

CHAPTER 2

COOLING LOAD CALCULATION

2.1 CALCULATING PARAMETERS:

Calculating data of air in the building to design Air-conditioning and ensure comfortable conditions, following TCVN 5687 – 2012.

No	Labour intensity	Winter			Summer		
		Temperature t, °C	Relative humidity φ,%	Wind velocity v, m/s	Temperature t, °C	Relative humidity φ,%	Wind velocity v, m/s
1	Rested	From 22 - 24	From 70 - 60	From 0,1 - 0,2	From 25 - 28	From 70 - 60	From 0,5 - 0,6
2	Light labor	From 21 - 23	From 70 - 60	From 0,4 - 0,5	From 23 - 26	From 70 - 60	From 0,8 - 1,0
3	Moderate labor	From 20 - 22	From 70 - 60	From 0,8 - 1,0	From 22 - 25	From 70 - 60	From 1,2 - 1,5
4	Hard labor	From 18 - 20	From 70 - 60	From 1,2 - 1,5	From 20 - 23	From 70 - 60	From 2,0 - 2,5

(Appendix A – TCVN 5687-2010) Table 2.1: Optimal microclimate parameters to adapt the labour status

In the framework of this thesis group will apply mainly to the following standards apply to the categories of air conditioners:

- **TCVN 5687 - 2010** – Ventilation – Air conditioning – Design standards
- **ASHRAE 90.1.2007** “The Library and Central plants” is built with relative important purposes, so we decide to use the air conditioning system level 2 following “**4.2.2-TCVN 5687 – 2010**” to maintain the indoor air condition at a permitted range with a deviation of 150h ÷ 200h / year.

External design conditions

The parameters of outside humidity and temperature are interpolated by the distance between the two sides or by climate (Note 2 – TCVN 5687 – 2010). Therefore, Binh Duong Province climate parameters are close to Ho Chi Minh City. Level MV = 150h/year: and [Picture 3.22 1, page 121].

- Room temperature outside $t_N = 36\text{ }^\circ\text{C}$
- Room temperature $t_T = 27\text{ }^\circ\text{C}$. *The temperature inside the room always ensures comfort for people inside the room*
- $\varphi = 50.1\%$
- Entaphy=90 kJ/kg
- Steam capacity $d=19\text{ g/kg}$
- Dew point $t_{ds}=25\text{ }^\circ\text{C}$

Structural features of the work (Appendix 3 QCVN 09:2013/BXD):

Single wall

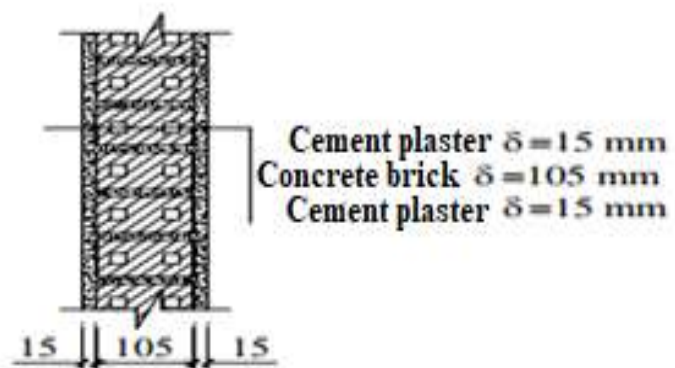


Figure 2.1: Single wall (standard thickness: 105 mm) hollow brick clay.

NO	Layers of material from outside to inside	Thick, m	Thermal conductivity, λ W/(m.K)	Total heat resistance R_0 , $m^2.K/W$	Pass or fail to meet the standards
1	Outside mortar	0,015	0,93	0,383	$R_0 < 0,56 m^2.K/W$ Unsatisfactory
2	Hollow brick ($\gamma = 1300$) with a slight mortar ($\gamma = 1400$)	0,105	0,58		
3	Inside mortar	0,015	0,93		

Table 2.2 Synthesis of heat transfer coefficient for structure and cover.

Double wall

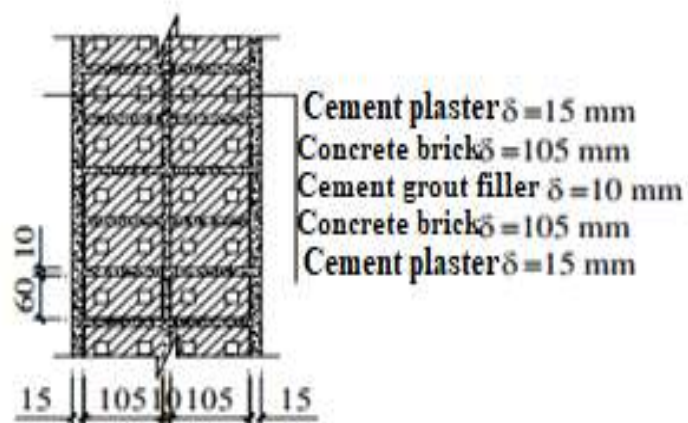


Figure 2.2: Double wall (standard thickness: 220 mm) hollow brick clay.

No	Layers of material from outside to inside	Thick, m	Thermal conductivity, λ W/(m.K)	Total heat resistance R_0 , $m^2.K/W$	Pass or fail to meet the standards
1	Outside mortar	0,015	0,93	0,584 or 0,625	$R_0 > 0,56 m^2.K/W$ Qualified or Pass and exceed requirements
2	Hollow brick ($\gamma = 1300$) with a slight mortar ($\gamma = 1400$) or multi-hole bricks with heavy mortar (mortar)	0,220	0,58 or 0,52		
3	Inside mortar	0,015	0,93		

Table 2.3 Synthesis of heat transfer coefficient for structure and cover

Type of cover and wall	k (W/(m ² .K))	R (m ² .K/W)
Thickness wall 110 with hollow brick clay and mortar 30 mm	2,753	0,332
Thickness wall 110 with hollow brick clay and mortar 30 mm	1,781	0,474
150 mm concrete floor with mortar above 25 mm	2,84	-

Tables 2.4 Synthesis of heat transfer coefficient for structure and cover

2.2 COOLING LOAD CALCULATION BY CARRIER METHOD

2.2.1 Sensible heat transfer in room by heat radiation through glazing Q_{11}

Location work at HCM in latitude 11°06'32.1"N. Only the area open to below is arranged glass on the ceiling. Therefore, we only calculate the roof and rooftop of the library

Heat by radiation through the glass in the room:

$$Q_{11} = n_t \cdot Q'_{11} \text{ , } W \text{ (2.1)}$$

That is: n_t - The multiplier effect of radiation.

$$Q'_{11} = F_1 \cdot R_k \cdot \varepsilon_c \cdot \varepsilon_{ds} \cdot \varepsilon_{mm} \cdot \varepsilon_{kh} \cdot \varepsilon_m \text{ , } W \text{ (2.2)}$$

- Radiation heat instantaneous through the glass in the room. [1, page 123].

That is:

$$- R_k = [0,4 \cdot \alpha_k + \tau_k \cdot (\alpha_m + \tau_m + \rho_k \cdot \rho_m + 0,4 \cdot \alpha_k \cdot \alpha_m)] \cdot R_N \text{ (2.3)}$$

- R_N – thermal solar radiation through the glass that is not basic glass.

$$- R_N = \frac{R}{0,88} \text{ – solar radiation to the outside surface of the glass. [1, page 124]}$$

- R – solar radiation through the glass on the harmonic space. [1, page 123]

- ε_c – coefficient of influence of altitude above sea level. - In Binh Duong province, the altitude is near the sea level.: [1, page 124]

$$- \varepsilon_c = 1 + \frac{H}{1000} \cdot 0,023 = 1 + \frac{0}{1000} \cdot 0,0231 = 1 \text{ (2.4)}$$

- ε_{ds} – the multiplier effects of spread between the dew condensation temperature and air: [1, page 124]

$$- \varepsilon_{ds} = 1 - \frac{(t_s - 20)}{10} \cdot 0,13 = 1 - \frac{25 - 20}{10} \cdot 0,13 = 0,935 \text{ (2.5)}$$

- ε_{mm} – When it is not cloudy $\varepsilon_{mm} = 1$, when it is cloudy $\varepsilon_{mm} = 0.85$. The multiplier effects of the haze, select when the sky not clouds $\varepsilon_{mm} = 1$ [1, page 124]

- ε_{kh} – the multiplier effect of the frame, select the metal frame $\varepsilon_{kh} = 1.17$ [1, page 124]
- ε_m – coefficient of the glass, the glass in thick, flat, select 6 mm $\varepsilon_m = 0.94$ [1, page 131]
- α_k, ρ_k, τ_k – absorption coefficient, reflection, through the glass 0,15; 0,08; 0,77 [1, page 131]
- α_m, ρ_m, τ_m – absorption coefficient, reflection, through the veil 0,58; 0,39; 0,03 [1, page 131]

Binh Duong province is located at latitude $11^\circ 06' 32.1'' N$ (Data from the page Wikipedia), [table 4.2 page 131 TL1], Select the far largest solar output in June is $R_T = 126 \text{ W/m}^2$.

That is: $R_N = \frac{R_T}{0.88} = \frac{126}{0.88} = 143,2 \text{ W/m}^2$ (2.6)

We calculate: $R_k = [0,4 \cdot \alpha_k + \tau_k \cdot (\alpha_m + \tau_m + \rho_k \cdot \rho_m + 0,4 \cdot \alpha_k \cdot \alpha_m)] \cdot R_N$ (2.3)

$$R_k = [0,4 \cdot 0,15 + 0,77 \cdot (0,58 + 0,03 + 0,08 \cdot 0,39 + 0,4 \cdot 0,15 \cdot 0,58)] \cdot 143,2$$

$$R_k = 83,13 \text{ W/m}^2$$

$$Q'_{11} = F_1 \cdot 83,13 \cdot 1,0 \cdot 935 \cdot 1,1 \cdot 17 \cdot 0,94 = F_1 \cdot 85,48 \text{ , W}$$

Instant effect coefficient n_t :

$$n_t = \frac{Q_{11}}{Q'_{11}} \quad (2.7)$$

The value n_t depends on the: $g_s, \text{ kg/m}^2\text{s}\grave{a}\text{n}$ - the average volume of textures covering Warsawh, ceiling, floor create the harmonic space $1 \text{ m}^2\text{floor}$.

$$g_s = \frac{G' + 0,5 \cdot G''}{F_s} \text{ , kg/m}^2\text{s}\grave{a}\text{n} \quad (2.8)$$

That is:

G' – the volume of the wall has outer surface exposed to solar radiation and on the ground floor (kg).

G'' – the mass of the wall surface is not exposed with solar and on the ground floor (kg).

F_s – floor area (m^2).

Select the coefficient:

- Assuming the example 4.3, we choose weight of wall 360 kg/m^3 . [1, page 137]
- Assuming the example 4.3, we choose weight of floor 410 kg/m^3 . [1, page 137]

Calculate:

Calculate g_s , select the coefficient effect instantaneous Table 4.6 [1, page 135], Select the coefficient n_t .

NO	ROOM NAME	nt	AREA ROOM (m2)	G'	G''	gs	Q'11	Q11
		NE						
LIBRARY-RF								
1	Open to below-Sky glass	0.33	3526	1582682	4378670	1069.77	301402.48	99462.82

Table 2.5: The heat loss due to radiation through glass Q_{11}

2.2.2 Sensible heat transfer in room by heat radiation through roof Q_{21}

$$Q_{21r} = k_r \times F_r \times \Delta t$$

With heat transfer factor of roof: $k_r = 0.321 \text{ W}/(\text{m}^2.\text{K})$ with 150mm thick concrete ceiling, 25mm thick sand and cement mortar, with bitum layer on it and rockwool is 100mm thick. Table 4.9 [1, page 140]

- F_w : The roof floor area, the terrace, m^2
- $\Delta t = (t_N - t_T) = 36 - 27 = 9^\circ\text{C}$: when the room is on the ground
- $\Delta t = 0.5(t_N - t_T) = 4.5^\circ\text{C}$: when the room is located on the basement or Non-air-conditioned rooms..
- $\Delta t = 0$: when the room is between two air-conditioned rooms

NO	ROOM NAME	AREA ROOM (m2)	Δt_r			kr W/(m2.K)	Q21r W/(m2.K)
			when the room is on the ground	when the room is located on the basement or Non-air-conditioned rooms.	when the room is between two air-conditioned rooms		
CENTRAL PLANT-RF							
1	Cooling towers	522	9	4.5	0	0.321	754.03
2	Generator room	349.16	9	4.5	0	0.321	504.36

3	Mechanical room	166.84	9	4.5	0	0.321	241.00
4	AHU sever	192	9	4.5	0	0.321	277.34
LIBRARY-5F							
5	Yard	2451.26	9	4.5	0	0.321	3540.85
6	Roof mechanical room	295.32	9	4.5	0	0.321	426.59
7	Roof mechanical room	295.32	9	4.5	0	0.321	426.59
LIBRARY-RF							
8	Roof	207.5	9	4.5	0	0.321	299.73

Table 2.6: Sensible heat transfer in room by heat radiation through roof Q_{21}

2.2.3 Sensible Heat transfer through walls, windows, doors Q_{22w}

To calculate, the whole cover including walls, doors, windows...

Heat transfer through walls is determined by

$$Q_{22w} = k_i \cdot F_i \cdot \Delta t = Q_{22w} + Q_{22d} + Q_{22wd}, \text{ W} \quad (2.10)$$

➤ **That is: Q_{22w} – Heat transfer through walls, doors, windows,..**

❖ Q_{22w} – The heat transfer through the wall.

- Where: k_w heat transfer coefficient of wall $W/(m^2.K)$

$$k_w = \frac{1}{\frac{1}{\alpha_N} + \sum \frac{\delta_i}{\lambda_i} + \frac{1}{\alpha_T}} = \frac{1}{\frac{1}{\alpha_N} + \sum R_i + \frac{1}{\alpha_T}}$$

α_N – heat convection factor of outdoor atmosphere, $W/(m^2.K)$, with:

- $\alpha_N = 20 \text{ W}/m^2K$ walls in direct contact with the sun
- $\alpha_N = 10 \text{ W}/m^2K$ walls exposed indirectly to the sun

$\alpha_T = 10 \text{ W}/m^2K$ – heat convection factor of indoor, $W/(m^2.K)$

R_i – thermal resistance of the I material of the wall structure, $(m^2.K)/W$

δ_i – the thickness of the i material of the structure, m

λ_i – heat conduction of the i material of the wall structure, $W/(m.K)$

- With outer wall 220mm thickness: 2 class hollow brick 100mm + grout 10mm

$$k_{wo} = \frac{1}{\frac{1}{\alpha_N} + 2 \cdot \frac{\delta_g}{\lambda_g} + 2 \cdot \frac{\delta_v}{\lambda_v} + \frac{1}{\alpha_T}} = \frac{1}{\frac{1}{20} + 2 \cdot \frac{0,01}{0,93} + 2 \cdot \frac{0,1}{0,81} + \frac{1}{10}} = 2,39 \text{ W}/(m^2.K)$$

- With inner wall 220mm thickness: 2 class hollow brick 100mm + grout 10mm

$$k_{wi} = \frac{1}{\frac{1}{\alpha_N} + 2 \cdot \frac{\delta_g}{\lambda_g} + 2 \cdot \frac{\delta_v}{\lambda_v} + \frac{1}{\alpha_T}} = \frac{1}{\frac{1}{10} + 2 \cdot \frac{0,01}{0,93} + 2 \cdot \frac{0,1}{0,81} + \frac{1}{10}} = 2,13 \text{ W}/(m^2.K)$$

- With partition wall 100mm thickness: 1 class hollow brick 80mm + 2 class grout 10mm

$$k_{wp} = \frac{1}{\frac{1}{\alpha_T} + \frac{\delta_g}{\lambda_g} + 2 \cdot \frac{\delta_v}{\lambda_v} + \frac{1}{\alpha_T}} = \frac{1}{\frac{1}{10} + \frac{0,08}{0,58} + 2 \cdot \frac{0,01}{0,93} + \frac{1}{10}} = 2,78 \text{ W}/(\text{m}^2 \cdot \text{K})$$

- F_w – The area of the surrounding wall with the corresponding wall thickness, m^2

$$\Delta t = (t_N - t_T) = 36 - 27 = 9^\circ\text{C}$$

- ❖ Q_{22d} – The heat transfer through the doors.

- With heat transfer factor of door : $k_d = 2.01 \text{ W}/(\text{m}^2 \cdot \text{K})$ with a thickness of wooden doors 50mm. Table 4.12 [1, page 144]

- F_d – The door area, m^2

$$\Delta t = (t_N - t_T) = 36 - 27 = 9^\circ\text{C}$$

- ❖ Q_{22wd} – The heat transfer through the windows.

- With heat transfer factor of window glass: $k_g = 3.35 \text{ W}/(\text{m}^2 \cdot \text{K})$ with the distance between the two glass layers is 5mm. Table 4.13 [1, page 144]

- F_{wd} – The window area, m^2

$$\Delta t = (t_N - t_T) = 36 - 27 = 9^\circ\text{C}$$

NO	ROOM NAME	Q22w		Q22d		Q22wd		Δt	$\Sigma Q_{22} W$
		AREA ROO M (m2)	kw	AREA DOOR(m 2)	k d	AREA WINDO W (m2)	kw d		(W)
CENTRAL PLANT-1F									
1	Fire room	102.35	2.4	2.2	2	0	3.4	9	2361.27
2	Corridor	80.25	2.4	2.2	2	0	3.4	9	1808.33
3	Server room	293.1	2.4	4.4	2	0	3.4	9	6536.50
4	Server room support	128.2	2.4	4.4	2	0	3.4	9	2991.49
5	Chillers and Pumps room	894.92	2.4	13.2	2	13	3.4	9	20973.99
6	Corridor	637.94	2.4	2.2	2	1.3	3.4	9	13417.54
7	Fuel Storage Tank	240.14	2.4	2.2	2	3.9	3.4	9	5457.56
8	Transformer room	305.5	2.4	2.2	2	3.9	3.4	9	7092.87
9	Medium voltage switchgear room	300.44	2.4	6.6	2	0	3.4	9	6940.79

10	Transformer room	307.02	2.4	2.2	2	3.9	3.4	9	7130.90
11	Low voltage switchgear room	298.92	2.4	6.6	2	0	3.4	9	6902.76
12	Corridor	36.4	2.4	4.4	2	0	3.4	9	1000.96
13	Control center	161.4	2.4	6.6	2	4.55	3.4	9	4168.02
14	Technical room	122.05	2.4	3.3	2	1.3	3.4	9	2861.92
15	Odor treatment room	125.65	2.4	4.4	2	0	3.4	9	2927.69
CENTRAL PLANT-2F									
16	UPS battery room	85.64	2.4	2.2	2	0	3.4	9	1991.57
17	Corridor	64.72	2.4	4.4	2	0	3.4	9	1563.00
18	Server room support	133.84	2.4	4.4	2	0	3.4	9	3194.66
19	Server room	197.2	2.4	4.4	2	0	3.4	9	4523.84
20	Storage	71.2	2.4	4.4	2	0	3.4	9	1718.39
21	Corridor	112.24	2.4	4.4	2	0	3.4	9	2590.21
22	Janitor	87.08	2.4	2.2	2	0	3.4	9	1943.36
23	Corridor-hành lang	89.2	2.4	4.4	2	0	3.4	9	2081.14
24	Electrical workroom area	120.16	2.4	4.4	2	0	3.4	9	2855.76
25	Control room	103.6	2.4	4.4	2	0	3.4	9	2438.06
CENTRAL PLANT-RF									
26	Cooling towers	275.6	2.4	8.8	2	0	3.4	9	6432.48
27	Generator room	220.6	2.4	4.4	2	0	3.4	9	5139.07
28	Mechanical room	157	2.4	4.4	2	0	3.4	9	3634.85
29	AHU sever	214	2.4	4.4	2	0	3.4	9	4701.56
LIBRARY-1F									
30	Conference/Training room	167.6	2.4	8.8	2	27.3	3.4	9	5547.73
31	Storage	53.09	2.4	2.2	2	0	3.4	9	1259.73
32	Janitor	47.27	2.4	2.2	2	0	3.4	9	1154.97
33	Frist Aid	84.77	2.4	2.2	2	1.3	3.4	9	2015.13
34	Aid relaxing room	63.43	2.4	2.2	2	1.3	3.4	9	1576.54
35	Storage	66.31	2.4	2.2	2	7.15	3.4	9	1889.63
36	Book return room	102.41	2.4	1.76	2	1.56	3.4	9	2392.85
37	Corridor	174.37	2.4	4.4	2	6.5	3.4	9	4207.39
38	Post room	77.72	2.4	4.4	2	1.3	3.4	9	1983.52
39	Storage/Receiving	79.02	2.4	4.4	2	0	3.4	9	1957.94
40	Porter room	51.15	2.4	2.2	2	0	3.4	9	1233.89
41	Uni shop	190.79	2.4	8.8	2	44.85	3.4	9	6964.53

42	Coffee shop	117.71	2.4	2.2	2	9.1	3.4	9	3128.89
43	Coffee Storage room	71.52	2.4	2.2	2	0	3.4	9	1607.36
44	Mechanical room	95.51	2.4	4.4	2	0	3.4	9	2306.97
45	Elec/tele	47.27	2.4	2.2	2	0	3.4	9	1154.97
LIBRARY-2F									
46	Journal display/reading	44.925	2.4	2.2	2	0	3.4	9	1106.90
47	Journal display/reading	44.925	2.4	2.2	2	0	3.4	9	1106.90
48	Journal display/reading	42.025	2.4	2.2	2	0	3.4	9	1041.12
49	Journal display/reading	42.025	2.4	2.2	2	0	3.4	9	1041.12
50	Group Workroom	68.85	2.4	2.2	2	0	3.4	9	1620.68
51	Group Workroom	68.85	2.4	2.2	2	0	3.4	9	1620.68
52	Group Workroom	68.85	2.4	2.2	2	0	3.4	9	1620.68
53	Group Workroom	68.85	2.4	2.2	2	0	3.4	9	1620.68
54	Storage	36.95	2.4	2.2	2	0	3.4	9	917.54
55	Storage	36.225	2.4	2.2	2	0	3.4	9	902.79
56	Storage	34.775	2.4	2.2	2	0	3.4	9	873.30
57	Prints/Storage	63.965	2.4	2.2	2	4.16	3.4	9	1748.32
58	Kitchen/staff lounge	63.775	2.4	2.2	2	0	3.4	9	1514.06
59	Directors office	73.2	2.4	2.2	2	0	3.4	9	1736.30
60	Assistants desk	50.725	2.4	2.2	2	0	3.4	9	1201.12
61	Meeting room	89.85	2.4	4.4	2	0	3.4	9	2159.51
62	Computer pool	121.7	2.4	13.2	2	50.7	3.4	9	5749.47
LIBRARY-3F									
63	Reading theatre	91.455	2.4	0	2	15.6	3.4	9	2817.58
64	Reading theatre	212.05	2.4	4.4	2	0	3.4	9	4920.24
65	Book stacks/Reading room	496.75	2.4	4.4	2	31.2	3.4	9	12302.75
66	Learing room	49.28	2.4	2.2	2	0	3.4	9	1179.99
67	Learing room	49.28	2.4	2.2	2	0	3.4	9	1179.99
68	Storage	21.2	2.4	2.2	2	0	3.4	9	556.82
69	Copy/print	21.785	2.4	2.2	2	0	3.4	9	568.72
70	Group Workroom	51.035	2.4	2.2	2	0	3.4	9	1237.59
71	Group Workroom	48.695	2.4	2.2	2	0	3.4	9	1179.04
72	Group Workroom	39.335	2.4	2.2	2	0	3.4	9	944.85
73	Group Workroom	39.335	2.4	2.2	2	0	3.4	9	944.85

74	Group Workroom	45.77	2.4	2.2	2	0	3.4	9	1105.86
75	Study carells	94.66	2.4	4.4	2	15.6	3.4	9	3087.46
76	Multimedia workroom	99.145	2.4	4.4	2	0	3.4	9	2423.89
LIBRARY-4F									
77	Book stacks/Reading room	334	2.4	4.4	2	31.2	3.4	9	8874.90
78	Reading room	136.4	2.4	4.4	2	0	3.4	9	3201.80
LIBRARY-5F									
79	Yard	604.1	2.4	4.4	2	0	3.4	9	13350.37
80	Roof mechanical room	171.6	2.4	4.4	2	0	3.4	9	3982.36
81	Roof mechanical room	171.6	2.4	4.4	2	0	3.4	9	3982.36

Table 2.7: The heat transfer through the wall Q_{22W}

2.2.4 Sensible heat transmitted through the floor Q_{23}

$$Q_{23} = k \times F_{fl} \times \Delta t$$

Where:

k: heat transfer coefficient of floor, $W/(m^2.K)$.

Choose: $k_{23} = 2.18 W/(m^2K)$. *Table 4.15 [1, page 145]*

F_{fl} : the floor area, m^2

When calculating the heat transfer through the floor, we must consider 3 cases:

- The floor located above the ground surface: take k value of the thick concrete floor is 300mm, $\Delta t = (t_N - t_T)$
- The floor located on the basement or conditioned rooms, take $\Delta t = 0.5(t_N - t_T)$, which mean the basement or air conditioned room have the same average temperature between the outside and inside.
- The floor between the air conditioned room $\Delta t = 0$

$\Delta t = (t_N - t_T) = 36 - 27 = 9^\circ C$: when the room is on the ground

$\Delta t = 0.5(t_N - t_T) = 4.5^\circ C$: when the room is located on the basement or Non-air-conditioned rooms..

$\Delta t = 0$: when the room is between two air-conditioned rooms

We have:

- **Central Plant**

+ 2nd floor: $Q_{22} = 0$

+ 1st floor, roof floor by calculation

- **Library**

+ From 2nd floor to 4th floor: $Q_{22} = 0$

+ 1st floor, 4th floor and roof floor by calculation

NO	ROOM NAME	CODE ROOM	AREA ROOM (m2)	kf	Δt_f		Q23 (W)
CENTRAL PLANT-1F							
1	Fire room	104	36.26	2.18	4.5	9	711.42
2	Corridor	1CR	17.02	2.18	4.5	9	333.93
3	Server room	D101	252.96	2.18	4.5	9	4963.08
4	Server room support	D102	55.08	2.18	4.5	9	1080.67
5	Chillers and Pumps room	C101	858.8	2.18	4.5	9	16849.66
6	Corridor	E106	156.21	2.18	4.5	9	3064.84
7	Fuel Storage Tank	E101	49.61	2.18	4.5	9	973.35
8	Transformer room	E102	101.64	2.18	4.5	9	1994.18
9	Medium voltage switchgear room	E103	98.01	2.18	4.5	9	1922.96
10	Transformer room	E104	102.85	2.18	4.5	9	2017.92
11	Low voltage switchgear room	E105	96.8	2.18	4.5	9	1899.22
12	Corridor	1CR2	5.75	2.18	4.5	9	112.82
13	Control center	W103	103.02	2.18	4.5	9	2021.25
14	Technical room	W102	47.94	2.18	4.5	9	940.58
15	Odor treatment room	W101	52.02	2.18	4.5	9	1020.63
CENTRAL PLANT-RF							
16	Cooling towers	C301	522	2.18	4.5	9	5120.82
17	Generator room	E301	349.16	2.18	4.5	9	3425.26
18	Mechanical room	300B	166.84	2.18	4.5	9	1636.70
19	AHU sever	D301	192	2.18	4.5	9	1883.52
LIBRARY-1F							
20	Conference/Training room	114	108.81	2.18	4.5	9	2134.85
21	Storage	114A	7.56	2.18	4.5	9	148.33
22	Janitor	1JC1	6.48	2.18	4.5	9	127.14
23	Frist Aid	102	18.6	2.18	4.5	9	364.93
24	Aid relaxing room	102B	11.7	2.18	4.5	9	229.55
25	Storage	103A	11.97	2.18	4.5	9	234.85

26	Book return room	101	26.28	2.18	4.5	9	515.61
27	Corridor	1CR1	55.8	2.18	4.5	9	1094.80
28	Post room	104	18.13	2.18	4.5	9	355.71
29	Storage/Receiving	107	18.4	2.18	4.5	9	361.01
30	Porter room	113	7.44	2.18	4.5	9	145.97
31	Uni shop	112	154.76	2.18	4.5	9	3036.39
32	Coffee shop	110	38.22	2.18	4.5	9	749.88
33	Coffee Storage room	111	9.15	2.18	4.5	9	179.52
34	Mechanical room	109	25.8	2.18	4.5	9	506.20
35	Elec/tele	108	6.48	2.18	4.5	9	127.14
LIBRARY-RF							
36	Yard		1066.56	2.18	4.5	9	10462.95
37	Roof		207.5	2.18	4.5	9	2035.58

Table 2.8: By calculation, sensible heat transmitted through floor Q_{23}

2.2.5 Sensible heat emitted by the lamps Q_{31}

$$Q_{31} = n_t \times n_d \times Q$$

Where:

- Q : total heat gain by lights (W), if the total capacity of the light is not available, the standard value can be chosen is $N = 10 \div 12 \text{ W}/(\text{m}^2 \cdot \text{floor})$. [1, page 146]

$$Q = \Sigma 1.25 \times N$$

$$\Rightarrow N = 12 \text{ W}/(\text{m}^2 \cdot \text{floor})$$

- n_t : immediate effects factor of lights. Table 4.8 [1, page 136]
- n_d : concurrent effects factor, just use building and the large air-conditioned constructions
 - For office: $n_d = 0.7 \div 0.85$
 - For building: $n_d = 0.3 \div 0.5$
 - For shop: $n_d = 0.9 \div 1$

$$\Rightarrow n_d = 0.3$$

NO	ROOM NAME	CODE ROOM	n_t	AREA ROOM (m ²)	LPD (W/m ²)	N (W)	$Q = 1.25 \times N$ (W)	Q_{31} (W)
CENTRAL PLANT-1F								
1	Fire room	104	0.87	36.26	12	435.12	543.9	141.96
2	Corridor	1CR	0.87	17.02	12	204.24	255.3	66.63
3	Server room	D101	0.9	252.96	12	3035.52	3794.4	1024.49

4	Server room support	D102	0.87	55.08	12	660.96	826.2	215.64
5	Chillers and Pumps room	C101	0.9	858.8	12	10305.6	12882	3478.14
6	Corridor	E106	0.87	156.21	12	1874.52	2343.15	611.56
7	Fuel Storage Tank	E101	0.87	49.61	12	595.32	744.15	194.22
8	Transformer room	E102	0.87	101.64	12	1219.68	1524.6	397.92
9	Medium voltage switchgear room	E103	0.87	98.01	12	1176.12	1470.15	383.71
10	Transformer room	E104	0.87	102.85	12	1234.2	1542.75	402.66
11	Low voltage switchgear room	E105	0.87	96.8	12	1161.6	1452	378.97
12	Corridor	1CR2	0.87	5.75	12	69	86.25	22.51
13	Control center	W103	0.9	103.02	12	1236.24	1545.3	417.23
14	Technical room	W102	0.87	47.94	12	575.28	719.1	187.69
15	Odor treatment room	W101	0.87	52.02	12	624.24	780.3	203.66
CENTRAL PLANT-2F								
16	UPS battery room	D201	0.87	35.77	12	429.24	536.55	140.04
17	Corridor	2CR3	0.87	16.79	12	201.48	251.85	65.73
18	Server room support	D200	0.87	91.8	12	1101.6	1377	359.40
19	Server room	D202	0.9	181.56	12	2178.72	2723.4	735.32
20	Storage	D205	0.87	22.5	12	270	337.5	88.09
21	Corridor	2CR2	0.87	49.61	12	595.32	744.15	194.22
22	Janitor	2JC1	0.87	25.48	12	305.76	382.2	99.75
23	Corridor-hành lang	2CR4	0.87	29.29	12	351.48	439.35	114.67
24	Electrical workroom area	D203	0.87	72.72	12	872.64	1090.8	284.70

25	Control room	D204	0.87	48.96	12	587.52	734.4	191.68
CENTRAL PLANT-RF								
26	Cooling towers	C301	0.9	522	12	6264	7830	2114.10
27	Generator room	E301	0.9	349.16	12	4189.92	5237.4	1414.10
28	Mechanical room	300B	0.9	166.84	12	2002.08	2502.6	675.70
29	AHU sever	D301	0.9	192	12	2304	2880	777.60
LIBRARY-1F								
30	Conference/Training room	114	0.9	108.81	12	1305.72	1632.15	440.68
31	Storage	114A	0.87	7.56	12	90.72	113.4	29.60
32	Janitor	1JC1	0.87	6.48	12	77.76	97.2	25.37
33	Frist Aid	102	0.87	18.6	12	223.2	279	72.82
34	Aid relaxing room	102B	0.87	11.7	12	140.4	175.5	45.81
35	Storage	103A	0.87	11.97	12	143.64	179.55	46.86
36	Book return room	101	0.87	26.28	12	315.36	394.2	102.89
37	Corridor	1CR1	0.87	55.8	12	669.6	837	218.46
38	Post room	104	0.87	18.13	12	217.56	271.95	70.98
39	Storage/Receiving	107	0.87	18.4	12	220.8	276	72.04
40	Porter room	113	0.87	7.44	12	89.28	111.6	29.13
41	Uni shop	112	0.9	154.76	12	1857.12	2321.4	626.78
42	Coffee shop	110	0.87	38.22	12	458.64	573.3	149.63
43	Coffee Storage room	111	0.87	9.15	12	109.8	137.25	35.82
44	Mechanical room	109	0.87	25.8	12	309.6	387	101.01
45	Elec/tele	108	0.87	6.48	12	77.76	97.2	25.37
LIBRARY-2F								

46	Journal display/reading	215	0.87	10.56	12	126.72	158.4	41.34
47	Journal display/reading	215	0.87	10.56	12	126.72	158.4	41.34
48	Journal display/reading	214	0.87	9.3	12	111.6	139.5	36.41
49	Journal display/reading	214	0.87	9.3	12	111.6	139.5	36.41
50	Group Workroom	217	0.87	23.2	12	278.4	348	90.83
51	Group Workroom	218	0.87	23.2	12	278.4	348	90.83
52	Group Workroom	219	0.87	23.2	12	278.4	348	90.83
53	Group Workroom	220	0.87	23.2	12	278.4	348	90.83
54	Storage	213	0.87	7.2	12	86.4	108	28.19
55	Storage	221	0.87	6.96	12	83.52	104.4	27.25
56	Storage	210	0.87	6.48	12	77.76	97.2	25.37
57	Prints/Storage	209	0.87	23.4	12	280.8	351	91.61
58	Kitchen/staff lounge	208	0.87	20.28	12	243.36	304.2	79.40
59	Directors office	206	0.87	26.88	12	322.56	403.2	105.24
60	Assistants desk	205	0.87	12	12	144	180	46.98
61	Meeting room	203	0.87	39.36	12	472.32	590.4	154.09
62	Computer pool	225	0.87	118.95	12	1427.4	1784.25	465.69
LIBRARY-3F								
63	Reading theatre	316	0.9	75.02	12	900.24	1125.3	303.83
64	Reading theatre	BS2	0.9	336	12	4032	5040	1360.80
65	Book stacks/Reading room	BS1	0.9	1235.04	12	14820.5	18525.6	5001.91
66	Learing room	310	0.87	18.36	12	220.32	275.4	71.88

67	Learing room	311	0.87	18.36	12	220.32	275.4	71.88
68	Storage	312	0.87	3.75	12	45	56.25	14.68
69	Copy/print	313	0.87	3.9	12	46.8	58.5	15.27
70	Group Workroom	303	0.87	20.58	12	246.96	308.7	80.57
71	Group Workroom	304	0.87	18.62	12	223.44	279.3	72.90
72	Group Workroom	307	0.87	10.78	12	129.36	161.7	42.20
73	Group Workroom	308	0.87	10.78	12	129.36	161.7	42.20
74	Group Workroom	309	0.87	16.17	12	194.04	242.55	63.31
75	Study carells	315	0.9	90.75	12	1089	1361.25	367.54
76	Multiedia workroom	314	0.87	78.3	12	939.6	1174.5	306.54
LIBRARY-4F								
77	Book stacks/Reading room	BS1	0.9	1339.2	12	16070.4	20088	5423.76
78	Reading room	BS2	0.9	295.32	12	3543.84	4429.8	1196.05
LIBRARY-5F								
79	Yard							
80	Roof mechanical room	R1	0.9	295.32	12	3543.84	4429.8	1196.05
81	Roof mechanical room	R2	0.9	295.32	12	3543.84	4429.8	1196.05

Table 2.9: The heat radiate due to lights Q_{31}

2.2.6 Sensible heat emitted by the machinery Q_{32}

Sensible heat is emitted by electric equipment such as television, radio, computers, hair-dryer, iron,...in the home or office that are non-electric motor that can be calculated as heat gain of the light:

$$Q_{32} = \Sigma N_i \text{ (W)}$$

Where:

N_i – the rated power of equipment, W

The heat generated by equipment using electric motors, such as fan in duct system or in workshops as power-loom, printing machine,...will be divided into 3 cases to calculate:

- Case 1: The electric motors and the equipment are located in the air conditioned room with the rated power N (W) and full load efficiency η , the total energy supplied to the motors is converted into electricity:

$$Q_{32} = \frac{N}{\eta} \text{ (W)}$$

- Case 2: The electric motors are located outside and the equipment are located in the air conditioned room, so the heat gain is equal the power rating:

$$Q_{32} = N \text{ (W)}$$

- Case 3: The electric motors are located in the air conditioned room and equipment are located outside, so heat gain is calculated by formula:

$$Q_{32} = \frac{N}{\eta} - N \text{ (W)}$$

NO	ROOM NAME	CODE ROOM	Equipment name			η	Q32
			Name	Q.ty	Motor Data (kW)		
CENTRAL PLANT-1F							
1	Fire room	104	FCU 1F-01	1	0.18	64	281.25
2			EAF 1F-01	1	0.03	41	73.17
3	Server room	D101	AHU 1F-01~06	6	15	87	103448.28
4			EAF 1F-03	1	0.03	41	73.17
5	Chillers and Pumps room	C101	EAF 2F-01	1	18.5	88	21022.73
6			CH-1.1~1.2	2	881	92	1915217.39
7			CH-1.3	1	440	92	478260.87
8			CHWP- 1.1~1.2	2	37	89	83146.07
9			CHWP-1.3	1	15	87	17241.38
10			SCHWP- 1.1~1.3	3	55	90	183333.33

11			CWP-1.1~1.2	2	132	91	290109.89
12			CWP-.3	1	55	90	61111.11
13	Transformer room	E102	EA 2F-02	1	3	82	3658.54
14	Medium voltage switchgear room	E103	EA 2F-03	1	4	83	4819.28
15	Transformer room	E104	EA 2F-04,10	2	5.5	84	13095.24
16	Low voltage switchgear room	E105	EA 2F-05	1	5.5	84	6547.62
17	Control center	W103	FCU 1F-02	2	0.2	64	625.00
18			EA 1F-04	1	0.03	41	73.17
19	Technical room	W102	EA 1F-05	1	0.37	70	528.57
20			CD-1.1~1.2	2	0.02	41	97.56
CENTRAL PLANT-2F							
21	UPS battery room	D201	EA 2F-09	1	0.03	41	73.17
22			FCU 2F-01~02	2	0.18	64	562.50
23	Server room support	D200	EA 2F-07	1	0.03	41	73.17
24			AHU 2F-01~03	3	15	87	51724.14
25	Server room	D202	AHU 2F-04~06	3	15	87	51724.14
26	Storage	D205	EA 2F-08	1	0.03	41	73.17
27	Electrical workroom area	D203	EA 2F-08	1	0.12	60	200.00
28			FCU 2F-03~04	2	0.18	64	562.50
29	Control room	D204	FCU 2F-05	1	0.2	64	312.50
CENTRAL PLANT-RF							
30	Cooling towers	C301	CT-1.1~1.2	8	11	86	102325.58
31			CT-1.3	2	11	86	25581.40
LIBRARY-1F							

32	Conference/Training room	114	Tivi LED Sony 32 inches KDL- 32W700B	4	0.069	49	563.27
33			Computer	10	0.04	41	975.61
34			Projector Panasonic PT-SX320A	1	0.295	67	440.30
35			Speaker	4	0.15	60	1000.00
36	Storage	114A	EAF 1F-01	1	0.034	41	82.93
37	Frist Aid	102	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
38			Computer	1	0.04	41	97.56
39	Aid relaxing room	102B	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
40	Storage	103A	EAF 1F-02	1	0.034	41	82.93
41	Book return room	101	Computer	1	0.04	41	97.56
42	Post room	104	Computer	1	0.04	41	97.56
43	Storage/Receiving	107	Computer	1	0.04	41	97.56
44	Porter room	113	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
45			Computer	2	0.04	41	195.12
46	Uni shop	112	Tivi LED Sony 32 inches KDL- 32W700B	2	0.069	49	281.63
47			Computer	2	0.04	41	195.12
48			Speaker	1	0.15	60	250.00
49	Coffee shop	110	Tivi LED Sony 32 inches KDL- 32W700B	2	0.069	49	281.63
50			Computer	2	0.04	41	195.12
51			Speaker	1	0.15	60	250.00
52	Mechanical room	109	CHWP- 1F-01,02	1	3	82	3658.54

53	Elec/tele	108	Tivi LED Sony 32 inches KDL- 32W700B	2	0.069	49	281.63
54			Computer	2	0.04	41	195.12
LIBRARY-2F							
55	Journal display/reading	215	Tivi LED Sony 32 inches KDL- 32W700B	2	0.069	49	281.63
56	Journal display/reading	215	Tivi LED Sony 32 inches KDL- 32W700B	2	0.069	49	281.63
57	Journal display/reading	214	Tivi LED Sony 32 inches KDL- 32W700B	2	0.069	49	281.63
58	Journal display/reading	214	Tivi LED Sony 32 inches KDL- 32W700B	2	0.069	49	281.63
59	Group Workroom	217	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
60			Computer	5	0.04	41	487.80
61			Projector Panasonic PT-SX320A	1	0.295	67	440.30
62			Speaker	1	0.15	60	250.00
63	Group Workroom	218	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
64			Computer	5	0.04	41	487.80
65			Projector Panasonic PT-SX320A	1	0.295	67	440.30
66			Speaker	1	0.15	60	250.00
67	Group Workroom	219	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82

68			Computer	5	0.04	41	487.80
69			Projector Panasonic PT-SX320A	1	0.295	67	440.30
70			Speaker	1	0.15	60	250.00
71	Group Workroom	220	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
72			Computer	5	0.04	41	487.80
73			Projector Panasonic PT-SX320A	1	0.295	67	440.30
74			Speaker	1	0.15	60	250.00
75	Storage	213	EAF 2F-01	1	0.034	41	82.93
76	Storage	221	EAF 2F-02	1	0.034	41	82.93
77	Storage	210	EAF 2F-03	1	0.034	41	82.93
78	Prints/Storage	209	Computer	3	0.04	41	292.68
79			Photocopy	2	1.2	79	3037.97
80	Kitchen/staff lounge	208	Induction hob	2	1.8	80	4500.00
81			Freezer	2	0.187	64	584.38
82	Directors office	206	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
83			Computer	1	0.04	41	97.56
84	Assistants desk	205	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
85			Computer	1	0.04	41	97.56
86	Meeting room	203	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
87			Computer	4	0.04	41	390.24
88			Projector Panasonic PT-SX320A	1	0.295	67	440.30
89			Speaker	2	0.15	60	500.00

90	Computer pool	225	Computer	10	0.04	41	975.61
91			Projector Panasonic PT-SX320A	2	0.295	67	880.60
92			Speaker	4	0.15	60	1000.00
LIBRARY-3F							
93	Reading theatre	316	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
94			Computer	1	0.04	41	97.56
95	Learing room	310	Computer	1	0.04	41	97.56
96			Projector Panasonic PT-SX320A	1	0.295	67	440.30
97			Speaker	1	0.15	60	250.00
98	Learing room	311	Computer	1	0.04	41	97.56
99			Projector Panasonic PT-SX320A	1	0.295	67	440.30
100			Speaker	1	0.15	60	250.00
101	Storage	312	EAF 2F-04	1	0.034	41	82.93
102	Copy/print	313	Photocopy	1	1.2	79	1518.99
103	Group Workroom	303	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
104			Computer	5	0.04	41	487.80
105			Projector Panasonic PT-SX320A	1	0.295	67	440.30
106			Speaker	1	0.15	60	250.00
107	Group Workroom	304	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
108			Computer	5	0.04	41	487.80
109			Projector Panasonic PT-SX320A	1	0.295	67	440.30
110			Speaker	1	0.15	60	250.00

111	Group Workroom	307	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
112			Computer	5	0.04	41	487.80
113			Projector Panasonic PT-SX320A	1	0.295	67	440.30
114			Speaker	1	0.15	60	250.00
115	Group Workroom	308	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
116			Computer	5	0.04	41	487.80
117			Projector Panasonic PT-SX320A	1	0.295	67	440.30
118			Speaker	1	0.15	60	250.00
119	Group Workroom	309	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
120			Computer	5	0.04	41	487.80
121			Projector Panasonic PT-SX320A	1	0.295	67	440.30
122			Speaker	1	0.15	60	250.00
123	Study carells	315	Computer	1	0.04	41	97.56
124	Multimedia workroom	314	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
125			Computer	5	0.04	41	487.80
126			Projector Panasonic PT-SX320A	1	0.295	67	440.30
127			Speaker	1	0.15	60	250.00
LIBRARY-4F							
103	Book stacks/Reading room	303	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
104			Computer	5	0.04	41	487.80

105			Projector Panasonic PT-SX320A	1	0.295	67	440.30
106			Speaker	1	0.15	60	250.00
107	Reading room	304	Tivi LED Sony 32 inches KDL- 32W700B	1	0.069	49	140.82
108			Computer	5	0.04	41	487.80
109			Projector Panasonic PT-SX320A	1	0.295	67	440.30
110			Speaker	1	0.15	60	250.00

Table 2.10: The heat radiate due to machines Q_{32}

2.2.7 Sensible heat and latent heat from person Q_4

Sensible heat by person Q_{4sh}

$$Q_{4h} = n_d \times n_t \times n \times q_{sh}$$

Where:

n_d : non-concurrent effects coefficient only applicable to large building, other constructions

- Office building: $n_d = 0.75 \div 0.9$
- **Hotel building: $n_d = 0.8 \div 0.9$**
- Shop: $n_d = 0.8 \div 0.9$

$$\Rightarrow n_d = 0.8$$

n_t : concurrent effects coefficient. Cases such as dance hall, conference, theater, sporting event hall,...

n : the number of person in space condition

q_{sh} : sensible heat per person, W/person

$$Q_{4lh} = n \times q_{lh}$$

Where:

n : the number of person in space condition

q_{lh} : latent heat per person, W/person

- Sensible heat per person: $q_{sh} = 55 \text{ W}$.

- Latent heat per person: $q_{lh} = 65 \text{ W}$.

NO	ROOM NAME	CODE ROOM	nt	n	qsh	qlh	Q4sh	Q4lh	Q4
CENTRAL PLANT-1F									
1	Fire room	104	0.9	2	55	65	79.2	130	209.20
2	Corridor	1CR	0.87	10	55	65	382.8	650	1032.80
3	Server room	D101	0.9	20	55	65	792	1300	2092.00
4	Server room support	D102	0.87	8	55	65	306.24	520	826.24
5	Chillers and Pumps room	C101	0.9	5	55	65	198	325	523.00
6	Corridor	E106	0.9	10	55	65	396	650	1046.00
7	Fuel Storage Tank	E101	0.87	2	55	65	76.56	130	206.56
8	Transformer room	E102	0.9	2	55	65	79.2	130	209.20
9	Medium voltage switchgear room	E103	0.9	2	55	65	79.2	130	209.20
10	Transformer room	E104	0.9	2	55	65	79.2	130	209.20
11	Low voltage switchgear room	E105	0.9	2	55	65	79.2	130	209.20
12	Corridor	1CR2	0.87	10	55	65	382.8	650	1032.80
13	Control center	W103	0.9	5	55	65	198	325	523.00
14	Technical room	W102	0.87	2	55	65	76.56	130	206.56
15	Odor treatment room	W101	0.87	2	55	65	76.56	130	206.56
CENTRAL PLANT-2F									
16	UPS battery room	D201	0.87	2	55	65	76.56	130	206.56
17	Corridor	2CR3	0.87	10	55	65	382.8	650	1032.80
18	Server room support	D200	0.87	8	55	65	306.24	520	826.24
19	Server room	D202	0.9	5	55	65	198	325	523.00
20	Storage	D205	0.87	2	55	65	76.56	130	206.56
21	Corridor	2CR2	0.87	10	55	65	382.8	650	1032.80
22	Janitor	2JC1	0.87	2	55	65	76.56	130	206.56
23	Corridor-hành lang	2CR4	0.87	10	55	65	382.8	650	1032.80
24	Electrical workroom area	D203	0.87	4	55	65	153.12	260	413.12
25	Control room	D204	0.87	2	55	65	76.56	130	206.56
CENTRAL PLANT-RF									
26	Cooling towers	C301	0.9	10	55	65	396	650	1046.00
27	Generator room	E301	0.9	2	55	65	79.2	130	209.20
28	Mechanical room	300B	0.87	4	55	65	153.12	260	413.12
29	AHU sever	D301	0.87	4	55	65	153.12	260	413.12

LIBRARY-1F									
30	Conference/Training room	114	0.9	20	55	65	792	1300	2092.00
31	Storage	114A	0.87	5	55	65	191.4	325	516.40
32	Janitor	1JC1	0.87	2	55	65	76.56	130	206.56
33	Frist Aid	102	0.87	3	55	65	114.84	195	309.84
34	Aid relaxing room	102B	0.87	5	55	65	191.4	325	516.40
35	Storage	103A	0.87	2	55	65	76.56	130	206.56
36	Book return room	101	0.87	3	55	65	114.84	195	309.84
37	Corridor	1CR1	0.87	10	55	65	382.8	650	1032.80
38	Post room	104	0.87	3	55	65	114.84	195	309.84
39	Storage/Receiving	107	0.87	2	55	65	76.56	130	206.56
40	Porter room	113	0.87	5	55	65	191.4	325	516.40
41	Uni shop	112	0.9	20	55	65	792	1300	2092.00
42	Coffee shop	110	0.87	10	55	65	382.8	650	1032.80
43	Coffee Storage room	111	0.87	2	55	65	76.56	130	206.56
44	Mechanical room	109	0.87	4	55	65	153.12	260	413.12
45	Elec/tele	108	0.87	5	55	65	191.4	325	516.40
LIBRARY-2F									
46	Journal display/reading	215	0.87	10	55	65	382.8	650	1032.80
47	Journal display/reading	215	0.87	10	55	65	382.8	650	1032.80
48	Journal display/reading	214	0.87	10	55	65	382.8	650	1032.80
49	Journal display/reading	214	0.87	10	55	65	382.8	650	1032.80
50	Group Workroom	217	0.87	10	55	65	382.8	650	1032.80
51	Group Workroom	218	0.87	10	55	65	382.8	650	1032.80
52	Group Workroom	219	0.87	10	55	65	382.8	650	1032.80
53	Group Workroom	220	0.87	10	55	65	382.8	650	1032.80
54	Storage	213	0.87	2	55	65	76.56	130	206.56
55	Storage	221	0.87	2	55	65	76.56	130	206.56
56	Storage	210	0.87	2	55	65	76.56	130	206.56
57	Prints/Storage	209	0.87	3	55	65	114.84	195	309.84
58	Kitchen/staff lounge	208	0.87	10	55	65	382.8	650	1032.80
59	Directors office	206	0.87	2	55	65	76.56	130	206.56
60	Assistants desk	205	0.87	2	55	65	76.56	130	206.56
61	Meeting room	203	0.87	10	55	65	382.8	650	1032.80
62	Computer pool	225	0.87	20	55	65	765.6	1300	2065.60
LIBRARY-3F									
63	Reading theatre	316	0.87	17	55	65	650.76	1105	1755.76

64	Reading theatre	BS2	0.9	20	55	65	792	1300	2092.00
65	Book stacks/Reading room	BS1	0.9	30	55	65	1188	1950	3138.00
66	Learing room	310	0.87	30	55	65	1148.4	1950	3098.40
67	Learing room	311	0.87	30	55	65	1148.4	1950	3098.40
68	Storage	312	0.87	2	55	65	76.56	130	206.56
69	Copy/print	313	0.87	3	55	65	114.84	195	309.84
70	Group Workroom	303	0.87	10	55	65	382.8	650	1032.80
71	Group Workroom	304	0.87	10	55	65	382.8	650	1032.80
72	Group Workroom	307	0.87	10	55	65	382.8	650	1032.80
73	Group Workroom	308	0.87	10	55	65	382.8	650	1032.80
74	Group Workroom	309	0.87	10	55	65	382.8	650	1032.80
75	Study carells	315	0.9	1	55	65	39.6	65	104.60
76	Multiedia workroom	314	0.87	8	55	65	306.24	520	826.24
LIBRARY-4F									
77	Book stacks/Reading room	BS1	0.9	30	55	65	1188	1950	3138.00
78	Reading room	BS2	0.9	20	55	65	792	1300	2092.00
LIBRARY-5F									
79	Yard		0.9	3	55	65	118.8	195	313.80
80	Roof mechanical room	R1	0.9	3	55	65	118.8	195	313.80
81	Roof mechanical room	R2	0.9	2	55	65	79.2	130	209.20

Table 2.11: Sensible and latent heat by people Q_4

2.2.8 Sensible and latent heat by fresh air Q_{5h} & Q_{5a}

To ensure sufficient fresh air is required necessary, regulate must always provide a fresh air, so air will radiate heat quantities are calculated according to:

$$Q_N = Q_{5h} + Q_{5a} \quad (2.18)$$

$$Q_{5h} = 1,2 \cdot n \cdot l \cdot (t_N - t_T), \quad W$$

$$Q_{5a} = 3 \cdot n \cdot l \cdot (d_N - d_T), \quad W$$

That is :

t_N, t_T – temperature of fresh air inside and outside, °C

d_N, d_T – steam capacity of fresh air outside and inside, based on the temperature outside and inside, calculate steam capacity 12; 19 g /kg.

n – the number of person in conditioning room.

l – the amount of fresh air from the outdoors and get into the room for a person per a second, $l/s \Rightarrow l=7.5l/s$ Table 4.19[1, page 150].

NO	ROOM NAME	CODE ROOM	n	l	tN-tT	dN-dT	Q5sh	Q5lh	QN
CENTRAL PLANT-1F									
1	Fire room	104	2	7.5	9	7	162	315.00	477.00
2	Corridor	1CR	10	7.5	9	7	810	1575.00	2385.00
3	Server room	D101	20	7.5	9	7	1620	3150.00	4770.00
4	Server room support	D102	8	7.5	9	7	648	1260.00	1908.00
5	Chillers and Pumps room	C101	5	7.5	9	7	405	787.50	1192.50
6	Corridor	E106	10	7.5	9	7	810	1575.00	2385.00
7	Transformer room	E102	2	7.5	9	7	162	315.00	477.00
8	Medium voltage switchgear room	E103	2	7.5	9	7	162	315.00	477.00
9	Transformer room	E104	2	7.5	9	7	162	315.00	477.00
10	Low voltage switchgear room	E105	2	7.5	9	7	162	315.00	477.00
11	Corridor	1CR2	10	7.5	9	7	810	1575.00	2385.00
12	Control center	W103	5	7.5	9	7	405	787.50	1192.50
13	Technical room	W102	2	7.5	9	7	162	315.00	477.00
14	Odor treatment room	W101	2	7.5	9	7	162	315.00	477.00
CENTRAL PLANT-2F									
15	UPS battery room	D201	2	7.5	9	7	162	315.00	477.00
16	Corridor	2CR3	10	7.5	9	7	810	1575.00	2385.00
17	Server room support	D200	8	7.5	9	7	648	1260.00	1908.00
18	Server room	D202	5	7.5	9	7	405	787.50	1192.50
19	Storage	D205	2	7.5	9	7	162	315.00	477.00
20	Corridor	2CR2	10	7.5	9	7	810	1575.00	2385.00
21	Janitor	2JC1	2	7.5	9	7	162	315.00	477.00
22	Corridor-hành lang	2CR4	10	7.5	9	7	810	1575.00	2385.00
23	Electrical workroom area	D203	4	7.5	9	7	324	630.00	954.00
24	Control room	D204	2	7.5	9	7	162	315.00	477.00

CENTRAL PLANT-RF									
25	Cooling towers	C301	10	7.5	9	7	810	1575.00	2385.00
26	Generator room	E301	2	7.5	9	7	162	315.00	477.00
27	Mechanical room	300B	4	7.5	9	7	324	630.00	954.00
28	AHU sever	D301	4	7.5	9	7	324	630.00	954.00
LIBRARY-1F									
29	Conference/Training room	114	20	7.5	9	7	1620	3150.00	4770.00
30	Storage	114A	5	7.5	9	7	405	787.50	1192.50
31	Janitor	1JC1	2	7.5	9	7	162	315.00	477.00
32	Frist Aid	102	3	7.5	9	7	243	472.50	715.50
33	Aid relaxing room	102B	5	7.5	9	7	405	787.50	1192.50
34	Storage	103A	2	7.5	9	7	162	315.00	477.00
35	Book return room	101	3	7.5	9	7	243	472.50	715.50
36	Corridor	1CR1	10	7.5	9	7	810	1575.00	2385.00
37	Post room	104	3	7.5	9	7	243	472.50	715.50
38	Storage/Receiving	107	2	7.5	9	7	162	315.00	477.00
39	Porter room	113	5	7.5	9	7	405	787.50	1192.50
40	Uni shop	112	20	7.5	9	7	1620	3150.00	4770.00
41	Coffee shop	110	10	7.5	9	7	810	1575.00	2385.00
42	Coffee Storage room	111	2	7.5	9	7	162	315.00	477.00
43	Mechanical room	109	4	7.5	9	7	324	630.00	954.00
44	Elec/tele	108	5	7.5	9	7	405	787.50	1192.50
LIBRARY-2F									
45	Journal display/reading	215	10	7.5	9	7	810	1575.00	2385.00
46	Journal display/reading	215	10	7.5	9	7	810	1575.00	2385.00
47	Journal display/reading	214	10	7.5	9	7	810	1575.00	2385.00
48	Journal display/reading	214	10	7.5	9	7	810	1575.00	2385.00
49	Group Workroom	217	10	7.5	9	7	810	1575.00	2385.00
50	Group Workroom	218	10	7.5	9	7	810	1575.00	2385.00
51	Group Workroom	219	10	7.5	9	7	810	1575.00	2385.00
52	Group Workroom	220	10	7.5	9	7	810	1575.00	2385.00
53	Storage	213	2	7.5	9	7	162	315.00	477.00
54	Storage	221	2	7.5	9	7	162	315.00	477.00
55	Storage	210	2	7.5	9	7	162	315.00	477.00

56	Prints/Storage	209	3	7.5	9	7	243	472.50	715.50
57	Kitchen/staff lounge	208	10	7.5	9	7	810	1575.00	2385.00
58	Directors office	206	2	7.5	9	7	162	315.00	477.00
59	Assistants desk	205	2	7.5	9	7	162	315.00	477.00
60	Meeting room	203	10	7.5	9	7	810	1575.00	2385.00
61	Computer pool	225	20	7.5	9	7	1620	3150.00	4770.00
LIBRARY-3F									
62	Reading theatre	316	17	7.5	9	7	1377	2677.50	4054.50
63	Reading theatre	BS2	20	7.5	9	7	1620	3150.00	4770.00
64	Book stacks/Reading room	BS1	30	7.5	9	7	2430	4725.00	7155.00
65	Learing room	310	30	7.5	9	7	2430	4725.00	7155.00
66	Learing room	311	30	7.5	9	7	2430	4725.00	7155.00
67	Storage	312	2	7.5	9	7	162	315.00	477.00
68	Copy/print	313	3	7.5	9	7	243	472.50	715.50
69	Group Workroom	303	10	7.5	9	7	810	1575.00	2385.00
70	Group Workroom	304	10	7.5	9	7	810	1575.00	2385.00
71	Group Workroom	307	10	7.5	9	7	810	1575.00	2385.00
72	Group Workroom	308	10	7.5	9	7	810	1575.00	2385.00
73	Group Workroom	309	10	7.5	9	7	810	1575.00	2385.00
74	Study carells	315	1	7.5	9	7	81	157.50	238.50
75	Multiedia workroom	314	8	7.5	9	7	648	1260.00	1908.00
LIBRARY-4F									
76	Book stacks/Reading room	BS1	30	7.5	9	7	2430	4725.00	7155.00
77	Reading room	BS2	20	7.5	9	7	1620	3150.00	4770.00
LIBRARY-5F									
78	Yard		3	7.5	9	7	243	472.50	715.50
79	Roof mechanical room	R1	3	7.5	9	7	243	472.50	715.50
80	Roof mechanical room	R2	2	7.5	9	7	162	315.00	477.00

Table 2.12: Sensible and latent heat by fresh air Q_{5h} and Q_{5a}

2.2.9 Sensible and latent heat by air Q_{6h} và Q_{6a}

To save energy, need to reconcile must be sealed to make the initiative to grant the amount of fresh air to the room. However still have fresh air phenomenon into the room through the doors, through the window, ...The extent of the leak depends on many factors: the difference in voltage levels inside the outside, wind speed, number of times to close the open,..The amount of heat that is determined as follows :

$$Q_6 = Q_{6h} + Q_{6a} \quad (2.19)$$

$$Q_{6h} = 0,39.\xi.V.(t_N - t_T), W \quad (2.20)$$

$$Q_{6a} = 0,84.\xi.V.(d_N - d_T), W$$

That is : ξ – experience factor

V – the volume of room, m^3

NO	ROOM NAME	CODE ROOM	V m ³	ξ	Q _{6sh}	Q _{6lh}	QN
CENTRAL PLANT-1F							
1	Fire room	104	154.105	0.7	378.64	634.30	1012.93
2	Corridor	1CR	72.335	0.7	177.73	297.73	475.46
3	Server room	D101	1075.08	0.55	2075.44	3476.81	5552.25
4	Server room support	D102	234.09	0.7	575.16	963.51	1538.67
5	Chillers and Pumps room	C101	6526.88	0.35	8018.27	13432.32	21450.59
6	Corridor	E106	1187.196	0.60	2500.23	4188.43	6688.66
7	Fuel Storage Tank	E101	377.036	0.70	926.38	1551.88	2478.26
8	Transformer room	E102	772.464	0.60	1626.81	2725.25	4352.06
9	Medium voltage switchgear room	E103	744.876	0.60	1568.71	2627.92	4196.63
10	Transformer room	E104	781.66	0.60	1646.18	2757.70	4403.87
11	Low voltage switchgear room	E105	735.68	0.60	1549.34	2595.48	4144.82
12	Corridor	1CR2	24.4375	0.7	60.04	100.58	160.63
13	Control center	W103	437.835	0.7	1075.76	1802.13	2877.89
14	Technical room	W102	203.745	0.7	500.60	838.61	1339.22
15	Odor treatment room	W101	221.085	0.7	543.21	909.99	1453.19
CENTRAL PLANT-2F							
16	UPS battery room	D201	128.772	0.7	316.39	530.03	846.42
17	Corridor	2CR3	60.444	0.7	148.51	248.79	397.30
18	Server room support	D200	330.48	0.7	811.99	1360.26	2172.25
19	Server room	D202	653.616	0.55	1261.81	2113.79	3375.60

20	Storage	D205	81	0.7	199.02	333.40	532.41
21	Corridor	2CR2	178.596	0.7	438.81	735.10	1173.91
22	Janitor	2JC1	91.728	0.7	225.38	377.55	602.93
23	Corridor-hành lang	2CR4	105.444	0.7	259.08	434.01	693.08
24	Electrical workroom area	D203	261.792	0.7	643.22	1077.54	1720.76
25	Control room	D204	176.256	0.7	433.06	725.47	1158.53
CENTRAL PLANT-RF							
26	Cooling towers	C301	1566	0.42	2308.60	3867.39	6175.99
27	Generator room	E301	1047.48	0.50	1838.33	3079.59	4917.92
28	Mechanical room	300B	500.52	0.60	1054.10	1765.83	2819.93
29	AHU sever	D301	576	0.55	1111.97	1862.78	2974.75
LIBRARY-1F							
30	Conference/Training room	114	527.7285	0.60	1111.40	1861.83	2973.22
31	Storage	114A	36.666	0.7	90.09	150.92	241.01
32	Janitor	1JC1	31.428	0.7	77.22	129.36	206.58
33	Frist Aid	102	90.21	0.7	221.65	371.30	592.95
34	Aid relaxing room	102B	56.745	0.7	139.42	233.56	372.98
35	Storage	103A	58.0545	0.7	142.64	238.95	381.59
36	Book return room	101	127.458	0.7	313.16	524.62	837.78
37	Corridor	1CR1	270.63	0.7	664.94	1113.91	1778.85
38	Post room	104	87.9305	0.7	216.05	361.92	577.97
39	Storage/Receiving	107	89.24	0.7	219.26	367.31	586.57
40	Porter room	113	36.084	0.7	88.66	148.52	237.18
41	Uni shop	112	750.586	0.60	1580.73	2648.07	4228.80
42	Coffee shop	110	185.367	0.7	455.45	762.97	1218.42
43	Coffee Storage room	111	44.3775	0.7	109.04	182.66	291.69
44	Mechanical room	109	125.13	0.7	307.44	515.04	822.48
45	Elec/tele	108	31.428	0.7	77.22	129.36	206.58
LIBRARY-2F							
46	Journal display/reading	215	38.28	0.7	94.05	157.56	251.61
47	Journal display/reading	215	38.28	0.7	94.05	157.56	251.61
48	Journal display/reading	214	33.7125	0.7	82.83	138.76	221.59
49	Journal display/reading	214	33.7125	0.7	82.83	138.76	221.59
50	Group Workroom	217	84.1	0.7	206.63	346.16	552.79
51	Group Workroom	218	84.1	0.7	206.63	346.16	552.79
52	Group Workroom	219	84.1	0.7	206.63	346.16	552.79

53	Group Workroom	220	84.1	0.7	206.63	346.16	552.79
54	Storage	213	26.1	0.7	64.13	107.43	171.56
55	Storage	221	25.23	0.7	61.99	103.85	165.84
56	Storage	210	23.49	0.7	57.71	96.68	154.40
57	Prints/Storage	209	84.825	0.7	208.42	349.14	557.55
58	Kitchen/staff lounge	208	73.515	0.7	180.63	302.59	483.21
59	Directors office	206	97.44	0.7	239.41	401.06	640.47
60	Assistants desk	205	43.5	0.7	106.88	179.05	285.93
61	Meeting room	203	142.68	0.7	350.56	587.27	937.84
62	Computer pool	225	431.19375	0.60	908.09	1521.25	2429.35
LIBRARY-3F							
63	Reading theatre	316	219.4335	0.7	539.15	903.19	1442.34
64	Reading theatre	BS2	982.8	0.50	1724.81	2889.43	4614.25
65	Book stacks/Reading room	BS1	3612.492	0.35	4437.95	7434.51	11872.45
66	Learing room	310	53.703	0.7	131.95	221.04	352.99
67	Learing room	311	53.703	0.7	131.95	221.04	352.99
68	Storage	312	10.96875	0.7	26.95	45.15	72.10
69	Copy/print	313	11.4075	0.7	28.03	46.95	74.98
70	Group Workroom	303	60.1965	0.7	147.90	247.77	395.67
71	Group Workroom	304	54.4635	0.7	133.82	224.17	357.99
72	Group Workroom	307	31.5315	0.7	77.47	129.78	207.26
73	Group Workroom	308	31.5315	0.7	77.47	129.78	207.26
74	Group Workroom	309	47.29725	0.7	116.21	194.68	310.88
75	Study carells	315	265.44375	0.7	652.20	1092.57	1744.76
76	Multimedia workroom	314	229.0275	0.7	562.72	942.68	1505.40
LIBRARY-4F							
77	Book stacks/Reading room	BS1	2678.4	0.40	3760.47	6299.60	10060.07
78	Reading room	BS2	590.64	0.50	1036.57	1736.48	2773.05
LIBRARY-5F							
79	Roof mechanical room	R1	738.3	0.50	1295.72	2170.60	3466.32
80	Roof mechanical room	R2	738.3	0.50	1295.72	2170.60	3466.32

Table 2.13: Sensible and latent heat by win Q_{6h} and Q_{6a}

2.2.10 Total of cooling capacity

N O	ROOM NAME	Q11 (W)	Q21 (W)	Q22 W (W)	Q23 (W)	Q31 (W)	Q32 (W)	Q4 (W)	Q5 (W)	Q6 (W)	Q0
CENTRAL PLANT-1F											
1	Fire room			2361.2 7	711.42	141.9 6	354.42	209.2 0	477.0 0	1012.9 3	5268.20
2	Corridor			1808.3 3	333.93	66.63		1032. 80	2385. 00	475.46	6102.15
3	Server room			6536.5 0	4963.0 8	1024. 49	103521. 45	2092. 00	4770. 00	5552.2 5	128459. 76
4	Server room support			2991.4 9	1080.6 7	215.6 4		826.2 4	1908. 00	1538.6 7	8560.71
5	Chillers and Pumps room			20973. 99	16849. 66	3478. 14	3049442 .77	523.0 0	1192. 50	21450. 59	3113910 .65
6	Corridor			13417. 54	3064.8 4	611.5 6		1046. 00	2385. 00	6688.6 6	27213.6 0
7	Fuel Storage Tank			5457.5 6	973.35	194.2 2		206.5 6		2478.2 6	9309.95
8	Transformer room			7092.8 7	1994.1 8	397.9 2	3658.54	209.2 0	477.0 0	4352.0 6	18181.7 7
9	Medium voltage switchgear room			6940.7 9	1922.9 6	383.7 1	4819.28	209.2 0	477.0 0	4196.6 3	18949.5 6
10	Transformer room			7130.9 0	2017.9 2	402.6 6	13095.2 4	209.2 0	477.0 0	4403.8 7	27736.7 9
11	Low voltage switchgear room			6902.7 6	1899.2 2	378.9 7	6547.62	209.2 0	477.0 0	4144.8 2	20559.5 9
12	Corridor			1000.9 6	112.82	22.51		1032. 80	2385. 00	160.63	4714.72
13	Control center			4168.0 2	2021.2 5	417.2 3	698.17	523.0 0	1192. 50	2877.8 9	11898.0 7
14	Technical room			2861.9 2	940.58	187.6 9	626.13	206.5 6	477.0 0	1339.2 2	6639.10
15	Odor treatment room			2927.6 9	1020.6 3	203.6 6		206.5 6	477.0 0	1453.1 9	6288.73
CENTRAL PLANT-2F											
16	UPS battery room			1991.5 7		140.0 4	635.67	206.5 6	477.0 0	846.42	4297.26
17	Corridor			1563.0 0		65.73		1032. 80	2385. 00	397.30	5443.83
18	Server room support			3194.6 6		359.4 0	51797.3 1	826.2 4	1908. 00	2172.2 5	60257.8 5
19	Server room			4523.8 4		735.3 2	51724.1 4	523.0 0	1192. 50	3375.6 0	62074.3 9
20	Storage			1718.3 9		88.09	73.17	206.5 6	477.0 0	532.41	3095.62
21	Corridor			2590.2		194.2		1032.	2385.	1173.9	7376.14

				1		2		80	00	1	
22	Janitor			1943.3 6		99.75		206.5 6	477.0 0	602.93	3329.61
23	Corridor-hành lang			2081.1 4		114.6 7		1032. 80	2385. 00	693.08	6306.69
24	Electrical workroom area			2855.7 6		284.7 0	762.50	413.1 2	954.0 0	1720.7 6	6990.84
25	Control room			2438.0 6		191.6 8	312.50	206.5 6	477.0 0	1158.5 3	4784.33
CENTRAL PLANT-RF											
26	Cooling towers		754.0 3	6432.4 8	5120.8 2	2114. 10	127906. 98	1046. 00	2385. 00	6175.9 9	151935. 40
27	Generator room		504.3 6	5139.0 7	3425.2 6	1414. 10		209.2 0	477.0 0	4917.9 2	16086.9 1
28	Mechanical room		241.0 0	3634.8 5	1636.7 0	675.7 0		413.1 2	954.0 0	2819.9 3	10375.3 0
29	AHU sever		277.3 4	4701.5 6	1883.5 2	777.6 0		413.1 2	954.0 0	2974.7 5	11981.9 0
LIBRARY-1F											
30	Conference/Training room			5547.7 3	2134.8 5	440.6 8	2979.17	2092. 00	4770. 00	2973.2 2	20937.6 6
31	Storage			1259.7 3	148.33	29.60	82.93	516.4 0	1192. 50	241.01	3470.49
32	Janitor			1154.9 7	127.14	25.37		206.5 6	477.0 0	206.58	2197.61
33	Frist Aid			2015.1 3	364.93	72.82	238.38	309.8 4	715.5 0	592.95	4309.55
34	Aid relaxing room			1576.5 4	229.55	45.81	140.82	516.4 0	1192. 50	372.98	4074.60
35	Storage			1889.6 3	234.85	46.86	82.93	206.5 6	477.0 0	381.59	3319.42
36	Book return room			2392.8 5	515.61	102.8 9	97.56	309.8 4	715.5 0	837.78	4972.03
37	Corridor			4207.3 9	1094.8 0	218.4 6		1032. 80	2385. 00	1778.8 5	10717.2 9
38	Post room			1983.5 2	355.71	70.98	97.56	309.8 4	715.5 0	577.97	4111.08
39	Storage/Receiving			1957.9 4	361.01	72.04	97.56	206.5 6	477.0 0	586.57	3758.68
40	Porter room			1233.8 9	145.97	29.13	335.94	516.4 0	1192. 50	237.18	3691.01
41	Uni shop			6964.5 3	3036.3 9	626.7 8	726.75	2092. 00	4770. 00	4228.8 0	22445.2 5
42	Coffee shop			3128.8 9	749.88	149.6 3	726.75	1032. 80	2385. 00	1218.4 2	9391.37
43	Coffee Storage room			1607.3 6	179.52	35.82		206.5 6	477.0 0	291.69	2797.96
44	Mechanical room			2306.9 7	506.20	101.0 1	3658.54	413.1 2	954.0 0	822.48	8762.31
45	Elec/tele			1154.9 7	127.14	25.37	476.75	516.4 0	1192. 50	206.58	3699.71
LIBRARY-2F											
46	Journal display/reading			1106.9 0		41.34	281.63	1032. 80	2385. 00	251.61	5099.29
47	Journal display/reading			1106.9 0		41.34	281.63	1032. 80	2385. 00	251.61	5099.29

48	Journal display/reading			1041.12		36.41	281.63	1032.80	2385.00	221.59	4998.56
49	Journal display/reading			1041.12		36.41	281.63	1032.80	2385.00	221.59	4998.56
50	Group Workroom			1620.68		90.83	1318.92	1032.80	2385.00	552.79	7001.01
51	Group Workroom			1620.68		90.83	1318.92	1032.80	2385.00	552.79	7001.01
52	Group Workroom			1620.68		90.83	1318.92	1032.80	2385.00	552.79	7001.01
53	Group Workroom			1620.68		90.83	1318.92	1032.80	2385.00	552.79	7001.01
54	Storage			917.54		28.19	82.93	206.56	477.00	171.56	1883.77
55	Storage			902.79		27.25	82.93	206.56	477.00	165.84	1862.37
56	Storage			873.30		25.37	82.93	206.56	477.00	154.40	1819.56
57	Prints/Storage			1748.32		91.61	3330.66	309.84	715.50	557.55	6753.48
58	Kitchen/staff lounge			1514.06		79.40	5084.38	1032.80	2385.00	483.21	10578.84
59	Directors office			1736.30		105.24	238.38	206.56	477.00	640.47	3403.94
60	Assistants desk			1201.12		46.98	238.38	206.56	477.00	285.93	2455.96
61	Meeting room			2159.51		154.09	1471.36	1032.80	2385.00	937.84	8140.59
62	Computer pool			5749.47		465.69	2856.21	2065.60	4770.00	2429.35	18336.31
LIBRARY-3F											
63	Reading theatre			2817.58		303.83	238.38	1755.76	4054.50	1442.34	10612.39
64	Reading theatre			4920.24		1360.80		2092.00	4770.00	4614.25	17757.28
65	Book stacks/Reading room			12302.75		5001.91		3138.00	7155.00	11872.45	39470.12
66	Learing room			1179.99		71.88	787.86	3098.40	7155.00	352.99	12646.12
67	Learing room			1179.99		71.88	787.86	3098.40	7155.00	352.99	12646.12
68	Storage			556.82		14.68	82.93	206.56	477.00	72.10	1410.09
69	Copy/print			568.72		15.27	1518.99	309.84	715.50	74.98	3203.30
70	Group Workroom			1237.59		80.57	1318.92	1032.80	2385.00	395.67	6450.55
71	Group Workroom			1179.04		72.90	1318.92	1032.80	2385.00	357.99	6346.64
72	Group Workroom			944.85		42.20	1318.92	1032.80	2385.00	207.26	5931.03
73	Group Workroom			944.85		42.20	1318.92	1032.80	2385.00	207.26	5931.03
74	Group			1105.8		63.31	1318.92	1032.80	2385.00	310.88	6216.77

	Workroom			6				80	00		
75	Study carells			3087.4 6		367.5 4	97.56	104.6 0	238.5 0	1744.7 6	5640.42
76	Multiedia workroom			2423.8 9		306.5 4	1318.92	826.2 4	1908. 00	1505.4 0	8288.99
LIBRARY-4F											
77	Book stacks/Reading room			8874.9 0		5423. 76	1318.92	3138. 00	7155. 00	10060. 07	35970.6 5
78	Reading room			3201.8 0		1196. 05	1318.92	2092. 00	4770. 00	2773.0 5	15351.8 2
LIBRARY-5F											
79	Yard		3540. 85	13350. 37	10462. 95			313.8 0	715.5 0		28383.4 6
80	Roof mechanical room		426.5 9	3982.3 6		1196. 05		313.8 0	715.5 0	3466.3 2	10100.6 1
81	Roof mechanical room		426.5 9	3982.3 6		1196. 05		209.2 0	477.0 0	3466.3 2	9757.51
LIBRARY-RF											
82	Open to below-Sky glass	99462. 82									99462.8 2
83	Roof		299.7 3		2035.5 8						2335.31
									Q0	4460285,20	
									Q0x1 .1	4906313,72	

2.3 COOLING LOAD BY HAP SOFTWARE

2.3.1 Running room model : 1st floor, Fire room

Air System Sizing Summary for CP-1F FIRE ROOM

Air System Information

Air System Name	CP-1F FIRE ROOM	Number of zones	1
Equipment Class	UNDEF	Floor Area	36.3 m ²
Air System Type	SZCAV	Location	Ho Chi Minh City, Vietnam

Sizing Calculation Information

Calculation Months	Jan to Dec	Zone L/s Sizing	Sum of space airflow rates
Sizing Data	Calculated	Space L/s Sizing	Individual peak space loads

Central Cooling Coil Sizing Data

Total coil load	5.8 kW	Load occurs at	Jul 1900
Sensible coil load	5.2 kW	OA DB / WB	32.2 / 24.3 °C
Coil L/s at Jul 1900	484 L/s	Entering DB / WB	24.6 / 18.6 °C
Max block L/s	484 L/s	Leaving DB / WB	15.8 / 15.2 °C
Sum of peak zone L/s	484 L/s	Coil ADP	14.8 °C
Sensible heat ratio	0.893	Bypass Factor	0.100
m ² /kW	6.3	Resulting RH	57 %
W/m ²	159.7	Design supply temp.	14.4 °C
Water flow @ 5.6 °K rise	0.25 L/s	Zone T-stat Check	1 of 1 OK
		Max zone temperature deviation	0.0 °K

Central Heating Coil Sizing Data

Max coil load	0.3 kW	Load occurs at	Des Htg
Coil L/s at Des Htg	484 L/s	W/m ²	8.0
Max coil L/s	484 L/s	Ent. DB / Lvg DB	21.1 / 21.6 °C
Water flow @ 11.1 °K drop	0.01 L/s		

Supply Fan Sizing Data

Actual max L/s	484 L/s	Fan motor BHP	0.00 BHP
Standard L/s	483 L/s	Fan motor kW	0.00 kW
Actual max L/(s-m ²)	13.34 L/(s-m ²)	Fan static	0 Pa

Outdoor Ventilation Air Data

Design airflow L/s	14 L/s	L/s/person	7.00 L/s/person
L/(s-m ²)	0.39 L/(s-m ²)		

Zone Sizing Summary for CP-1F FIRE ROOM

Air System Information

Air System Name CP-1F FIRE ROOM	Number of zones 1
Equipment Class UNDEF	Floor Area 36.3 m ²
Air System Type SZCAV	Location Ho Chi Minh City, Vietnam

Sizing Calculation Information

Calculation Months Jan to Dec	Zone L/s Sizing Sum of space airflow rates
Sizing Data Calculated	Space L/s Sizing Individual peak space loads

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (kW)	Design Airflow (L/s)	Minimum Airflow (L/s)	Time of Peak Load	Maximum Heating Load (kW)	Zone Floor Area (m ²)	Zone L/(s-m ²)
Zone 1	5.5	484	484	Jul 2000	0.3	36.3	13.34

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (kW)	Time of Load	Air Flow (L/s)	Heating Load (kW)	Floor Area (m ²)	Space L/(s-m ²)
Zone 1							
1. FIRE ROOM	1	5.5	Jul 2000	484	0.3	36.3	13.34

Air System Design Load Summary for CP-1F FIRE ROOM

	DESIGN COOLING			DESIGN HEATING		
	COOLING DATA AT Jul 1900			HEATING DATA AT DES HTG		
	COOLING OA DB / WB 32.2 °C / 24.3 °C			HEATING OA DB / WB 20.0 °C / 13.8 °C		
ZONE LOADS	Details	Sensible (W)	Latent (W)	Details	Sensible (W)	Latent (W)
Window & Skylight Solar Loads	0 m ²	0	-	0 m ²	-	-
Wall Transmission	104 m ²	4069	-	104 m ²	256	-
Roof Transmission	0 m ²	0	-	0 m ²	0	-
Window Transmission	0 m ²	0	-	0 m ²	0	-
Skylight Transmission	0 m ²	0	-	0 m ²	0	-
Door Loads	2 m ²	35	-	2 m ²	5	-
Floor Transmission	36 m ²	0	-	36 m ²	0	-
Partitions	0 m ²	0	-	0 m ²	0	-
Ceiling	0 m ²	0	-	0 m ²	0	-
Overhead Lighting	435 W	416	-	0	0	-
Task Lighting	0 W	0	-	0	0	-
Electric Equipment	210 W	205	-	0	0	-
People	1	82	95	0	0	0
Infiltration	-	0	0	-	0	0
Miscellaneous	-	554	315	-	0	0
Safety Factor	0% / 0%	0	0	0%	0	0
>> Total Zone Loads	-	5362	410	-	261	0
Zone Conditioning	-	5047	410	-	272	0
Plenum Wall Load	0%	0	-	0	0	-
Plenum Roof Load	0%	0	-	0	0	-
Plenum Lighting Load	0%	0	-	0	0	-
Return Fan Load	484 L/s	0	-	484 L/s	0	-
Ventilation Load	14 L/s	131	207	14 L/s	19	0
Supply Fan Load	484 L/s	0	-	484 L/s	0	-
Space Fan Coil Fans	-	0	-	-	0	-
Duct Heat Gain / Loss	0%	0	-	0%	0	-
>> Total System Loads	-	5179	617	-	291	0
Central Cooling Coil	-	5179	618	-	0	0
Central Heating Coil	-	0	-	-	291	-
>> Total Conditioning	-	5179	618	-	291	0
Key:	Positive values are clg loads Negative values are htg loads			Positive values are htg loads Negative values are clg loads		

July DESIGN COOLING DAY, 1900

System Psychrometrics for CP-1F FIRE ROOM

TABLE 1: SYSTEM DATA

Component	Location	Dry-Bulb Temp (°C)	Specific Humidity (kg/kg)	Airflow (L/s)	CO2 Level (ppm)	Sensible Heat (W)	Latent Heat (W)
Ventilation Air	Inlet	32.2	0.01588	14	400	131	207
Vent - Return Mixing	Outlet	24.6	0.01099	484	804	-	-
Central Cooling Coil	Outlet	15.8	0.01056	484	804	5179	618
Central Heating Coil	Outlet	15.8	0.01056	484	804	0	-
Supply Fan	Outlet	15.8	0.01056	484	804	0	-
Cold Supply Duct	Outlet	15.8	0.01056	484	804	-	-
Zone Air	-	24.4	0.01084	484	816	5047	410
Return Plenum	Outlet	24.4	0.01084	484	816	0	-

Air Density x Heat Capacity x Conversion Factor: At sea level = 1.207; At site altitude = 1.204 W(L/s-K)

Air Density x Heat of Vaporization x Conversion Factor: At sea level = 2947.0; At site altitude = 2941.0 W(L/s)

Site Altitude = 18.0 m

TABLE 2: ZONE DATA

Zone Name	Zone Sensible Load (W)	T-stat Mode	Zone Cond (W)	Zone Temp (°C)	Zone Airflow (L/s)	CO2 Level (ppm)	Terminal Heating Coil (W)	Zone Heating Unit (W)
Zone 1	5362	Cooling	5047	24.4	484	816	0	0

WINTER DESIGN HEATING

System Psychrometrics for CP-1F FIRE ROOM

TABLE 1: SYSTEM DATA

Component	Location	Dry-Bulb Temp (°C)	Specific Humidity (kg/kg)	Airflow (L/s)	CO2 Level (ppm)	Sensible Heat (W)	Latent Heat (W)
Ventilation Air	Inlet	20.0	0.00727	14	400	-19	0
Vent - Return Mixing	Outlet	21.1	0.00728	484	735	-	-
Central Cooling Coil	Outlet	21.1	0.00728	484	735	0	0
Central Heating Coil	Outlet	21.6	0.00728	484	735	291	-
Supply Fan	Outlet	21.6	0.00728	484	735	0	-
Cold Supply Duct	Outlet	21.6	0.00728	484	735	-	-
Zone Air	-	21.1	0.00728	484	745	-272	0
Return Plenum	Outlet	21.1	0.00728	484	745	0	-

Air Density x Heat Capacity x Conversion Factor: At sea level = 1.207; At site altitude = 1.204 W(L/s-K)

Air Density x Heat of Vaporization x Conversion Factor: At sea level = 2947.6; At site altitude = 2941.0 W(L/s)

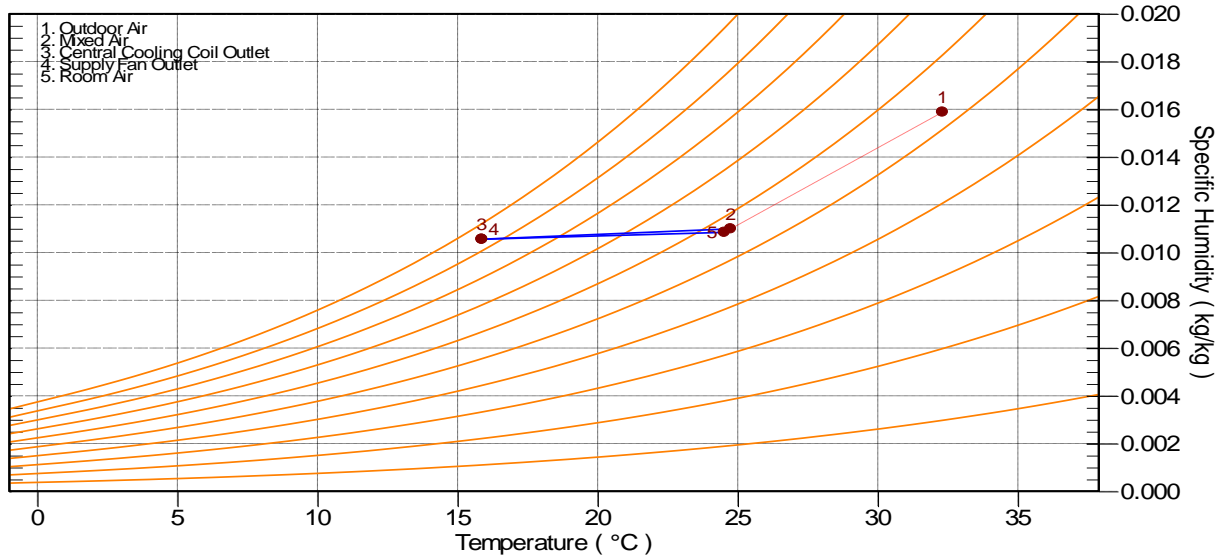
Site Altitude = 18.9 m

TABLE 2: ZONE DATA

Zone Name	Zone Sensible Load (W)	T-stat Mode	Zone Cond (W)	Zone Temp (°C)	Zone Airflow (L/s)	CO2 Level (ppm)	Terminal Heating Coil (W)	Zone Heating Unit (W)
Zone 1	-261	Deadband	-272	21.1	484	745	0	0

Psychrometric Analysis for CP-1F FIRE ROOM

Location: Ho Chi Minh City, Vietnam
 Altitude: 18.9 m.
 Data for: July DESIGN COOLING DAY, 1900



2.4 TABLE SUMMARY COOLING LOAD BY TWO METHODS

		COOLING LOAD CALCULATION BY CARRIER METHOD		COOLING LOAD CALCULATION BY HAP SOFTWARE	
NO	ROOM NAME	ΣQTONG (W)	W/m2 sàn	ΣQTONG (W)	W/m2 sàn
CENTRAL PLANT-1F					
1	Fire room	5268.20	145.29	5801.00	159.98
2	Corridor	6102.15	358.53	6634.95	389.83
3	Server room	128459.76	507.83	128992.56	509.93
4	Server room support	8560.71	155.42	9093.51	165.10
5	Chillers and Pumps room	3113910.65	3625.89	3114443.45	3626.51
6	Corridor	27213.60	174.21	27746.41	177.62
7	Fuel Storage Tank	9309.95	187.66	9842.75	198.40
8	Transformer room	18181.77	178.88	18714.57	184.13
9	Medium voltage switchgear room	18949.56	193.34	19482.36	198.78
10	Transformer room	27736.79	269.68	28269.59	274.86
11	Low voltage switchgear room	20559.59	212.39	21092.39	217.90
12	Corridor	4714.72	819.95	5247.52	912.61

13	Control center	11898.07	115.49	12430.87	120.66
14	Technical room	6639.10	138.49	7171.90	149.60
15	Odor treatment room	6288.73	120.89	6821.53	131.13
CENTRAL PLANT-2F					
16	UPS battery room	4297.26	120.14	3764.46	105.24
17	Corridor	5443.83	324.23	5976.63	355.96
18	Server room support	60257.85	656.40	59725.05	650.60
19	Server room	62074.39	341.89	62607.20	344.83
20	Storage	3095.62	137.58	2562.82	113.90
21	Corridor	7376.14	148.68	7908.94	159.42
22	Janitor	3329.61	130.68	2796.80	109.76
23	Corridor-hành lang	6306.69	215.32	6839.49	233.51
24	Electrical workroom area	6990.84	96.13	6458.03	88.81
25	Control room	4784.33	97.72	5317.13	108.60
CENTRAL PLANT-RF					
26	Cooling towers	151935.40	291.06	152468.20	292.08
27	Generator room	16086.91	46.07	16619.71	47.60
28	Mechanical room	10375.30	62.19	10908.10	65.38
29	AHU sever	11981.90	62.41	12514.70	65.18
LIBRARY-1F					
30	Conference/Training room	20937.66	192.42	20404.86	187.53
31	Storage	3470.49	459.06	4003.29	529.54
32	Janitor	2197.61	339.14	1664.81	256.92
33	Frist Aid	4309.55	231.70	4842.35	260.34
34	Aid relaxing room	4074.60	348.26	3541.80	302.72
35	Storage	3319.42	277.31	3852.22	321.82
36	Book return room	4972.03	189.19	4439.23	168.92
37	Corridor	10717.29	192.07	11250.09	201.61
38	Post room	4111.08	226.76	3578.28	197.37
39	Storage/Receiving	3758.68	204.28	4291.48	233.23
40	Porter room	3691.01	496.10	3158.21	424.49
41	Uni shop	22445.25	145.03	22978.05	148.48
42	Coffee shop	9391.37	245.72	8858.57	231.78
43	Coffee Storage room	2797.96	305.79	3330.76	364.02
44	Mechanical room	8762.31	339.62	8229.51	318.97
45	Elec/tele	3699.71	570.94	4232.51	653.16
LIBRARY-2F					
46	Journal display/reading	5099.29	482.89	5632.09	533.34
47	Journal display/reading	5099.29	482.89	5632.09	533.34
48	Journal display/reading	4998.56	537.48	5531.36	594.77

49	Journal display/reading	4998.56	537.48	5531.36	594.77
50	Group Workroom	7001.01	301.77	7533.81	324.73
51	Group Workroom	7001.01	301.77	7533.81	324.73
52	Group Workroom	7001.01	301.77	7533.81	324.73
53	Group Workroom	7001.01	301.77	7533.81	324.73
54	Storage	1883.77	261.63	2416.57	335.64
55	Storage	1862.37	267.58	2395.17	344.13
56	Storage	1819.56	280.80	2352.36	363.02
57	Prints/Storage	6753.48	288.61	7286.28	311.38
58	Kitchen/staff lounge	10578.84	521.64	11111.64	547.91
59	Directors office	3403.94	126.63	3936.74	146.46
60	Assistants desk	2455.96	204.66	2988.76	249.06
61	Meeting room	8140.59	206.82	8673.39	220.36
62	Computer pool	18336.31	154.15	18869.11	158.63
LIBRARY-3F					
63	Reading theatre	10612.39	141.46	10079.59	134.36
64	Reading theatre	17757.28	52.85	18290.08	54.43
65	Book stacks/Reading room	39470.12	31.96	38937.32	31.53
66	Learing room	12646.12	688.79	13178.92	717.81
67	Learing room	12646.12	688.79	12113.31	659.77
68	Storage	1410.09	376.02	1942.89	518.10
69	Copy/print	3203.30	821.36	2670.50	684.74
70	Group Workroom	6450.55	313.44	6983.35	339.33
71	Group Workroom	6346.64	340.85	5813.84	312.24
72	Group Workroom	5931.03	550.19	6463.83	599.61
73	Group Workroom	5931.03	550.19	5398.23	500.76
74	Group Workroom	6216.77	384.46	6749.57	417.41
75	Study carells	5640.42	62.15	5107.61	56.28
76	Multimedia workroom	8288.99	105.86	8821.79	112.67
LIBRARY-4F					
77	Book stacks/Reading room	35970.65	26.86	36503.45	27.26
78	Reading room	15351.82	51.98	15884.63	53.79
LIBRARY-5F					
79	Yard	28383.46	8.90	27850.66	8.73
80	Roof mechanical room	10100.61	34.20	10633.41	36.01
81	Roof mechanical room	9757.51	33.04	9224.71	31.24
LIBRARY-RF					
82	Open to below-Sky glass	99462.82	28.21	99995.62	28.36
83	Roof	2335.31	11.25	2868.11	13.82