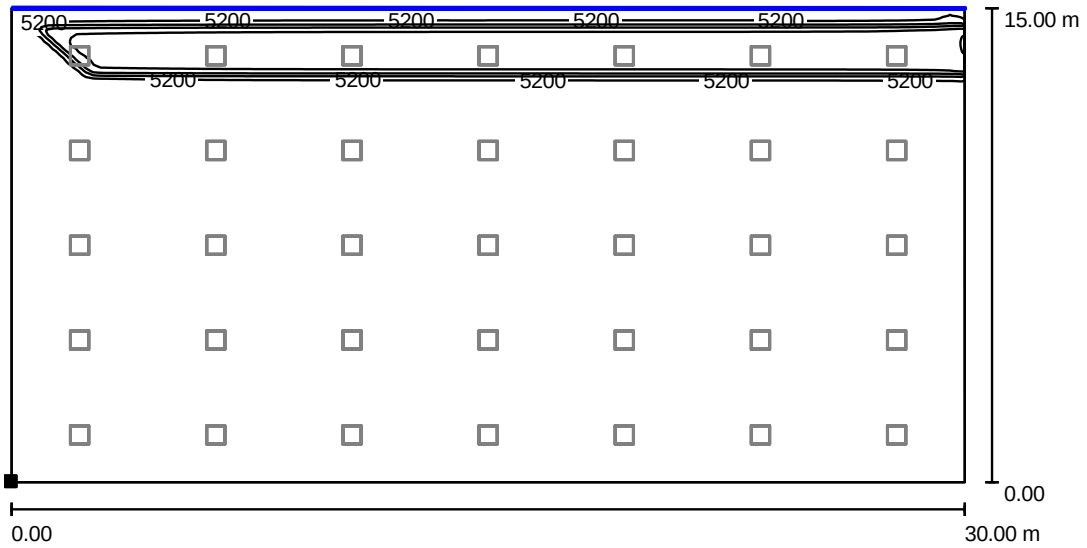


Figure A.13: Luminaire arrangement and illumination level W/W ratio at 55%

Scale 1 : 215

Daylight parameters:

Location: Sri Jaywardanapura, Longitude: 80.13°, Latitude: 6.10°, North deviation: 245.0°

Date: 21.06.2011, Time:09:00:00 (+5 hours difference to GMT)

Reference sky type: Clear sky

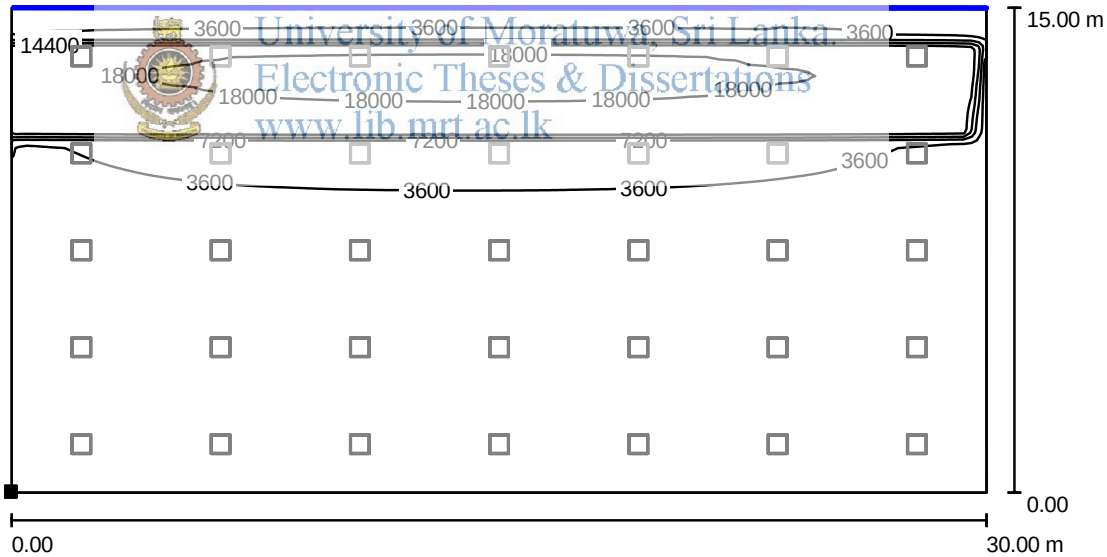


Figure A.14: Luminaire arrangement and illumination level W/W ratio at 55%

Scale 1 : 215

Daylight parameters:

Location: Sri Jaywardanapura, Longitude: 80.13°, Latitude: 6.10°, North deviation: 245.0°

Date: 21.12.2011, Time:09:00:00 (+5 hours difference to GMT)

Reference sky type: Clear sky

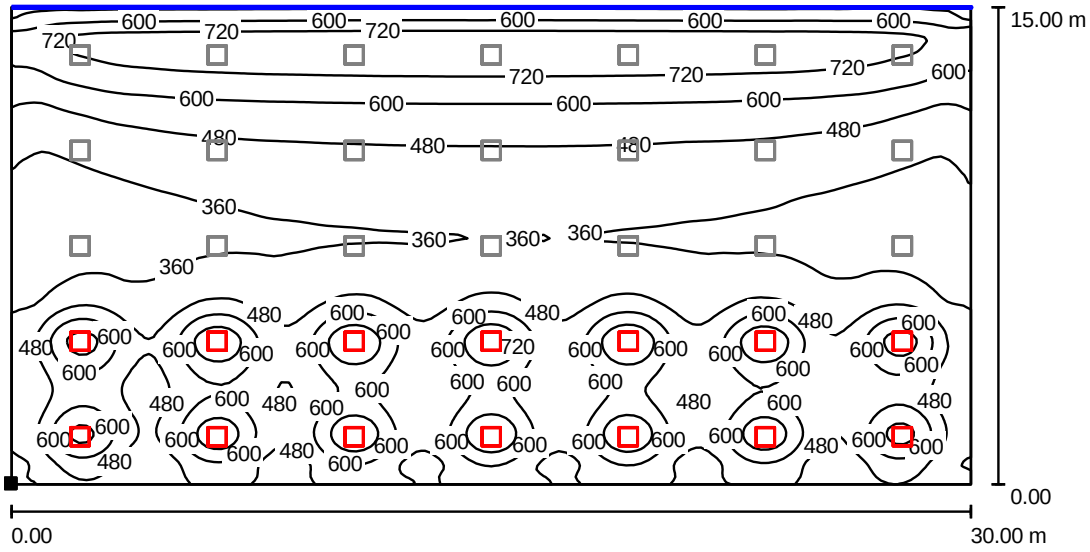


Figure A.15: Luminaire arrangement and illumination level W/W ratio at 55%

Scale 1 : 215

Daylight parameters:

Location: Sri Jaywardanapura, Longitude: 80.13°, Latitude: 6.10°, North deviation: 245.0°

Date: 21.06.2011, Time:17:00:00 (+5 hours difference to GMT)

Reference sky type: Clear sky

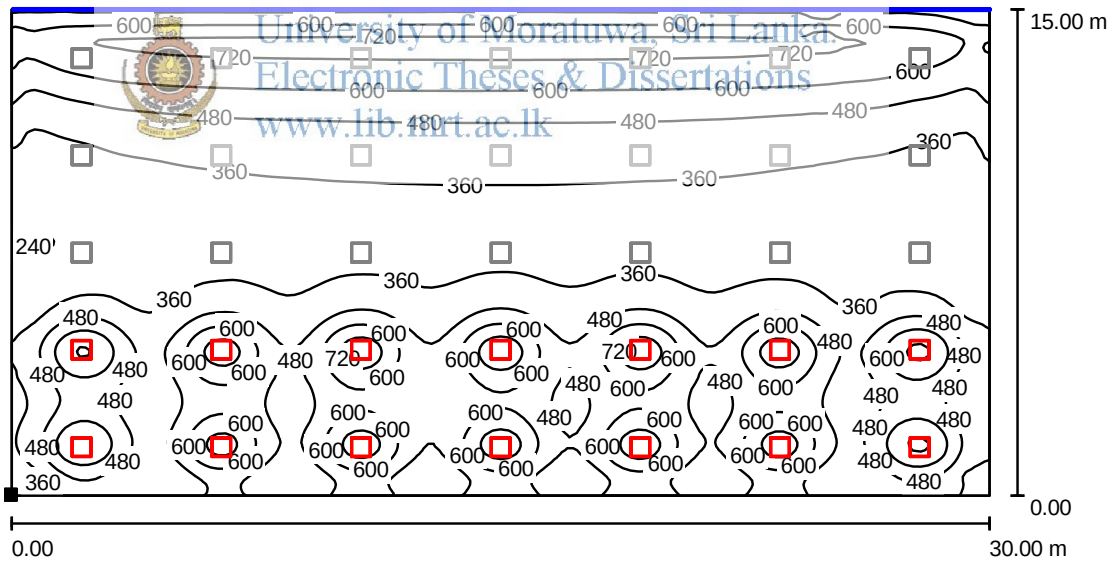


Figure A.16: Luminaire arrangement and illumination level W/W ratio at 55%

Scale 1 : 215

Daylight parameters:

Location: Sri Jaywardanapura, Longitude: 80.13°, Latitude: 6.10°, North deviation: 245.0°

Date: 21.12.2011, Time:17:00:00 (+5 hours difference to GMT)

Reference sky type: Clear sky

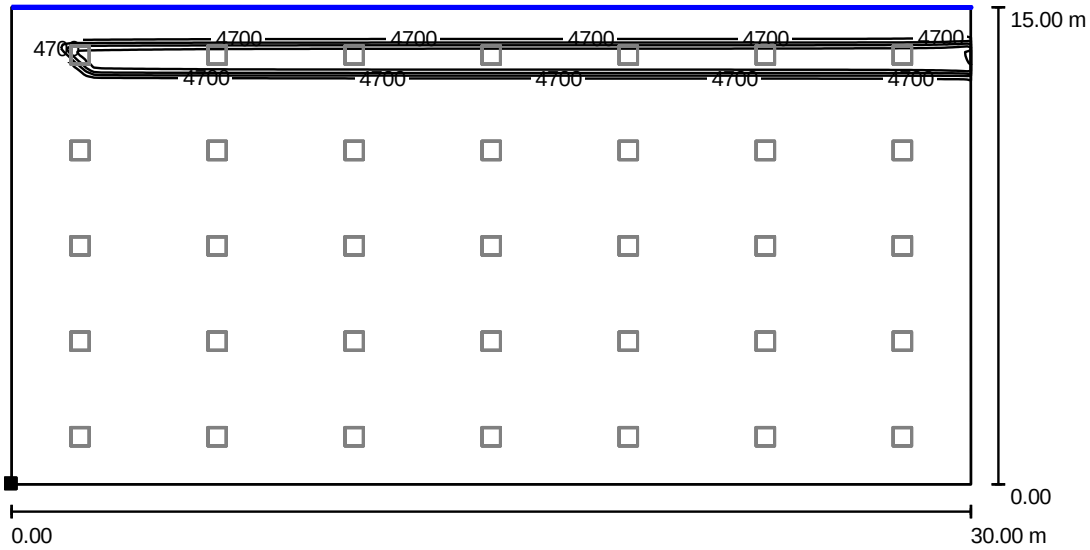


Figure A.17: Luminaire arrangement and illumination level W/W ratio at 35%

Scale 1 : 215

Daylight parameters:

Location: Sri Jaywardanapura, Longitude: 80.13°, Latitude: 6.10°, North deviation: 245.0°

Date: 21.06.2011, Time:09:00:00 (+5 hours difference to GMT)

Reference sky type: Clear sky

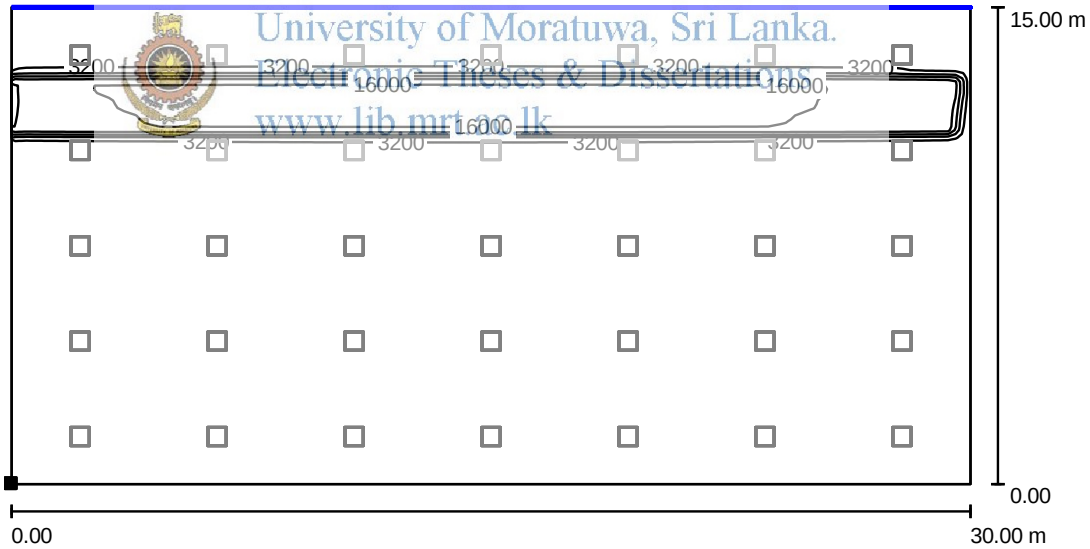


Figure A.18: Luminaire arrangement and illumination level W/W ratio at 35%

Scale 1 : 215

Daylight parameters:

Location: Sri Jaywardanapura, Longitude: 80.13°, Latitude: 6.10°, North deviation: 245.0°

Date: 21.12.2011, Time:09:00:00 (+5 hours difference to GMT)

Reference sky type: Clear sky

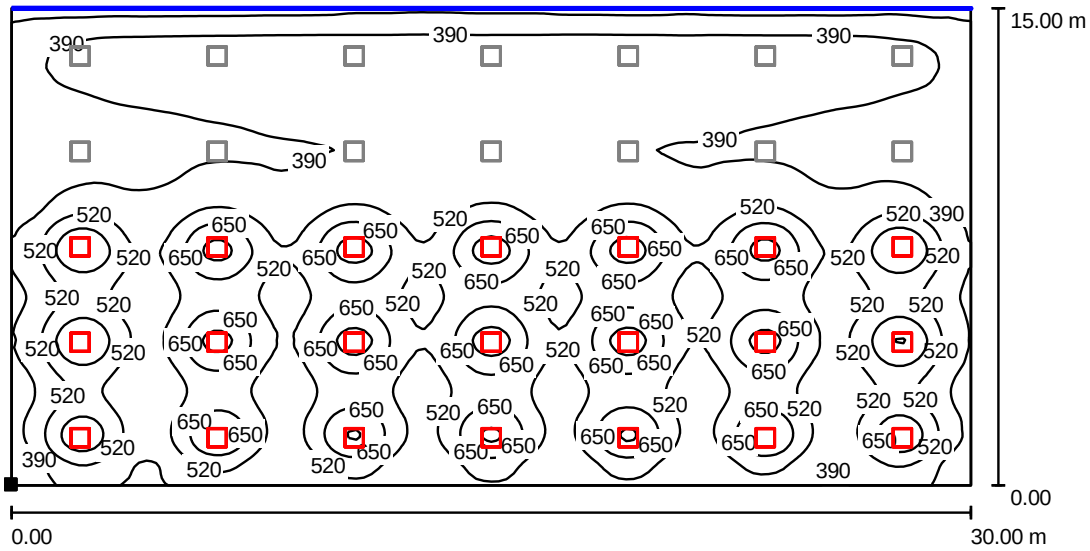


Figure A.19: Luminaire arrangement and illumination level W/W ratio at 35%

Scale 1 : 215

Daylight parameters:

Location: Sri Jaywardanapura, Longitude: 80.13°, Latitude: 6.10°, North deviation: 245.0°

Date: 21.06.2011, Time:17:00:00 (+5 hours difference to GMT)

Reference sky type: Clear sky

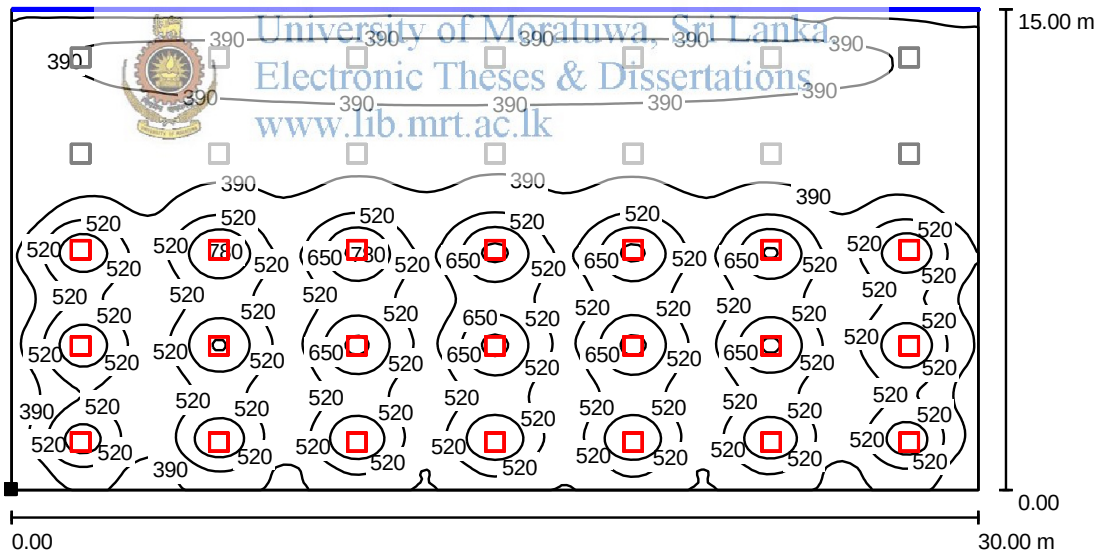


Figure A.20: Luminaire arrangement and illumination level W/W ratio at 35%

Scale 1 : 215

Daylight parameters:

Location: Sri Jaywardanapura, Longitude: 80.13°, Latitude: 6.10°, North deviation: 245.0°

Date: 21.12.2011, Time:17:00:00 (+5 hours difference to GMT)

Reference sky type: Clear sky

Appendix B: Cooling Load Temperature Difference for Calculating Load from Flat roof

Table 5 Cooling Load Temperature Differences for Calculating Cooling Load from Flat Roofs

Roof No	Description of Construction	Mass, kg/m²	U-value, W/m²·°C	Solar Time, h 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Maximum CLTD	Minimum CLTD	Maximum CLTD
Without Suspended Ceiling																															
1	Steel sheet with 25.4-mm (or 50.8-mm) insulation	34 (39)	1.209 (0.704)	0	−1	−2	−2	−3	−2	3	11	19	27	34	40	43	44	43	39	33	25	17	10	7	5	3	1	14	−3	44	4
2	25.4-mm wood with 25.4-mm insulation	39	0.965	3	2	0	−1	−2	−2	−1	2	8	15	22	29	35	39	41	41	39	35	29	21	15	11	8	5	16	−2	41	4
3	101.6-mm l.w concrete	88	1.209	5	3	1	0	−1	−2	−2	1	5	11	18	25	31	36	39	40	40	37	32	25	19	14	10	7	16	−2	40	4
4	50.8-mm h.w. concrete with 25.4-mm (or 50.8-mm) insulation	142	1.170 (0.693)	7	5	3	2	0	−1	0	2	6	11	17	23	28	33	36	37	37	34	30	25	20	16	12	10	16	−1	37	3
5	25.4-mm wood with 50.8-mm insulation	44	0.619	2	0	−2	−3	−4	−4	−4	−2	3	9	15	22	27	32	35	36	35	32	27	20	14	10	6	3	16	−4	36	4
6	152.4-mm l.w. concrete	117	0.897	12	10	7	5	3	2	1	0	2	4	8	13	18	24	29	33	35	36	35	32	28	24	19	16	18	0	36	3
7	63.5-mm wood with 25.4-mm insulation	63	0.738	16	13	11	9	7	6	4	3	4	5	8	11	15	19	23	27	29	31	31	30	27	25	22	19	19	3	31	2
8	203.2-mm l.w. concrete	151	0.715	20	17	14	12	10	8	6	5	4	4	5	7	11	14	18	22	25	28	30	30	29	27	25	22	20	4	30	2
9	101.6-mm h.w. concrete with 25.4-mm (or 50.8-mm) insulation	254 (254)	1.136 (0.681)	14	12	10	8	7	5	4	4	6	8	11	15	18	22	25	28	29	30	29	27	24	21	19	16	18	4	30	2
10	63.5-mm wood with 50.8-mm insulation	63	0.528	18	15	13	11	9	8	6	5	5	5	7	10	13	17	21	24	27	28	29	29	27	25	23	20	19	5	29	2
11	Roof terrace system	366	0.602	19	17	15	14	12	11	9	8	7	8	8	10	12	15	18	20	22	24	25	26	25	24	22	21	20	7	26	1
12	152.4-mm h.w. concrete with 25.4-mm (or 50.8-mm) insulation	366 (366)	(1.090) 0.664	18	16	14	12	11	10	9	8	8	9	10	12	15	17	20	22	24	25	25	25	24	22	20	19	19	8	25	1
13	101.6-mm wood with 25.4-mm (or 50.8-mm) insulation	83 (88)	0.602 (0.443)	21	20	18	17	15	14	13	11	10	9	9	9	10	12	14	16	18	20	22	23	24	24	23	22	22	9	24	1
With Suspended Ceiling																															
1	Steel Sheet with 25.4-mm (or 50.8-mm) insulation	44 (49)	0.761 (0.522)	1	0	−1	−2	−3	−3	0	5	13	20	28	35	40	43	43	41	37	31	23	15	10	7	5	3	15	−3	43	4
2	25.4-mm wood with 25.4-mm insulation	49	0.653	11	8	6	5	3	2	1	2	4	7	12	17	22	27	31	33	35	34	32	28	24	20	17	14	17	1	35	3
3	101.6-mm l.w. concrete	97	0.761	10	8	6	4	2	1	0	0	2	6	10	16	21	27	31	34	35	36	34	30	26	21	17	13	17	0	36	3
4	50.8-mm h.w. concrete with 25.4-mm insulation	146	0.744	16	14	13	11	10	8	7	7	8	9	11	14	17	19	22	24	25	26	26	25	23	21	20	18	18	7	26	1
5	25.4-mm wood with 50.8-mm insulation	49	0.477	14	11	9	7	5	4	3	3	5	7	10	14	18	23	27	30	31	32	31	29	26	22	19	16	18	3	32	3
6	152.4-mm l.w. concrete	127	0.619	18	15	13	11	9	7	6	4	4	5	7	9	12	16	20	24	27	29	30	30	28	26	23	20	20	4	30	2
7	63.5-mm wood with 25.4-mm insulation	73	0.545	19	18	16	14	13	12	10	9	8	8	9	10	12	14	17	19	21	23	24	25	24	23	22	21	20	8	25	1
8	203.2-mm l.w. concrete	176	0.528	22	20	18	16	15	13	11	10	9	8	8	8	9	11	14	16	19	21	23	25	25	25	24	23	20	8	25	1
9	101.6-mm h.w. concrete with 25.4-mm (or 50.8-mm) insulation	259 (264)	0.727 (0.511)	17	16	15	14	13	13	12	11	11	11	12	13	15	16	18	19	20	21	21	21	21	20	19	18	19	11	21	1
10	63.5-mm wood with 50.8-mm insulation	73	0.409	19	18	17	16	14	13	12	11	10	10	10	11	12	14	16	18	19	21	22	23	23	22	22	21	21	10	23	1
11	Roof terrace system	376	0.466	17	16	16	15	15	14	13	13	13	12	12	13	13	14	15	16	16	17	18	18	19	18	18	18	21	12	19	1
12	152.4-mm h.w. concrete with 25.4-mm (or 50.8-mm) insulation	376 (376)	0.710 0.499	16	16	15	15	14	13	13	12	12	12	12	13	14	15	16	17	18	18	19	19	19	18	18	18	20	12	19	1
13	101.6-mm wood with 25.4-mm (or 50.8-mm) insulation	93 (97)	0.465 (0.363)	20	19	19	18	17	16	15	14	14	13	12	12	12	12	13	14	15	16	18	19	20	20	20	20	23	12	20	1

(1) *Direct Application of Table 5 Without Adjustments:*

Values in Table 5 were calculated using the following conditions:

- Dark flat surface roof ("dark" for solar radiation absorption)
- Indoor temperature of 25.5°C
- Outdoor maximum temperature of 35°C with outdoor mean temperature of 29.4°C and an outdoor daily range of 11.6°C
- Solar radiation typical of 40 deg North latitude on July 21
- Outside surface resistance, $R_o = 0.059$ m²·°C/W
- Without and with suspended ceiling, but no attic fans or return air ducts in suspended ceiling space
- Inside surface resistance, $R_i = 0.121$ m²·°C/W

(2) *Adjustments to Table 5 Values:*

The following equation makes adjustments for deviations of design and solar conditions from those listed in (1) above.

$$CLTD_{corr} = [(CLTD + LM) \cdot K + (25.5 - T_R) + (T_o - 29.4)] \cdot f$$

where CLTD is from this table

(a) LM is latitude-month correction from Table 9 for a horizontal surface.

(b) K is a color adjustment factor and is applied after first making month-latitude adjustments. Credit should not be taken for a light-colored roof except where permanence of light color is established by experience, as in rural areas or where there is little smoke.

$K = 1.0$ if dark colored or light in an industrial area

$K = 0.5$ if permanently light-colored (rural area)

(c) $(25.5 - T_R)$ is indoor design temperature correction.

(d) $(T_o - 29.4)$ is outdoor design temperature correction, where T_o is the average outside temperature on design day.

(e) f is a factor for attic fan and or ducts above ceiling and is applied after all other adjustments have been made.

$f = 1.0$ no attic or ducts

$f = 0.75$ positive ventilation

Values in Table 5 were calculated without and with a suspended ceiling, but made no allowances for positive ventilation or return ducts thru the space. If ceiling is insulated and a fan is used between ceiling and roof, CLTD may be reduced by 25% ($f = 0.75$). Use of the suspended ceiling space for a return air plenum or with return air ducts should be analyzed separately.

(3) *Roof Constructions Not Listed in Table:*

The U-Values listed are to be used only as guides. The actual value of U as obtained from tables such as Tables 3 and 4, Chapter 23, or as calculated for the actual roof construction should be used.

Appendix C: Cooling Load Temperature Difference for Calculating Cooling Load from Sunlit Walls

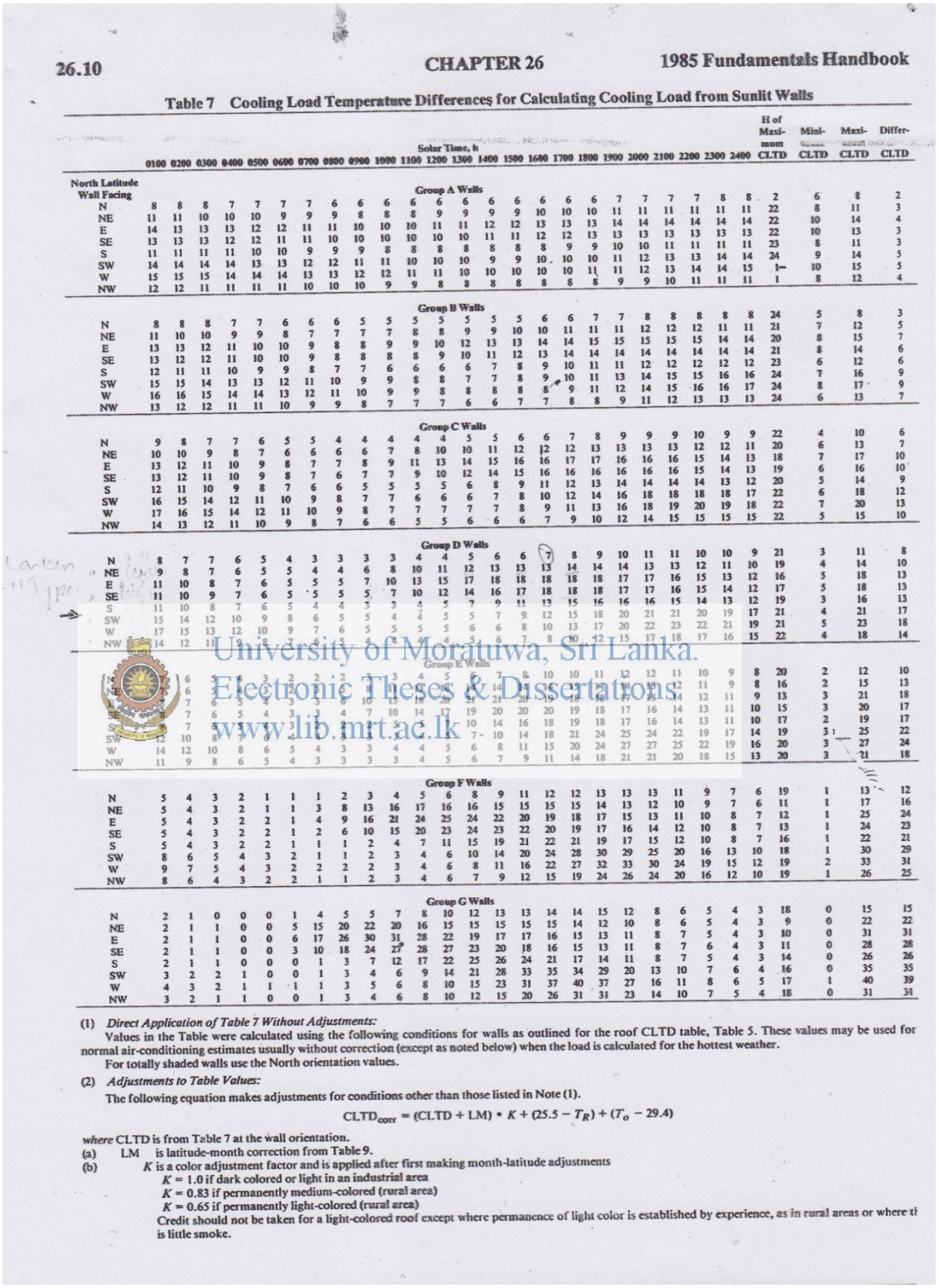


Table 7 Cooling Load Temperature Differences for Calculating Cooling Load from Sunlit Walls

North Latitude Wall Facing	Solar Time, h 0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	H of Maximum CLTD	Minimum CLTD	Maximum CLTD	Difference CLTD
Group A Walls																												
N	8	8	8	7	7	7	7	6	6	6	6	6	6	6	6	6	6	7	7	7	7	8	8	2	6	8	2
NE	11	11	10	10	10	9	9	9	8	8	8	9	9	9	9	10	10	10	11	11	11	11	11	11	22	8	11	3
E	14	13	13	13	12	12	11	11	10	10	10	11	11	12	12	13	13	13	14	14	14	14	14	14	22	10	14	4
SE	13	13	13	12	12	11	11	10	10	10	10	10	10	11	11	12	12	13	13	13	13	13	13	13	22	10	13	3
S	11	11	11	11	10	10	9	9	9	8	8	8	8	8	8	8	9	9	10	10	11	11	11	11	23	8	11	3
SW	14	14	14	14	13	13	12	12	11	11	10	10	10	9	9	10	10	10	11	12	13	13	14	14	24	9	14	5
W	15	15	15	14	14	14	13	13	12	12	11	11	10	10	10	10	10	11	11	12	13	14	14	15	1—	10	15	5
NW	12	12	11	11	11	11	10	10	10	9	9	8	8	8	8	8	8	8	9	9	10	11	11	11	1	8	12	4
Group B Walls																												
N	8	8	8	7	7	6	6	6	5	5	5	5	5	5	6	6	7	7	8	8	8	8	8	24	5	8	3
NE	11	10	10	9	9	8	7	7	7	7	8	8	9	9	10	10	11	11	11	12	12	12	11	11	21	7	12	5
E	13	13	12	11	10	10	9	8	8	9	9	10	12	13	13	14	14	15	15	15	15	15	14	14	20	8	15	7
SE	13	12	12	11	10	10	9	8	8	8	8	9	10	11	12	13	14	14	14	14	14	14	14	14	21	8	14	6
S	12	11	11	10	9	9	8	7	7	6	6	6	6	7	8	9	10	11	11	12	12	12	12	12	23	6	12	6
SW	15	15	14	13	13	12	11	10	9	9	8	8	7	7	8	9	10	11	13	14	15	15	16	16	24	7	16	9
W	16	16	15	14	14	13	12	11	10	9	9	8	8	8	8	8	9	11	12	14	15	16	16	17	24	8	17	9
NW	13	12	12	11	11	10	9	9	8	7	7	7	6	6	7	7	8	8	9	11	12	13	13	13	24	6	13	7
Group C Walls																												
N	9	8	7	7	6	5	5	4	4	4	4	4	5	5	6	6	7	8	9	9	9	10	9	9	22	4	10	6
NE	10	10	9	8	7	6	6	6	6	7	8	10	10	11	12	12	12	13	13	13	13	12	12	11	20	6	13	7
E	13	12	11	10	9	8	7	7	8	9	11	13	14	15	16	16	17	17	16	16	16	15	14	13	18	7	17	10
SE	13	12	11	10	9	8	7	6	7	7	9	10	12	14	15	16	16	16	16	16	16	15	14	13	19	6	16	10
S	12	11	10	9	8	7	6	6	5	5	5	5	6	8	9	11	12	13	14	14	14	14	13	12	20	5	14	9
SW	16	15	14	12	11	10	9	8	7	7	6	6	6	7	8	10	12	14	16	18	18	18	18	17	22	6	18	12
W	17	16	15	14	12	11	10	9	8	7	7	7	7	7	8	9	11	13	16	18	19	20	19	18	22	7	20	13
NW	14	13	12	11	10	9	8	7	6	6	5	5	6	6	6	7	9	10	12	14	15	15	15	15	22	5	15	10
Group D Walls																												
N	8	7	7	6	5	4	3	3	3	3	4	4	5	6	6	7	8	9	10	11	11	10	10	9	21	3	11	8
NE	9	8	7	6	5	5	4	4	6	8	10	11	12	13	13	13	14	14	14	13	13	12	11	10	19	4	14	10
E	11	10	8	7	6	5	5	5	7	10	13	15	17	18	18	18	18	18	17	17	16	15	13	12	16	5	18	13
SE	11	10	9	7	6	5	5	5	5	7	10	12	14	16	17	18	18	18	17	17	16	15	14	12	17	5	18	13
S	11	10	8	7	6	5	4	4	3	3	4	5	7	9	11	13	15	16	16	16	15	14	13	12	19	3	16	13
SW	15	14	12	10	9	8	6	5	5	4	4	5	5	7	9	12	15	18	20	21	21	20	19	17	21	4	21	17
W	17	15	13	12	10	9	7	6	5	5	5	5	6	6	8	10	13	17	20	22	23	22	21	19	21	5	23	18
NW	14	12	11	10	8	7	6	5	4	4	4	4	5	6	7	8	10	12	15	17	18	17	16	15	22	4	18	14
Group E Walls																												
N	6	5	4	3	2	2	2	2	3	3	4	5	6	7	8	10	10	11	12	12	11	10	9	8	20	2	12	10
NE	6	5	4	3	3	3	3	4	5	7	9	11	13	15	16	17	18	18	18	17	16	15	12	11	16	2	15	13
E	7	6	5	4	3	3	3	4	6	8	11	14	17	19	20	21	21	21	20	19	18	16	14	12	21	3	21	18
SE	7	6	5	4	3	3	3	4	7	10	14	17	19	20	20	20	19	18	17	16	14	13	11	10	15	3	20	17
S	7	6	5	4	3	3	3	4	7	10	13	16	18	19	19	19	18	17	16	14	13	11	10	17	2	19	17	
SW	12	10	8	7	6	5	4	4	5	7	10	14	16	18	21	24	25	24	22	19	17	14	19	3	25	22		
W	14	12	10	8	6	5	4	3	3	4	4	5	6	8	11	15	20	24	27	27	25	22	19	16	20	3	27	24
NW	11	9	8	6	5	4	3	3	3	3	4	5	6	7	9	11	14	18	21	21	20	18	15	13	20	3	21	18
Group F Walls																												
N	5	4	3	2	1	1	1	2	3	4	5	6	8	9	11	12	12	13	13	13	11	9	7	6	19	1	13	12
NE	5	4	3	2	1	1	3	8	13	16	17	16	16	15	15	15	15	14	13	12	10	9	7	6	11	1	17	16
E	5	4	3	2	2	1	4	9	16	21	24	25	24	22	20	19	18	17	15	13	11	10	8	7	12	1	25	24
SE	5	4	3	2	2	1	2	6	10	15	20	23	24	23	22	20	19	19	17	16	14	12	10	8	13	1	24	23
S	5	4	3	2	2	1	1	1	2	4	7	11	15	19	21	22	21	19	17	15	12	10	8	7	16	1	22	21
SW	8	6	5	4	3	2	1	1	2	3	4	6	10	14	20	24	28	30	29	25	20	16	13	10	18	1	30	29
W	9	7	5	4	3	2	2	2	2	3	4	6	8	11	16	22	27	32	33	30	24	19	15	12	19	2	33	31
NW	8	6	4	3	2	2	1	1	2	3	4	6	7	9	12	15	19	24	26	24	20	16	12	10	19	1	26	25
Group G Walls																												
N	2	1	0	0	0	1	4	5	5	7	8	10	12	13	13	14	14	15	12	8	6	5	4	3	18	0	15	15
NE	2	1	1	0	0	5	15	20	22	20	16	15	15	15	15	15	14	12	10	8	6	5	4	3	9	0	22	22
E	2	1	1	0	0	6	17	26	30	31	28	22	19	17	17	16	15	13	11	8	7	5	4	3	10	0	31	31
SE	2	1	1	0	0	3	10	18	24	27	28	27	23	20	18	16	15	13	11	8	7	6	4	3	11	0	28	28
S	2	1	1	0	0	0	1	3	7	12	17	22	25	26	24	21	17	14	11	8	7	5	4	3	14	0	26	26
SW	3	2	2	1	0	0	1	3	4	6	9	14	21	28	33	35	34	29	20	13	10	7	6	4	16	0	35	35
W	4	3	2	1	1	1	1	3	5	6	8	10	15	23	31	37	40	37	27	16	11	8	6	5	17	1	40	39
NW	3	2	1	1	0	0	1	3	4	6	8	10	12	15	20	26	31	31	23	14	10	7	5	4	18	0	31	31

(1) *Direct Application of Table 7 Without Adjustments:*
Values in the Table were calculated using the following conditions for walls as outlined for the roof CLTD table, Table 5. These values may be used for normal air-conditioning estimates usually without correction (except as noted below) when the load is calculated for the hottest weather.
For totally shaded walls use the North orientation values.

(2) *Adjustments to Table Values:*
The following equation makes adjustments for conditions other than those listed in Note (1).

$$CLTD_{corr} = (CLTD + LM) \cdot K + (25.5 - T_R) + (T_o - 29.4)$$

where CLTD is from Table 7 at the wall orientation.
(a) LM is latitude-month correction from Table 9.
(b) *K* is a color adjustment factor and is applied after first making month-latitude adjustments
K = 1.0 if dark colored or light in an industrial area
K = 0.83 if permanently medium-colored (rural area)
K = 0.65 if permanently light-colored (rural area)
Credit should not be taken for a light-colored roof except where permanence of light color is established by experience, as in rural areas or where th is little smoke.

Appendix D: Cooling Load Temperature Differences for conduction through Glass

Table 10 Cooling Load Temperature Differences for Conduction through Glass

Solar Time, h	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
CLTD °C	1	0	−1	−1	−1	−1	−1	0	1	2	4	5	7	7	8	8	7	7	6	4	3	2	2	1

Corrections: The values in the table were calculated for an inside temperature of 25.5°C and an outdoor maximum temperature of 35°C with an outdoor daily range of 11.6°C. The table remains approximately correct for other outdoor maximums 33.8-38.8°C and other outdoor daily ranges 8.9-18.9°C, provided the outdoor daily average temperature remains approximately 29.4°C. If the room air temperature is different from 25.5°C and/or the outdoor daily average temperature is different from 29.4°C, the following rules apply: (a) For room air temperature less than 25.5°C, add the difference between 25.5°C and room air temperature; if greater than 25.5°C, subtract the difference. (b) For outdoor daily average temperature less than 29.4°C, subtract the difference between 29.4°C and the daily average temperature; if greater than 29.4°C, add the difference.

Using the basic equations of Chapter 27, a computer program was generated to calculate the SHGFs for the double-strength sheet glass. The SHGFs—calculated for different latitudes (0°N to 64°N), months (January through December), orientations (seventeen) and daylight hours—were used as the "heat gain" input for calculating cooling load factors, employing appropriate room transfer functions (from Methodology and Equations for Hour-by-Hour Load Calculations, below). However, this implied the introduction of two new, interdependent variables into the calculations—(1) type of interior construction in the space: light, medium or heavy and (2) presence or absence of an interior shading device for the glass—with the consequent increase in the number of variables.

To simplify the data, a *normalized* profile of the SHGFs was obtained by dividing the SHGFs for a particular month by the maximum SHGF in that month. A comparison of the normalized profiles obtained for *different* months indicated great similarity among SHGFs in the warmest months of the year (May through September). These summer season SHGFs were then compared to those of other latitudes and orientations. As a result, a set of factors for one latitude and one month—40°N latitude and July—was considered *representative* of all latitudes and months of hottest weather (May through September). These representative values were used as the input for calculating cooling load factors.

For calculation, the cooling load from solar radiation must be analyzed in one of two cases: (1) presence of interior shading or (2) absence of interior shading. In converting heat gain to cooling load, the time lag, caused by the radiant solar energy entering the space, is variable; for example, it differs when energy is absorbed by interior draperies or Venetian blinds, it differs from when it is absorbed by the floor. Interior shading devices cause the cooling load to track the solar heat gain profile more closely, while the case without the interior shading spreads the load out. Rudoy[36] has shown that the lightweight construction of interior shading changes the cooling load profile less, but reduces the energy by virtue of a lower SC. The time lag difference in converting heat gain to cooling load appears in the cooling load factors used to multiply the solar heat gains.

Cooling load caused by solar radiation through fenestration is calculated by:

$$q = \text{Area} \cdot \text{Shading Coefficient} \cdot \text{Maximum Solar Heat Gain} \cdot \text{Cooling Load Factor} \quad (12)$$

The *area* is the net glass area of the fenestration. The *maximum solar heat gain* is obtained for the appropriate latitude, month and surface orientation (Table 11). The *shading coefficient*, for combination of the fenestration and shading device, can be obtained from Tables 28 and 34 to 36, Chapter 27. The CLF values for three common room thermal characteristics are in Tables 12 and 13 of this chapter.

Total Load through Fenestration

The total load through fenestration is the sum of the from to conduction heat gain [Eq. (9)] and the load from solar heat gain [Eq. (12)].

Example 4: Determine the cooling load caused by glass on the south and west walls of a building at 1200, 1400 and 1600 hours in Aug. The building is located at 32°N latitude with outside design conditions of 32°C dry-bulb temperature and a 11°C daily range. The inside design dry-bulb temperature is 25°C. Assume the room construction is of medium weight. The south glass is the insulating glass (6.35 mm air space) with an area of 9.29 m² with no interior shading. The west glass is 5.56 mm single grey-tinted glass with an area of 9.29 m² and with light-colored Venetian blinds.

Solution: Data required for the calculations are as follows:

	U W/m²·K (Chapter 27, Table 13)	SC (Chapter 27)	Maximum SHG (Table 11)
S. Glass	3.46	0.82 (Table 29, Chapter 27)	350
W. Glass	4.60	0.53 (Table 35, Chapter 27)	619

The conduction heat gain component of the cooling is calculated by:

$$q = UA\,(\text{CLTD})$$

Time	CLTD (Table 10)	CLTD Corrected	S. Glass *UA* (CLTD) W	W. Glass *UA* (CLTD) W
1200	5	2.2	71	94
1400	7	4.2	135	179
1600	8	5.2	167	222

The correction factor applied to the above values was −2.8°C, computed from the notes of Table 10. The CLTDs are rounded off and the solar heat gain component of the cooling load is calculated by:

$$q = A\,(\text{SC})(\text{SHG})(\text{CLF})$$

	S. Glass		W. Glass	
Time	CLF (Table 12)	*A* SC SHG CLF W	CLF Table 13	*A* SC SHG CLF W
1200	0.52	1386	0.17	578
1400	0.58	1546	0.53	1803
1600	0.47	1253	0.82	2789

The total cooling load from heat gain through the glass is therefore:

Time	S. Glass W	W. Glass W
1200	1457	672
1400	1681	1982
1600	1420	3011

Appendix E: Maximum Solar Heat Gain Factor, W/m2 for Sunlit Glass, North Latitudes

Table 11 Maximum Solar Heat Gain Factor, W/m² for Sunlit Glass, North Latitudes

0 Deg

	N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR
Jan.	107	107	278	558	738	801	741	574	372	934
Feb.	114	123	416	647	773	779	663	445	211	965
Mar.	120	274	536	704	764	704	536	274	120	956
Apr.	224	423	609	707	697	581	372	120	117	896
May	357	517	640	688	634	486	252	117	117	836
June	407	546	650	669	603	441	208	117	117	805
July	363	517	634	672	615	470	243	120	120	820
Aug.	237	423	590	681	669	552	353	123	120	871
Sep.	126	265	514	672	729	672	514	265	126	924
Oct.	117	126	407	628	745	751	637	426	208	943
Nov.	110	110	278	552	726	789	726	565	369	924
Dec.	107	107	224	517	713	798	757	618	435	909

4 Deg

	N	NNE/ NNW	NE NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR
Jan.	104	104	249	536	722	795	514	609	445	902
Feb.	110	110	388	628	764	782	678	480	278	550
Mar.	120	243	514	691	764	716	558	303	136	953
Apr.	174	394	596	704	704	599	398	136	120	905
May	293	486	631	694	650	508	281	120	120	858
June	347	517	637	678	618	464	230	120	120	830
July	303	486	622	678	631	492	268	123	120	842
Aug.	186	391	581	678	675	571	379	133	126	880
Sep.	123	237	492	659	729	681	536	293	139	924
Oct.	114	114	379	609	738	754	653	467	271	928
Nov.	107	107	249	530	713	782	732	599	439	896
Dec.	104	104	196	495	697	789	764	650	505	874

8 Deg

	N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR
Jan.	101	101	224	514	707	789	764	640	511	868
Feb.	107	107	360	609	754	782	691	521	347	828
Mar.	117	244	492	678	764	726	581	347	142	842
Apr.	139	360	581	697	710	615	423	167	123	912
May	233	461	625	694	659	527	306	123	120	874
June	284	489	631	685	631	445	259	123	123	849
July	243	457	615	678	644	511	294	126	123	858
Aug.	148	369	565	675	681	587	404	161	129	890
Sep	120	208	470	647	726	691	555	338	177	915
Oct.	110	110	353	590	729	754	666	505	341	909
Nov.	104	104	224	508	694	773	735	631	505	861
Dec.	98	98	174	470	678	776	779	678	565	836

12 Deg

	N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR
Jan.	98	98	199	489	685	776	779	669	574	827
Feb.	107	107	331	587	741	782	713	558	420	902
Mar.	114	183	467	663	757	735	599	391	230	937
Apr.	126	341	562	691	716	631	448	202	126	915
May	189	439	612	694	669	546	334	126	126	883
June	237	470	625	685	644	508	284	126	126	864
July	199	439	603	678	653	530	322	129	129	868
Aug.	133	344	549	669	688	603	426	196	448	890
Sep.	117	180	448	634	722	700	574	382	230	905
Oct.	107	107	325	568	716	751	691	543	410	883
Nov.	101	101	199	483	675	760	767	659	565	820
Dec.	95	95	148	445	653	764	792	704	622	789

16 Deg

	N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR
Jan.	95	95	174	464	663	770	792	704	628	782
Feb.	104	104	303	568	729	779	735	593	486	868
Mar.	110	167	441	647	745	741	622	435	293	918
Apr.	123	312	543	681	716	644	473	243	142	912
May	164	416	596	688	678	565	363	142	129	890
June	208	448	612	685	653	527	312	129	129	874
July	174	416	590	675	663	549	350	139	133	874
Aug.	129	316	530	659	691	644	451	233	145	890
Sep.	114	158	423	618	716	707	603	423	293	890
Oct.	104	104	300	549	704	748	710	577	473	852
Nov.	95	95	174	457	650	760	779	694	618	776
Dec.	91	91	129	416	625	760	801	735	669	738

20 Deg

	N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR
Jan.	91	91	151	435	634	767	798	735	675	732
Feb.	98	98	278	546	713	770	751	634	549	830
Mar.	107	155	416	631	748	745	650	480	363	896
Apr.	120	290	524	672	719	656	498	287	183	905
May	148	388	581	685	685	581	391	170	133	893
June	186	426	596	681	663	546	341	142	133	880
July	151	391	574	672	669	565	375	167	136	877
Aug.	126	287	511	650	694	631	480	278	180	883
Sep.	114	145	401	603	710	710	628	467	360	868
Oct.	101	101	274	527	685	745	729	618	536	814
Nov.	91	91	151	429	622	754	786	722	666	726
Dec.	85	85	110	385	590	751	801	760	713	685

24 Deg

	N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR
Jan.	85	85	129	404	599	757	798	760	716	675
Feb.	95	95	252	521	694	770	767	672	606	786
Mar.	107	142	391	615	738	748	675	530	432	868
Apr.	117	278	502	659	719	669	533	338	237	893
May	136	369	562	675	688	599	416	211	145	890
June	174	401	581	675	669	565	369	174	136	880
July	142	366	555	663	672	584	407	205	145	877
Aug.	120	274	492	640	694	644	511	325	227	874
Sep.	110	133	375	584	700	710	650	514	423	839
Oct.	98	98	249	502	666	748	741	653	590	770
Nov.	85	85	133	398	590	745	786	748	707	672
Dec.	82	82	91	353	568	738	779	779	748	628

28 Deg

	N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE SSW	S	HOR
Jan.	79	79	110	369	577	741	792	779	751	618
Feb.	91	91	227	495	672	770	776	707	653	738
Mar.	104	129	366	596	729	748	697	574	495	836
Apr.	114	265	476	647	719	681	562	391	297	877
May	126	363	543	666	691	615	454	262	183	883
June	161	394	562	666	672	581	404	707	155	877
July	129	360	536	656	678	599	442	252	180	870
Aug.	120	262	470	628	694	653	543	379	287	858
Sep.	107	120	350	565	691	713	672	558	486	808
Oct.	95	95	224	476	644	745	751	685	637	722
Nov.	82	82	110	363	571	732	779	767	741	615
Dec.	75	76	76	312	543	716	782	792	776	565

32 Deg

	N (Shade)	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR
June	76	76	91	331	552	722	786	789	776	555
Feb.	85	85	205	470	647	764	782	732	697	685
Mar.	101	117	338	577	716	748	716	615	555	795
Apr.	114	252	461	631	716	691	590	445	363	855
May	120	350	536	656	694	628	489	312	233	874
June	139	385	555	656	675	596	439	262	189	871
July	126	350	527	643	678	612	473	303	227	861
Aug.	117	249	445	615	691	663	571	429	350	836
Sep.	104	110	325	546	678	716	688	596	540	770
Oct.	88	88	199	451	615	738	754	710	678	672
Nov.	76	76	91	325	546	710	773	776	767	552
Dec.	69	69	69	265	511	688	776	795	795	498

36 Deg

	N (Shade)	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE SSW	S	HOR
Jan.	69	69	76	284	524	691	779	795	795	489
Feb.	82	82	180	439	615	754	782	754	732	628
Mar.	95	104	312	555	704	751	732	650	606	751
Apr.	110	240	454	618	710	697	618	492	426	827
May	120	338	530	644	694	644	521	366	293	858
June	148	372	552	647	678	612	473	312	243	861
July	123	338	521	634	681	628	508	357	284	846
Aug.	114	237	435	599	688	669	596	476	413	811
Sep.	98	98	300	527	663	719	704	631	590	726
Oct.	85	85	177	420	590	726	754	729	710	615
Nov.	69	69	76	274	514	678	767	782	782	486
Dec.	63	63	63	218	476	644	760	798	801	429

Appendix F: Cooling Load Factors for Glass without Interior Shading, North Latitudes

Values of U can be obtained from Chapter 23. Temperature t_b may have any value over a considerable range according to conditions in the adjacent space. The temperature in a kitchen or boiler room may be as much as 8 to 25°C above the outdoor air temperature. It is recommended that actual temperatures in adjoining spaces be measured wherever practicable; where nothing is known except that the adjacent space is of conventional construction and contains no heat sources, $t_b - t_i$ should be considered the difference between the outdoor air and conditioned-space design dry- bulb temperatures *minus* 2.8°C. In some cases, the air temperature in the adjacent space will always correspond to the outdoor air temperature.

For floors directly in contact with the ground, or over an underground basement that is neither ventilated nor warmed, heat transfer may be neglected for cooling load estimates.

Table 13 Cooling Load Factors for Glass without Interior Shading, North Latitudes

Fenestration Facing	Room Construction	Solar Time, h																						
		0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
N (Shaded)	L	0.17	0.14	0.11	0.09	0.08	0.33	0.42	0.48	0.56	0.63	0.71	0.76	0.80	0.82	0.82	0.79	0.75	0.84	0.61	0.48	0.38	0.31	0.25	0.20
	M	0.23	0.20	0.18	0.16	0.14	0.34	0.41	0.46	0.53	0.59	0.65	0.70	0.73	0.75	0.76	0.74	0.75	0.79	0.61	0.50	0.42	0.36	0.31	0.27
	H	0.25	0.23	0.21	0.20	0.19	0.38	0.45	0.49	0.55	0.60	0.65	0.69	0.72	0.72	0.72	0.70	0.70	0.75	0.57	0.46	0.39	0.34	0.31	0.28
NNE	L	0.06	0.05	0.04	0.03	0.03	0.26	0.43	0.47	0.44	0.41	0.40	0.39	0.39	0.38	0.36	0.33	0.30	0.26	0.20	0.16	0.13	0.10	0.08	0.07
	M	0.09	0.08	0.07	0.06	0.06	0.24	0.38	0.42	0.39	0.37	0.37	0.36	0.36	0.36	0.34	0.33	0.30	0.27	0.22	0.18	0.16	0.14	0.12	0.10
	H	0.11	0.10	0.09	0.09	0.08	0.26	0.39	0.42	0.39	0.36	0.35	0.34	0.34	0.33	0.32	0.31	0.28	0.25	0.21	0.18	0.16	0.14	0.13	0.12
NE	L	0.04	0.04	0.03	0.02	0.02	0.23	0.41	0.51	0.51	0.45	0.39	0.36	0.33	0.31	0.28	0.26	0.23	0.19	0.15	0.12	0.10	0.08	0.06	0.05
	M	0.07	0.06	0.06	0.05	0.04	0.21	0.36	0.44	0.45	0.40	0.36	0.33	0.31	0.30	0.28	0.26	0.23	0.21	0.17	0.15	0.13	0.11	0.09	0.08
	H	0.09	0.08	0.08	0.07	0.07	0.23	0.37	0.44	0.44	0.39	0.34	0.31	0.29	0.27	0.26	0.24	0.22	0.20	0.17	0.14	0.13	0.12	0.11	0.10
ENE	L	0.04	0.03	0.03	0.02	0.02	0.21	0.40	0.52	0.57	0.53	0.45	0.39	0.34	0.31	0.28	0.25	0.22	0.18	0.14	0.12	0.09	0.08	0.06	0.05
	M	0.07	0.06	0.05	0.05	0.04	0.20	0.35	0.45	0.49	0.47	0.41	0.36	0.33	0.30	0.28	0.26	0.23	0.20	0.17	0.14	0.12	0.11	0.09	0.08
	H	0.09	0.09	0.08	0.07	0.07	0.22	0.36	0.46	0.49	0.45	0.38	0.33	0.30	0.27	0.25	0.23	0.21	0.19	0.16	0.14	0.13	0.12	0.11	0.10
E	L	0.04	0.03	0.03	0.02	0.02	0.19	0.37	0.51	0.57	0.57	0.50	0.42	0.37	0.32	0.29	0.26	0.23	0.19	0.15	0.12	0.10	0.08	0.06	0.05
	M	0.07	0.06	0.06	0.05	0.04	0.18	0.33	0.44	0.49	0.51	0.46	0.39	0.35	0.31	0.28	0.26	0.23	0.21	0.17	0.15	0.13	0.11	0.10	0.08
	H	0.09	0.09	0.08	0.08	0.07	0.20	0.34	0.45	0.49	0.49	0.43	0.36	0.32	0.29	0.26	0.24	0.22	0.19	0.17	0.15	0.13	0.12	0.11	0.10
ESE	L	0.03	0.03	0.02	0.02	0.02	0.17	0.36	0.51	0.59	0.61	0.57	0.48	0.41	0.36	0.32	0.28	0.24	0.20	0.16	0.13	0.10	0.09	0.07	0.06
	M	0.06	0.05	0.05	0.04	0.03	0.16	0.34	0.47	0.54	0.57	0.53	0.46	0.39	0.35	0.32	0.29	0.26	0.22	0.19	0.16	0.14	0.12	0.11	0.09
	H	0.10	0.09	0.09	0.08	0.08	0.19	0.32	0.43	0.50	0.52	0.49	0.41	0.36	0.32	0.29	0.26	0.24	0.21	0.18	0.16	0.14	0.13	0.12	0.11
SE	L	0.05	0.04	0.04	0.03	0.03	0.14	0.31	0.48	0.59	0.62	0.63	0.57	0.48	0.42	0.37	0.33	0.28	0.24	0.19	0.15	0.12	0.10	0.08	0.07
	M	0.09	0.08	0.07	0.06	0.05	0.14	0.26	0.38	0.48	0.54	0.56	0.51	0.45	0.40	0.36	0.33	0.29	0.25	0.21	0.18	0.16	0.14	0.12	0.10
	H	0.11	0.10	0.10	0.09	0.08	0.17	0.28	0.40	0.49	0.53	0.53	0.48	0.41	0.36	0.33	0.30	0.27	0.24	0.20	0.18	0.16	0.14	0.13	0.12
SSE	L	0.07	0.05	0.04	0.04	0.03	0.06	0.15	0.29	0.43	0.55	0.63	0.64	0.60	0.52	0.45	0.40	0.35	0.29	0.23	0.18	0.15	0.12	0.10	0.08
	M	0.11	0.09	0.08	0.07	0.06	0.08	0.16	0.26	0.38	0.48	0.55	0.57	0.54	0.48	0.43	0.39	0.35	0.30	0.25	0.21	0.18	0.16	0.14	0.12
	H	0.12	0.11	0.11	0.10	0.09	0.12	0.19	0.29	0.40	0.49	0.54	0.55	0.51	0.44	0.39	0.35	0.31	0.27	0.23	0.20	0.18	0.16	0.15	0.13
S	L	0.08	0.07	0.05	0.04	0.04	0.06	0.09	0.14	0.22	0.34	0.48	0.59	0.65	0.65	0.59	0.50	0.43	0.36	0.28	0.22	0.18	0.15	0.12	0.10
	M	0.12	0.11	0.09	0.08	0.07	0.08	0.11	0.14	0.21	0.31	0.42	0.52	0.57	0.58	0.53	0.47	0.41	0.36	0.29	0.25	0.21	0.18	0.16	0.14
	H	0.13	0.12	0.12	0.11	0.10	0.11	0.14	0.17	0.24	0.33	0.43	0.51	0.56	0.55	0.50	0.43	0.37	0.32	0.26	0.22	0.20	0.18	0.16	0.15
SSW	L	0.10	0.08	0.07	0.06	0.05	0.06	0.09	0.11	0.15	0.19	0.27	0.39	0.52	0.62	0.67	0.65	0.58	0.46	0.36	0.28	0.23	0.19	0.15	0.12
	M	0.14	0.12	0.11	0.09	0.08	0.09	0.11	0.13	0.15	0.18	0.25	0.35	0.46	0.55	0.59	0.59	0.53	0.44	0.35	0.30	0.25	0.22	0.19	0.16
	H	0.15	0.14	0.13	0.12	0.11	0.12	0.14	0.16	0.18	0.21	0.27	0.37	0.46	0.53	0.57	0.55	0.49	0.40	0.32	0.26	0.23	0.20	0.18	0.16
SW	L	0.12	0.10	0.08	0.06	0.05	0.06	0.08	0.10	0.12	0.14	0.16	0.24	0.36	0.49	0.60	0.66	0.66	0.58	0.43	0.33	0.27	0.22	0.18	0.14
	M	0.15	0.14	0.12	0.10	0.09	0.09	0.10	0.12	0.13	0.15	0.17	0.23	0.33	0.44	0.53	0.58	0.59	0.53	0.41	0.33	0.28	0.24	0.21	0.18
	H	0.15	0.14	0.13	0.12	0.11	0.12	0.13	0.14	0.16	0.17	0.19	0.25	0.34	0.44	0.52	0.56	0.56	0.49	0.37	0.30	0.25	0.21	0.19	0.17
WSW	L	0.12	0.10	0.08	0.07	0.05	0.06	0.07	0.09	0.10	0.12	0.13	0.17	0.26	0.40	0.52	0.62	0.66	0.61	0.44	0.34	0.27	0.22	0.18	0.15
	M	0.15	0.13	0.12	0.10	0.09	0.09	0.10	0.11	0.12	0.13	0.14	0.17	0.24	0.35	0.46	0.54	0.58	0.55	0.42	0.34	0.28	0.24	0.21	0.18
	H	0.15	0.14	0.13	0.12	0.11	0.11	0.12	0.13	0.14	0.15	0.16	0.19	0.26	0.36	0.46	0.53	0.56	0.51	0.38	0.30	0.25	0.21	0.19	0.17
W	L	0.12	0.10	0.08	0.06	0.05	0.06	0.07	0.08	0.10	0.11	0.12	0.14	0.20	0.32	0.45	0.57	0.64	0.61	0.44	0.34	0.27	0.22	0.18	0.14
	M	0.15	0.13	0.11	0.10	0.09	0.09	0.09	0.10	0.11	0.12	0.13	0.14	0.19	0.29	0.40	0.50	0.56	0.55	0.41	0.33	0.27	0.23	0.20	0.17
	H	0.14	0.13	0.12	0.11	0.10	0.11	0.12	0.13	0.14	0.14	0.15	0.16	0.21	0.30	0.40	0.49	0.54	0.52	0.38	0.30	0.24	0.21	0.18	0.16
WNW	L	0.12	0.10	0.08	0.06	0.05	0.06	0.07	0.09	0.10	0.12	0.13	0.15	0.17	0.26	0.40	0.53	0.63	0.62	0.44	0.34	0.27	0.22	0.18	0.14
	M	0.15	0.13	0.11	0.10	0.09	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.17	0.24	0.35	0.47	0.55	0.55	0.41	0.33	0.27	0.23	0.20	0.17
	H	0.14	0.13	0.12	0.11	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.25	0.36	0.46	0.53	0.52	0.38	0.30	0.24	0.20	0.18	0.16
NW	L	0.11	0.09	0.08	0.06	0.05	0.06	0.08	0.10	0.12	0.14	0.16	0.17	0.19	0.23	0.33	0.47	0.59	0.60	0.42	0.33	0.26	0.21	0.17	0.14
	M	0.14	0.12	0.11	0.09	0.08	0.09	0.10	0.11	0.13	0.14	0.16	0.17	0.18	0.21	0.30	0.42	0.51	0.54	0.39	0.32	0.26	0.22	0.19	0.16
	H	0.14	0.12	0.11	0.10	0.10	0.10	0.12	0.13	0.15	0.16	0.18	0.18	0.19	0.22	0.30	0.41	0.50	0.51	0.36	0.29	0.23	0.20	0.17	0.15
NNW	L	0.12	0.09	0.08	0.06	0.05	0.07	0.11	0.14	0.18	0.22	0.25	0.27	0.29	0.30	0.33	0.44	0.57	0.62	0.44	0.33	0.26	0.21	0.17	0.14
	M	0.15	0.13	0.11	0.10	0.09	0.10	0.12	0.15	0.18	0.21	0.23	0.26	0.27	0.28	0.31	0.39	0.51	0.56	0.41	0.33	0.27	0.23	0.20	0.17
	H	0.14	0.13	0.12	0.11	0.10	0.12	0.15	0.17	0.20	0.23	0.25	0.26	0.28	0.28	0.31	0.38	0.49	0.53	0.38	0.30	0.25	0.21	0.18	0.16
HOR	L	0.11	0.09	0.07	0.06	0.05	0.07	0.14	0.24	0.36	0.48	0.58	0.66	0.72	0.74	0.73	0.67	0.59	0.47	0.37	0.29	0.24	0.19	0.16	0.13
	M	0.16	0.14	0.12	0.11	0.09	0.11	0.16	0.24	0.33	0.43	0.52	0.59	0.64	0.67	0.66	0.62	0.56	0.47	0.38	0.32	0.28	0.24	0.21	0.18
	H	0.17	0.16	0.15	0.14	0.13	0.15	0.20	0.28	0.36	0.45	0.52	0.59	0.62	0.64	0.62	0.58	0.51	0.42	0.35	0.29	0.26	0.23	0.21	0.19

L = Light construction: frame exterior wall, 50.8 mm concrete floor slab, approximately 146 kg of material/m^2 of floor area.
M = Medium construction: 101.6 mm concrete exterior wall, 101.6 mm concrete floor slab, approximately 341 kg of building material/m^2 of floor area.
H = Heavy construction: 152.4 mm concrete exterior wall, 152.4 mm concrete floor slab, approximately 635 kg of building materials/m^2 of floor area.

Appendix G: Cooling Load Factors for Glass with Interior Shading, North Latitudes

Table 14 Cooling Load Factors for Glass with Interior Shading, North Latitudes (All Room Constructions)

Fenestration Facing	Solar Time, h																						
	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
N	0.08	0.07	0.06	0.06	0.07	0.73	0.66	0.65	0.73	0.80	0.86	0.89	0.89	0.86	0.82	0.75	0.78	0.91	0.24	0.18	0.15	0.13	0.11	0.10
NNE	0.03	0.03	0.02	0.02	0.03	0.64	0.77	0.62	0.42	0.37	0.37	0.37	0.36	0.35	0.32	0.28	0.23	0.17	0.08	0.07	0.06	0.05	0.04	0.04
NE	0.03	0.02	0.02	0.02	0.02	0.56	0.76	0.74	0.58	0.37	0.29	0.27	0.26	0.24	0.22	0.20	0.16	0.12	0.06	0.05	0.04	0.04	0.03	0.03
ENE	0.03	0.02	0.02	0.02	0.02	0.52	0.76	0.80	0.71	0.52	0.31	0.26	0.24	0.22	0.20	0.18	0.15	0.11	0.06	0.05	0.04	0.04	0.03	0.03
E	0.03	0.02	0.02	0.02	0.02	0.47	0.72	0.80	0.76	0.62	0.41	0.27	0.24	0.22	0.20	0.17	0.14	0.11	0.06	0.05	0.05	0.04	0.03	0.03
ESE	0.03	0.03	0.02	0.02	0.02	0.41	0.67	0.79	0.80	0.72	0.54	0.34	0.27	0.24	0.21	0.19	0.15	0.12	0.07	0.06	0.05	0.04	0.04	0.03
SE	0.03	0.03	0.02	0.02	0.02	0.30	0.57	0.74	0.81	0.79	0.68	0.49	0.33	0.28	0.25	0.22	0.18	0.13	0.08	0.07	0.06	0.05	0.04	0.04
SSE	0.04	0.03	0.03	0.03	0.02	0.12	0.31	0.54	0.72	0.81	0.81	0.71	0.54	0.38	0.32	0.27	0.22	0.16	0.09	0.08	0.07	0.06	0.05	0.04
S	0.04	0.04	0.03	0.03	0.03	0.09	0.16	0.23	0.38	0.58	0.75	0.83	0.80	0.68	0.50	0.35	0.27	0.19	0.11	0.09	0.08	0.07	0.06	0.05
SSW	0.05	0.04	0.04	0.03	0.03	0.09	0.14	0.18	0.22	0.27	0.43	0.63	0.78	0.84	0.80	0.66	0.46	0.25	0.13	0.11	0.09	0.08	0.07	0.06
SW	0.05	0.05	0.04	0.04	0.03	0.07	0.11	0.14	0.16	0.19	0.22	0.38	0.59	0.75	0.83	0.81	0.69	0.45	0.16	0.12	0.10	0.09	0.07	0.06
WSW	0.05	0.05	0.04	0.04	0.03	0.07	0.10	0.12	0.14	0.16	0.17	0.23	0.44	0.64	0.78	0.84	0.78	0.55	0.16	0.12	0.10	0.09	0.07	0.06
W	0.05	0.05	0.04	0.04	0.03	0.06	0.09	0.11	0.13	0.15	0.16	0.17	0.31	0.53	0.72	0.82	0.81	0.61	0.16	0.12	0.10	0.08	0.07	0.06
WNW	0.05	0.05	0.04	0.03	0.03	0.07	0.10	0.12	0.14	0.16	0.17	0.18	0.22	0.43	0.65	0.80	0.84	0.66	0.16	0.12	0.10	0.08	0.07	0.06
NW	0.05	0.04	0.04	0.03	0.03	0.07	0.11	0.14	0.17	0.19	0.20	0.21	0.22	0.30	0.52	0.73	0.82	0.69	0.16	0.12	0.10	0.08	0.07	0.06
NNW	0.05	0.05	0.04	0.03	0.03	0.11	0.17	0.22	0.26	0.30	0.32	0.33	0.34	0.34	0.39	0.61	0.82	0.76	0.17	0.12	0.10	0.08	0.07	0.06
HOR	0.06	0.05	0.04	0.04	0.03	0.12	0.27	0.44	0.59	0.72	0.81	0.85	0.85	0.81	0.71	0.58	0.42	0.25	0.14	0.12	0.10	0.08	0.07	0.06

CALCULATING SPACE COOLING LOAD FROM HEAT SOURCES WITHIN THE CONDITIONED SPACE

Lighting

An accurate estimate of the space cooling load imposed by lighting, often the major space load component, is essential in air-conditioning system design. Calculation of this load component is not straightforward; the rate of heat gain to the air caused by lights can be quite different from the power supplied to the lights.

Some of the energy emanating from lights is in the form of radiation that only affects the air after it has been absorbed by walls, floors and furniture, and has warmed them to a temperature higher than the air temperature. This absorbed energy, stored by the structure, contributes to the space cooling load after a time lag, and is present after the lights are switched off. The time lag effect (Fig. 2) should be taken into account when calculating the cooling load, since the actual load is lower than the instantaneous heat gain and the peak load may be affected significantly.

Generally, the instantaneous rate of heat gain from electric lighting in watts can be calculated from:

$$q = \text{total light wattage} \cdot \text{use factor} \cdot \text{special allowance factor} \quad (14)$$

The rate of heat gain can be expressed in units of Btu/h by multiplying Eq.(14) by 3.413. The *total light wattage* is obtained from the ratings of all fixtures installed for general illumination or special use. The *use factor* is the ratio of the wattage in use, for the conditions under which the load estimate is being made, to the total installed wattage. For commercial applications such as stores, the use factor is generally unity. The *special allowance factor* is introduced for fluorescent fixtures and fixtures requiring more energy than their rated wattage. For fluorescent fixtures, the special allowance factor accounts for ballast losses, which can be as high as 2.19 for 32-W single lamp high-output fixtures on 277 V. Rapid-start, 40-W lamp fixture allowance factors vary from a low of 1.18 for two lamps on 277 V to a high of 1.30 for one lamp on 118 V. For other industrial fixtures, such as sodium lamp fixtures, special allowance factors may vary from 1.04 to 1.37, depending on the manufacturer.

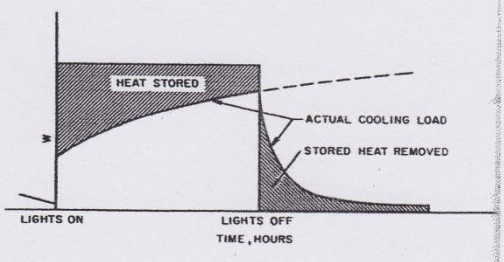


Fig. 2 Thermal Storage Effect in Cooling Load from Lights

Appendix H: Shading Coefficients for Single Glass with Indoor Shading by Venetian Blinds or Roller Shades

Table 35 Shading Coefficients for Single Glass with Indoor Shading by Venetian Blinds or Roller Shades

	Nominal Thickness[a] in.	Solar Trans.[b]	Type of Shading: Venetian Blinds Medium	Venetian Blinds Light	Roller Shade Opaque Dark	Roller Shade Opaque White	Roller Shade Translucent Light
Clear	2.5 to 6	0.87 to 0.80					
Clear	6 to 12	0.80 to 0.71					
Clear Pattern	3 to 12	0.87 to 0.79	0.64	0.55	0.59	0.25	0.39
Heat-Absorbing Pattern	3	—					
Tinted	5 to 5.5	0.74, 0.71					
Heat-Absorbing[d]	5 to 6	0.46					
Heat-Absorbing Pattern	5 to 6	—	0.57	0.53	0.45	0.30	0.36
Tinted	3 to 5.5	0.59, 0.45					
Heat-Absorbing or Pattern	—	0.44 to 0.30	0.54	0.52	0.40	0.28	0.32
Heat-Absorbing[d]	10	0.34					
Heat-Absorbing or Pattern	—	0.29 to 0.15 0.24	0.42	0.40	0.36	0.28	0.31
Reflective Coated Glass							
S.C.[c] = 0.30			0.25	0.23			
0.40			0.33	0.29			
0.50			0.42	0.38			
0.60			0.50	0.44			

[a] Refer to manufacturer's literature for values.
[b] For vertical blinds with opaque white and beige louvers in the tightly closed position, SC is 0.25 and 0.29 when used with glass of 0.71 to 0.80 transmittance.
[c] SC for glass with no shading device.
[d] Refers to gray, bronze, and green tinted heat-absorbing glass.

Table 36 Shading Coefficients for Insulating Glass[a] with Indoor Shading by Venetian Blinds or Roller Shades

Type of Glass	Nominal Thickness, Each Light	Solar Trans.[b] Outer Pane	Solar Trans.[b] Inner Pane	Type of Shading: Venetian Blinds[c] Medium	Venetian Blinds[c] Light	Roller Shade Opaque Dark	Roller Shade Opaque White	Roller Shade Translucent Light
Clear Out Clear In	2.5, 3 mm	0.87	0.87	0.57	0.51	0.60	0.25	0.37
Clear Out Clear In	6 mm	0.80	0.80					
Heat-Absorbing[d] Out Clear In	6 mm	0.46	0.80	0.39	0.36	0.40	0.22	0.30
Reflective Coated Glass								
SC[e] = 0.20				0.19	0.18			
0.30				0.27	0.26			
0.40				0.34	0.33			

[a] Refers to factory-fabricated units with 5, 6 or 13 mm air space, or to prime windows plus storm windows.
[b] Refer to manufacturer's literature for exact values.
[c] For vertical blinds with opaque white or beige louvers, tightly closed, SC is approximately the same as for opaque white roller shades.
[d] Refers to bronze, or green tinted, heat-absorbing glass.
[e] SC for glass with no shading device.

Table 37 Shading Coefficients for Double Glazing with Between-Glass Shading

Type of Glass	Nominal Each Pane	Solar Trans.[a] Outer Pane	Solar Trans.[a] Inner Pane	Description of Air Space	Type of Shading: Venetian Blinds Light	Venetian Blinds Medium	Louvered Sun Screen
Clear Out, Clear In	2.5, 3 mm	0.87	0.87	Shade in contact with glass or shade separated from glass by air space.	0.33	0.36	0.43
Clear Out, Clear In	6 mm	0.80	0.80	Shade in contact with glass-voids filled with plastic.	—	—	0.49
Heat-Abs.[b] Out, Clear In				Shade in contact with glass or shade separated from glass by air space.	0.28	0.30	0.37
	6 mm	0.46	0.80	Shade in contact with glass-voids filled with plastic.	—	—	0.41

[a] Refer to manufacturer's literature for exact values.
[b] Refers to grey, bronze and green tinted heat-absorbing glass.

Appendix I: Cooling Load Factors When Lights Area on for 8 Hours

Table 17A Cooling Load Factors When Lights Are on for 8 Hours

"a" Coefficients	"b" Classification	Number of hours after lights are turned on 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0.45	A	0.02	0.46	0.57	0.65	0.72	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.24	0.19	0.15	0.12	0.10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	B	0.07	0.51	0.56	0.61	0.65	0.68	0.71	0.74	0.77	0.34	0.31	0.28	0.25	0.22	0.20	0.18	0.16	0.15	0.13	0.12	0.11	0.10	0.09	0.
	C	0.11	0.55	0.58	0.60	0.63	0.65	0.67	0.69	0.71	0.28	0.26	0.25	0.23	0.22	0.20	0.19	0.18	0.17	0.16	0.15	0.14	0.13	0.12	0.
	D	0.14	0.58	0.60	0.61	0.62	0.63	0.64	0.65	0.66	0.22	0.22	0.21	0.20	0.20	0.19	0.19	0.18	0.18	0.17	0.16	0.16	0.16	0.15	0.
0.55	A	0.01	0.56	0.65	0.72	0.77	0.82	0.85	0.88	0.90	0.37	0.30	0.24	0.19	0.16	0.13	0.10	0.08	0.07	0.05	0.04	0.03	0.03	0.02	0.
	B	0.06	0.60	0.64	0.68	0.71	0.74	0.76	0.79	0.81	0.28	0.25	0.23	0.20	0.18	0.16	0.15	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.
	C	0.09	0.63	0.66	0.68	0.70	0.71	0.73	0.75	0.76	0.23	0.21	0.20	0.19	0.18	0.17	0.16	0.15	0.14	0.13	0.12	0.11	0.11	0.10	0.
	D	0.11	0.66	0.67	0.68	0.69	0.70	0.71	0.72	0.72	0.18	0.18	0.17	0.17	0.16	0.16	0.15	0.15	0.14	0.14	0.13	0.13	0.13	0.12	0.
0.65	A	0.01	0.66	0.73	0.78	0.82	0.86	0.88	0.91	0.93	0.29	0.23	0.19	0.15	0.12	0.10	0.08	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.
	B	0.04	0.69	0.72	0.75	0.77	0.80	0.82	0.84	0.85	0.22	0.19	0.18	0.16	0.14	0.13	0.12	0.10	0.09	0.08	0.08	0.07	0.06	0.06	0.
	C	0.07	0.72	0.73	0.75	0.76	0.78	0.79	0.80	0.82	0.18	0.17	0.16	0.15	0.14	0.13	0.12	0.11	0.11	0.10	0.10	0.09	0.08	0.08	0.
	D	0.09	0.73	0.74	0.75	0.76	0.77	0.77	0.78	0.79	0.14	0.14	0.13	0.13	0.13	0.12	0.12	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.
0.75	A	0.01	0.76	0.80	0.84	0.87	0.90	0.92	0.93	0.95	0.21	0.17	0.13	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.
	B	0.03	0.78	0.80	0.82	0.84	0.85	0.87	0.88	0.89	0.15	0.14	0.13	0.11	0.10	0.09	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.04	0.
	C	0.05	0.80	0.81	0.82	0.83	0.84	0.85	0.86	0.87	0.13	0.12	0.11	0.10	0.10	0.09	0.09	0.08	0.08	0.07	0.07	0.06	0.06	0.06	0.
	D	0.06	0.81	0.82	0.82	0.83	0.83	0.84	0.84	0.85	0.10	0.10	0.10	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.

Table 17B Cooling Load Factors When Lights Are on for 10 Hours

"a" Coefficients	"b" Classification	Number of hours after lights are turned on 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
0.45	A	0.03	0.47	0.58	0.66	0.73	0.78	0.82	0.86	0.88	0.91	0.93	0.49	0.39	0.32	0.26	0.21	0.17	0.13	0.11	0.09	0.07	0.06	0.05	0.
	B	0.10	0.54	0.59	0.63	0.66	0.70	0.73	0.76	0.78	0.80	0.82	0.39	0.35	0.32	0.28	0.26	0.23	0.21	0.19	0.17	0.15	0.14	0.12	0.
	C	0.15	0.59	0.61	0.64	0.66	0.68	0.70	0.72	0.73	0.75	0.76	0.33	0.31	0.29	0.27	0.26	0.24	0.23	0.21	0.20	0.19	0.18	0.17	0.
	D	0.18	0.62	0.63	0.64	0.66	0.67	0.68	0.69	0.69	0.70	0.71	0.27	0.26	0.26	0.25	0.24	0.23	0.23	0.22	0.21	0.21	0.20	0.19	0.
0.55	A	0.02	0.57	0.65	0.72	0.78	0.82	0.85	0.88	0.91	0.92	0.94	0.40	0.32	0.26	0.21	0.17	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.
	B	0.08	0.62	0.66	0.69	0.73	0.75	0.78	0.80	0.82	0.84	0.85	0.32	0.29	0.26	0.23	0.21	0.19	0.17	0.15	0.14	0.12	0.11	0.10	0.
	C	0.12	0.66	0.68	0.70	0.72	0.74	0.75	0.77	0.78	0.79	0.81	0.27	0.25	0.24	0.22	0.21	0.20	0.19	0.17	0.16	0.15	0.14	0.14	0.
	D	0.15	0.69	0.70	0.71	0.72	0.73	0.73	0.74	0.75	0.76	0.76	0.22	0.22	0.21	0.20	0.20	0.19	0.18	0.18	0.17	0.17	0.16	0.16	0.
0.65	A	0.02	0.66	0.73	0.78	0.83	0.86	0.89	0.91	0.93	0.94	0.95	0.31	0.25	0.20	0.16	0.13	0.11	0.08	0.07	0.05	0.04	0.04	0.03	0.
	B	0.06	0.71	0.74	0.76	0.79	0.81	0.83	0.84	0.86	0.87	0.89	0.25	0.22	0.20	0.18	0.16	0.15	0.13	0.12	0.11	0.10	0.09	0.08	0.
	C	0.09	0.74	0.75	0.77	0.78	0.80	0.81	0.82	0.83	0.84	0.85	0.21	0.20	0.18	0.17	0.16	0.15	0.14	0.14	0.13	0.12	0.11	0.11	0.
	D	0.11	0.76	0.77	0.77	0.78	0.79	0.79	0.80	0.81	0.81	0.82	0.17	0.17	0.16	0.16	0.15	0.15	0.14	0.14	0.14	0.13	0.13	0.12	0.
0.75	A	0.01	0.76	0.81	0.84	0.88	0.90	0.92	0.93	0.95	0.96	0.97	0.22	0.18	0.14	0.12	0.09	0.08	0.06	0.05	0.04	0.03	0.03	0.02	0.
	B	0.04	0.79	0.81	0.83	0.85	0.86	0.88	0.89	0.90	0.91	0.92	0.18	0.16	0.14	0.13	0.12	0.10	0.09	0.08	0.08	0.07	0.06	0.06	0.
	C	0.07	0.81	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.89	0.15	0.14	0.13	0.12	0.12	0.11	0.10	0.10	0.09	0.09	0.08	0.08	0.
	D	0.08	0.83	0.83	0.84	0.84	0.85	0.85	0.86	0.86	0.87	0.87	0.12	0.12	0.12	0.11	0.11	0.11	0.10	0.10	0.10	0.09	0.09	0.09	0.

Table 17C Cooling Load Factors When Lights Are on for 12 Hours

"a" Coefficients	"b" Classification	Number of hours after lights are turned on 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
[illegible]	A	0.05	0.49	0.59	0.67	0.73	0.78	0.83	0.86	0.89	0.91	0.93	0.94	0.95	0.51	0.41	0.33	0.27	0.22	0.17	0.14	0.11	0.09	0.07	0
	B	0.13	0.57	0.61	0.65	0.69	0.72	0.75	0.77	0.79	0.82	0.83	0.85	0.87	0.43	0.39	0.35	0.31	0.28	0.25	0.23	0.21	0.18	0.17	0
	C	0.19	0.63	0.65	0.67	0.69	0.71	0.73	0.74	0.76	0.77	0.79	0.80	0.81	0.37	0.35	0.33	0.31	0.29	0.27	0.26	0.24	0.23	0.21	0
	D	0.22	0.66	0.67	0.68	0.69	0.70	0.71	0.72	0.73	0.74	0.74	0.75	0.76	0.32	0.31	0.30	0.29	0.28	0.27	0.26	0.26	0.25	0.24	0
0.55	A	0.04	0.58	0.66	0.73	0.78	0.82	0.86	0.89	0.91	0.93	0.94	0.95	0.96	0.42	0.34	0.27	0.22	0.18	0.14	0.11	0.09	0.07	0.06	0
	B	0.11	0.65	0.68	0.72	0.74	0.77	0.79	0.81	0.83	0.85	0.86	0.88	0.89	0.35	0.32	0.28	0.26	0.23	0.21	0.19	0.17	0.15	0.14	0
	C	0.15	0.69	0.71	0.73	0.75	0.76	0.78	0.79	0.80	0.81	0.83	0.84	0.85	0.30	0.29	0.27	0.25	0.24	0.22	0.21	0.20	0.19	0.17	0
	D	0.18	0.72	0.73	0.74	0.75	0.76	0.76	0.77	0.78	0.78	0.79	0.80	0.80	0.26	0.25	0.24	0.24	0.23	0.22	0.22	0.21	0.20	0.20	0
0.65	A	0.03	0.67	0.74	0.79	0.83	0.86	0.89	0.91	0.93	0.94	0.95	0.96	0.97	0.33	0.26	0.21	0.17	0.14	0.11	0.09	0.07	0.06	0.05	0
	B	0.09	0.73	0.75	0.78	0.80	0.82	0.84	0.85	0.87	0.88	0.89	0.90	0.91	0.27	0.25	0.22	0.20	0.18	0.16	0.15	0.13	0.12	0.11	0
	C	0.12	0.76	0.78	0.79	0.80	0.81	0.83	0.84	0.85	0.86	0.86	0.87	0.88	0.24	0.22	0.21	0.20	0.19	0.17	0.16	0.15	0.14	0.14	0
	D	0.14	0.79	0.79	0.80	0.80	0.81	0.82	0.82	0.83	0.83	0.84	0.84	0.85	0.20	0.20	0.19	0.18	0.18	0.17	0.17	0.16	0.16	0.15	0
0.75	A	0.02	0.77	0.81	0.85	0.88	0.90	0.92	0.94	0.95	0.96	0.97	0.97	0.98	0.23	0.19	0.15	0.12	0.10	0.08	0.06	0.05	0.04	0.03	0
	B	0.06	0.81	0.82	0.84	0.86	0.87	0.88	0.90	0.91	0.92	0.92	0.93	0.94	0.19	0.18	0.16	0.14	0.13	0.12	0.10	0.09	0.08	0.08	0
	C	0.09	0.83	0.84	0.85	0.86	0.87	0.88	0.88	0.89	0.90	0.90	0.91	0.91	0.17	0.16	0.15	0.14	0.13	0.12	0.12	0.11	0.10	0.10	0
	D	0.10	0.85	0.85	0.86	0.86	0.86	0.87	0.87	0.88	0.88	0.88	0.89	0.89	0.14	0.14	0.14	0.13	0.13	0.12	0.12	0.12	0.11	0.11	0

Table 17D Cooling Load Factors When Lights Are on for 14 Hours

"a" Coefficients	"b" Classification	Number of hours after lights are turned on 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
0.45	A	0.07	0.51	0.61	0.68	0.74	0.79	0.83	0.87	0.89	0.91	0.93	0.94	0.95	0.96	0.97	0.53	0.42	0.34	0.27	0.22	0.18	0.14	0.12
	B	0.18	0.61	0.65	0.68	0.72	0.74	0.77	0.79	0.81	0.83	0.85	0.86	0.88	0.89	0.90	0.46	0.41	0.37	0.34	0.30	0.27	0.24	0.22
	C	0.24	0.67	0.69	0.71	0.73	0.74	0.76	0.77	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.41	0.39	0.36	0.34	0.32	0.30	0.28	0.27
	D	0.26	0.71	0.72	0.72	0.73	0.74	0.75	0.76	0.77	0.78	0.78	0.79	0.80	0.80	0.80	0.36	0.35	0.34	0.33	0.32	0.31	0.30	0.29
0.55	A	0.06	0.69	0.68	0.74	0.79	0.83	0.86	0.89	0.91	0.93	0.94	0.95	0.96	0.97	0.98	0.43	0.35	0.28	0.22	0.18	0.15	0.12	0.09
	B	0.15	0.68	0.71	0.74	0.77	0.79	0.81	0.83	0.85	0.86	0.88	0.89	0.90	0.91	0.92	0.38	0.34	0.31	0.27	0.25	0.22	0.20	0.18
	C	0.19	0.73	0.75	0.76	0.78	0.79	0.80	0.81	0.83	0.84	0.85	0.86	0.86	0.87	0.88	0.34	0.32	0.30	0.28	0.26	0.25	0.23	0.22
	D	0.22	0.76	0.77	0.77	0.78	0.79	0.79	0.80	0.81	0.81	0.82	0.82	0.83	0.83	0.84	0.29	0.28	0.28	0.27	0.26	0.25	0.24	0.24
0.65	A	0.05	0.69	0.75	0.80	0.84	0.87	0.89	0.92	0.93	0.95	0.96	0.96	0.97	0.98	0.98	0.34	0.27	0.22	0.17	0.14	0.11	0.09	0.07
	B	0.11	0.75	0.78	0.80	0.82	0.64	0.85	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.29	0.26	0.24	0.21	0.19	0.17	0.16	0.14
	C	0.15	0.79	0.80	0.82	0.83	0.84	0.85	0.86	0.86	0.87	0.88	0.89	0.89	0.90	0.91	0.26	0.25	0.23	0.22	0.20	0.19	0.18	0.17
	D	0.17	0.81	0.82	0.82	0.83	0.83	0.84	0.84	0.85	0.85	0.86	0.86	0.87	0.87	0.87	0.23	0.22	0.21	0.21	0.20	0.20	0.19	0.18
0.75	A	0.03	0.78	0.82	0.86	0.88	0.91	0.92	0.94	0.95	0.96	0.97	0.97	0.98	0.98	0.99	0.24	0.19	0.16	0.12	0.10	0.08	0.07	0.05
	B	0.08	0.82	0.84	0.86	0.87	0.88	0.90	0.91	0.92	0.92	0.93	0.94	0.94	0.95	0.96	0.21	0.19	0.17	0.15	0.14	0.12	0.11	0.10
	C	0.11	0.85	0.86	0.87	0.88	0.88	0.89	0.90	0.90	0.91	0.91	0.92	0.92	0.93	0.93	0.19	0.18	0.17	0.16	0.15	0.14	0.13	0.12
	D	0.12	0.87	0.87	0.87	0.88	0.88	0.89	0.89	0.89	0.90	0.90	0.90	0.90	0.91	0.91	0.16	0.16	0.15	0.15	0.14	0.14	0.14	0.13

Appendix J: Rates of Heat Gain from Occupant of Conditioned Spaces and Sensible Heat Cooling Load Factors for People

Table 17E Cooling Load Factors When Lights Are on for 16 Hours

Coef-nts	"b" Classification	Number of hours after lights are turned on: 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	A	0.12	0.54	0.63	0.70	0.76	0.81	0.85	0.88	0.90	0.92	0.94	0.95	0.96	0.97	0.97	0.98	0.98	0.54	0.43	0.35	0.28	0.23	0.18	0.15
	B	0.23	0.66	0.69	0.72	0.75	0.78	0.80	0.82	0.84	0.85	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.49	0.44	0.39	0.35	0.32	0.29	0.26
.45	C	0.29	0.72	0.74	0.75	0.77	0.78	0.80	0.81	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.88	0.89	0.45	0.42	0.39	0.37	0.35	0.33	0.31
	D	0.31	0.75	0.76	0.77	0.77	0.78	0.79	0.79	0.80	0.81	0.81	0.82	0.82	0.83	0.83	0.84	0.84	0.40	0.39	0.37	0.36	0.35	0.34	0.33
	A	0.10	0.63	0.70	0.76	0.81	0.84	0.87	0.90	0.92	0.93	0.95	0.96	0.97	0.97	0.98	0.98	0.99	0.44	0.35	0.28	0.23	0.18	0.15	0.12
	B	0.19	0.72	0.75	0.77	0.80	0.82	0.84	0.85	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.94	0.40	0.36	0.32	0.29	0.26	0.24	0.21
.55	C	0.24	0.77	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.88	0.89	0.90	0.90	0.91	0.37	0.34	0.32	0.30	0.29	0.27	0.25
	D	0.26	0.80	0.80	0.81	0.82	0.82	0.83	0.83	0.84	0.84	0.85	0.85	0.86	0.86	0.86	0.87	0.87	0.33	0.32	0.31	0.30	0.29	0.28	0.27
	A	0.07	0.71	0.77	0.81	0.85	0.88	0.90	0.92	0.94	0.95	0.96	0.97	0.97	0.98	0.98	0.99	0.99	0.34	0.27	0.22	0.18	0.14	0.12	0.09
	B	0.15	0.78	0.81	0.82	0.84	0.86	0.87	0.88	0.90	0.91	0.92	0.92	0.93	0.94	0.94	0.95	0.96	0.31	0.28	0.25	0.23	0.20	0.18	0.16
.65	C	0.18	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.89	0.90	0.90	0.91	0.92	0.92	0.93	0.93	0.28	0.27	0.25	0.24	0.22	0.21	0.20
	D	0.20	0.84	0.85	0.85	0.86	0.86	0.87	0.87	0.87	0.88	0.88	0.88	0.89	0.89	0.89	0.90	0.90	0.25	0.25	0.24	0.23	0.22	0.22	0.21
	A	0.05	0.79	0.83	0.87	0.89	0.91	0.93	0.94	0.95	0.96	0.97	0.98	0.98	0.98	0.99	0.99	0.99	0.24	0.20	0.16	0.13	0.10	0.08	0.07
	B	0.11	0.85	0.86	0.87	0.89	0.90	0.91	0.92	0.93	0.93	0.94	0.95	0.95	0.96	0.96	0.96	0.97	0.22	0.20	0.18	0.16	0.15	0.13	0.12
.75	C	0.13	0.87	0.88	0.89	0.89	0.90	0.91	0.91	0.92	0.92	0.93	0.93	0.94	0.94	0.94	0.95	0.95	0.20	0.19	0.18	0.17	0.16	0.15	0.14
	D	0.14	0.89	0.89	0.89	0.90	0.90	0.90	0.91	0.91	0.91	0.91	0.92	0.92	0.92	0.92	0.93	0.93	0.18	0.18	0.17	0.17	0.16	0.16	0.15

Table 18 Rates of Heat Gain from Occupants of Conditioned Spaces[a]

egree of Activity	Typical Application	Total Heat Adults, Male Watts	Total Heat Adjusted[b] Watts	Sensible Heat Watts	Latent Heat Watts
:ated at rest	Theater, movie	115	100	60	40
:ated, very light work writing	Offices, hotels, apts	140	120	65	55
:ated, eating	Restaurant[c]	150	170[c]	75	95
:ated, light work, typing	Offices, hotels, apts	185	150	75	75
tanding, light work, or walking slowly	Retail store, bank	185	185	90	95
ight bench work	Factory	255	230	100	130
Valking, 1.3 m/s, light machine work	Factory	305	305	100	205
owling[d]	Bowling alley	350	280	100	180
foderate dancing	Dance hall	400	375	120	255
leavy work, heavy machine work, lifting	Factory	470	470	165	300
leavy work, athletics	Gymnasium	585	525	185	340

[a]Note; Tabulated values are based on 25.5°C room dry-bulb temperature. For 26.6°C room dry-bulb, the total heat remains the same, but the sensible heat value should be decreased by approximately 8% and the latent heat values increased accordingly.

[b]Adjusted total heat gain is based on normal percentage of men, women, and children for the application listed, with the postulate that the gain from an adult female is 85% of that for an adult male, and that the gain from a child is 75% of that for an adult male.

[c]Adjusted total heat value for eating in a restaurant, includes 17.6 W for food per individual (8.8 W sensible and 8.8 W latent).

[d]For bowling figure one person per alley actually bowling, and all others as sitting 117 W or standing and walking slowly 231 W.

lso refer to Tables 4 and 7, Chapter 8.
ll values rounded to nearest 5 watts.

Table 19 Sensible Heat Cooling Load Factors for People

Total Hours in Space	Hours after Each Entry Into Space: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2	0.49	0.58	0.17	0.13	0.10	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4	0.49	0.59	0.66	0.71	0.27	0.21	0.16	0.14	0.11	0.10	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.01
6	0.50	0.60	0.67	0.72	0.76	0.79	0.34	0.26	0.21	0.18	0.15	0.13	0.11	0.10	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.03	0.03	0.03
8	0.51	0.61	0.67	0.72	0.76	0.80	0.82	0.84	0.38	0.30	0.25	0.21	0.18	0.15	0.13	0.12	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.04
10	0.53	0.62	0.69	0.74	0.77	0.80	0.83	0.85	0.87	0.89	0.42	0.34	0.28	0.23	0.20	0.17	0.15	0.13	0.11	0.10	0.09	0.08	0.07	0.06
12	0.55	0.64	0.70	0.75	0.79	0.81	0.84	0.86	0.88	0.89	0.91	0.92	0.45	0.36	0.30	0.25	0.21	0.19	0.16	0.14	0.12	0.11	0.09	0.08
14	0.58	0.66	0.72	0.77	0.80	0.83	0.85	0.87	0.89	0.90	0.91	0.92	0.93	0.94	0.47	0.38	0.31	0.26	0.23	0.20	0.17	0.15	0.13	0.11
16	0.62	0.70	0.75	0.79	0.82	0.85	0.87	0.88	0.90	0.91	0.92	0.93	0.94	0.95	0.95	0.96	0.49	0.39	0.33	0.28	0.24	0.20	0.18	0.16
18	0.66	0.74	0.79	0.82	0.85	0.87	0.89	0.90	0.92	0.93	0.94	0.94	0.95	0.96	0.96	0.97	0.97	0.97	0.50	0.40	0.33	0.28	0.24	0.21

Appendix K: Overall Coefficient of Heat Transmission(U-Factor) of Windows, Shading Patio Doors and Skylights for User in Peak Load Determination and Mechanical Equipment Sizing only and not in Any Analysis of Annual Energy Usage, W/m2·0C

Table 13 Overall Coefficients of Heat Transmission (*U*-Factor) of Windows, Sliding Patio Doors, and Skylights for Use in Peak Load Determination and Mechanical Equipment Sizing Only and Not in Any Analysis of Annual Energy Usage, W/m² · °C

Part A. Exterior[a] Vertical Panels

	No Storm Sash				Glass Outdoor Storm Sash 1-in. Air Space[b] Added to Described Product			
	No Shade		Indoor Shade		No Shade		Indoor Shade	
	Winter*	Summer**	Winter*	Summer**	Winter*	Summer**	Winter*	Summer**
Flat Glass[c]								
Single Glass, Clear	6.2	5.9	4.7	4.6	2.3	2.8	2.5	2.8
Single Glass, Low Emittance Coating[d]								
ε = 0.60	5.8	5.7	4.3	4.5	2.7	3.4	2.2	3.1
ε = 0.40	5.2	5.1	3.9	4.0	2.5	3.4	2.1	3.1
ε = 0.20	4.5	4.3	3.3	3.1	2.3	2.8	1.9	2.6
Insulating Glass, Double[e]								
5 mm air space[f]	3.5	3.7	3.0	3.3	2.1	2.3	1.7	2.1
6 mm air space[f]	3.3	3.5	2.7	3.1	2.0	2.2	1.6	2.0
13 mm air space[g]	2.8	3.2	2.4	3.0	1.8	2.2	1.4	2.1
13 mm air space low emittance coating[h]								
ε = 0.60	2.4	3.0	2.2	2.8	2.3	2.3	1.4	2.1
ε = 0.40	2.2	2.7	2.0	2.4	1.5	2.2	1.3	2.0
ε = 0.20	1.8	2.2	1.7	2.0	1.4	1.9	1.1	1.7
Insulating Glass, Triple[e]								
6 mm air space[f]	2.2	2.5	1.8	2.3	1.5	1.8	1.3	1.7
13 mm air space[i]	1.8	2.2	1.5	2.0	1.3	1.8	1.1	1.7

	Glass Indoor Storm Sash 25 mm Air Space[b] Added to Described Product				Acrylic Indoor Storm Sash 25 mm Air Space[b] Added to Described Product			
	Winter*	Summer**	Winter*	Summer**	Winter*	Summer**	Winter*	Summer**
Flat Glass[c]								
Single Glass, Clear	2.8	2.8	2.5	2.8	2.7	2.7	2.4	2.7
Single Glass, Low Emittance Coating[d]								
ε = 0.60	2.7	2.8	2.2	2.6	2.6	2.8	2.2	2.6
ε = 0.40	2.4	2.6	2.0	2.3	2.3	2.6	2.0	2.3
ε = 0.20	2.1	2.0	1.8	1.7	2.0	2.0	1.8	1.7
Insulating Glass, Double[e]								
5 mm air space[f]	2.1	2.3	1.7	2.0	2.0	2.2	1.6	2.0
6 mm air space[f]	2.0	2.2	1.6	2.0	1.9	2.2	1.5	1.9
13 mm air space[g]	1.8	2.2	1.4	2.0	1.7	2.1	1.4	1.9
13 mm air space, Low emittance coating[h]								
ε = 0.60	1.7	2.1	1.4	1.9	1.6	2.0	1.3	1.8
ε = 0.40	1.5	1.9	1.3	1.7	1.5	1.8	1.3	1.6
ε = 0.20	1.4	1.6	1.1	1.5	1.4	1.6	1.1	1.4
Insulating Glass, Triple[e]								
6 mm air space[f]	1.5	1.8	1.3	1.7	1.5	1.8	1.3	1.7
13 mm air space[i]	1.3	1.7	1.1	1.6	1.3	1.7	1.0	1.6

Passive Solar Gain

Energy analysis of a fenestration product should include the value of passive solar gain in winter through the product. As described in Chapter 57, 1982 APPLICATIONS VOLUME, the magnitude of this energy gain depends on a number of variables such as latitude and orientation. In many cases, passive solar gain enables properly designed and used fenestration products to allow more energy into the building over the course of a heating season than they lose, making them energy contributing rather than energy consuming. Care must be taken to control excessive solar gain during the cooling season.

Overall Coefficient of Heat Transfer

In the absence of sunlight, heat flows through fenestration by thermal conduction. When the outdoor temperature, t_o, is

Part B. Exterior[a] Horizontal Panels (Skylights)

Description	Winter[j]	Summer[k]
Flat Glass[g]		
Single Glass	7.0	4.7
Insulating Glass; Double[e]		
5 mm air space[f]	4.0	3.2
6 mm air space[f]	3.7	3.1
13 mm air space[g]	3.4	2.8
13 mm air space, low emittance coating[h]		
ε = 0.60	3.2	2.6
ε = 0.40	3.0	2.4
ε = 0.20	2.7	2.0
Plastic Domes[l]		
Single Walled	6.5	4.5
Double Walled	4.0	2.6

Appendix L: Glass Performance Data

GLASS PERFORMANCE DATA : 24mm IG Unit (6mm-12mm gap-6mm)

Insulated Glass Unit Comparisons with PPG Glass - 6mm-12mm-6mm

Glass Configuration	Visible Light			Solar Energy					U-Values - W/m² · °K			
6mm-12mm Gap -6mm	LT%	LR% Ext.	LR% Int.	R%	T%	SF EN410	SHGC	SC	Win-NFRC air/argon**	Sum - NFRC air/argon**	EN 673 air/argon**	LSG
Uncoated												
STARPHIRE + STARPHIRE	84	15	15	14	84	0.81	0.82	0.94	2.70 / 2.55	2.84 / 2.71	2.8 / 2.7	1.02
Clear + Clear	79	15	15	12	61	0.71	0.70	0.81	2.70 / 2.55	2.84 / 2.71	2.8 / 2.7	1.13
SOLEXIA + Clear	69	13	15	8	39	0.50	0.49	0.57	2.70 / 2.55	2.84 / 2.71	2.8 / 2.7	1.41
ATLANTICA + Clear	60	11	14	7	28	0.41	0.40	0.47	2.70 / 2.55	2.84 / 2.71	2.8 / 2.7	1.50
AZURIA + Clear	61	11	14	7	28	0.41	0.39	0.45	2.70 / 2.55	2.84 / 2.71	2.8 / 2.7	1.56
CARIBIA + Clear	60	11	14	7	28	0.40	0.39	0.45	2.70 / 2.55	2.84 / 2.71	2.8 / 2.7	1.54
PACIFICA + Clear	38	7	13	6	23	0.35	0.36	0.41	2.70 / 2.55	2.84 / 2.71	2.8 / 2.7	1.06
SOLARBLUE + Clear	50	9	13	7	37	0.49	0.49	0.56	2.70 / 2.55	2.84 / 2.71	2.8 / 2.7	1.02
SOLARBRONZE + Clear	47	8	13	7	39	0.49	0.51	0.59	2.70 / 2.55	2.84 / 2.71	2.8 / 2.7	0.92
SOLARGRAY + Clear	40	7	13	7	33	0.44	0.45	0.53	2.70 / 2.55	2.84 / 2.71	2.8 / 2.7	0.89
OPTIGRAY 23 + Clear	21	5	12	5	15	0.27	0.29	0.34	2.70 / 2.55	2.84 / 2.71	2.8 / 2.7	0.72
GRAYLITE + Clear	12	5	12	5	19	0.30	0.34	0.39	2.70 / 2.55	2.84 / 2.71	2.8 / 2.7	0.35
Coated												
SUNGATE 500 Low-E Glass												
SUNGATE 500 (2) + Clear	74	17	17	14	52	0.63	0.62	0.71	1.98 / 1.75	2.03 / 1.79	2.0 / 1.7	1.19
SOLEXIA + SUNGATE 500 (3) Clear	64	14	16	9	33	0.46	0.45	0.51	1.98 / 1.75	2.03 / 1.79	2.0 / 1.7	1.42
ATLANTICA + SUNGATE 500 (3) Clear	56	12	16	7	25	0.36	0.35	0.41	1.98 / 1.75	2.03 / 1.79	2.0 / 1.7	1.60
AZURIA + SUNGATE 500 (3) Clear	57	12	15	7	24	0.37	0.34	0.40	1.98 / 1.75	2.03 / 1.79	2.0 / 1.7	1.68
CARIBIA + SUNGATE 500 (3) Clear	56	12	15	7	24	0.36	0.34	0.40	1.98 / 1.75	2.03 / 1.79	2.0 / 1.7	1.65
PACIFICA + SUNGATE 500 (3) Clear	35	7	14	6	19	0.31	0.30	0.35	1.98 / 1.75	2.03 / 1.79	2.0 / 1.7	1.17
SOLARBLUE + SUNGATE 500 (3) Clear	46	10	15	9	32	0.44	0.44	0.51	1.98 / 1.75	2.03 / 1.79	2.0 / 1.7	1.05
SOLARBRONZE + SUNGATE 500 (3) Clear	44	9	15	9	33	0.45	0.46	0.53	1.98 / 1.75	2.03 / 1.79	2.0 / 1.7	0.96
SOLARGRAY + SUNGATE (3) Clear	37	8	15	8	28	0.40	0.40	0.47	1.98 / 1.75	2.03 / 1.79	2.0 / 1.7	0.93
OPTIGRAY 23 + SUNGATE 500 (3) Clear	19	6	14	6	13	0.23	0.24	0.28	1.98 / 1.75	2.03 / 1.79	2.0 / 1.7	0.79
GRAYLITE + SUNGATE 500 (3) Clear	11	5	14	6	16	0.26	0.28	0.33	1.98 / 1.75	2.03 / 1.79	2.0 / 1.7	0.39
SOLARBAN 60 Solar Control Low-E Glass												
SOLARBAN 60 (2) STARPHIRE + STARPHIRE	74	11	11	23	33	0.47	0.40	0.46	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.85
SOLARBAN 60 (2) Clear + Clear	71	12	12	20	33	0.47	0.39	0.45	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.84
SOLARBAN 60 (2) SOLEXIA + Clear	61	10	12	11	25	0.34	0.32	0.37	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.91
SOLARBAN 60 (2) ATLANTICA + Clear	54	8	11	7	21	0.3	0.28	0.32	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.96
SOLARBAN 60 (2) AZURIA + Clear	54	8	11	7	21	0.3	0.28	0.32	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.93
SOLARBAN 60 (2) CARIBIA + Clear	51	8	11	7	20	0.29	0.27	0.32	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	2.00
SOLARBAN 60 (2) PACIFICA + Clear	34	6	10	7	15	0.24	0.22	0.26	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.55
SOLARBAN 60 (2) SOLARBLUE + Clear	44	7	11	13	21	0.30	0.28	0.32	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.57
SOLARBAN 60 (2) SOLARBRONZE + Clear	42	7	11	16	20	0.28	0.27	0.31	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.56
SOLARBAN 60 (2) SOLARGRAY + Clear	35	6	11	12	17	0.26	0.25	0.28	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.40
SOLEXIA + SOLARBAN 60 (3) Clear	61	11	11	11	25	0.39	0.36	0.42	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.69
ATLANTICA + SOLARBAN 60 (3) Clear	53	9	10	7	20	0.33	0.31	0.35	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.71
AZURIA + SOLARBAN 60 (3) Clear	54	9	10	7	21	0.35	0.31	0.36	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.74
CARIBIA + SOLARBAN 60 (3) Clear	54	9	10	7	20	0.34	0.31	0.35	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.74
PACIFICA + SOLARBAN 60 (3) Clear	34	6	9	7	15	0.27	0.29	0.25	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.17
SOLARBLUE + SOLARBAN 60 (3) Clear	45	8	10	13	21	0.35	0.32	0.37	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.41
SOLARBRONZE + SOLARBAN 60 (3) Clear	42	7	10	17	20	0.33	0.31	0.36	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.35
SOLARGRAY + SOLARBAN 60 (3) Clear	35	7	10	13	17	0.30	0.28	0.33	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.25
OPTIGRAY 23 + SOLARBAN 60 (3) Clear	18	5	9	6	9	0.30	0.18	0.21	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.00
GRAYLITE + SOLARBAN 60 (3) Clear	11	5	9	10	7	0.17	0.18	0.2	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	0.61
SOLARBAN z50 Solar Control Low-E Glass												
SOLARBAN z50 (2) OPTIBLUE + Clear	51	8	11	23	26	0.34	0.32	0.36	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.59
SOLARBAN z50 (2) OPTIBLUE + OPTIBLUE	36	7	8	23	20	0.33	0.31	0.36	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.16
SOLEXIA + SOLARBAN z50 (3) OPTIBLUE	44	10	7	11	19	0.38	0.35	0.41	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.26
ATLANTICA + SOLARBAN z50 (3) OPTIBLUE	39	8	7	7	15	0.32	0.30	0.34	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.30
AZURIA + SOLARBAN z50 (3) OPTIBLUE	39	8	7	7	15	0.34	0.30	0.35	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.30
CARIBIA + SOLARBAN z50 (3) OPTIBLUE	39	8	7	7	15	0.33	0.30	0.35	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.30
PACIFICA + SOLARBAN z50 (3) OPTIBLUE	24	6	7	7	11	0.26	0.24	0.28	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.00
SOLARBLUE + SOLARBAN z50 (3) OPTIBLUE	32	7	7	13	16	0.34	0.32	0.36	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	1.00
SOLARBRONZE + SOLARBAN z50 (3) OPTIBLUE	30	7	7	16	15	0.32	0.31	0.35	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	0.97
SOLARGRAY + SOLARBAN z50 (3) OPTIBLUE	25	6	7	13	13	0.29	0.28	0.32	1.66 / 1.38	1.60 / 1.29	1.6 / 1.3	0.89

Appendix M: Data for Cooling Load

DATA FOR COOLING LOAD

1. Thermal properties of building materials –Resistance (R)
   a. Roofing
      i. Asbestos –cement shingles 0.037 m^2.°C/W
      ii. Asphalt shingles 0.077 m^2.°C/W

   b. Masonry materials
      i. Concretes mortar 1.39 m.°C/W per thickness
      ii. Concrete sand/stone aggregate 0.76 m.°C/W per thickness
      iii. Brick common 1.39 m.°C/W per thickness
      iv. Concrete block 3 cores 200 mm 0.20 m^2.°C/W

   c. Plastering materials
      i. Cement plaster 9.5 mm 0.014 m^2.°C/W
      ii. Gypsum plaster 12 mm 0.056 m^2.°C/W

   d. Insulating materials
      i. Mineral fibre acoustic tile 19.85 m.°C/W per thickness

   e. Finishing floor materials
      i. Carpet & fibrous pad 0.37 m^2.°C/W
      ii. Tile ceramic 0.009 m^2.°C/W

Table 1 Surface Conductances and Resistances for Air

Position of Surface	Direction of Heat Flow	Surface Emittance, ε: Non-reflective ε = 0.90 h_i	R	Reflective ε = 0.20 h_i	R	Reflective ε = 0.05 h_i	R
STILL AIR							
Horizontal	Upward	9.26	0.11	5.17	0.19	4.32	0.23
Sloping—45°	Upward	9.09	0.11	5.00	0.20	4.15	0.24
Vertical	Horizontal	8.29	0.12	4.20	0.24	3.35	0.30
Sloping—45°	Downward	7.50	0.13	3.41	0.29	2.56	0.39
Horizontal	Downward	6.13	0.16	2.10	0.48	1.25	0.80
MOVING AIR (Any position)		h_o	R				
Wind (for winter) 6.7 m/s (24 km/h)	Any	34.0	0.030	—	—	—	—
Wind (for summer) 3.4 m/s (12 km/h)	Any	22.7	0.044	—	—	—	—

2. Overall coefficients of heat transmission (U-factor) of Windows
   a. Flat glass- single pane, clear — 5.9 W/ m^2°C No shade
   b. Flat glass- single pane, clear — 4.6 W/ m^2°C Indoor shade
   c. Insulating glass, 5 mm air space — 3.7 W/ m^2°C No shade
   d. Insulating glass, 5 mm air space — 3.3 W/ m^2°C Indoor shade

3. Heat output from occupancy

Table 1 Representative Rates at Which Heat and Moisture Are Given Off by Human Beings in Different States of Act

Degree of Activity		Total Heat, W		Sensible Heat, W	Latent Heat, W	% Sensible He Radian
		Adult Male	Adjusted, M/F[a]			Low T
Seated at theater	Theater, matinee	115	95	65	30	
Seated at theater, night	Theater, night	115	105	70	35	60
Seated, very light work	Offices, hotels, apartments	130	115	70	45	
Moderately active office work	Offices, hotels, apartments	140	130	75	55	
Standing, light work; walking	Department store; retail store	160	130	75	55	58
Walking, standing	Drug store, bank	160	145	75	70	
Sedentary work	Restaurant[c]	145	160	80	80	
Light bench work	Factory	235	220	80	140	
Moderate dancing	Dance hall	265	250	90	160	49
Walking 4.8 km/h; light machine work	Factory	295	295	110	185	
Bowling[d]	Bowling alley	440	425	170	255	
Heavy work	Factory	440	425	170	255	54
Heavy machine work; lifting	Factory	470	470	185	285	
Athletics	Gymnasium	585	525	210	315	

Appendix N: Minimum Ventilation Rates in Breathing Zone

TABLE 6-1 MINIMUM VENTILATION RATES IN BREATHING ZONE
(This table is not valid in isolation; it must be used in conjunction with the accompanying notes.)

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Notes	Default Values			Air Class
						Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)		
	cfm/person	L/s·person	cfm/ft^2	L/s·m^2		#/1000 ft^2 or #/100 m^2	cfm/person	L/s·person	
Correctional Facilities									
Cell	5	2.5	0.12	0.6		25	10	4.9	2
Dayroom	5	2.5	0.06	0.3		30	7	3.5	1
Guard stations	5	2.5	0.06	0.3		15	9	4.5	1
Booking/waiting	7.5	3.8	0.06	0.3		50	9	4.4	2
Educational Facilities									
Daycare (through age 4)	10	5	0.18	0.9		25	17	8.6	2
Daycare sickroom	10	5	0.18	0.9		25	17	8.6	3
Classrooms (ages 5–8)	10	5	0.12	0.6		25	15	7.4	1
Classrooms (age 9 plus)	10	5	0.12	0.6		35	13	6.7	1
Lecture classroom	7.5	3.8	0.06	0.3		65	8	4.3	1
Lecture hall (fixed seats)	7.5	3.8	0.06	0.3		150	8	4.0	1
Art classroom	10	5	0.18	0.9		20	19	9.5	2
Science laboratories	10	5	0.18	0.9		25	17	8.6	2
University/college laboratories	10	5	0.18	0.9		25	17	8.6	2
Wood/metal shop	10	5	0.18	0.9		20	19	9.5	2
Computer lab	10	5	0.12	0.6		25	15	7.4	1
Media center	10	5	0.12	0.6		25	15	7.4	1
Music room/theater/dance	10	5	0.06	0.3		35	12	5.9	1
Multiuse assembly	7.5	3.8	0.06	0.3		100	8	4.1	1
Food and Beverage Service									
Restaurant dining rooms	7.5	3.8	0.18	0.9		70	10	5.1	2
Cafeteria/fast-food dining	7.5	3.8	0.18	0.9		100	9	4.7	2
Bars, cocktail lounges	7.5	3.8	0.18	0.9		100	9	4.7	2
General									
Break rooms	5	2.5	0.06	0.3		25	10	5.1	1
Coffee stations	5	2.5	0.06	0.3		20	11	5.5	1
Conference/meeting	5	2.5	0.06	0.3		50	6	3.1	1
Corridors	–	–	0.06	0.3		–			1
Storage rooms	–	–	0.12	0.6	B	–			1
Hotels, Motels, Resorts, Dormitories									
Bedroom/living room	5	2.5	0.06	0.3		10	11	5.5	1
Barracks sleeping areas	5	2.5	0.06	0.3		20	8	4.0	1
Laundry rooms, central	5	2.5	0.12	0.6		10	17	8.5	2
Laundry rooms within dwelling units	5	2.5	0.12	0.6		10	17	8.5	1
Lobbies/prefunction	7.5	3.8	0.06	0.3		30	10	4.8	1
Multipurpose assembly	5	2.5	0.06	0.3		120	6	2.8	1

Minimum Ventilation Rates in Breathing Zone (*continued*)

TABLE 6-1 MINIMUM VENTILATION RATES IN BREATHING ZONE *(continued)*
(This table is not valid in isolation; it must be used in conjunction with the accompanying notes.)

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Notes	Default Values			Air Class
						Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)		
	cfm/person	L/s·person	cfm/ft^2	L/s·m^2		#/1000 ft^2 or #/100 m^2	cfm/person	L/s·person	
Office Buildings									
Office space	5	2.5	0.06	0.3		5	17	8.5	1
Reception areas	5	2.5	0.06	0.3		30	7	3.5	1
Telephone/data entry	5	2.5	0.06	0.3		60	6	3.0	1
Main entry lobbies	5	2.5	0.06	0.3		10	11	5.5	1
Miscellaneous Spaces									
Bank vaults/safe deposit	5	2.5	0.06	0.3		5	17	8.5	2
Computer (not printing)	5	2.5	0.06	0.3		4	20	10.0	1
Electrical equipment rooms	–	–	0.06	0.3	B	–			1
Elevator machine rooms	–	–	0.12	0.6	B	–			1
Pharmacy (prep. area)	5	2.5	0.18	0.9		10	23	11.5	2
Photo studios	5	2.5	0.12	0.6		10	17	8.5	1
Shipping/receiving	–	–	0.12	0.6	B	–			1
Telephone closets	–	–	0.00	0.0		–			1
Transportation waiting	7.5	3.8	0.06	0.3		100	8	4.1	1
Warehouses	–	–	0.06	0.3	B	–			2
Public Assembly Spaces									
Auditorium seating area	5	2.5	0.06	0.3		150	5	2.7	1
Places of religious worship	5	2.5	0.06	0.3		120	6	2.8	1
Courtrooms	5	2.5	0.06	0.3		70	6	2.9	1
Legislative chambers	5	2.5	0.06	0.3		50	6	3.1	1
Libraries	5	2.5	0.12	0.6		10	17	8.5	1
Lobbies	5	2.5	0.06	0.3		150	5	2.7	1
Museums (children's)	7.5	3.8	0.12	0.6		40	11	5.3	1
Museums/galleries	7.5	3.8	0.06	0.3		40	9	4.6	1
Residential									
Dwelling unit	5	2.5	0.06	0.3	F,G	F			1
Common corridors	–	–	0.06	0.3					1
Retail									
Sales (except as below)	7.5	3.8	0.12	0.6		15	16	7.8	2
Mall common areas	7.5	3.8	0.06	0.3		40	9	4.6	1
Barbershop	7.5	3.8	0.06	0.3		25	10	5.0	2
Beauty and nail salons	20	10	0.12	0.6		25	25	12.4	2
Pet shops (animal areas)	7.5	3.8	0.18	0.9		10	26	12.8	2
Supermarket	7.5	3.8	0.06	0.3		8	15	7.6	1
Coin-operated laundries	7.5	3.8	0.06	0.3		20	11	5.3	2

Minimum Ventilation Rates in Breathing Zone (*continued*)

TABLE 6-1 MINIMUM VENTILATION RATES IN BREATHING ZONE *(continued)*
(This table is not valid in isolation; it must be used in conjunction with the accompanying notes.)

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Notes	Default Values			Air Class
						Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)		
	cfm/person	L/s·person	cfm/ft^2	L/s·m^2		#/1000 ft^2 or #/100 m^2	cfm/person	L/s·person	
Sports and Entertainment									
Sports arena (play area)	–	–	0.30	1.5	E	–			1
Gym, stadium (play area)	–	–	0.30	1.5		30			2
Spectator areas	7.5	3.8	0.06	0.3		150	8	4.0	1
Swimming (pool & deck)	–	–	0.48	2.4	C	–			2
Disco/dance floors	20	10	0.06	0.3		100	21	10.3	1
Health club/aerobics room	20	10	0.06	0.3		40	22	10.8	2
Health club/weight rooms	20	10	0.06	0.3		10	26	13.0	2
Bowling alley (seating)	10	5	0.12	0.6		40	13	6.5	1
Gambling casinos	7.5	3.8	0.18	0.9		120	9	4.6	1
Game arcades	7.5	3.8	0.18	0.9		20	17	8.3	1
Stages, studios	10	5	0.06	0.3	D	70	11	5.4	1

GENERAL NOTES FOR TABLE 6-1

1 **Related requirements:** The rates in this table are based on all other applicable requirements of this standard being met.
2 **Smoking:** This table applies to no-smoking areas. Rates for smoking-permitted spaces must be determined using other methods. See Section 6.2.9 for ventilation requirements in smoking areas.
3 **Air density:** Volumetric airflow rates are based on an air density of 0.075 lb_{da}/ft^3 (1.2 kg_{da}/m^3), which corresponds to dry air at a barometric pressure of 1 atm (101.3 kPa) and an air temperature of 70°F (21°C). Rates may be adjusted for actual density but such adjustment is not required for compliance with this standard.
4 **Default occupant density:** The default occupant density shall be used when actual occupant density is not known.
5 **Default combined outdoor air rate (per person):** This rate is based on the default occupant density.
6 **Unlisted occupancies:** If the occupancy category for a proposed space or zone is not listed, the requirements for the listed occupancy category that is most similar in terms of occupant density, activities and building construction shall be used.
7 **Health-care facilities:** Rates shall be determined in accordance with Appendix E.

ITEM-SPECIFIC NOTES FOR TABLE 6-1

A For high school and college libraries, use values shown for Public Assembly Spaces—Libraries.
B Rate may not be sufficient when stored materials include those having potentially harmful emissions.
C Rate does not allow for humidity control. Additional ventilation or dehumidification may be required to remove moisture.
D Rate does not include special exhaust for stage effects, e.g., dry ice vapors, smoke.
E When combustion equipment is intended to be used on the playing surface, additional dilution ventilation and/or source control shall be provided.
F Default occupancy for dwelling units shall be two persons for studio and one-bedroom units, with one additional person for each additional bedroom.
G Air from one residential dwelling shall not be recirculated or transferred to any other space outside of that dwelling.

6.2.7 Dynamic Reset. The system may be designed to reset the design *outdoor air intake flow* (V_{ot}) and/or space or zone airflow as operating conditions change. These conditions include but are not limited to:

1. Variations in occupancy or ventilation airflow in one or more individual zones for which ventilation airflow requirements will be reset.

   Note: Examples of measures for estimating such variations include: occupancy scheduled by time-of-day, a direct count of occupants, or an estimate of occupancy or ventilation rate per person using occupancy sensors such as those based on indoor CO_2 concentrations.
2. Variations in the efficiency with which outdoor air is distributed to the occupants under different ventilation system airflows and temperature.
3. A higher fraction of outdoor air in the air supply due to intake of additional outdoor air for free cooling or exhaust air makeup.

6.2.8 Exhaust Ventilation. Exhaust airflow shall be provided in accordance with the requirements in Table 6-4. Exhaust makeup air may be any combination of outdoor air, recirculated air, and transfer air.

6.2.9 Ventilation in Smoking Areas. Smoking areas shall have more ventilation and/or air cleaning than comparable no-smoking areas. Specific ventilation rate requirements cannot be determined until cognizant authorities determine the concentration of smoke that achieves an acceptable level of risk. Air from smoking areas shall not be recirculated or transferred to no-smoking areas.

6.3 Indoor Air Quality (IAQ) Procedure. The Indoor Air Quality (IAQ) Procedure is a performance-based design approach in which the building and its ventilation system are designed to maintain the concentrations of specific contaminants at or below certain limits identified during the building design and to achieve the design target level of perceived indoor air quality acceptability by building occupants and/or