

TABELAS PARA CÁLCULO DE CARGA TÉRMICA

MÉTODO CLTD/CLF

Tabela 1. Propriedades de materiais de paredes (LABEEE, 2003).

Nome do material	Espessura equivalente (cm)	Condutividade térmica (W/mK)	Densidade equivalente (kg/m ³)	Calor específico (kJ/kg K)	Resistência térmica (m ² K/W)
Argamassa de Emboço (2,5 cm)	2,5	1,15	2000	1,00	0,022
Câmara de ar (2 - 5 cm)	-	-	-	-	0,160
Concreto maciço (5 cm)	5,0	1,75	2400	1,00	0,029
Ceram Tijolo Maciço Aparente (10 cm)	9,0	0,90	1800	0,92	0,100
Concreto maciço (10 cm)	10,0	1,75	2400	1,00	0,057
Ceram Tij 6 fur quad (9 cm)	1,4	0,90	2290	0,92	0,016
Ceram Tij 8 fur quad (9 cm)	1,4	0,90	2252	0,92	0,016
Ceram Tij 8 fur circ (10 cm)	3,3	0,90	1103	0,92	0,037
Ceram Tij 6 fur circ (10 cm)	3,0	0,90	1232	0,92	0,033
Ceram Tij 4 fur circ (9,5 cm)	1,3	0,90	3595	0,92	0,014
Ceram Bloc 3 fur quad (13 cm)	1,7	0,90	2941	0,92	0,019
Tijolo Maciço (10 cm)	9,6	0,90	1764	0,92	0,106
Ceram Bloc 2 fur quad (14 cm)	1,5	0,90	3732	0,92	0,017
Ceram Tij 2 fur circ (12,5 cm)	1,7	0,90	3836	0,92	0,019
Ceram Tij 6 fur quad (14 cm)	5,5	0,90	909	0,92	0,061
Ceram Tij 21 fur circ (12 cm)	2,7	0,90	2556	0,92	0,030
Ceram Tij 6 fur circ (15 cm)	6,6	0,90	840	0,92	0,073
Ceram Tij 8 fur quad (19 cm)	8,2	0,90	868	0,92	0,091
Ceram Tij 8 fur circ (20 cm)	11,1	0,90	646	0,92	0,123
Ceram Tij Duplo 6 fur circ (10 cm)	12,8	0,90	628	0,92	0,142
Tijolo Maciço Duplo (10 cm)	19,8	0,90	1812	0,92	0,220
Tijolo Maciço (22 cm)	20,7	0,90	1812	0,92	0,230
Ceram Tij Duplo 21 fur circ (12 cm)	12,3	0,90	1184	0,92	0,137
Ceram Tij Duplo 6 fur circ (15 cm)	20,3	0,90	568	0,92	0,226
Ceram Tij Duplo 8 fur quad (19 cm)	23,4	0,90	613	0,92	0,260
Ceram Tij Duplo 8 fur circ (20 cm)	29,1	0,90	500	0,92	0,323

Tabela 2. Propriedades de materiais de coberturas (LABEEE, 2003).

Nome do material	Espessura (cm)	Condutividade térmica (W/m K)	Densidade de massa aparente (kg/m ³)	Calor específico (kJ/kg K)	Resistência térmica (m ² K/W)
Câmara de ar com alta emissividade (> 5 cm)	-	-	-	-	0,210
Câmara de ar com baixa emissividade (> 5 cm)	-	-	-	-	0,610
Telha de barro (1 cm)	1,0	1,05	2000	0,92	0,010
Telha de fibro-cimento (0,7 cm)	0,7	0,95	1900	0,84	0,007
Forno madeira (1 cm)	1,0	0,14	600	2,30	0,071
Forno concreto (3 cm)	3,0	1,75	2200	1,00	0,017
Laje mista (12 cm) *	9,5	1,05	1087	0,92	0,090
Laje de concreto (20 cm)	20,0	1,75	2200	1,00	0,114
Laje de concreto (25 cm)	25,0	1,75	2200	1,00	0,143
Lamina de alumínio polido ($\epsilon < 0,2$)	0,1	230,00	2700	0,88	0,000
Lã de vidro (2,5 cm)	2,5	0,05	50	0,70	0,556
Lã de vidro (5 cm)	5,0	0,05	50	0,70	1,111

Tabela 3. Propriedades de materiais de pisos térreos (LABEEE, 2003).

Nome do material	Espessura (cm)	Condutividade térmica (W/m K)	Densidade de massa aparente (kg/m ³)	Calor específico (kJ/kg K)	Resistência térmica (m ² K/W)
Solo (45,7 cm)	45,7	0,87	1361	0,8373	0,528
Radier concreto (10 cm)	10,0	1,75	2400	1,00	0,057
Argamassa de reboco (2,5 cm)	2,5	1,15	2000	1,00	0,022
Piso cerâmico (10 mm)	1,0	0,90	1600	0,92	0,011
Piso madeira (10 mm)	1,0	0,14	600	2,30	0,071

Tabela 4. Propriedades de materiais de pisos entre andares (LABEEE, 2003).

Nome do material	Espessura (cm)	Condutividade térmica (W/m K)	Densidade de massa aparente (kg/m ³)	Calor específico (kJ/kg K)	Resistência térmica (m ² K/W)
Laje mista (12 cm) *	9,5	1,05	1087	0,92	0,090
Laje de concreto (20 cm)	20,0	1,75	2200	1,00	0,114
Laje de concreto (25 cm)	25,0	1,75	2200	1,00	0,143
Radier concreto (10 cm)	10,0	1,75	2400	1,00	0,057
Argamassa de reboco (2,5 cm)	2,5	1,15	2000	1,00	0,022
Piso cerâmico (10 mm)	1,0	0,90	1600	0,92	0,011
Piso madeira (10 mm)	1,0	0,14	600	2,30	0,071

Tabela 5. Propriedades de materiais de forros (LABEEE, 2003).

Nome do material	Espessura (cm)	Condutividade térmica (W/m K)	Densidade de massa aparente (kg/m ³)	Calor específico (kJ/kg K)	Resistência térmica (m ² K/W)
Painel fibra de madeira isolante	3,5	0,20	850	2,30	0,175
Painel vidro	-	-	-	-	0,610

Tabela 6. Propriedades de materiais de divisórias (LABEEE, 2003).

Nome do material	Espessura (cm)	Condutividade térmica (W/m K)	Densidade de massa aparente (kg/m ³)	Calor específico (kJ/kg K)	Resistência térmica (m ² K/W)
Painel fibra de madeira isolante	3,5	0,20	850	2,30	0,175
Painel vidro	0,8	1,15	2700	0,84	0,007

Tabela 7. Propriedades de materiais de paredes externas (ASHRAE, 1989).

Code Number	Description	L	k	Thickness and Thermal Properties			
				ρ	c_p	R	Mass
A0	Outside surface resistance	0	0.000	0	0.00	0.059	0.00
A1	25 mm Stucco	25	0.692	1858	0.84	0.037	47.34
A2	100 mm Facebrick	100	1.333	2002	0.92	0.076	203.50
A3	Steel siding	2	44.998	7689	0.42	0.000	11.71
A4	12 mm Slag	13	0.190	1121	1.67	0.067	10.74
A5	Outside surface resistance	0	0.000	0	0.00	0.059	0.00
A6	Finish	13	0.415	1249	1.09	0.031	16.10
A7	100 mm Facebrick	100	1.333	2002	0.92	0.076	203.50
B1	Air space resistance	0	0.000	0	0.00	0.160	0.00
B2	25 mm Insulation	25	0.043	32	0.84	0.587	0.98
B3	50 mm Insulation	51	0.043	32	0.84	1.173	1.46
B4	75 mm Insulation	76	0.043	32	0.84	1.760	2.44
B5	25 mm Insulation	25	0.043	91	0.84	0.587	2.44
B6	50 mm Insulation	51	0.043	91	0.84	1.173	4.88
B7	25 mm Wood	25	0.121	593	2.51	1.760	15.13
B8	62 mm Wood	63	0.121	593	2.51	0.524	37.58
B9	100 mm Wood	101	0.121	593	2.51	0.837	60.02
B10	50 mm Wood	51	0.121	593	2.51	0.420	30.26
B11	75 mm Wood	76	0.121	593	2.51	0.628	45.38
B12	75 mm Insulation	76	0.043	91	0.84	1.760	6.83
B13	100 mm Insulation	100	0.043	91	0.84	2.347	9.27
B14	125 mm Insulation	125	0.043	91	0.84	2.933	11.71
B15	150 mm Insulation	150	0.043	91	0.84	3.520	14.15
B16	4 mm Insulation	4	0.043	91	0.84	0.088	0.49
B17	8 mm Insulation	8	0.043	91	0.84	0.176	0.49
B18	12 mm Insulation	12	0.043	91	0.84	0.264	0.98
B19	15 mm Insulation	15	0.043	91	0.84	0.352	1.46
B20	20 mm Insulation	20	0.043	91	0.84	0.440	1.95
B21	35 mm Insulation	35	0.043	91	0.84	0.792	2.93
B22	42 mm Insulation	42	0.043	91	0.84	0.968	3.90
B23	60 mm Insulation	62	0.043	91	0.84	1.408	5.86
B24	70 mm Insulation	70	0.043	91	0.84	1.584	6.34
B25	85 mm Insulation	85	0.043	91	0.84	1.936	7.81
B26	92 mm Insulation	92	0.043	91	0.84	2.112	8.30
B27	115 mm Insulation	115	0.043	91	0.84	2.640	10.74
C1	100 mm Clay tile	100	0.571	1121	0.84	0.178	113.70
C2	100 mm Lightweight concrete block	100	0.381	609	0.84	0.266	61.98
C3	100 mm Heavyweight concrete block	100	0.813	977	0.84	0.125	99.06
C4	100 mm Common brick	100	0.727	1922	0.84	0.140	195.20
C5	100 mm Heavyweight concrete	100	1.731	2243	0.84	0.059	227.90
C6	200 mm Clay tile	200	0.571	1121	0.84	0.352	227.90
C7	200 mm Lightweight concrete block	200	0.571	609	0.84	0.352	123.46
C8	200 mm Heavyweight concrete block	200	1.038	977	0.84	0.196	198.62
C9	200 mm Common brick	200	0.727	1922	0.84	0.279	390.40
C10	200 mm Heavyweight concrete	200	1.731	2243	0.84	0.117	455.79
C11	300 mm Heavyweight concrete	300	1.731	2243	0.84	0.176	683.20
C12	50 mm Heavyweight concrete	50	1.731	2243	0.84	0.029	113.70
C13	150 mm Heavyweight concrete	150	1.731	2243	0.84	0.088	341.60
C14	100 mm Lightweight concrete	100	0.173	641	0.84	0.587	64.90
C15	150 mm Lightweight concrete	150	0.173	641	0.84	0.880	97.60
C16	200 mm Lightweight concrete	200	0.173	641	0.84	1.173	130.30
C17	200 mm Lightweight conc. blk. (filled)	200	0.138	288	0.84	1.467	58.56
C18	200 mm Heavyweight conc. blk. (filled)	200	0.588	849	0.84	0.345	172.75
C19	300 mm Lightweight conc. blk. (filled)	300	0.138	304	0.84	2.200	92.72
C20	300 mm Heavyweight conc. blk. (filled)	300	0.675	897	0.84	0.451	273.28
E0	Inside surface resistance	0	0.000	0	0.00	0.121	0.00
E1	20 mm Plaster or gypsum	20	0.727	1602	0.84	0.026	30.74
E2	12 mm Slag or stone	12	1.436	881	1.67	0.009	11.22
E3	10 mm Felt and membrane	10	0.190	1121	1.67	0.050	10.74
E4	Ceiling air space	0	0.000	0	0.00	0.176	0.00
E5	Acoustic tile	19	0.061	481	0.84	0.314	9.27

L = thickness, mm; k = thermal conductivity, W/(m · °C); ρ = density, kg/m³; c_p = specific heat, kJ/(kg · °C); R = thermal resistance, (m² · °C)/W; Mass = kg/m²

Tabela 8. Seleção de grupos de paredes externas (ASHRAE, 1989).

Group No.	Description of Construction	Mass, kg/m ²	U-Value, W/(m ² ·°C)
100-mm	Face brick + (brick)		
C	Air space + 100-mm face brick	405	2.03
D	100-mm common brick	440	2.36
C	25-mm insulation or air space + 100-mm common brick	440	1.00-1.71
B	50-mm insulation + 100-mm common brick	430	0.63
B	200-mm common brick	635	1.71
A	Insulation or air space + 200-mm common brick	635	0.87-1.38
100-mm	Face brick + (heavyweight concrete)		
C	Air space + 50-mm concrete	459	2.00
B	50-mm insulation + 100-mm concrete	474	0.66
A	Air space or insulation + 200-mm or more concrete	698-928	0.62-0.64
100-mm	Face brick + (light or heavyweight concrete block)		
E	100-mm block	303	1.81
D	Air space or insulation + 100-mm block	303	0.86-1.40
D	200-mm block	342	1.56
C	Air space or 25-mm insulation + 150-mm or 200-mm block	356-434	1.25-1.56
B	50-mm insulation + 200-mm block	434	0.55-0.61
100-mm	Face brick + (clay tile)		
D	100-mm tile	347	2.16
D	Air space + 100-mm tile	347	1.60
C	Insulation + 100-mm tile	347	0.96
C	200-mm tile	470	1.56
B	Air space or 25-mm insulation + 200-mm tile	470	0.81-1.26
A	50-mm insulation + 200-mm tile	474	0.55
Heavyweight concrete wall + (finish)			
E	100-mm concrete	308	3.32
D	100-mm concrete + 25-mm or 50-mm insulation	308	0.68-1.14
C	50-mm insulation + 100-mm concrete	308	0.68
C	200-mm concrete	532	2.78
B	200-mm concrete + 25-mm or 50-mm insulation	537	0.65-1.06
A	50-mm insulation + 200-mm concrete	537	0.65
B	300-mm concrete	762	2.39
A	300-mm concrete + insulation	762	0.64
Light and heavyweight concrete block + (finish)			
F	100-mm block + air space/insulation	142	0.91-1.49
E	50-mm insulation + 100-mm block	142-181	0.60-0.65
E	200-mm block	229-249	1.67-2.28
D	200-mm block + air space/insulation	200-278	0.85-0.98
Clay tile + (finish)			
F	100-mm tile	190	2.38
F	100-mm tile + air space	190	1.72
E	100-mm tile + 25-mm insulation	190	0.99
D	50-mm insulation + 100-mm tile	195	0.63
D	200-mm tile	308	1.68
C	200-mm tile + air space/25-mm insulation	308	0.86-1.31
B	50-mm insulation + 200-mm tile	308	0.56
Metal curtain wall			
G	With/without air space + 25- to 75-mm insulation	24-29	0.52-1.31
Frame wall			
G	25-mm to 75-mm insulation	78	0.46-1.01

Tabela 9. Seleção do fator LM (ASHRAE, 1989).

38

Table 32 CLTD Correction For Latitude and Month Applied to Walls and Roofs, North Latitudes

Lat.	Month	N	NNE NNW	NE NW	ENE WNW	E W	ESE WSW	SE SW	SSE SSW	S	HOR
0	Dec	-1.6	-2.7	-2.7	-2.7	-1.1	0.0	1.6	3.3	5.0	-0.5
	Jan/Nov	-1.6	-2.7	-2.2	-2.2	-0.5	0.0	1.1	2.2	3.8	-0.5
	Feb/Oct	-1.6	-1.1	-1.1	-1.1	-0.5	-0.5	0.0	-0.5	-3.8	0.0
	Mar/Sept	-1.6	0.0	0.5	-0.5	-0.5	-1.6	-1.6	-2.7	-4.4	0.0
	Apr/Aug	2.7	2.2	1.6	0.0	-1.1	-2.7	-3.3	-4.4	-4.4	-1.1
	May/Jul	5.5	3.8	2.7	0.0	-1.6	-3.8	-4.4	-5.0	-4.4	-2.2
	Jun	6.6	5.0	2.7	0.0	-1.6	-3.8	-5.0	-5.5	-4.4	-2.7
8	Dec	-2.2	-3.3	-3.3	-3.3	-1.6	0.0	2.2	4.4	6.6	-2.7
	Jan/Nov	-1.6	-2.7	-3.3	-2.7	-1.1	0.0	1.6	3.3	5.5	-2.2
	Feb/Oct	-1.6	-2.2	-1.6	-1.6	-0.5	-0.5	0.5	1.1	2.2	-0.5
	Mar/Sept	-1.6	-1.1	-0.5	-0.5	-0.5	-1.1	-1.1	-1.6	-2.2	0.0
	Apr/Aug	1.1	1.1	1.1	0.0	-0.5	-2.2	-2.7	-3.8	-3.8	-0.5
	May/Jul	3.8	2.7	2.2	0.0	-1.1	-2.7	-3.8	-5.0	-3.8	-1.1
	Jun	5.0	3.3	2.2	0.0	-1.1	-3.3	-4.4	-5.0	-3.8	-1.1
16	Dec	-2.2	-3.3	-4.4	-4.4	-2.2	-0.5	2.2	5.0	7.2	-5.0
	Jan/Nov	-2.2	-3.3	-3.8	-3.8	-2.2	-0.5	2.2	4.4	6.6	-3.8
	Feb/Oct	-1.6	-2.7	-2.7	-2.2	-1.1	0.0	1.1	2.7	3.8	-2.2
	Mar/Sept	-1.6	-1.6	-1.1	-1.1	-0.5	-0.5	0.0	0.0	0.0	-0.5
	Apr/Aug	-0.5	0.0	-0.5	-0.5	-0.5	-1.6	-1.6	-2.7	-3.3	0.0
	May/Jul	2.2	1.6	1.6	0.0	-0.5	-2.2	-2.7	-3.8	-3.8	0.0
	Jun	3.3	2.2	2.2	0.5	-0.5	-2.2	-3.3	-4.4	-3.8	0.0
24	Dec	-2.7	-3.8	-5.0	-5.5	-3.8	-1.6	1.6	5.0	7.2	-7.2
	Jan/Nov	-2.2	-3.3	-4.4	-5.0	-3.3	-1.6	1.6	5.0	7.2	-6.1
	Feb/Oct	-2.2	-2.7	-3.3	-3.3	-1.6	-0.5	1.6	3.8	5.5	-3.8
	Mar/Sept	-1.6	-2.2	-1.6	-1.6	-0.5	-0.5	0.5	1.1	2.2	-1.6
	Apr/Aug	-1.1	-0.5	0.0	-0.5	-0.5	-1.1	-0.5	-1.1	-1.6	0.0
	May/Jul	0.5	1.1	1.1	0.0	0.0	-1.6	-1.6	-2.7	-3.3	0.5
	Jun	1.6	1.6	1.6	0.5	0.0	-1.6	-2.2	-3.3	-3.3	0.5
32	Dec	-2.7	-3.8	-5.5	-6.1	-4.4	-2.7	1.1	5.0	6.6	-9.4
	Jan/Nov	-2.7	-3.8	-5.0	-6.1	-4.4	-2.2	1.1	5.0	6.6	-8.3
	Feb/Oct	-2.2	-3.3	-3.8	-4.4	-2.2	-1.1	2.2	4.4	6.1	-5.5
	Mar/Sept	-1.6	-2.2	-2.2	-2.2	-1.1	-0.5	1.6	2.7	3.8	-2.7
	Apr/Aug	-1.1	-1.1	-0.5	-1.1	0.0	-0.5	0.0	0.5	0.5	-0.5
	May/Jul	0.5	0.5	0.5	0.0	0.0	-0.5	-0.5	-1.6	-1.6	0.5
	Jun	0.5	1.1	1.1	0.5	0.0	-1.1	-1.1	-2.2	-2.2	1.1
40	Dec	-3.3	-4.4	-5.5	-7.2	-5.5	-3.8	0.0	3.8	5.5	-11.6
	Jan/Nov	-2.7	-3.8	-5.5	-6.6	-5.0	-3.3	0.5	4.4	6.1	-10.5
	Feb/Oct	-2.7	-3.8	-4.4	-5.0	-3.3	-1.6	1.6	4.4	6.6	-7.7
	Mar/Sept	-2.2	-2.7	-2.7	-3.3	-1.6	0.5	2.2	3.8	5.5	-4.4
	Apr/Aug	-1.1	-1.6	-1.1	-1.1	0.0	0.0	1.1	1.6	2.2	1.6
	May/Jul	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5
	Jun	0.5	0.5	0.5	0.0	0.5	0.0	0.0	-0.5	-0.5	1.1
48	Dec	-3.3	-4.4	-6.1	-7.7	-7.2	-5.5	-1.6	1.1	3.3	-13.8
	Jan/Nov	-3.3	-4.4	-6.1	-7.2	-6.1	-4.4	-0.5	2.7	4.4	-13.3
	Feb/Oct	-2.7	-3.8	-5.5	-6.1	-4.4	-2.7	0.5	4.4	6.1	-10.0
	Mar/Sept	-2.2	-3.3	-3.3	-3.8	-2.2	-0.5	2.2	4.4	6.1	-6.1
	Apr/Aug	-1.6	-1.6	-1.6	-1.6	-0.5	0.0	2.2	3.3	3.8	-2.7
	May/Jul	0.0	-0.5	0.0	0.0	0.5	0.5	1.6	1.6	2.2	0.0
	Jun	0.5	0.5	1.1	0.5	1.1	0.5	1.1	1.1	1.6	1.1
56	Dec	-3.8	-5.0	-6.6	-8.8	-8.8	-7.7	-5.0	-2.7	-1.6	-15.5
	Jan/Nov	-3.3	-4.4	-6.1	-8.3	-7.7	-6.6	-3.3	-0.5	1.1	-15.0
	Feb/Oct	-3.3	-4.4	-5.5	-6.6	-5.5	-3.8	3.3	0.0	5.0	-12.2
	Mar/Sept	-2.7	-3.3	-3.8	-4.4	-2.7	-1.1	2.2	4.4	6.6	-8.3
	Apr/Aug	-1.6	-2.2	-2.2	-2.2	-0.5	0.5	2.7	3.8	5.0	-4.4
	May/Jul	0.0	0.0	0.0	0.0	1.1	1.1	2.7	3.3	3.8	-1.1
	Jun	1.1	0.5	1.1	0.5	1.6	1.6	2.2	2.7	3.3	0.5
64	Dec	-3.8	-5.0	-6.6	-0.8	-9.4	-10.0	-8.8	-7.7	-6.6	-16.6
	Jan/Nov	-3.8	-5.0	-6.6	-8.8	-8.8	-8.8	-7.2	-5.5	-4.4	-16.1
	Feb/Oct	-3.3	-4.4	-6.1	-7.7	-7.2	-5.5	-2.2	0.5	2.2	-14.4
	Mar/Sept	-2.7	-3.8	-5.0	-5.5	-3.8	-2.2	1.1	3.8	6.1	-11.1
	Apr/Aug	-1.6	-2.2	-2.2	-2.2	-0.5	0.5	2.7	5.0	6.1	-6.1
	May/Jul	0.5	0.0	0.5	0.0	1.6	2.2	3.3	4.4	5.5	-1.6
	Jun	1.1	1.1	1.1	1.1	2.2	2.2	3.8	3.8	5.0	0.0

(1) Corrections in this table are in °C. The correction is applied directly to the CLTD for a wall or roof as given in Tables 29 and 31.

(2) The CLTD correction given in this table is *not* applicable to Table 33, Cooling Load Temperature Differences for Conduction through Glass.

(3) For South latitudes, replace Jan. through Dec. by July through June.

Tabela 10. CLTDs para paredes externas (ASHRAE, 1989).

Solar Time, h																								Hr of Maxi- mum CLTD	Mini- mum CLTD	Maxi- mum CLTD	Differ- ence CLTD		
0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400						
Group A Walls																													
N	8	8	8	7	7	7	6	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	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	14	14	14	14	14	22	10	14	4			
SE	13	13	13	12	12	11	11	10	10	10	10	10	11	11	12	12	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	9	9	10	10	11	11	11	23	8	11	3			
SW	14	14	14	14	13	13	12	12	11	11	10	10	9	9	10	10	10	11	12	13	13	14	24	9	14	5			
W	15	15	15	14	14	14	13	13	12	12	11	11	10	10	10	10	11	11	12	13	13	14	15	1	10	15	5		
NW	12	12	11	11	11	10	10	10	9	9	8	8	8	8	8	8	8	8	9	9	10	11	11	1	8	12	4		
Group B Walls																													
N	8	8	8	7	7	6	5	5	5	5	5	5	5	5	6	6	6	7	7	7	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	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	20	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	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	6	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	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	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	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	7	9	10	12	14	15	15	15	22	5	15	10			
Group D Walls																													
N	8	7	7	6	5	4	3	3	3	3	4	4	5	5	6	6	7	8	9	10	11	11	10	10	9	21	3	11	8
NE	9	8	7	6	5	4	4	4	6	8	10	11	12	13	13	13	14	14	14	14	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	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	4	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	9	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	7	6	5	4	3	2	2	2	3	3	4	5	6	7	8	10	10	11	12	12	11	10	9	8	20	2	12	10	
NE	7	6	5	4	3	2	3	3	5	8	11	13	14	14	14	14	15	14	14	14	13	12	11	9	8	16	2	15	13
E	8	7	6	5	4	3	3	6	10	15	18	20	21	21	20	19	18	18	17	15	14	12	11	9	13	3	21	18	
SE	8	7	6	5	4	3	3	4	7	10	14	17	19	20	20	19	18	17	16	14	13	11	10	15	3	20	17		
S	8	7	6	5	4	3	2	2	3	3	5	7	10	14	16	18	19	18	17	16	14	13	11	10	17	2	19	17	
SW	12	10	8	7	6	4	4	3	3	3	4	5	7	10	14	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	17	16	14	12	10	8	7	13	1	24	23	
S	5	4	3	2	2	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	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	5	4	3	11	0	31	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	
(I) Direct Application of Table 2 Without Adjustment																													

Tabela 11. CLTDs para tetos (ASHRAE, 1989).

Roof No	Description of Construction	Mass, kg/m ²	U-value, W/m ² ·°C	Solar Time																								Hour of Day			
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Maxi-CLTD	Mini-CLTD	Maxi-Difference	Difference
Without Suspended Ceiling																															
1	Steel sheet with 25-mm (or 50-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	47
2	25-mm wood with 25-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	43
3	100-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	42
4	50-mm h.w. concrete with 25-mm (or 50-mm) ins.	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	38
5	25-mm wood with 50-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	40
6	150-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	36
7	60-mm wood with 25-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	28
8	200-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	26
9	100-mm h.w. concrete with 25-mm (or 50-mm) ins.	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	26
10	60-mm wood with 50-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	24
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	19
12	150-mm h.w. concrete with 25-mm (or 50-mm) ins.	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	17
13	100-mm wood with 25-mm (or 50-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	15
With Suspended Ceiling																															
1	Steel Sheet with 25-mm (or 50-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	46
2	25-mm wood with 25-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	34
3	100-mm l.w. concrete	97	0.761	10	8	6	4	2	1	0	0	2	6	10	16	21	27	31	34	36	36	34	30	26	21	17	13	17	0	36	36
4	50-mm h.w. concrete with 25-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	19
5	25-mm wood with 50-mm insulation	49	0.471	14	11	9	7	5	4	3	3	4	6	10	14	18	23	27	30	31	32	31	29	26	22	19	16	18	3	32	30
6	150-mm l.w. concrete	127	0.619	18	15	13	11	9	7	6	4	4	6	9	12	16	20	24	27	29	30	30	28	26	23	20	20	4	30	26	
7	60-mm wood with 25-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	17
8	200-mm l.w. concrete	161	0.528	22	20	18	16	15	13	11	10	9	8	8	9	11	14	16	19	21	23	25	25	25	24	23	20	8	25	17	
9	100-mm h.w. concrete with 25-mm (or 50-mm) ins.	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	10
10	60-mm wood with 50-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	13
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	7
12	150-mm h.w. concrete with 25-mm (or 50-mm) ins.	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	7
13	100-mm wood with 25-mm (or 50-mm) insulation	93 (97)	0.465 (0.363)	20	19	19	18	17	16	15	14	14	13	12	12	12	13	14	15	16	18	19	20	20	20	20	23	12	20	8	

(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, $R_o = 0.059 \text{ m}^2 \cdot ^\circ\text{C}/\text{W}$
- Without and with suspended ceiling, but no attic fans or return air ducts in suspended ceiling space
- Inside surface resistance, $R_i = 0.121 \text{ m}^2 \cdot ^\circ\text{C}/\text{W}$

(2) Adjustments to Table 5 Values:

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

$$\text{CLTD}_{\text{corr}} = [(\text{CLTD} + \text{LM}) K + (25.5 - t_R) + (t_o - 29.4)] f$$

where CLTD is from this table

- (a) LM is latitude-month correction from Table 32 for a horizontal surface,
 (b) K is a color adjustment factor 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 applied after all other adjustments have been made
 $f = 1.0$ no attic or ducts
 $f = 0.75$ positive ventilation

Values in Table 29 were calculated without and with suspended ceiling, but make no allowances for positive ventilation or return ducts through the space. If ceiling is insulated and fan is used between ceiling and roof, CLTD may be reduced 25% ($f = 0.75$). Analyze use of the suspended ceiling space for a return air plenum or with return air ducts separately.

(3) Roof Constructions Not Listed in Table:

The U-Values listed are only guides. The actual value of U as obtained from tables such as Table 4, Chapter 22 or as calculated for the actual roof construction should be used.

An actual roof construction not in this table would be thermally similar to a roof in the table, if it has similar mass and similar heat capacity. In this case, use the CLTD from this table as corrected by Note (2) above.

Example: A flat roof without a suspended ceiling has mass = 88 kg/m², $U = 1.14 \text{ W}/(\text{m}^2 \cdot ^\circ\text{C})$ and heat capacity = 54 kJ/(m²·°C).

Use $\text{CLTD}_{\text{uncorr}}$ from Roof No. 13, to obtain $\text{CLTD}_{\text{corr}}$ and use the actual U value to calculate $q/A = U (\text{CLTD}_{\text{corr}}) = 1.14 (\text{CLTD}_{\text{corr}})$.

(4) Additional Insulation:

For each 1.23m²·°C/W increase in R-value from insulation added to the roof structure, use a CLTD for a roof whose mass and heat capacity are approximately the same, but whose CLTD has a maximum value 2 h later. If this is not possible, because a roof with longest time lag has already been selected, use an effective CLTD in cooling load calculation equal to 16°C.

Tabela 12. CLTDs para tetos (ASHRAE, 1989).

Roof No.	Description
1	Steel Sheet with 25-mm insulation
2	25-mm wood with 25-mm insulation
3	100-mm l. w. concrete
4	50-mm h.w. concrete with 25-mm insulation
5	25-mm wood with 50-mm insulation
6	150-mm l. w. concrete
7	63-mm wood with 25-mm insulation
8	200-mm l. w. concrete
9	100-mm h. w. concrete with 25-mm insulation
10	63-mm wood with 50-mm insulation
11	Roof terrace system
12	150-mm h. w. conc. with 25-mm ins.
13	100-mm wood with 25-mm insulation

Tabela 13. Propriedades de materiais de vidros (ASHRAE, 1989).

Part A: U-Values for Vertical Installation ^a , W/(m ² ·°C)								
Glazing Type ^b	Glass Only		Aluminum Frame no thermal break ($U_f=10.8$)		Aluminum Frame thermal break ($U_f=5.7$)		Wood or Vinyl Frame ($U_f=2.3$)	
	Center of Glass	Edge ^c of Glass	Product ^d Type		Product ^d Type		Product ^d Type	
			R	C	R	C	R	C
Single glazing								
Glass	6.30	0.00	7.44	6.98	6.19	6.25	5.11	5.56
3 mm acrylic	5.85	0.00	7.15	6.59	5.79	5.85	4.77	5.22
Double glass								
6 mm airspace	3.24	3.75	5.22	4.43	3.97	3.69	3.07	3.12
9 mm airspace	2.95	3.52	5.00	4.20	3.75	3.41	2.84	2.90
13 mm and greater airspace	2.78	3.35	4.94	4.09	3.63	3.35	2.78	2.78
Double glass, $\epsilon = 0.40$ on surface 2 or 3								
6 mm airspace	2.84	3.41	4.94	4.15	3.69	3.35	2.78	2.84
9 mm airspace	2.44	3.12	4.71	3.80	3.41	3.07	2.56	2.56
13 mm and greater airspace	2.33	3.07	4.60	3.69	3.29	2.95	2.44	2.38
Double glass, $\epsilon = 0.15$ on surface 2 or 3								
6 mm airspace	2.56	3.18	4.77	3.86	3.46	3.12	2.61	2.61
9 mm airspace	2.04	2.90	4.43	3.52	3.18	2.73	2.33	2.21
13 mm airspace	1.93	2.84	4.32	3.41	3.07	2.61	2.21	2.10
Double glass								
6 mm argon space	2.95	3.52	5.00	4.20	3.75	3.46	2.84	2.90
9 mm argon space	2.73	3.35	4.88	4.03	3.58	3.24	2.73	2.73
13 mm and greater argon space	2.61	3.24	4.66	3.92	3.52	3.18	2.67	2.67
Double glass, $\epsilon = 0.40$ on surface 2 or 3								
6 mm argon space	2.44	3.12	4.71	3.80	3.41	3.07	2.56	2.56
9 mm argon space	2.16	2.95	4.49	3.58	3.24	2.78	2.38	2.27
13 mm and greater argon space	2.04	2.90	4.43	3.52	3.18	2.73	2.33	2.21
Double glass, $\epsilon = 0.15$ on surface 2 or 3								
6 mm argon space	2.04	2.90	4.43	3.52	3.18	2.73	2.33	2.21
9 mm argon space	1.70	2.73	4.20	3.24	2.90	2.44	2.10	1.93
13 mm and greater argon space	1.59	2.67	4.15	3.12	2.84	2.38	2.04	1.87
Double glazing, 3 mm acrylic or polycarbonate								
6 mm airspace	2.95	3.52	5.05	4.20	3.80	3.46	2.90	2.90
9 mm airspace	2.73	3.35	4.88	4.03	3.63	3.24	2.73	2.73
13 mm and greater airspace	2.61	3.24	4.83	3.92	3.52	3.18	2.67	2.67
Double glazing, 6 mm acrylic or polycarbonate								
6 mm airspace	2.73	3.35	4.88	4.03	3.63	3.24	2.73	2.73
9 mm airspace	2.50	3.18	4.77	3.86	3.46	3.07	2.61	2.56
13 mm and greater airspace	2.38	3.07	4.66	3.75	3.41	3.01	2.56	2.44
Triple glass								
6 mm airspace	2.16	2.95	4.49	3.63	3.24	2.84	2.38	2.33
9 mm airspace	1.93	2.84	4.32	3.41	3.07	2.61	2.21	2.16
13 mm and greater airspace	1.82	2.78	4.26	3.29	3.01	2.56	2.16	2.04
Triple glass, $\epsilon = 0.40$ on surface 2, 3, 4 or 5								
6 mm airspaces	1.99	2.84	4.37	3.46	3.12	2.73	2.27	2.21
9 mm airspaces	1.70	2.73	4.20	3.24	2.95	2.50	2.10	1.99
13 mm and greater airspaces	1.59	2.67	4.09	3.12	2.84	2.33	2.04	1.87
Triple glass or double glass with polyester film suspended in between, $\epsilon = 0.15$ on surface 2, 3, 4, or 5								
6 mm airspaces	1.87	2.78	4.32	3.35	3.01	2.56	2.21	2.10
9 mm airspaces	1.53	2.61	4.09	3.07	2.84	2.33	1.99	1.82
13 mm and greater airspaces	1.36	2.56	3.97	2.95	2.73	2.21	1.93	1.70
Triple glass or double glass with polyester film suspended in between, $\epsilon = 0.15$ on surfaces 2 or 3 and 4 or 5								
6 mm airspaces	1.59	2.67	4.15	3.12	3.01	2.38	2.04	1.87
9 mm airspaces	1.25	2.56	3.92	2.90	2.67	2.10	1.82	1.65
13 mm and greater airspaces	1.08	2.50	3.80	2.73	2.56	1.99	1.76	1.48
Triple glass								
6 mm argon spaces	1.93	2.84	4.37	3.41	3.07	2.61	2.21	2.16
9 mm argon spaces	1.76	2.73	4.20	3.24	2.95	2.50	2.10	1.99
13 mm and greater argon spaces	1.65	2.67	4.15	3.18	2.90	2.38	2.04	1.93
Triple glass, $\epsilon = 0.40$ on surface 2, 3, 4 or 5								
6 mm argon spaces	1.70	2.73	4.20	3.24	2.95	2.50	2.10	1.99
9 mm argon spaces	1.48	2.61	4.09	3.07	2.78	2.33	1.99	1.82
13 mm and greater argon spaces	1.42	2.61	4.03	3.01	2.73	2.21	1.93	1.76

Tabela 14. CLTDs para vidros (ASHRAE, 1989).

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

Tabela 15. Coeficiente de sombreamento para vidros(ASHRAE, 1989).

A. Single Glass				
Type of Glass	Nominal Thickness ^b	Solar Trans. ^b	Shading Coefficient $h_0 = 22.7$ $h_0 = 7.0$	
Clear	3 mm	0.86	1.00	1.00
	6 mm	0.78	0.94	0.95
	10 mm	0.72	0.90	0.92
	13 mm	0.67	0.87	0.88
Heat Absorbing	3 mm	0.64	0.83	0.85
	6 mm	0.46	0.69	0.73
	10 mm	0.33	0.60	0.64
	13 mm	0.24	0.53	0.58
B. Insulating Glass				
Clear Out, Clear In	3 mm ^c	0.71 ^e	0.88	0.88
Clear Out, Clear In	6 mm	0.61	0.81	0.82
Heat Absorbing ^d Out, Clear In	6 mm	0.36	0.55	0.58

^aRefers to factory-fabricated units with 5-, 6-, or 13-mm airspace or to prime windows plus storm sash.

^bRefer to manufacturer's literature for values.

^cThickness of each pane of glass, not thickness of assembled unit.

^dRefers to gray, bronze, and green tinted heat-absorbing float glass.

^eCombined transmittance for assembled unit.

Tabela 16. Valores de SHGF para vidros (ASHRAE, 1989).

8°N Lat										
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	600	754	782	681	521	347	928
Mar.	117	211	492	678	790	726	581	347	174	947
Apr.	139	369	581	897	710	615	423	167	123	912
May	233	461	625	894	659	527	306	123	120	874
June	284	489	631	883	631	445	259	123	123	849
July	243	457	615	678	644	511	204	126	123	858
Aug.	148	369	565	675	681	587	404	161	129	890
Sep.	120	308	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°N Lat										
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	802
Mar.	114	183	467	663	757	735	599	391	230	937
Apr.	126	341	562	691	716	631	448	282	126	915
May	189	439	612	694	669	546	334	126	126	883
June	237	470	625	685	644	508	264	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°N Lat										
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	632	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°N Lat										
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	348	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°N Lat										
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	684	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

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

0°N Lat										
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	437	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°N Lat										
N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR	
Jan.	104	104	249	536	722	795	714	609	445	902
Feb.	110	110	388	628	764	782	678	480	278	950
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

Tabela 16(cont.). Valores de SHGF para vidros (ASHRAE, 1989).

28°N Lat										
N (Shade)	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°N Lat										
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°N Lat										
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

40°N Lat										
N (Shade)	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR	
Jan.	63	63	63	233	486	647	760	795	801	420
Feb.	76	76	158	407	587	738	776	770	760	568
Mar.	91	91	293	533	688	751	745	681	650	704
Apr.	107	224	441	599	707	704	640	536	486	795
May	117	322	521	637	694	656	552	420	357	836
June	151	357	543	647	681	628	508	366	300	842
July	120	322	514	625	681	641	536	681	344	827
Aug.	110	224	426	584	681	675	618	536	470	779
Sep.	95	95	274	505	640	716	713	659	631	678
Oct.	79	79	154	388	568	710	751	745	738	558
Nov.	63	63	63	230	476	634	748	782	789	416
Dec.	57	57	57	189	476	593	732	786	798	357

44°N Lat										
N (Shade)	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR	
Jan.	54	57	54	202	440	596	732	782	795	344
Feb.	69	69	136	369	562	716	776	782	779	505
Mar.	85	85	274	511	666	745	751	707	688	650
Apr.	104	208	429	57	697	707	663	577	540	757
May	114	303	511	634	691	666	577	467	416	811
June	148	341	533	647	678	640	540	416	363	803
July	117	303	502	624	678	650	565	454	404	821
Aug.	107	208	416	568	675	678	637	558	521	745
Sep.	88	88	252	480	625	713	716	681	666	828
Oct.	73	73	133	350	540	685	748	757	754	495
Nov.	57	57	57	202	426	587	716	770	782	344
Dec.	47	47	47	155	363	552	683	757	776	281

48°N Lat										
N (Shade)	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR	
Jan.	47	47	47	167	372	552	681	754	773	268
Feb.	63	63	114	325	530	681	764	786	789	435
Mar.	82	82	252	486	644	738	754	732	719	593
Apr.	98	192	416	568	691	710	678	612	587	713
May	110	306	498	631	290	675	606	514	473	779
June	145	347	521	644	678	650	568	467	423	795
July	117	303	492	618	675	659	590	498	461	770
Aug.	104	192	404	549	666	681	656	593	568	704
Sep.	85	41	227	454	290	704	719	704	694	574
Oct.	66	66	110	303	508	653	735	760	764	42
Nov.	47	47	492	164	363	543	669	738	757	268
Dec.	41	41	41	114	287	492	615	710	735	205

52°N Lat										
N (Shade)	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR	
Jan.	41	41	41	123	290	489	609	700	726	196
Feb.	57	57	91	268	492	637	741	779	789	363
Mar.	76	76	230	457	618	726	754	751	745	533
Apr.	95	177	404	558	678	707	694	644	628	666
May	79	309	486	625	685	685	628	552	527	741
June	142	350	508	637	675	663	593	511	480	764
July	114	306	480	612	672	669	615	540	514	735
Aug.	101	177	391	533	656	681	669	622	609	656
Sep.	79	79	205	429	574	688	719	719	716	514
Oct.	60	60	88	252	467	606	710	751	757	360
Nov.	41	41	41	123	284	480	596	685	710	196
Dec.	32	32	32	60	230	401	543	628	659	133

56°N Lat										
N (Shade)	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR	
Jan.	32	32	32	66	233	398	533	612	647	126
Feb.	50	50	66	224	439	581	704	754	770	287
Mar.	69	69	205	429	584	707	751	760	760	470
Apr.	88	183	388	546	666	704	704	672	663	615
May	114	312	470	615	678	688	650	590	571	700
June	167	350	505	628	672	672	618	549	530	729
July	117	309	464	606	666	675	634	577	558	697
Aug.	95	177	375	521	640	681	678	650	640	609
Sep.	73	73	183	398	540	666	650	726	729	454
Oct.	50	50	63	215	416	555	672	722	738	287
Nov.	32	32	32	66	227	385	521	599	631	126
Dec.	22	22	22	22	148	290	426	502	540	73

60°N Lat										
N (Shade)	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR	
Jan.	22	22	22	22	145	278	410	480	517	66
Feb.	41	41	41	183	372	530	644	710	729	215
Mar.	63	63	177	394	546	678	738	760	764	404
Apr.	85	186	372	530	650	700	710	694	688	362
May	136	309	470	606	669	694	666	625	612	656
June	183	347	511	622	672	678	637	587	571	685
July	139	306	464	596	656	678	650	609	599	653
Aug.	88	180	360	508	628	675	685	672	666	555
Sep.	66	66	158	363	505	637	700	722	729	388
Oct.	44	44	44	177	350	502	609	678	697	21
Nov.	22	22	22	22	142	271	401	467	505	69
Dec.	13	13	13	13	50	161	240	316	338	28

64°N Lat										
	N (Shade)	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	HOR
Jan.	9	9	9	9	47	142	211	281	303	24
Feb.	35	35	35	136	281	454	558	637	663	12
Mar.	57	57	148	357	502	640	713	745	754	33
Apr.	79	186	357	514	634	691	710	710	707	50
May	151	306	473	596	666	694	678	633	644	60
June	196	360	511	609	672	681	656	618	609	64
July	155	303	467	587	653	678	666	637	631	60
Aug.	85	183	344	495	609	666	685	685	685	50
Sep.	60	60	136	325	467	596	672	707	716	31
Oct.	35	35	35	126	262	426	527	603	628	14
Nov.	13	13	13	13	47	139	208	274	293	2
Dec.	0	0	0	0	3	15	35	44	47	2

Tabela 16(cont.). Valores de SHGF para vidros (ASHRAE, 1989).

Maximum Solar Heat Gain Factor (SHGF) for Externally Shaded Glass, W/m² (Based on Ground Reflectance of 0.2)

Use for latitudes 0 to 24 deg.
For latitudes greater than 24, use north orientation, Table 34.
For horizontal glass in shade, use the tabulated values for all latitudes.

	N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SSW	S	(All Lat.) HOR
Jan.	98	98	98	101	107	114	117	120	120	50
Feb.	107	107	107	110	114	117	120	120	123	50
Mar.	114	114	117	120	123	126	126	123	123	60
Apr.	126	126	130	133	133	133	129	126	126	76
May	137	139	142	145	142	136	129	126	126	88
June	142	145	148	148	145	139	129	126	126	98
July	142	142	145	148	148	142	133	129	129	98
Aug.	133	133	136	142	145	142	136	133	133	88
Sept.	117	117	120	126	129	133	133	129	129	73
Oct.	107	107	107	114	120	123	126	126	126	60
Nov.	101	101	101	101	107	114	120	120	123	54
Dec.	95	95	95	98	101	107	114	117	117	47

Tabela 17. Valores de CLFs para vidros sem sombreamento interno (ASHRAE, 1989).

Cooling Load Factors (CLF) for Glass <i>Without</i> Interior Shading, North Latitudes, General																									
Fenestration Facing	Room Construction	Solar Time, h																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
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	0.25	0.22	0.19	0.15	0.12	0.10	0.08	0.06	0.05
	M	0.07	0.06	0.06	0.05	0.05	0.18	0.33	0.44	0.50	0.51	0.46	0.39	0.35	0.31	0.29	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	0.05	0.04	0.03	0.03	0.02	0.17	0.34	0.49	0.58	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	0.08	0.07	0.06	0.05	0.05	0.16	0.31	0.43	0.51	0.54	0.51	0.44	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	0.13	0.28	0.43	0.55	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

Tabela 17(cont). Valores de CLFs para vidros sem sombreamento interno (ASHRAE, 1989).

Room		Solar Time																							
		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	L	.00	.00	.00	.00	.01	.64	.73	.74	.81	.88	.95	.98	.98	.94	.88	.79	.79	.55	.31	.12	.04	.02	.01	.00
	M	.03	.02	.02	.02	.02	.64	.69	.69	.77	.84	.91	.94	.95	.91	.86	.79	.79	.56	.32	.16	.10	.07	.05	.04
	H	.10	.09	.08	.07	.07	.62	.64	.64	.71	.77	.83	.87	.88	.85	.81	.75	.76	.55	.34	.22	.17	.15	.13	.11
NE	L	.00	.00	.00	.00	.01	.51	.83	.88	.72	.47	.33	.27	.24	.23	.20	.18	.14	.09	.03	.01	.00	.00	.00	.00
	M	.01	.01	.00	.00	.01	.50	.78	.82	.67	.44	.32	.28	.26	.24	.22	.19	.15	.11	.05	.03	.02	.02	.01	.01
	H	.03	.03	.03	.02	.03	.47	.71	.72	.59	.40	.30	.27	.26	.25	.23	.20	.17	.13	.08	.06	.05	.05	.04	.04
E	L	.00	.00	.00	.00	.00	.42	.76	.91	.90	.75	.51	.30	.22	.18	.16	.13	.11	.07	.02	.01	.00	.00	.00	.00
	M	.01	.01	.00	.00	.01	.41	.72	.86	.84	.71	.48	.30	.24	.21	.18	.16	.13	.09	.04	.03	.02	.01	.01	.01
	H	.03	.03	.03	.02	.02	.39	.66	.76	.74	.63	.43	.29	.24	.22	.20	.18	.15	.12	.08	.06	.05	.05	.04	.04
SE	L	.00	.00	.00	.00	.00	.27	.58	.81	.93	.93	.81	.59	.37	.27	.21	.18	.14	.09	.03	.01	.00	.00	.00	.00
	M	.01	.01	.01	.00	.01	.26	.55	.77	.88	.87	.76	.56	.37	.29	.24	.20	.16	.11	.05	.04	.03	.02	.02	.01
	H	.04	.04	.03	.03	.03	.26	.51	.69	.78	.78	.68	.51	.35	.29	.25	.22	.19	.15	.09	.08	.07	.06	.05	.05
S	L	.00	.00	.00	.00	.00	.07	.15	.23	.39	.62	.82	.94	.93	.80	.59	.38	.26	.16	.06	.02	.01	.00	.00	.00
	M	.01	.01	.01	.01	.01	.07	.14	.22	.38	.59	.78	.88	.88	.76	.57	.38	.28	.18	.09	.06	.04	.03	.02	.02
	H	.05	.05	.04	.04	.03	.09	.15	.21	.35	.54	.70	.79	.79	.69	.52	.37	.29	.21	.13	.10	.09	.08	.07	.06
SW	L	.00	.00	.00	.00	.00	.04	.09	.13	.16	.19	.23	.39	.62	.82	.94	.94	.81	.54	.19	.07	.03	.01	.00	.00
	M	.02	.02	.01	.01	.01	.05	.09	.13	.16	.19	.22	.38	.60	.78	.89	.89	.77	.52	.20	.10	.07	.05	.04	.03
	H	.07	.06	.05	.05	.04	.07	.11	.14	.16	.18	.21	.35	.55	.71	.80	.79	.69	.48	.20	.14	.11	.10	.08	.07
W	L	.00	.00	.00	.00	.00	.03	.07	.10	.13	.15	.16	.18	.31	.55	.78	.92	.93	.73	.25	.10	.04	.01	.01	.00
	M	.02	.02	.01	.01	.01	.04	.07	.10	.13	.14	.16	.17	.30	.53	.74	.87	.88	.69	.24	.12	.07	.05	.04	.03
	H	.06	.06	.05	.04	.04	.06	.09	.11	.13	.15	.16	.17	.28	.49	.67	.78	.79	.62	.23	.14	.11	.09	.08	.07
NW	L	.00	.00	.00	.00	.00	.04	.09	.14	.17	.20	.22	.23	.24	.31	.53	.78	.92	.81	.28	.10	.04	.02	.01	.00
	M	.02	.02	.01	.01	.01	.05	.10	.13	.17	.19	.21	.22	.23	.30	.52	.75	.88	.77	.26	.12	.07	.05	.04	.03
	H	.06	.05	.05	.04	.04	.07	.11	.14	.17	.19	.20	.21	.22	.28	.48	.68	.79	.69	.23	.14	.10	.09	.08	.07
Hor.	L	.00	.00	.00	.00	.00	.08	.25	.45	.64	.80	.91	.97	.97	.91	.80	.64	.44	.23	.08	.03	.01	.00	.00	.00
	M	.02	.02	.01	.01	.01	.08	.24	.43	.60	.75	.86	.92	.92	.87	.77	.63	.45	.26	.12	.07	.05	.04	.03	.02
	H	.07	.06	.05	.05	.04	.11	.25	.41	.56	.68	.77	.83	.83	.80	.71	.59	.44	.28	.17	.13	.11	.10	.09	.08

Values for nominal 5 m by 5 m by 3 m high space, with ceiling, and 50% or less glass in exposed surface at listed orientation.

L = Lightweight construction, such as 25-mm wood floor, Group G wall.

M = Mediumweight construction, such as 50- to 100-mm concrete floor, Group E wall.

H = Heavyweight construction, such as 150- to 200-mm concrete floor, Group C wall.

Room		Solar Time																							
		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	L	.00	.00	.00	.00	.01	.64	.73	.74	.81	.88	.95	.98	.98	.94	.88	.79	.79	.55	.31	.12	.04	.02	.01	.00
	M	.12	.09	.07	.06	.05	.33	.45	.53	.61	.69	.76	.82	.85	.86	.85	.81	.80	.70	.60	.43	.32	.24	.19	.15
	H	.24	.21	.19	.18	.16	.43	.48	.51	.56	.61	.66	.71	.73	.74	.73	.71	.71	.62	.52	.42	.36	.32	.29	.26
NE	L	.00	.00	.00	.00	.01	.51	.83	.88	.72	.47	.33	.27	.24	.23	.20	.18	.14	.09	.03	.01	.00	.00	.00	.00
	M	.03	.02	.02	.02	.02	.24	.45	.57	.58	.49	.41	.36	.32	.29	.27	.24	.21	.17	.13	.10	.07	.06	.05	.04
	H	.08	.07	.07	.06	.06	.27	.43	.49	.45	.37	.32	.29	.28	.27	.26	.24	.22	.19	.16	.14	.12	.11	.10	.09
E	L	.00	.00	.00	.00	.00	.42	.76	.91	.90	.75	.51	.30	.22	.18	.16	.13	.11	.07	.02	.01	.00	.00	.00	.00
	M	.03	.02	.02	.02	.01	.20	.41	.57	.65	.64	.55	.44	.36	.31	.26	.23	.19	.16	.12	.09	.07	.06	.04	.04
	H	.08	.08	.07	.06	.06	.24	.40	.50	.53	.50	.41	.33	.30	.28	.26	.24	.22	.19	.16	.14	.13	.11	.10	.09
SE	L	.00	.00	.00	.00	.00	.27	.58	.81	.93	.93	.81	.59	.37	.27	.21	.18	.14	.09	.03	.01	.00	.00	.00	.00
	M	.04	.03	.02	.02	.02	.13	.31	.48	.62	.69	.69	.61	.50	.41	.35	.30	.25	.20	.15	.12	.09	.07	.06	.05
	H	.10	.09	.08	.08	.07	.18	.32	.45	.53	.56	.54	.47	.39	.35	.32	.29	.26	.23	.19	.17	.15	.14	.12	.11
S	L	.00	.00	.00	.00	.00	.07	.15	.23	.39	.62	.82	.94	.93	.80	.59	.38	.26	.16	.06	.02	.01	.00	.00	.00
	M	.05	.04	.04	.03	.02	.05	.09	.14	.24	.38	.53	.65	.72	.71	.63	.52	.42	.33	.24	.18	.14	.11	.09	.07
	H	.13	.12	.10	.09	.09	.11	.14	.17	.25	.36	.47	.55	.58	.56	.49	.41	.36	.30	.25	.21	.19	.17	.16	.14
SW	L	.00	.00	.00	.00	.00	.04	.09	.13	.16	.19	.23	.39	.62	.82	.94	.94	.81	.54	.19	.07	.03	.01	.00	.00
	M	.08	.07	.05	.04	.03	.05	.07	.09	.12	.15	.17	.26	.40	.54	.66	.73	.72	.61	.43	.31	.23	.17	.13	.10
	H	.15	.14	.12	.11	.10	.11	.12	.14	.15	.17	.18	.26	.37	.48	.56	.59	.57	.47	.33	.27	.23	.21	.19	.17
W	L	.00	.00	.00	.00	.00	.03	.07	.10	.13	.15	.16	.18	.31	.55	.78	.92	.93	.73	.25	.10	.04	.01	.01	.00
	M	.08	.07	.05	.04	.04	.06	.08	.10	.12	.13	.15	.16	.21	.35	.50	.63	.71	.67	.46	.33	.24	.18	.14	.11
	H	.14	.13	.12	.11	.10	.10	.11	.12	.13	.14	.15	.16	.21	.33	.45	.54	.58	.52	.33	.26	.22	.19	.18	.16
NW	L	.00	.00	.00	.00	.00	.04	.09	.14	.17	.20	.22	.23	.24	.31	.53	.78	.92	.81	.28	.10	.04	.02	.01	.00
	M	.08	.06	.05	.04	.03	.05	.07	.10	.13	.15	.17	.19	.20	.24	.36	.51	.64	.66	.46	.32	.23	.17	.13	.10
	H	.13	.12	.11	.10	.09	.10	.12	.13	.15	.16	.17	.18	.19	.23	.33	.46	.55	.53	.33	.25	.21	.18	.16	.15
Hor.	L	.00	.00	.00	.00	.00	.08	.25	.45	.64	.80	.91	.97	.97	.91	.80	.64	.44	.23	.08	.03	.01	.00	.00	.00
	M	.07	.06	.05	.04	.03	.06	.14	.26	.40	.53	.64	.73	.78	.80	.77	.70	.59	.45	.33	.24	.19	.14	.11	.09
	H	.16	.15	.13	.12	.11	.13	.20	.29	.39	.48	.56	.61	.65	.65	.63	.57	.49	.40	.32	.28	.25	.22	.20	.18

Values for nominal 5 m by 5 m by 3 m high space, with ceiling, and 50% or less glass in exposed surface at listed orientation.

L = Lightweight construction, such as 25-mm wood floor, Group G wall.

M = Mediumweight construction, such as 50- to 100-mm concrete floor, Group E wall.

H = Heavyweight construction, such as 150- to 200-mm concrete floor, Group C wall.

Tabela 17(cont.). Valores de CLFs para vidros com sombreamento interno(ASHRAE, 1989).

		Cooling Load Factors (CLF) 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	0.06
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

Tabela 18. Valores de carga térmica por pessoa (ABNT, 2008a).

Nível de atividade	Local	Calor total (W)		Calor Sensível (W)	Calor latente (W)	% Radiante do calor sensível	
		Homem adulto	Ajustado MF ^a			Baixa velocidade do ar	Alta velocidade do ar
Sentado no teatro	Teatro matiné	115	95	65	30		
Sentado no teatro, noite	Teatro noite	115	105	70	35	60	27
Sentado, trabalho leve	Escritórios, hotéis, apartamentos	130	115	70	45		
Atividade moderada em trabalhos de escritório	Escritórios, hotéis, apartamentos	140	130	75	55		
Parado em pé, trabalho moderado; caminhando	Loja de varejo ou de departamentos	160	130	75	55	58	38
Caminhando, parado em pé	Farmácia, agência bancária	160	145	75	70		
Trabalho sedentário	Restaurante ^b	145	160	80	80		
Trabalho leve em bancada	Fábrica	235	220	80	140		
Dançando moderadamente	Salão de baile	265	250	90	160	49	35
Caminhando 4,8 km/h; trabalho leve em máquina operatriz	Fábrica	295	295	110	185		
Jogando boliche ^c	Boliche	440	425	170	255		
Trabalho pesado	Fábrica	440	425	170	255	54	19
Trabalho pesado em máquina operatriz; carregando carga	Fábrica	470	470	185	285		
Praticando esportes	Ginásio, academia	585	525	210	315		

NOTA 1 Valores baseados em temperatura de bulbo seco ambiente de 24 °C. Para uma temperatura de bulbo seco ambiente de 27 °C, o calor total permanece o mesmo, porém o calor sensível deve ser reduzido em aproximadamente 20 %, e o calor latente aumentado correspondentemente. Para uma temperatura de bulbo seco ambiente de 21 °C, também o calor total permanece o mesmo, porém o calor sensível deve ser aumentado em aproximadamente 20 %, e o calor latente reduzido correspondentemente.

NOTA 2 Valores arredondados em 5 W.

^a O valor do calor ajustado é baseado numa porcentagem normal de homens, mulheres e crianças para cada uma das aplicações listadas, postulando-se que o calor liberado por uma mulher adulta é aproximadamente 85 % daquele liberado por um homem adulto, e o calor liberado por uma criança é aproximadamente 75 % daquele liberado por um homem adulto.

^b O ganho de calor ajustado inclui 18 W para um prato de comida individual (9 W de calor sensível e 9 W latente).

^c Considerando uma pessoa por cancha realmente jogando boliche, e todas as demais sentadas (117 W), paradas em pé ou caminhando lentamente (231 W).

Tabela 19. Vazão eficaz mínima de ar exterior para ventilação (ABNT, 2008b).

Local	D pessoas/ 100 m ²	Nível 1		Nível 2		Nível 3		Exaustão mecânica L/s* m ² *
		F _p L/s* pess.	F _a L/s* m ²	F _p L/s* pess.	F _a L/s* m ²	F _p L/s* pess.	F _a L/s* m ²	
Comércio varejista								
Supermercado de alto padrão	8	3,8	0,3	4,8	0,4	5,7	0,5	–
Supermercado de padrão médio	10	3,8	0,3	4,8	0,4	5,7	0,5	–
Supermercado popular	12	3,8	0,3	4,8	0,4	5,7	0,5	–
Mal de centros comerciais	40	3,8	0,3	4,8	0,4	5,7	0,5	–
Lojas (exceto abaixo)	15	3,8	0,6	4,8	0,8	5,7	0,9	–
Salão de beleza e/ou barbearia ^b	25	10	0,6	12,5	0,8	15,0	0,9	–
Animais de estimação ^b	10	3,8	0,9	4,8	1,1	5,7	1,4	4,5
Lavanderia "self-service"	20	3,8	0,3	4,8	0,4	5,7	0,5	–
Edifícios de escritórios								
Hall do edifício, recepção	10	2,5	0,3	3,1	0,4	3,8	0,5	–
Escritórios de diretoria	6	2,5	0,3	3,1	0,4	3,8	0,5	–
Escritório com baixa densidade	11	2,5	0,3	3,1	0,4	3,8	0,5	–
Escritório com média densidade	14	2,5	0,3	3,1	0,4	3,8	0,5	–
Escritório com alta densidade	20	2,5	0,3	3,1	0,4	3,8	0,5	–
Sala de reunião	50	2,5	0,3	3,1	0,4	3,8	0,5	–
CPD (exceto impressoras)	4	2,5	0,3	3,1	0,4	3,8	0,5	–
Sala impressoras, copiadoras	--	–	--	–	–	–	–	2,5
Sala digitação	60	2,5	0,3	3,1	0,4	3,8	0,5	–
"Call center"	60	3,8	0,8	4,8	0,8	5,7	0,9	–
Bancos								
Bancos (área do público)	41	3,8	0,3	4,8	0,4	5,7	0,5	–
Caixa forte	5	2,5	0,3	3,1	0,4	3,8	0,5	–

Tabela 19(cont.). Vazão eficaz mínima de ar exterior para ventilação (ABNT, 2008b).

Local	D pessoas/ 100 m ²	Nível 1		Nível 2		Nível 3		Exaustão mecânica L/s* m ² a
		F _p L/s* pess.	F _s L/s* m ²	F _p L/s* pess.	F _s L/s* m ²	F _p L/s* pess.	F _s L/s* m ²	
Edifícios públicos								
Aeroporto – saguão ^c	15	3,8	0,3	5,3	0,4	5,7	0,5	–
Aeroporto – sala de embarque ^c	100	3,8	0,3	5,3	0,4	5,7	0,5	–
Biblioteca	10	2,5	0,6	3,5	0,8	3,8	0,9	–
Museu, galeria de arte ^d	40	3,8	0,3	5,3	0,4	5,7	0,5	–
Local de culto	120	2,5	0,3	3,5	0,4	3,8	0,5	–
Legislativo – plenário	50	2,5	0,3	3,5	0,4	3,8	0,5	–
Teatro, cinema, auditório – lobby	150	2,5	0,3	3,5	0,4	3,8	0,5	–
Teatro, cinema, auditório e platéia	150	2,5	0,3	3,5	0,4	3,8	0,5	–
Teatro, cinema, auditório – palco	70	5	0,3	6,3	0,4	7,5	0,5	–
Tribunal – sala de audiências	70	2,5	0,3	3,5	0,4	3,8	0,5	–
Esportes								
Boliche – área do público	40	5	0,6	6,3	0,8	7,5	0,9	–
Ginásio coberto (área do público)	150	3,8	0,3	4,8	0,4	5,7	0,5	–
Ginásio coberto (quadra)	–	–	0,3	–	0,4	–	0,5	–
Piscina coberta ^e	–	–	2,4	–	3,0	–	3,8	2,5
"Fitness center" – aeróbica	40	10	0,3	12,5	0,4	15,0	0,5	–
"Fitness center" – aparelhos	10	5	0,6	6,3	0,8	7,5	0,9	–
Estabelecimentos de ensino								
Sala de aula	35	5	0,6	6,3	0,8	7,5	0,9	–
Laboratório de informática	25	5	0,6	6,3	0,8	7,5	0,9	–
Laboratório de ciências	25	5	0,9	6,3	1,1	7,5	1,4	5,0
Hotéis								
Apartamento de hóspedes	–	5,5	–	6,9	–	10,3	–	–
Banheiro privativo	–	–	–	–	–	–	–	2,5/unid.
Lobby, sala de estar	30	3,8	0,3	4,8	0,4	5,7	0,5	–
Sala de convenções	120	2,5	0,3	3,1	0,4	3,8	0,5	–
Dormitório coletivo	20	2,5	0,3	3,1	0,4	3,8	0,5	–
Restaurantes, bares, diversão								
Restaurante – salão de refeições	70	3,8	0,9	4,8	1,1	5,7	1,4	–
Bar, salão de coquetel	100	3,8	0,9	4,8	1,1	5,7	1,4	–
Cafeteria, lanchonete, refeitório	100	3,8	0,9	4,8	1,1	5,7	1,4	–
Salão de jogos	120	3,8	0,9	4,8	1,1	5,7	1,4	–
Discoteca, danceteria	100	10,0	0,3	12,5	0,4	15,0	0,5	–
Jogos eletrônicos	20	3,8	0,9	4,8	1,1	5,7	1,4	–

Local	D pessoas/ 100 m ²	Nível 1		Nível 2		Nível 3		Exatidão mecânica L/s* m ² ^a
		F _p L/s* pess.	F _a L/s* m ²	F _p L/s* pess.	F _a L/s* m ²	F _p L/s* pess.	F _a L/s* m ²	
Locais diversos								
Câmara escura	--	--	--	--	--	--	--	5,0
Copa	--	--	--	--	--	--	--	1,5
Sala exclusiva para fumar ^f	--	--	--	--	--	--	--	9,0
Sanitários públicos	--	--	--	--	--	--	--	35 / bacia
Vestibúlos coletivos	--	--	--	--	--	--	--	2,5
Legenda								
Nível 1 - Nível mínimo vazão de ar exterior para ventilação.								
Nível 2 - Nível intermediário da vazão de ar exterior para ventilação.								
Nível 3 - Vazões de ar exterior para ventilação que segundo estudos existem evidências de redução de reclamações e manifestações alérgicas								
F _p - Fração do ar exterior relacionada às pessoas (L/s* pessoa)								
F _a - Fração do ar exterior relacionada ao recinto (L/s* m ²)								
D - Densidade de ocupação esperada, referida à área útil ocupada (pessoas/100 m ²)								
NOTA 1 A aplicação desta Tabela está condicionada à obediência a todos os demais requisitos desta parte da ABNT NBR 16401.								
NOTA 2 O nível (1,2 ou 3) de ar externo a ser utilizado no projeto deve ser definido entre o projetista e o cliente.								
NOTA 3 As vazões de ar exterior estipuladas são baseadas na proibição de fumar nos recintos (exceto local reservado).								
NOTA 4 Ar exterior com densidade do ar 1,2 kg/ m ³ (a vazão deve ser corrigida para a densidade efetiva).								
a	O ar de reposição para a exaustão pode ser proveniente de recintos vizinhos.							
b	Não recircular para outros recintos.							
c	Tratamento especial do ar exterior pode ser necessário para remover odores ou vapores nocivos.							
d	Tratamento especial do ar exterior pode ser necessário para remover elementos prejudiciais às obras de arte.							
e	A vazão estipulada não contempla controle de umidade. Pode ser necessário aumentar a vazão ou instalar um sistema de desumidificação.							
f	Não há valores estabelecidos da vazão de ar exterior necessária para diluir a fumaça de tabaco a níveis aceitáveis. A vazão de exaustão estipulada visa apenas evitar uma concentração excessiva de fumaça no recinto e a sua propagação para recintos vizinhos.							

Tabela 20. Valores de CLF para pessoas (ASHRAE, 1989).

Total Persons 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	0.40	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	0.52	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

CLF = 1.0 for systems shut down at night and for high occupant densities such as in theaters and auditoriums.

Tabela 21. Taxas típicas de dissipação de calor pela iluminação (ABNT, 2008b).

Local	Tipos de iluminação	Nível de iluminação Lux	Potência dissipada W/m²
Escritórios e bancos	Fluorescente	500	16
Lojas	Fluorescente	750	17
	Fluorescente compacta		23
	Vapor metálico		28
Residências	Fluorescente compacta	150	9
	Incandescente		30
Supermercados	Fluorescente	1 000	21
	Vapor metálico		30
Armazéns climatizados	Fluorescentes	100	2
	Vapor Metálico		3
Cinemas e teatros	Fluorescente compacta	50	6
	Vapor metálico		4
Museus	Fluorescente	200	5
	Fluorescente compacta		11
Bibliotecas	Fluorescente	500	16
	Fluorescente compacta		28
Restaurantes	Fluorescente compacta	150	13
	Incandescente		41
Auditórios:	a) Tribuna	750	30
			32
	b) Platéia	150	10
	c) Sala de espera	200	18
			8
Hotéis:	a) Corredores	100	8
	b) Sala de leitura	500	15
			22
	c) Quartos	150	9
			30
	d) Sala de convenções - Platéia	150	8
	- Tablado	750	30
			30
	e) Portaria e recepção	200	8
			9

Dados para fator de uso (F_{ul}) e fator de aplicação (F_{sa}) para o sistema de iluminação

Fator de uso (F_{ul}): porcentagem da potência da iluminação usada em relação a potência total instalada. Para aplicações em edificações comerciais , utilizar $F_{ul}=1$.

Fator de aplicação (F_{sa})

Aplicação	F_{sa}
Lâmpada fluorescente única 32 W a 277 V	2,19
Lâmpada fluorescente única 40 W a 118 V	1,30
Conjunto de duas lâmpadas fluorescentes de 40 W a 277 V	1,18
Recomendação para aplicações gerais	1,20
Aplicações industriais (exemplo lâmpadas de sódio) – consultar o fabricante	1,04 a 1,37

Tabela 22. Valores de CLFs para iluminação (ASHRAE, 1989).

Cooling Load Factors When Lights Are on for 8 Hours																									
"a" Coef- ficients	"b" Class- ification	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	0.37	0.63	0.72	0.77	0.82	0.85	0.88	0.46	0.37	0.30	0.24	0.19	0.15	0.12	0.10	0.08	0.06	0.05	0.04	0.03	0.03	0.02
	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	0.08
	C	0.11	0.58	0.60	0.63	0.67	0.67	0.69	0.71	0.72	0.28	0.26	0.23	0.22	0.20	0.19	0.18	0.17	0.16	0.15	0.14	0.13	0.12	0.12	0.12
	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	0.15	0.15	0.15
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	0.02
	B	0.06	0.60	0.64	0.68	0.71	0.74	0.76	0.79	0.81	0.28	0.23	0.20	0.18	0.16	0.15	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.06
	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	0.10
	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	0.16	0.16	0.15	0.15	0.14	0.14	0.13	0.13	0.13	0.13	0.12	0.12
0.65	A	0.01	0.66	0.73	0.78	0.82	0.86	0.88	0.91	0.95	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	0.02
	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	0.07	0.06	0.06	0.06	0.05
	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	0.10	0.10	0.09	0.08	0.08	0.07	0.07
	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	0.10	0.10	0.10	0.10	0.10	0.09
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	0.01
	B	0.03	0.78	0.80	0.82	0.84	0.85	0.87	0.88	0.89	0.13	0.14	0.13	0.11	0.10	0.08	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.04	0.04
	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	0.05
	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	0.07

Cooling Load Factors When Lights Are on for 10 Hours																									
"a" Coef- ficients	"b" Class- ification	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	0.38	0.66	0.73	0.78	0.82	0.86	0.88	0.91	0.93	0.49	0.39	0.32	0.28	0.21	0.17	0.13	0.11	0.09	0.07	0.06	0.05	0.04
	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	0.11
	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	0.16
	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	0.19
0.55	A	0.02	0.57	0.63	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	0.03
	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	0.09
	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	0.13
	D	0.13	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	0.15
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	0.02
	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	0.07
	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	0.10
	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	0.12
0.75	A	0.03	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	0.02
	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	0.07	0.06	0.06	0.05	0.05
	C	0.07	0.81	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.15	0.14	0.13	0.12	0.12	0.11	0.10	0.10	0.09	0.08	0.08	0.07	0.07
	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	0.12	0.11	0.11	0.10	0.10	0.09	0.09	0.09	0.09	0.09

Cooling Load Factors When Lights Are on for 12 Hours																									
"a" Coef- ficients	"b" Class- ification	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	0.05	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	0.06
	B	0.13	0.57	0.64	0.65	0.69	0.72	0.75	0.77	0.78	0.82	0.83	0.85	0.87	0.43	0.39	0.35	0.31	0.28	0.23	0.23	0.21	0.18	0.17	0.15
	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	0.23	0.20
	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	0.23
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	0.05
	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	0.12
	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	0.16
	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	0.19
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	0.04
	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	0.23	0.22	0.20	0.18	0.16	0.15	0.13	0.12	0.11	0.10
	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	0.13
	D	0.14	0.79	0.79	0.80	0.80	0.81	0.82	0.82	0.83	0.84	0.84	0.85	0.85	0.20	0.20	0.19	0.18	0.18	0.17	0.17	0.16	0.16	0.15	0.15
0.75	A	0.03	0.77	0.81	0.85	0.88	0.90	0.92	0.94	0.95	0.96	0.97	0.98	0.97	0.38	0.29	0.23	0.19	0.13	0.12	0.10	0.08	0.06	0.05	0.04
	B	0.08	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	0.07
	C	0.08	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.90	0.91	0.91	0.91	0.17	0.16	0.13	0.14	0.13	0.12	0.12	0.11	0.10	0.10	0.09
	D	0.10	0.83	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	0.11

Cooling Load Factors When Lights Are on for 14 Hours																								
"a" Coef- ficients	"b" Class- ification	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.																		

Tabela 23. Valores de “a” para iluminação (ASHRAE, 1989).

<i>a</i>	Furnishings	Air Supply and Return	Type of Light Fixture
0.45	Heavyweight, simple furnishings, no carpet	Low rate; supply and return below ceiling ($V \leq 2.5$) ^a	Recessed, not vented
0.55	Ordinary furniture, no carpet	Medium to high ventilation rate; supply and return below ceiling or through ceiling grill and space ($V \geq 2.5$) ^a	Recessed, not vented
0.65	Ordinary furniture, with or without carpet	Medium to high ventilation rate or fan coil or induction type air-conditioning terminal unit; supply through ceiling or wall diffuser; return around light fixtures and through ceiling space. ($V \geq 2.5$) ^a	Vented
0.75 or greater	Any type of furniture	Ducted returns through light fixtures	Vented or free-hanging in air stream with ducted returns

^a V is room air supply rate in L/s per square metre of floor area.

Tabela 24. Valores de “b” para iluminação (ASHRAE, 1989).

Room Envelope Construction ^a (mass of floor area, kg/m ²)	Room Air Circulation and Type of Supply and Return ^b			
	Low	Medium	High	Very High
50-mm Wood Floor (50)	B	A	A	A
75-mm Concrete Floor (200)	B	B	B	A
150-mm Concrete Floor (370)	C	C	C	B
200-mm Concrete Floor (590)	D	D	C	C
300-mm Concrete Floor (780)	D	D	D	D

^aFloor covered with carpet and rubber pad; for a floor covered only with floor tile take next classification to the right in the same row.

^bLow: Low ventilation rate—minimum required to cope with cooling load from lights and occupants in interior zone. Supply through floor, wall or ceiling diffuser. Ceiling space not vented and $h = 2.3 \text{ W}/(\text{m}^2 \cdot ^\circ\text{C})$ (where h = inside surface convection coefficient used in calculation of b).

Medium: Medium ventilation rate, supply through floor, wall or ceiling diffuser. Ceiling space not vented and $h = 3.4 \text{ W}/(\text{m}^2 \cdot ^\circ\text{C})$.

High: Room air circulation induced by primary air of induction unit or by fan coil unit. Return through ceiling space and $h = 4.5 \text{ W}/(\text{m}^2 \cdot ^\circ\text{C})$.

Very High: High room air circulation used to minimize temperature gradients in a room. Return through ceiling space and $h = 6.8 \text{ W}/(\text{m}^2 \cdot ^\circ\text{C})$.

Tabela 25. Taxas típicas de dissipação de calor de equipamentos de escritório – Computadores (ABNT, 2008).

Computadores	Uso contínuo W	Modo economizador W
Computadores		
Valor médio	55	20
Valor com fator de segurança	65	25
Valor com fator de segurança alto	75	30
Monitores		
Pequeno (13 pol. a 15 pol.)	55	0
Médio (16 pol. a 18 pol.)	70	0
Grande (19 pol. a 20 pol.)	80	0

Tabela 26. Taxas típicas de dissipação de calor de equipamentos de escritório – Impressoras e copiadoras (ABNT, 2008).

Impressoras e copiadoras	Uso contínuo W	1 página por minuto W	Ligada, em espera W
Impressoras a laser			
De mesa, pequena	130	75	10
De mesa	215	100	35
De escritório, pequena	320	160	70
De escritório, grande	550	275	125
Copiadoras			
De mesa	400	85	20
De escritório	1 100	400	300

Tabela 27. Taxas típicas de dissipação de calor de equipamentos de escritório – Equipamentos diversos (ABNT, 2008).

Equipamentos diversos	Potência máxima W	Dissipação recomendada W
Caixas registradoras	60	48
Máquinas de fax	15	10
Máquinas de café (10 xícaras)	1 500	1 050 sensível 450 latente
Máquinas de venda de bebidas refrigeradas	1 150 a 1 920	575 a 960
Máquinas de venda de salgadinhos	240 a 275	240 a 275
Bebedouros refrigerados	700	350

Tabela 28. Densidade típica de carga de equipamentos para diversos tipos de escritórios (ABNT, 2008).

Densidade típica de carga de equipamentos para diversos tipos de escritórios		
Tipo de carga	Densidade W/m ²	Descrição do escritório Assumindo:
Leve	5,4	15,5 m ² por posto de trabalho com computador e monitor em cada um, mais impressora e fax. Fator de diversidade de 0,67, exceto 0,33 para impressoras
Média	10,7	11,6 m ² por posto de trabalho com computador e monitor em cada um, mais impressora e fax. Fator de diversidade de 0,75, exceto 0,50 para impressoras
Média/alta	16,2	9,3 m ² por posto de trabalho com computador e monitor em cada um, mais impressora e fax. Fator de diversidade de 0,75, exceto 0,50 para impressoras
Alta	21,5	7,7 m ² por posto de trabalho com computador e monitor em cada um, mais impressora e fax. Fator de diversidade de 1,0, exceto 0,50 para impressoras

Fonte:

2005 ASHRAE Fundamentals Handbook, Capítulo 30, "Nonresidential Cooling and Heating Load Calculations", Tabelas 8, 9, 10, 11.

Tabela 29. Taxas típicas de dissipação de calor de motores elétricos (ABNT, 2008).

Potência nominal		Eficiência a plena carga	Localização em relação ao espaço condicionado ou fluxo de ar		
CV	kW		Motor e equipamento dentro	Motor fora / equipamento dentro	Motor dentro / equipamento fora
0,05	0,04	35,0	105	37	68
0,08	0,06	35,0	168	59	109
0,125	0,09	35,0	263	92	171
0,16	0,12	35,0	336	118	219
0,25	0,18	64,0	287	184	103
0,33	0,24	67,0	362	243	120
0,50	0,37	68,0	541	368	173
0,75	0,55	71,0	777	552	225
1,0	0,74	78,0	943	736	207
1,5	1,1	72,7	1 520	1 100	414
2,0	1,5	78,0	1 890	1 470	415
3,0	2,2	79,3	2 780	2 210	576
4,0	2,9	82,7	3 560	2 940	615
5,0	3,7	84,6	4 350	3 680	669
6,0	4,4	84,2	5 240	4 410	828
7,5	5,5	88,5	6 230	5 520	717
10,0	7,4	89,0	8 260	7 360	909
12,5	9,2	87,7	10 480	9 190	1 290
15	11,0	88,3	12 490	11 030	1 460
20	14,7	89,8	16 380	14 710	1 670
25	18,4	90,1	20 410	18 390	2 020
30	22,1	91,0	24 250	22 070	2 180
40	29,4	91,0	32 330	29 420	2 910
50	36,8	91,7	40 100	36 780	3 330
60	44,1	91,6	48 180	44 130	4 050
75	55,2	91,9	60 020	55 160	4 860
100	73,6	95,5	77 020	73 550	3 470
125	91,9	91,8	100 200	91 940	8 210
150	110,3	92,0	119 900	110 300	9 590
175	128,7	92,7	138 800	128 700	10 140
200	147,1	93,4	157 500	147 100	10 400
250	183,9	93,5	196 700	183 900	12 780
300	220,7	95,0	232 300	220 700	11 610
350	257,4	95,1	270 700	257 400	13 260
400	294,2	95,3	308 700	294 200	14 510
450	331,0	95,4	346 900	331 000	15 960
500	367,8	95,4	385 500	367 800	17 730
NOTA 1 Motores operando em regime de uso contínuo.					
NOTA 2 Motores com potência nominal de 0,05 CV a 0,16 CV são monofásicos, 1 500 rpm.					
NOTA 3 Motores com potência nominal de 0,25 CV a 500 CV são trifásicos, 1 750 rpm.					
NOTA 4 Cabe ao projetista avaliar o fluxo de calor efetivamente dissipado e o local onde é dissipado.					

Fonte:

Adaptado a partir de 2005 ASHRAE Fundamentals *Handbook*, Capítulo 30, "Nonresidential Cooling and Heating Load Calculations", Tabela 3.A.

Tabela 30. Taxas típicas de dissipação de calor e umidade de alguns equipamentos comerciais –Restaurantes e lanchonetes (ABNT, 2008).

Equipamento	Tamanho	Potência W	Ganho de calor W			
			Sem coifa			Com coifa
		Plena Carga	Sensível	Latente	Total	Sensível
Elétrico (sem exigência de coifa)						
Armário (grande, servir quente)	1,06 a 1,15 m³	2 000	180	90	270	82
Armário (provador grande)	0,45 a 0,48 m³	2 030	180	90	270	82
Armário (pequeno, manter quente)	0,09 a 0,18 m³	900	80	40	120	37
Cafeteira	12 xícaras	1 660	1 100	560	1 660	530
Expositor refrigerado, por metros cúbicos de interior	0,17 a 1,9 m³	1 590	640	0	640	0
Aquecedor de alimentos (lâmpada infra-vermelha), por lâmp.	1 a 6 lâmpadas	250	250	-	250	250
Aquecedor de alimentos (tipo prateleira), por metro quadrado de superfície	0,28 m³ a 0,84 m³	2 930	2 330	600	2 930	820
Aquecedor de alimentos (tubo infravermelho), por metro linear	1,0 m³ a 2,1 m	950	950	-	950	950
Aquecedor de alimentos (água quente), por metro cúbico de banho	20 a 70 L	37 400	12 400	6 360	18 760	6 000
Congelador (grande)	2,07 m³	1 340	540	-	540	0
Congelador (pequeno)	0,51 m³	810	320	-	320	0
Grelha de cachorro quente	48 a 56 unidades	1 160	100	50	150	48
Forno de microondas (resistente, comercial)	20 L	2 630	2 630	-	2 630	0
Forno de microonda (tipo residencial)	30 L	600 a 1 400	600 a 1 400	-	600 a 1 400	0
Refrigerador (grande), por metro cúbico de espaço de interior	0,71 a 2,1 m³	780	310	-	310	0
Refrigerador (pequeno) por metro cúbico de espaço de interior	0,17 a 0,71 m³	1 730	690	-	690	0
Carrinho de transporte (quente), por metro cúbico de banho	50 L a 90 L	21 200	7 060	3 530	10 590	3 390
Aquecedor de caldas, por litro de capacidade	11 L	87	29	16	45	14
Torradeira (grande automático)	10 fatias	5 300	2 810	2 490	5 300	1 700
Torradeira (pequeno automático)	4 fatias	2 470	1 310	1 160	2 470	790
Chapa de Waffle	0,05 m²	1 640	700	940	1640	520

Tabela 31. Taxas típicas de dissipação de calor e umidade de alguns equipamentos comerciais – Equipamentos médicos (W) (ABNT, 2008).

Equipamento	Nominal	Máximo	Média
Sistema de anestesia	250	177	166
Cobertor elétrico	500	504	221
Medidor de pressão	180	33	29
Aquecedor de sangue	360	204	114
ECG/RESP	1 440	54	50
Eletrocirurgia	1 000	147	109
Endoscópio	1 688	605	596
Bisturi	230	60	59
Bomba esteroscópica	180	35	34
Laser sônico	1 200	256	229
Microscópio óptico	330	65	63
Medidor de oxigênio de pulso	72	21	20
Medidor de stress	N/A	198	173
Sistema de ultra-som	1 800	1 063	1 050
Sucção a vácuo	621	337	302
Sistema de radiografia	968		82
	1 725	534	480
	2 070		18

Tabela 32. Valores típicos de dissipação de calor em equipamentos de laboratório (W) (ABNT, 2008).

Equipamento	Nominal	Máximo	Média
Balança analítica	7	7	7
Centrífuga	138	89	87
	288	136	132
	5 500	1 176	730
Analisador eletroquímico	50	45	44
	100	85	84
Fotômetro de chama	180	107	105
Microscópio fluorescente	150	144	143
	200	205	178
Gerador de função	58	29	29
Incubadora	515	461	451
	600	479	264
	3 125	1 335	1 222
Batedeira orbital	100	16	16
Osciloscópio	72	38	38
	345	99	97
Evaporador rotativo	75	74	73
	94	29	28
Espectrômetro	36	31	31
Espectrofotômetro	575	106	104
	200	122	121
	N/A	127	125
Espectrofluorômetro	340	405	395
Ciclo térmico	1 840	965	641
	N/A	233	198
Biocultura	475	132	46
	2 346	1 178	1 146

Fonte:
2005 ASHRAE Fundamentals Handbook, Capítulo 30, "Nonresidential Cooling and Heating Load Calculations", Tabela 5.

Tabela 33. Fator de uso e de carga típicos para equipamentos de cozinha com coifa (ASHRAE, 2009).

Appliance	Usage Factor F_{UA}	Radiation Factor F_{RA}	Load Factor $F_L = F_u F_R$ Elec. or Steam	Load Factor $F_L = F_u F_R / F_{FL}$ Gas
Griddle	0.10	0.35	0.04	0.025
Hot-top range				
Without oven	0.79	0.47	0.37	0.231
With oven	0.59	0.48	0.28	0.175
Convection oven	0.14	0.30	0.04	0.025
Broiler	0.55	0.36	0.20	0.125
Charbroiler	0.50	0.15	0.08	0.050
Fryer	0.03	0.30	0.01	0.056
Steam cooker	0.13	0.30	0.04	0.025

Tabela 34. Valores de CLFs para equipamentos com e sem coifa (ASHRAE, 2009).

Sensible Heat Cooling Load Factors for Appliances—Hooded																								
Total Operational Hours	Hours after appliances are on																							
	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	0.27	0.40	0.25	0.18	0.14	0.11	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
4	0.28	0.41	0.31	0.29	0.29	0.30	0.24	0.19	0.18	0.14	0.12	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.02
6	0.29	0.42	0.32	0.38	0.45	0.70	0.48	0.37	0.30	0.25	0.21	0.18	0.16	0.14	0.12	0.11	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04
8	0.31	0.44	0.34	0.61	0.66	0.71	0.75	0.78	0.55	0.43	0.35	0.30	0.25	0.22	0.19	0.16	0.14	0.13	0.11	0.10	0.08	0.07	0.06	0.06
10	0.33	0.46	0.35	0.62	0.68	0.72	0.76	0.79	0.81	0.84	0.60	0.48	0.39	0.33	0.28	0.24	0.21	0.18	0.16	0.14	0.12	0.11	0.09	0.08
12	0.36	0.49	0.38	0.64	0.69	0.74	0.77	0.80	0.82	0.85	0.87	0.88	0.84	0.51	0.42	0.36	0.31	0.26	0.23	0.20	0.18	0.15	0.13	0.12
14	0.40	0.52	0.61	0.67	0.72	0.76	0.79	0.82	0.84	0.86	0.88	0.89	0.91	0.92	0.87	0.54	0.45	0.38	0.32	0.28	0.24	0.21	0.19	0.16
16	0.45	0.57	0.65	0.70	0.75	0.78	0.81	0.84	0.86	0.87	0.89	0.90	0.92	0.93	0.94	0.94	0.89	0.56	0.46	0.39	0.34	0.29	0.25	0.22
18	0.52	0.63	0.70	0.75	0.79	0.82	0.84	0.86	0.88	0.89	0.91	0.92	0.93	0.94	0.95	0.95	0.96	0.96	0.71	0.56	0.48	0.41	0.35	0.30

Sensible Heat Cooling Load Factors for Appliances—Unhooded																								
Total Operational Hours	Hours after appliances are on																							
	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	0.36	0.64	0.15	0.11	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	0.01
4	0.37	0.65	0.71	0.75	0.23	0.18	0.14	0.12	0.10	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01
6	0.37	0.65	0.71	0.76	0.79	0.82	0.29	0.22	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	0.02
8	0.38	0.66	0.72	0.76	0.80	0.82	0.81	0.87	0.33	0.26	0.21	0.18	0.15	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.03
10	0.60	0.64	0.73	0.77	0.81	0.83	0.83	0.87	0.89	0.90	0.36	0.29	0.24	0.20	0.17	0.15	0.13	0.11	0.10	0.08	0.07	0.06	0.06	0.05
12	0.62	0.69	0.75	0.79	0.82	0.84	0.86	0.88	0.89	0.91	0.92	0.93	0.38	0.31	0.25	0.21	0.18	0.16	0.14	0.12	0.11	0.09	0.08	0.07
14	0.64	0.71	0.76	0.80	0.83	0.85	0.87	0.89	0.90	0.92	0.93	0.93	0.94	0.95	0.40	0.32	0.27	0.23	0.19	0.17	0.15	0.13	0.11	0.10
16	0.67	0.74	0.79	0.82	0.85	0.87	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.96	0.97	0.42	0.34	0.28	0.24	0.20	0.18	0.15	0.13
18	0.71	0.78	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	0.97	0.98	0.43	0.35	0.29	0.24	0.21

Referências bibliográficas

ASHRAE. 1989. Handbook of Fundamentals. ASHRAE.

LABEEE. 2003. METODOLOGIA UTILIZADA NA ELABORAÇÃO DA BIBLIOTECA DE MATERIAIS E COMPONENTES CONSTRUTIVOS BRASILEIROS PARA SIMULAÇÕES NO VISUALDOE-3.1. Laboratório de Eficiência Energética em Edificações (LabEEE), Núcleo de Pesquisa em Construção (NPC), DEPARTAMENTO DE ENGENHARIA CIVIL UNIVERSIDADE FEDERAL DE SANTA CATARINA, 19 páginas, disponível em www.labeee.ufsc.br, acesso em : 12/12/2014.

ABNT. 2008a. NBR 16401. Instalações de ar-condicionado - Sistemas centrais e unitários - Parte 1: Projetos das instalações. ABNT, 60 páginas.

ABNT. 2008b. NBR 16401. Instalações de ar-condicionado - Sistemas centrais e unitários - Parte 3: Qualidade do ar interior. ABNT, 28 páginas.