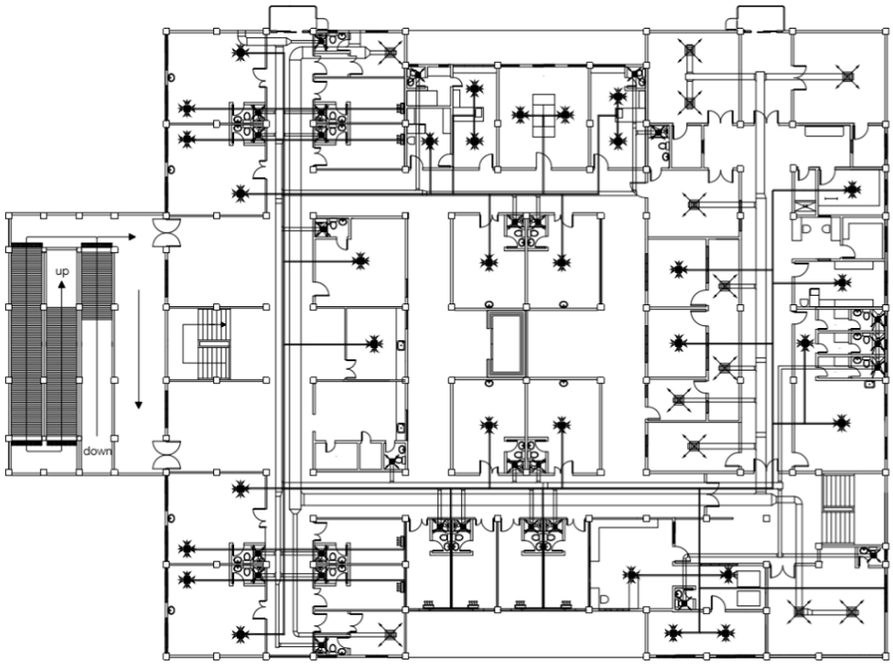
DESIGN OF CHILLED WATER TYPE AIR CODITIONING AND VENTILATION SYSTEM OF PROPOSAL THREE STOREY HOSPITAL IN BATANGAS



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DECEMBER 2019

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EXECUTIVE SUMMARY

Air Conditioning System in Hospitals provide a range of services with a unique environmental condition to adjust the comfort level of both ambient temperature and air humidity. The proponents designed a project that follows in the criteria for the design of health care facilities within their jurisdictions. A jurisdiction may utilize its own criteria and codes or cite model, national, or international building codes or design standards. Some adopted or cited codes, standards, and design guidelines relating to health care facility Air Conditioning Systems include Guidelines for Design and Construction of Hospital and Health Care Facilities known as the FGI Guidelines and ANSI/ASHRAE/ASHE Standard 170-2008, Ventilation of Health Care Facilities. Typical Criteria for Air Conditioning design include indoor and outdoor environmental design conditions; outdoor air and total air change requirements; economic considerations for equipment selection and other benchmarks for systems and equipment selection and sizing. The proponents used Chilled Water System for the applications of large cooling capacity. In addition to fundamental design criteria, a careful decision was done in choosing the appropriate air conditioning design and other equipment upon obtaining the values from the calculations of heat load analysis of Three Storey building hospital. There are engineering decisions made in the proper placement of the mechanical equipment throughout the layout of this building to satisfy all the requirements that the building demands.

CHAPTER I

PROJECT LOCATION AND DESIGN BUILDING ORIENTATION

Introduction

Air Conditioning has a big importance to daily lives to make sure everyone feels comfortable and happy while working hard. For hospital, it needs a functional Air-Conditioning System to stay operational. This is especially true for places like a clean room or an operating room. It provides a broad range of services in support of populations who are uniquely vulnerable to an elevated risk of health, fire, and safety hazard. These heavily regulated, high-stakes facilities undergo continuous maintenance, verification and inspection; typically operate 24hours/day, 7hours/week; and are health care organization for long life cycles. Hospital facilities and services are characterized by high rates of modification because of the continuously evolving science and economics of health care, and consume large quantities of energy and potable water. The often unique environmental conditions associated with these facilities, and the critical performance, reliability and maintainability of Air-Conditioning Systems necessary to their success, demand a specialized set of engineering practices and design criteria established by technical standards and guidelines like in accordance with the procedures outlined in the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Handbook of Fundamentals.

It is important to follow the design considerations for the hospital to create a comfortable environment for occupants and patients. Hospital air conditioning and ventilation systems are tasked with controlling temperature, air flow, air quality and humidity. It is essential to the healing and recovery process. Also, it works with in close coordination with specific medical practices. One example for the design of operating rooms which has specific requirements that include pressurization and higher levels of air filtration in addition to temperature and humidity control.

The design of the Three Storey Hospital Building would most be beneficial to the patients who are injured and sick and provide a comfortable environment in facilitating for healing and recovery. The design of the Air-Conditioning System would also benefit to the students who are taking the subject of Air Condition and Ventilation System (ME-517) which may serve as a reference material and the standards for the requirements of designing a hospital. And for the future researchers who are interested to that kind of matter, this material will help them to be a basis in their research especially for hospitals.

Subject of the Report

The subject of the report includes the following:

- Building Layout

  This includes the presentation of the evaluation of climate conditions, building orientation, components and other factors that contribute to the cooling load of the conditioned space.

  The layout of the building is included in the appendices.

- Load Calculation

  Heating load calculations or cooling load calculations are used to identify the heating or cooling load capacity that a conditioned space needs to stay cool at summer and warm at winter. The process was developed by the Heating, Ventilating and Air Conditioning (HVAC) industries and has been used for decades to accurately design a heating and air conditioning equipment. In the ventilated space of the building, the block load maximum peak hour load calculation will be used.

  Cooling load calculations using the procedures in ASHRAE manual and guide book with the selected indoor and outdoor conditions. The calculations include:

  - External Load
  - Internal Load

  Also, it includes the presentation the psychrometric calculation for the selection of equipment.

- Ducting System

  The ducting design layout is included in the appendices.

- Piping Design

  The piping design layout is included in the appendices.

- A/C Equipment Selection

  The design will utilize the use of chilled water type of airconditioning system and fan coil units. Also, split-type will be used on some spaces.

- System Cost Estimation

  It is the approximation of the cost of the project which also includes engineering economic analysis. It employs the different methods for

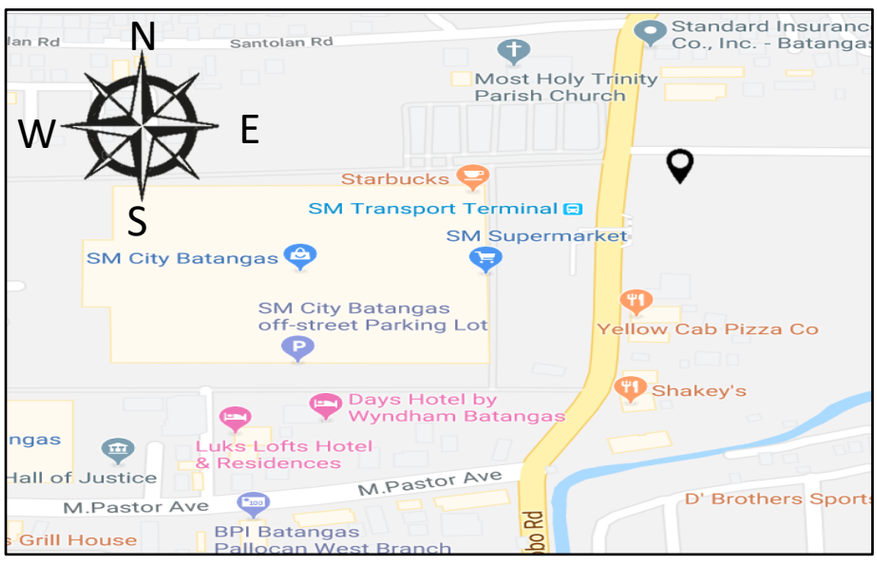
investment of capital and comparing alternatives which will be useful for selecting appropriate equipment for that system for cost minimization.

Project Location and Design Building Orientation

- Location Map

The building is to be located at Batangas-Tabangao-Lobo Rd., Barangay Pallocan West, Batangas City. The front elevation of the building is facing east and the rear is facing west.

Using the google earth application, the location map of the proposed site viewed by satellite is shown in Figure 5.0. It has a total perimeter of 171 m and total area of 1819 m^2.



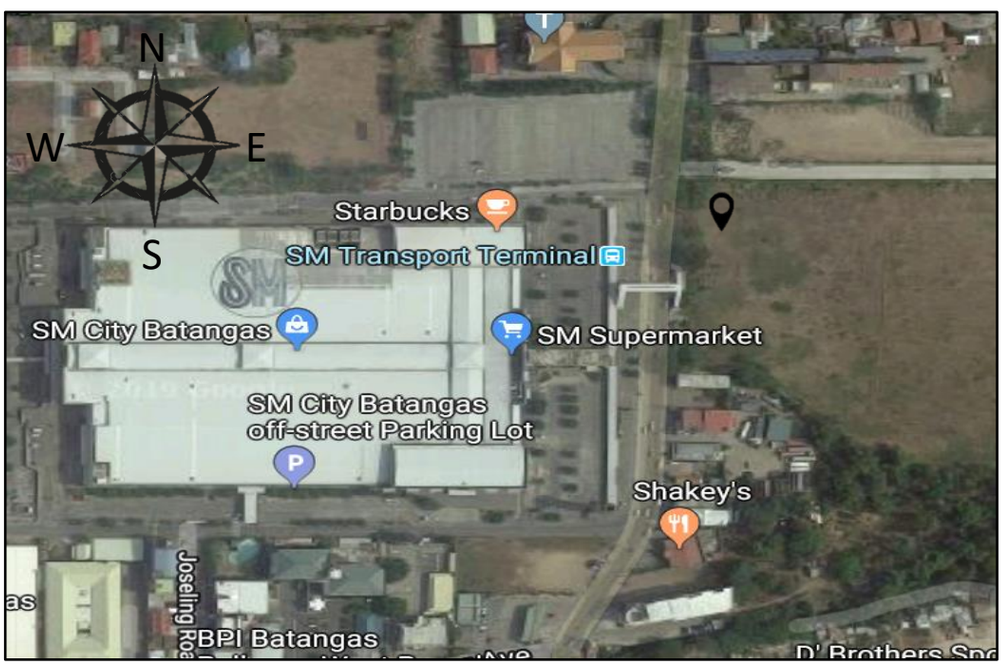


Figure 1.0 Location Map of Three-Storey Hospital Building

CHAPTER II

DESIGN CALCULATION AND EQUIPMENT SELECTION

This chapter presents the essential data required in establishing the appropriate air conditioning system to be used in the design proper. This includes the building components, material construction, heat load calculation, psychrometric calculation including the psychrometric chart plotting, and piping calculation.

The ground floor of the hospital has less than 70 spaces which primarily consists of work area, storage rooms, operating rooms, examination/ treatment area, emergency room, X-Ray room, OPD clinic medical rooms, administrative office, dark and control rooms, staff dining area, and canteen.

The second floor has also less than 70 spaces which primarily consists of bedwards for patients, isolation rooms, treatment rooms, dirty utility and clean linen, nurse station, conference room, delivery room, labor room, nurseries, breastfeeding room, operating rooms, supply and storage rooms.

The third floor of the hospital has less than 50 spaces which is actually the same rooms for the second room except there is a chapel.

Data Gathering

A. Building Components and Materials Construction

This section presents the materials used and the composition of the building walls, roofs, doors, glass windows, and partitions.

1. External Wall

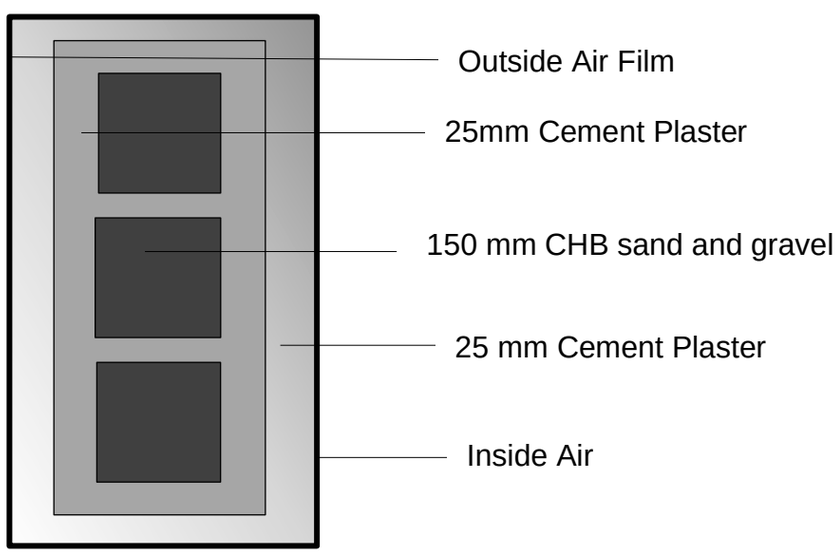


Figure 2.0 External Wall Construction

	R, $m^2\,^0K/Watt$	ρ_S, Kg/m^2
outside air film	0.0440	---
25 cement plaster	0.0347	39.95
150mm CHB sand and gravel	0.1350	147
25 cement plaster	0.0347	39.95
inside air film	0.12	---
	R_T = 1.2695	ρ_{ST} = 226 Kg/m^2
	U_W = 2.7144 W/m^2K	**TYPE F**

Table 1.0 Properties of each Components of External Wall

This table presents the composition of external wall including the outside and inside surface resistance, 25 mm cement plaster and 150 mm CHB with their corresponding thermal resistivity and surface density. Moreover, the heat transfer coefficient, U, is obtained by getting the inverse of the summation of the resistances of the components. Therefore, use Type F Wall. The height of the wall is 3 meters with permanent light color. Since the total mass per unit area of wall is greater than 226 kg/m2, the type of wall to be used was type F. See Appendix B.

2. Glass Portion

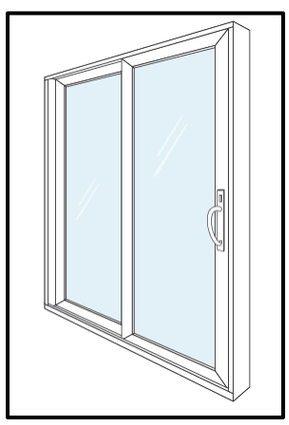


Figure 3.0 Glass Window Construction

Single Glass, Regular Sheet, Light Venetian Blinds

Number of panels = one to four panels

Area = depends on the architectural plan

Height = 2 m, 0.6 m

Heat Transfer Coefficient use U = 2.8211 W/m2K (fixed)

Heat Transfer Coefficient use U = 2.8722 W/m2K (awning, sliding)

Window Details

Ground Floor	
Dimension(m)	**Description**
2 x 2	Fixed Window
2 x 2	Sliding Window
1.2 x 2	Fixed Window
1.2 x 2	Awning Window
1.4 x 2	Sliding Window
0.6 x 0.6	Awning Window
1.6 x 2	Fixed Window
2.4 x 2	Fixed Window
0.9 x 0.6	Sliding Window
2.44 x 2	Sliding Window
1.28 x 2	Sliding Window
1 x 2	Sliding Window
4.2 x 2	Sliding Window
1.5 x 2	Sliding Window
3.35 x 2	Fixed Window
5.6 x 2	Fixed Window
1.8 x 2	Awning Window
2.2 x 2	Fixed Window

Table 2.0 Ground Floor Window Schedule

This table shows the dimensions of the window included in the ground floor.

Second Floor	
Dimension(m)	**Description**
2.3 x 2	Sliding Window
2.4 x 2	Fixed Window
0.6 x 0.6	Awning Window
1.4 x 2	Sliding Window
1.4 x 2	Fixed Window
1.2 x 2	Fixed Window
2 x 2	Sliding Window
2.7 x 2	Sliding Window
1.95 x 2	Sliding Window
2.1 x 2	Sliding Window
0.8 x 0.6	Fixed Window
1.6 x 2	Fixed Window

Table 3.0 Second Floor Window Schedule

This table shows the dimensions of the window included in the second floor.

Third Floor	
Dimension(m)	**Description**
2.3 x 2	Sliding Window
2.4 x 2	Fixed Window
2.7 x 2	Sliding Window
1.44 x 2	Sliding Window
1.44 x 2	Fixed Window
3.33 x 2	Sliding Window
0.6 x 0.6	Fixed Window

1.2 x 0.6	Awning Window
2 x 2	Sliding Window
0.8 x 2	Fixed Window
2.23 x 2	Sliding Window
2.4 x 2	Sliding Window
2.51 x 2	Fixed Window
3.51 x 2	Fixed Window
2.18 x 2	Fixed Window

Table 4.0 Third Floor Window Schedule

This table shows the dimensions of the window included in the third floor.

3. **External Roof**

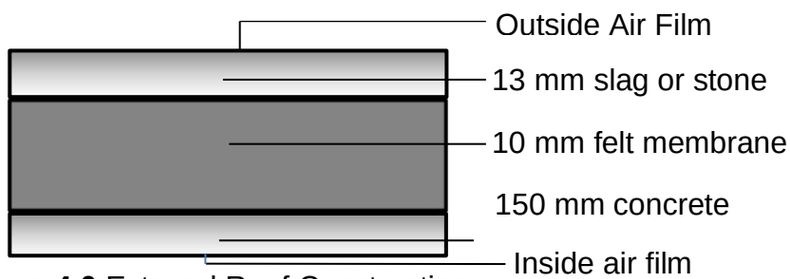


Figure 4.0 External Roof Construction

	R, m^2K/W	ρ_S, Kg/m^2
outside air film	0.044	---
25 mm granite	0.01375	42.5
200 mm concrete block, sand and gravel	0.18	196
25 mm cement plaster	0.02919	39.95
inside air film	0.12	---
	R_T = 1.104 m^2K/W	ρ_{ST} = 278.45 kg/m^2
	U_W = 2.58438 W/m^2K	**TYPE 6** roof with suspended ceiling

Table 5.0 Properties of each Components of External Roof

This table presents the composition of roof including the outside and inside surface resistance, 25 mm granite, 25 mm cement plaster and 200 mm concrete block, sand and gravel with their corresponding thermal resistivity and surface density. Moreover, the heat transfer coefficient, U, is obtained by getting the inverse of the summation of the resistances of the components. Therefore, use Type 6 – Roof with suspended ceilings.

4. **Partition**

4.1 Internal Wall Partition

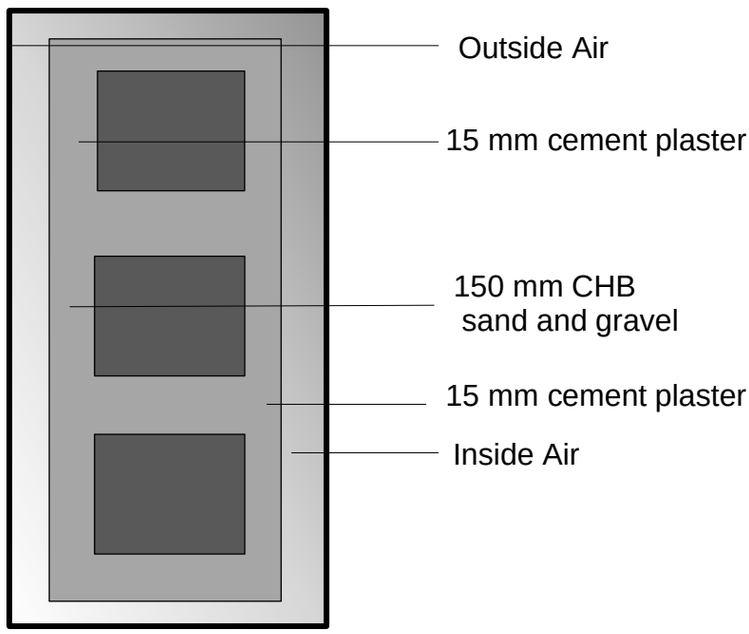


Figure 5.0 Internal Wall Construction

	R, $m^2\,^oK/Watt$	ρ_S, Kg/m^2
inside air film	0.12	---
15 mm cement plaster	0.0208	23.97
120 mm CHB sand and gravel	0.1350	117.6
15 mm cement plaster	0.0208	23.97
inside air film	0.12	---
	R_T = 0.3896 m^2K/W	ρ_{ST} = 165.54 Kg/m^2
	U_W = 2.5667 W/m^2K	**TYPE F**

Table 6.0 Properties of each Components of Internal Wall

This table presents the composition of external wall including the outside and inside surface resistance, 15 mm cement plaster and 120 mm CHB with their corresponding thermal resistivity and surface density. Moreover, the heat transfer

coefficient, U, is obtained by getting the inverse of the summation of the resistances of the components. The height of the wall is 4 meters with permanent light color. Since the total mass per unit area of wall is 165.54 kg/m^2, the type of wall to be used was type F because this value is nearest to 200 kg/m^2. See in Appendix.

4.2 Partition Door

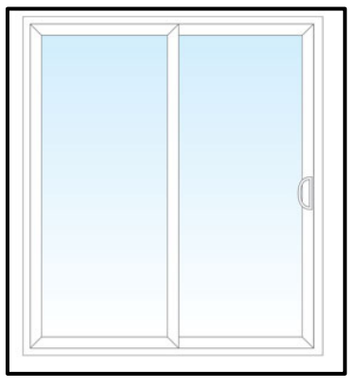


Figure 6.0 Glass Door Construction

		Description	U
D1	Single glass door	Powder-coated white aluminum frame single swing door with 6mm thick, clear glass	2.3576
D2	Double glass door	Powder-coated white aluminum frame double swing door with 6mm thick, clear glass	2.3576
D3	Uneven glass door	Powder-coated white aluminum frame uneven swing door with 6mm thick, clear glass	2.3576
D4	Kicking door	Double swing door with laminated surface, glass view panel S.S. push and kick plate	1.5625

D5	Comfort Room door	Single single fire rated metal door (1hr fire resistance)	1.6048

Table 7.0 Details of Door

This table shows the types and heating coefficient of each door included in the hospital building. The kinds of the doors used in the hospital are single and double glass door, kicking door, uneven glass door and comfort room door.

Design Calculation:

Table 8.0

Load Calculation Results for Zone 1

Space	LOADS (KW)													TOTAL (KW)	
	Wall	Glass	Roof	Occupant		Light	Misc. load		Infiltration		Ventilation		Parti-tion	Sensi-ble	La-tent
				Qs	Ql		Qs	Ql	Qs	Ql	Qs	Ql			
Emergency Room	0.48	0.15	0	0.07	0.02	0.17	0.77	0.38	0.11	0.21	0.7	1.34	0.62	3.07	1.95
Work Area Lab	1.47	0.09	0	0.07	0.01	0.36	0	0	0.15	0.29	0.62	1.19	0.28	3.04	1.49

This table shows the load calculation results for zone 1 at ground floor which has a temperature of 22 °C.

Table 9.0

Load Calculation Results for Zone 2

Space	LOADS (KW)													TOTAL (KW)	
	Wall	Glass	Roof	Occupant		Light	Misc. load		Infiltration		Ventilation		Parti-tion	Sensi-ble	La-tent
				Qs	Ql		Qs	Ql	Qs	Ql	Qs	Ql			
Storage Room	0	3.02	0	0	0	0.06	0	0	0.03	0.06	0	0	0.18	3.29	0.06
Eq. and Supply Sto.	0	0	0	0	0	0.03	0	0	0.02	0.04	0	0	0.03	0.08	0.04
Bulk Storage	0	0	0	0	0	0.04	0	0	0.01	0.03	0	0	0.18	0.23	0.03
Film File Storage	0.41	0.12	0	0	0	0.03	0	0	0.02	0.04	0	0	0.1	0.68	0.04
Linen Storage	0	0	0	0	0	0.06	0	0	0.03	0.06	0	0	0.12	0.21	0.06
Linen Office	0	0	0	0.03	0.01	0.06	0.09	0.05	0.03	0.07	0.07	0.14	0	0.28	0.27
Cooking Area	0	1.04	0	0	0	0.25	8.17	4.13	1.24	2.55	0	0	0	10.7	6.68
Dry Storage	0	0	0	0	0	0.02	0	0	0.01	0.02	0	0	0.06	0.09	0.02
Cold Storage	0	0	0	0	0	0.01	0	0	0.01	0.02	0	0	0	0.02	0.02
Dietary	0	0.32	0	0.05	0.01	0.28	0	0	1.39	3.1	0.15	0.29	1.59	3.78	3.4
Staff Dining	1.56	0	0	0.05	0.01	0.56	2.37	1.2	1.85	4.15	0.59	0.12	0	6.98	5.48
Canteen	2.09	3.02	0	0.05	0.01	1.33	0.08	0.04	6.62	1.38	2.07	4.24	0.26	15.5	5.67

This table shows the load calculation results for zone 2 at ground floor which has a temperature of 24 °C.

Table 10.0

Load Calculation Results for Zone 3

Space	LOADS (KW)													TOTAL (KW)	
	Wall	Glass	Roof	Occupant		Light	Misc. load		Infiltration		Ventilation		Parti-tion	Sensi-ble	La-tent
				Qs	Ql		Qs	Ql	Qs	Ql	Qs	Ql			
Power House	2.06	1.34	0	0	0	0.41	0	0	0.16	0.29	0	0	0.38	4.35	0.29
Maintenance Off.	0.38	1.46	0	0.04	0.02	0.12	0.02	0.02	0.03	0.06	0.24	0.47	0.45	2.74	0.57
Emergency Room	3.34	1.17	0	0.06	0.08	0.53	0.02	0.01	0.57	1.11	0.59	1.16	0.51	6.79	2.36

Cad. Holding Rm	1.52	0.54	0	0	0	0.15	0	0	0.09	0.17	0	0	0.26	2.56	0.17
Supply Room	0	0	0	0.07	0.02	0.23	0.1	0.05	0.14	0.27	0.11	0.22	0.58	1.23	0.56
Pharmacy	0	0	0	0.07	0.04	0.23	0.1	0.05	0.09	0.18	0.24	0.47	0.88	1.61	0.74
Med. Records Off.	0	0	0	0.08	0.03	0.2	0.1	0.05	0.08	0.15	0.07	0.15	0.68	1.21	0.38
Med. Records	0	0	0	0	0	0.2	0	0	0.08	0.16	0	0	0	0.28	0.16
PHILHEALTH	0	0	0	0.08	0.03	0.13	0	0	0.08	0.15	0.24	0.47	0.66	1.19	0.65
Dr. Duty	0	0	0	0.06	0.04	0.09	0.1	0.05	0.05	0.1	0.04	0.07	0.21	0.55	0.26
Waiting Area	0	0	0	0	0	0.14	0	0	0.06	0.11	0	0	0	0.2	0.11
OPD Clinic Dental 1	0	0	0	0.07	0.04	0.11	0.1	0.05	0.06	0.12	0.08	0.15	0.43	0.85	0.36
OPD Clinic Dental 2	0	0	0	0.07	0.04	0.11	0.1	0.05	0.06	0.12	0.08	0.15	0.28	0.7	0.36
OPD Clinic Surg. 1	0	0	0	0.07	0.04	0.11	0.1	0.05	0.06	0.12	0.08	0.15	0.43	0.85	0.36
OPD Clinic Surg. 2	0	0	0	0.07	0.04	0.11	0.1	0.05	0.06	0.12	0.08	0.15	0.43	0.85	0.36
Cashier	0	0	0	0.08	0.06	0.06	0.17	0.09	0.03	0.05	0.04	0.08	0.36	0.74	0.28
Billing	0	0	0	0.08	0.06	0.06	0.17	0.09	0.03	0.05	0.04	0.08	0.18	0.56	0.28
Admitting	0	0	0	0.08	0.06	0.06	0.1	0.05	0.03	0.05	0.04	0.08	0.18	0.49	0.24
Radiologist off.	0	0	0	0.07	0.07	0.07	0.06	0.03	0.04	0.08	0.04	0.08	0	0.28	0.26
Dark Rm	0	0	0	0.06	0.02	0.04	0	0	0.02	0.04	0.12	0.23	0	0.24	0.29
Control Booth	0	0	0	0.06	0.01	0.19	0	0	0.11	0.21	0.36	0.7	0	0.72	0.92
OPD Clinic Pedia 1	0	0	0	0.06	0.02	0.11	0.1	0.05	0.06	0.12	0.08	0.15	0.43	0.84	0.34
OPD Clinic Pedia 2	0	0	0	0.06	0.02	0.11	0.1	0.05	0.06	0.12	0.08	0.15	0.14	0.55	0.34
OPD Records	0	0	0	0	0	0.08	0	0	0.05	0.09	0	0	0.38	0.51	0.09
OPD info. and ad.	0	0	0	0.08	0.06	0.08	0.1	0.05	0.04	0.09	0.04	0.08	0.36	0.7	0.28
OPD Clinic Med 1	0	0	0	0.06	0.02	0.11	0.1	0.05	0.06	0.12	0.08	0.15	0.14	0.55	0.34
OPD Clinic Med 2	0	0	0	0.06	0.02	0.11	0.1	0.05	0.06	0.12	0.08	0.15	0.43	0.84	0.34
Pressing Area	0.68	0.67	0	0	0	0.06	0	0	0.04	0.07	0	0	0	1.45	0.07
Admin Off.	0	0	0	0.08	0.02	0.1	0.14	0.07	0.06	0.12	0.04	0.08	0.25	0.67	0.29
Washing area	0	0.57	0	0	0	0.13	0	0	0.08	0.15	0	0	0	0.78	0.15
Receiving area	0	0	0	0	0	0.06	0	0	0.04	0.08	0	0	0	0.1	0.08
Administrative off.	0	0	0	0.08	0.02	0.1	0.14	0.07	0.15	0.3	0.15	0.29	1	1.62	0.68
Social welfare	0	0	0	0.06	0.04	0.1	0.13	0.07	0.06	0.12	0.04	0.07	0.28	0.67	0.3
Ultrasound	2.76	0	0	0.06	0.02	0.14	0.08	0.04	0.09	0.16	0.24	0.47	0.44	3.81	0.69
Supply rec. area	0	0	0	0.07	0.07	0.06	0.1	0.05	0.03	0.05	0.04	0.07	0.29	0.59	0.24
Dietician's off.	1.03	0.39	0	0.08	0.06	0.07	0.05	0.03	0.04	0.08	0.04	0.07	0.02	1.72	0.24
OPD clinic ob-gyne	2.11	0.48	0	0.06	0.01	0.2	0.1	0.05	0.12	0.23	0.11	0.22	0.71	3.89	0.51

This table shows the load calculation results for zone 3 at ground floor which has a temperature of 22.5 °C.

Table 11.0

Load Calculation Results for Zone 4

Space	LOADS (KW)													TOTAL (KW)	
	Wall	Glass	Roof	Occupant		Lights	Misc. load		Infiltration		Ventilation		Parti-tion	Sensi-ble	La-tent
				Qs	Ql		Qs	Ql	Qs	Ql	Qs	Ql			
Dirty Utility	0.00	0.00	0.00	0.07	0.08	0.04	0.00	0.00	0.02	0.04	0.03	0.07	0.33	0.49	0.18
Clean Linen	0.00	0.00	0.00	0.07	0.08	0.02	0.00	0.00	0.01	0.02	0.03	0.07	0.14	0.26	0.16
Sub-Ster Room 1	0.00	0.22	0.00	0.07	0.08	0.06	0.00	0.00	0.02	0.04	0.03	0.07	0.22	0.62	0.18
Sterile supply room	0.00	1.70	0.00	0.06	0.04	0.24	0.07	0.03	0.08	0.16	0.16	0.33	0.05	2.35	0.57
Sub-Ster Room 2	0.44	0.22	0.00	0.07	0.08	0.06	0.00	0.00	0.02	0.04	0.03	0.07	0.20	1.05	0.18
Jan.Clo.	0.00	0.00	0.00	0.07	0.08	0.03	0.00	0.00	0.02	0.03	0.03	0.07	0.20	0.34	0.17
Clean up room	0.00	0.22	0.00	0.07	0.08	0.09	0.00	0.00	0.05	0.10	0.10	0.20	0.09	0.62	0.37
Sterile Instrument Supply Storage Area	1.08	0.00	0.00	0.06	0.04	0.08	0.00	0.00	0.03	0.06	0.06	0.13	0.12	1.43	0.23
Anesthesia Office & Storage	0.00	0.22	0.00	0.08	0.07	0.19	0.13	0.06	0.06	0.13	0.13	0.27	0.26	1.07	0.53

This table shows the load calculation results for zone 4 at ground floor which has a temperature of 24°C.

Table 12.0

Load Calculation Results for Zone 5

Space	LOADS (KW)													TOTAL (KW)	
	Wall	Glass	Roof	Occupant		Lights	Misc. load		Infiltration		Ventilation		Parti-tion	Sensi-ble	La-tent
				Qs	Ql		Qs	Ql	Qs	Ql	Qs	Ql			
Delivery Room	1.69	0	0	0.08	0.07	0.38	0.00	0.00	0.16	0.31	0.99	1.90	0.10	3.39	2.28
Pre-operation area	0.00	0	0	0.07	0.08	0.14	0.69	0.35	0.09	0.17	0.92	1.79	0.82	1.70	2.38
Major Operating Room	2.38	0	0	0.07	0.08	0.26	0.78	0.40	0.16	0.31	1.85	3.57	0.65	2.79	4.35

This table shows the load calculation results for zone 5 at second floor which has a temperature of 22°C.

Table 13.0

Load Calculation Results for Zone 6

Space	LOADS (KW)													TOTAL (KW)	
	Wall	Glass	Roof	Occupant		Lights	Misc. load		Infiltration		Ventilation		Parti-tion	Sensi-ble	La-tent
				Qs	Ql		Qs	Ql	Qs	Ql	Qs	Ql			
5 Bed Ward 1	2.13	0.44	0.00	0.05	0.02	0.38	0.01	0.00	0.15	0.29	0.96	1.88	0.33	4.44	2.20
5-Bed Ward 2	0.73	0.44	0.00	0.05	0.02	0.38	0.01	0.00	0.15	0.29	0.96	1.88	0.72	3.43	2.20

5-Bed Ward 3	0.73	0.44	0.00	0.05	0.02	0.38	0.01	0.00	0.15	0.29	0.96	1.88	0.72	3.43	2.20
5-Bed Ward 4	2.50	0.44	0.00	0.05	0.02	0.38	0.01	0.00	0.15	0.29	0.96	1.88	0.33	4.81	2.20
Isolation Room 1	1.28	0.48	0.00	0.05	0.02	0.15	0.00	0.00	0.06	0.12	0.38	0.75	0.16	2.56	0.89
Private Room 1	0.00	1.03	0.00	0.05	0.02	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.17	1.89	0.91
Private Room 2	0.00	1.03	0.00	0.05	0.02	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.51	2.24	0.91
Chief Nurse	0.00	0.00	0.00	0.06	0.04	0.23	0.07	0.04	0.13	0.26	0.26	0.51	1.03	1.78	0.84
Treatment Room	0.00	0.00	0.00	0.05	0.02	0.20	0.02	0.01	0.08	0.15	0.24	0.46	0.80	1.39	0.64
Private Room 3	0.00	1.03	0.00	0.05	0.02	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.51	2.24	0.91
Private Room 4	0.00	1.03	0.00	0.05	0.02	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.15	1.88	0.91
Isolation Room 2	0.00	0.47	0.00	0.05	0.02	0.15	0.00	0.00	0.06	0.12	0.38	0.75	0.15	1.27	0.89
Reception	0.00	0.00	0.00	0.06	0.04	0.08	0.00	0.00	0.05	0.09	0.38	0.75	0.22	0.80	0.89
Private Room 5	0.61	1.03	0.00	0.05	0.02	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.15	2.49	0.91
Chief of Hospital	0.44	0.91	0.00	0.06	0.04	0.14	0.13	0.07	0.08	0.16	0.11	0.22	0.22	2.09	0.48
3-Bed Ward 1	0.00	0.00	0.00	0.05	0.02	0.28	0.01	0.00	0.11	0.22	0.58	1.13	0.86	1.88	1.37
3-Bed Ward 2	0.00	0.00	0.00	0.05	0.02	0.28	0.01	0.00	0.11	0.22	0.58	1.13	0.91	1.93	1.37
Private Room 6	0.61	1.03	0.00	0.05	0.02	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.15	2.49	0.91
Conference Room	1.10	1.21	0.00	0.08	0.09	0.28	0.30	0.15	0.17	0.33	1.54	3.01	0.35	5.03	3.58
3-Bed Ward 3	0.00	0.00	0.00	0.05	0.02	0.28	0.01	0.00	0.11	0.22	0.58	1.13	0.79	1.81	1.37
3-Bed Ward 4	0.00	0.00	0.00	0.05	0.02	0.28	0.01	0.00	0.11	0.22	0.58	1.13	0.93	1.95	1.37
Private Room 7	0.61	1.03	0.00	0.05	0.02	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.15	2.49	0.91
Private Room 8	0.61	1.03	0.00	0.05	0.02	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.15	2.49	0.91
Chief of Clinics	0.69	0.71	0.00	0.08	0.07	0.16	0.13	0.07	0.09	0.18	0.18	0.36	0.34	2.38	0.68
Labor Room	0.00	0.00	0.00	0.07	0.08	0.28	0.00	0.00	0.11	0.22	0.71	1.39	0.65	1.83	1.68
Pathologic Nursery	0.00	0.00	0.00	0.05	0.02	0.18	0.00	0.00	0.07	0.14	0.15	0.29	0.23	0.69	0.45
Pre-mature nursery	0.00	0.00	0.00	0.05	0.02	0.18	0.00	0.00	0.07	0.14	0.15	0.29	0.24	0.69	0.45
Breastfeeding room	0.00	0.00	0.00	0.06	0.04	0.07	0.00	0.00	0.04	0.09	0.07	0.14	0.18	0.42	0.27
Autoclave area	0.00	0.00	0.00	0.06	0.04	0.11	0.44	0.22	0.06	0.13	0.35	0.70	0.00	1.03	1.09
Lounge Area	0.91	0.39	0.00	0.07	0.08	0.45	0.00	0.00	0.18	0.35	0.35	0.70	1.04	3.39	1.12
Recovery Room	2.99	0.33	0.00	0.05	0.02	0.52	0.00	0.00	0.20	0.40	0.71	1.39	0.46	5.26	1.81
Work Area (inside)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.00	0.00	0.72	0.83	0.20
Sterile Supply room	1.08	1.70	0.00	0.06	0.04	0.24	0.07	0.03	0.08	0.16	0.16	0.33	0.05	3.43	0.57

This table shows the load calculation results for zone 6 at second floor which has a temperature of 22.5°C.

Table 14.0

Load Calculation Results for Zone 7

Space	LOADS (KW)													TOTAL (KW)	
	Wall	Glass	Roof	Occupant		Light	Misc. load		Infiltration		Ventilation		Parti-tion	Sensi-ble	La-tent
				Qs	Ql		Qs	Ql	Qs	Ql	Qs	Ql			
Dirty Utility	0	0	0	0	0	0	0	0	0.02	0.04	0	0	0.13	0.29	0.04
Clean Linen	0	0	0	0	0	0	0	0	0.01	0.02	0	0	0.21	0.29	0.02

Personel's Dining	1.91	0.14	0.92	0.13	0.08	0.3	0.62	0.32	0.1	0.2	0.62	1.28	0.25	4.97	1.87

This table shows the load calculation results for zone 7 at ground floor which has a temperature of 24°C.

Table 15.0

Load Calculation Results for Zone 8

Space	LOADS (KW)													TOTAL (KW)	
	Wall	Glass	Roof	Occupant		Lights	Misc. load		Infiltration		Ventilation		Parti-tion	Sen-sible	La-tent
				Qs	Ql		Qs	Ql	Qs	Ql	Qs	Ql			
5 Bed Ward	2.45	0.08	1.16	0.24	0.08	0.38	0.01	0.00	0.15	0.29	0.96	1.88	0.30	5.72	2.26
5 Bed Ward	0.68	0.08	1.16	0.24	0.08	0.38	0.01	0.00	0.15	0.29	0.96	1.88	0.69	4.35	2.26
5 Bed Ward	0.68	0.08	1.16	0.24	0.08	0.38	0.01	0.00	0.15	0.29	0.96	1.88	0.69	4.35	2.26
5 Bed Ward	3.01	0.08	1.16	0.24	0.08	0.38	0.01	0.00	0.15	0.29	0.96	1.88	0.30	6.29	2.26
Isolation Room	1.44	0.05	0.34	0.03	0.05	0.11	0.06	0.03	0.04	0.09	0.38	0.75	0.12	2.58	0.92
Private Room 1	0.00	0.00	0.47	0.02	0.05	0.15	0.05	0.02	0.06	0.12	0.19	0.38	0.12	1.06	0.57
Private Room 2	0.00	0.00	0.47	0.03	0.05	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.52	1.67	0.94
Chief Nurse	0.00	0.00	1.04	0.43	0.08	0.23	0.07	0.04	0.13	0.26	0.26	0.51	0.99	3.15	0.88
Treatment Room	0.00	0.00	0.61	0.07	0.06	0.13	0.02	0.01	0.08	0.15	0.24	0.46	0.90	2.05	0.68
Private Room 3	0.00	0.00	0.47	0.03	0.05	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.48	1.63	0.94
Private Room 4	0.00	0.00	0.47	0.03	0.05	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.12	1.27	0.94
Isolation Room	1.92	0.05	0.34	0.02	0.05	0.11	0.00	0.00	0.04	0.09	0.19	0.38	0.12	2.79	0.51
Private Room 10	0.95	0.05	0.54	0.03	0.05	0.18	0.05	0.02	0.07	0.14	0.38	0.75	0.12	2.37	0.96
Private Room 9	0.95	0.05	0.54	0.03	0.05	0.18	0.05	0.02	0.07	0.14	0.38	0.75	0.12	2.37	0.96
Private Room 6	0.95	0.05	0.47	0.03	0.05	0.17	0.05	0.02	0.07	0.13	0.38	0.75	0.12	2.30	0.96
Private Room 5	0.95	0.05	0.47	0.03	0.05	0.17	0.05	0.02	0.07	0.13	0.38	0.75	0.12	2.30	0.96
3-Bed Ward	0.00	0.00	0.84	0.14	0.05	0.27	0.01	0.00	0.11	0.21	0.58	1.13	0.68	2.63	1.39
3-Bed Ward	0.00	0.00	0.84	0.14	0.05	0.27	0.01	0.00	0.11	0.21	0.58	1.13	0.68	2.64	1.39
Solarium	1.04	0.11	0.45	0.03	0.05	0.10	0.01	0.00	0.06	0.11	0.07	0.14	0.24	2.11	0.31
Admitting	1.61	0.08	0.37	0.03	0.05	0.12	0.10	0.05	0.05	0.09	0.07	0.14	0.00	2.43	0.33
Billing	1.18	0.08	0.36	0.12	0.08	0.12	0.17	0.08	0.05	0.09	0.07	0.14	0.00	2.16	0.40
Cashier	0.93	0.08	0.32	0.12	0.08	0.10	0.17	0.08	0.04	0.08	0.07	0.14	0.05	1.89	0.38
Solarium	0.79	0.11	0.46	0.03	0.05	0.10	0.01	0.00	0.06	0.11	0.07	0.14	0.18	1.81	0.31
Private Room 7	0.72	0.05	0.46	0.03	0.05	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.12	2.03	0.94
Private Room 8	0.72	0.05	0.47	0.03	0.05	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.12	2.03	0.94
Private Room 11	0.72	0.05	0.47	0.03	0.05	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.12	2.03	0.94
Private Room 12	0.72	0.05	0.47	0.03	0.05	0.15	0.05	0.02	0.06	0.12	0.38	0.75	0.12	2.03	0.94
Private Room 13	0.00	0.00	0.36	0.03	0.05	0.12	0.05	0.02	0.05	0.09	0.38	0.75	0.42	1.41	0.92
Private Room 14	0.00	0.00	0.38	0.03	0.05	0.12	0.05	0.02	0.05	0.10	0.38	0.75	0.43	1.45	0.92
Waiting Area	0.00	0.00	0.79	0.00	0.00	0.32	0.00	0.00	0.19	0.37	0.00	0.00	0.82	2.13	0.37
Private Room 15	0.00	0.00	0.38	0.03	0.05	0.12	0.05	0.02	0.05	0.09	0.38	0.75	0.42	1.44	0.92
Private Room 16	0.00	0.00	0.36	0.03	0.05	0.12	0.05	0.02	0.05	0.10	0.38	0.75	0.42	1.41	0.92

Elevator	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.04	0.08	0.00	0.00	0.40	0.75	0.08

This table shows the load calculation results for zone 8 at third floor which has a temperature of 22.5°C.

Table 16.0

Summary of Load Zone

Zone	Load (kW)			Sensible Heat Ratio	Supply Air (L/s)	Ventilation Air (L/s)
	Sensible	Latent	Total			
1	7.02	3.53	10.55	0.67	220	85
2	33.19	7.3	40.49	0.82	1302	207
3	60.35	22.55	82.9	0.73	4016	398
4	14.48	10.3	24.77	0.66	220	244
5	13.01	3.36	16.37	0.79	980	35
6	79.8	42.54	122.34	0.7	3475	1068.5
7	25	3.67	28.67	0.87	690	48
8	104.98	34.7	139.68	0.75	3582	620

This table shows the summary of total sensible and latent heat load in kW. For the sensible heat ratio, the proponent calculated it by dividing the sensible heat load into the total heat load. The ventilation air is used for well-ventilated area to maintain the temperature and humidity and used to provide a continuous supply of fresh outside air. Supply air is delivered by air handling unit through a ductwork containing outside fresh air.

Psychrometric Calculation

This section shows the values that will used in Psychrometric Calculation leading to equipment selection.

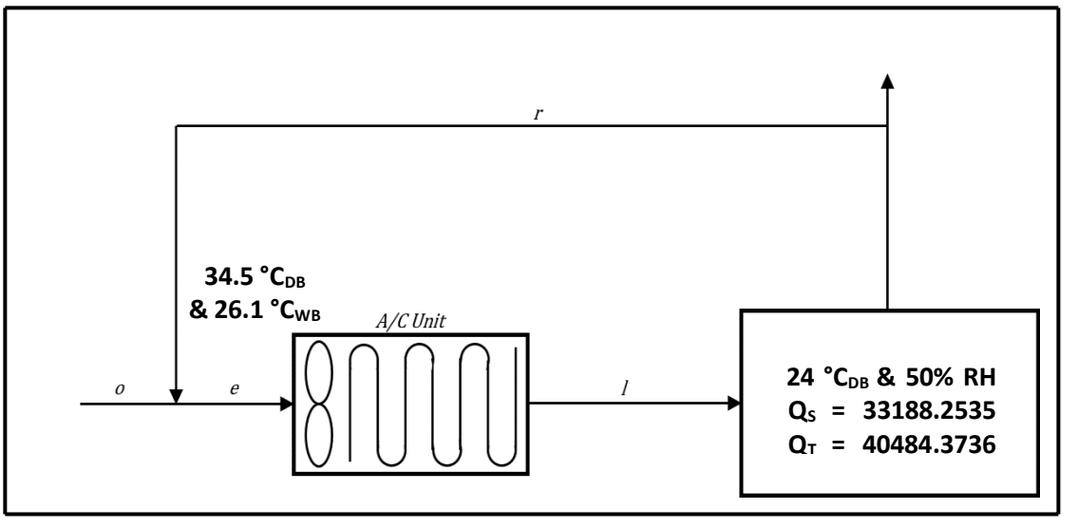


Figure 7.0 Flow Diagram at Ground Floor

Total Sensible Heat Load: 33,188.2535 W

Total Latent Heat Load: 7,296.1202 W

Sensible Heat Factor: 0.82

Entering Coil Condition:

T_e= 25.05 °C

H_e= 51.1381 kJ/kg

W_e= 0.0102 kg_a/ kg_v

Leaving Coil Condition:

T_l= 11.4 °C

h_l= 32.3298 kJ/kg

Total Capacity of AC Unit: 59.0828 kW

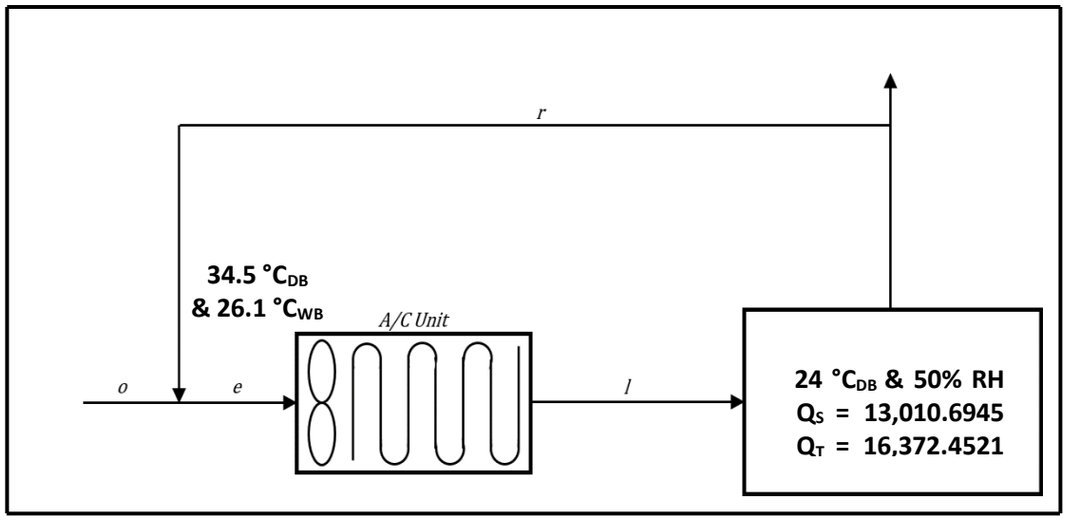


Figure 8.0 Flow Diagram at Second Floor

Total Sensible Heat Load: 13,010.6945 W

Total Latent Heat Load: 3361.7576 W

Sensible Heat Factor: 0.79

Entering Coil Condition:

T_e= 25.05°C

H_e= 51.1468 kJ/kg

W_e= 0.0102 kg_a/kg_v

Leaving Coil Condition:

T_l= 9.92 °C

h_l= 29.9768 kJ/kg

Total Capacity of AC Unit: 33.1554 kW

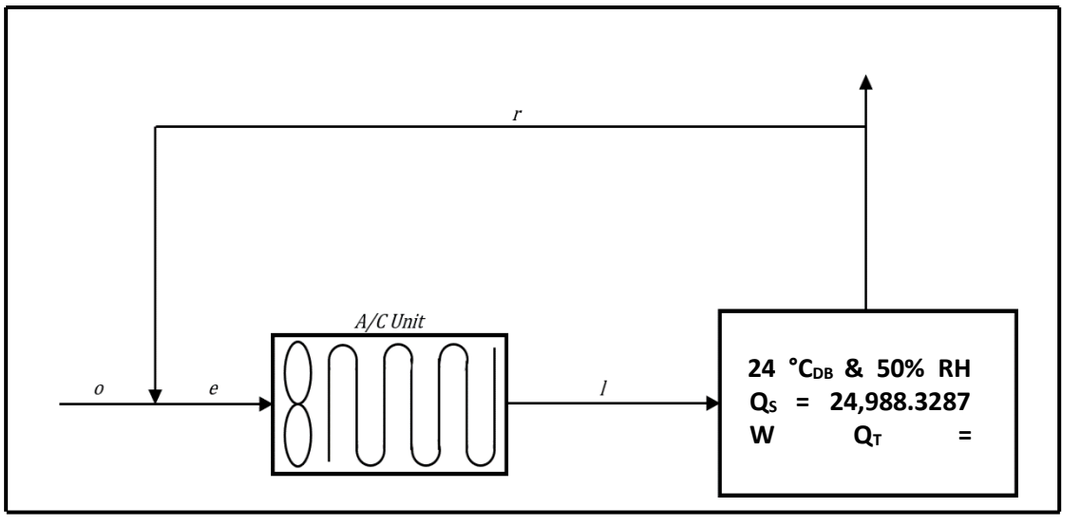


Figure 9.0 Flow Diagram at Third Floor

Total Sensible Heat Load: 24,988.3287 W

Total Latent Heat Load: 3674.8262 W

Sensible Heat Factor: 0.8

Entering Coil Condition:

T_e= 25.05 °C

H_e= 51.1468 kJ/kg

W_e=0.0102 kg_a/ kg_v

Leaving Coil Condition:

T_l= 11.9 °C

h_l=31.081 kJ/kg

Total Capacity of AC Unit: 47.4593 kW

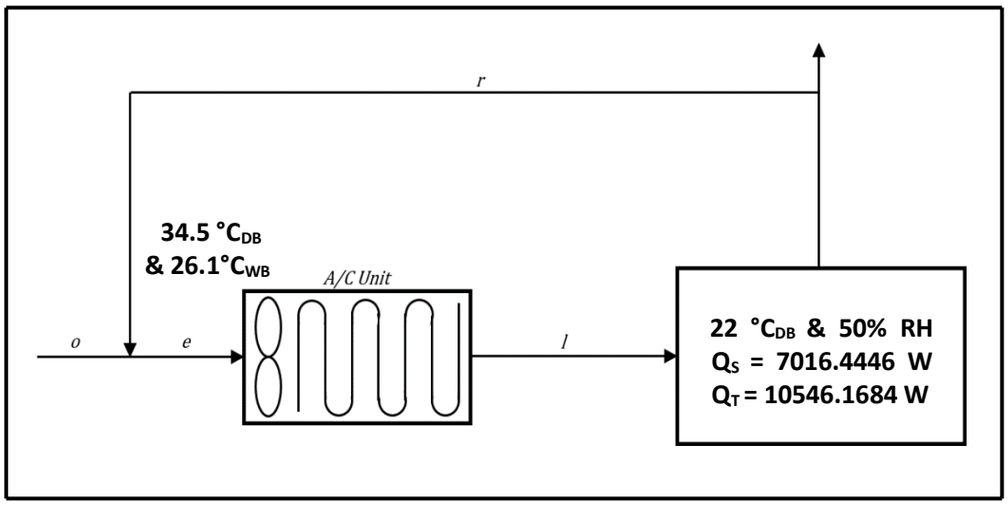


Figure 10.0 Flow Diagram at Ground Floor

Total Sensible Heat Load: 7016.4446 W

Total Latent Heat Load: 10,546. 1684 W

Sensible Heat Factor: 0.67

Entering Coil Condition:

T_e= 23.25 °C

H_e= 46.8490 kJ/kg

W_e= 0.0092 kg_a /kg_v

Leaving Coil Condition:

T_l= 5.1 °C

h_l=17.4701 kJ/kg

Total Capacity of AC Unit: 17.8804 kW

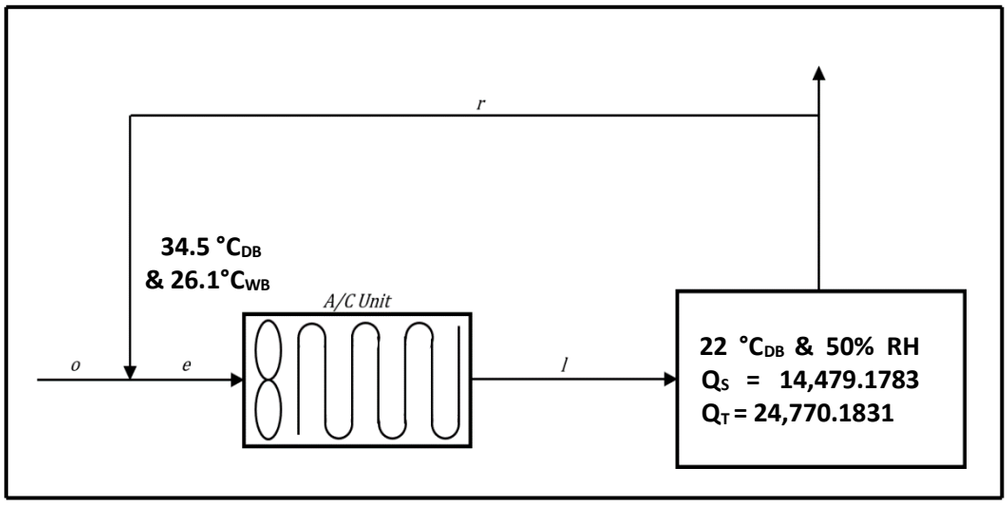


Figure 11.0 Flow Diagram at Second Floor

Total Sensible Heat Load: 14,479.1783 W

Total Latent Heat Load: 10,291.00477 W

Sensible Heat Factor: 0.60

Entering Coil Condition:

T_e= 24.96 °C

H_e= 52.0611 kJ/kg

W_e= 0.0106 kg_a/kg_v

Leaving Coil Condition:

T_l= 5.2 °

h_l=18.8805 kg_a/ kg_v

Total Capacity of AC Unit: 38.1972 kW

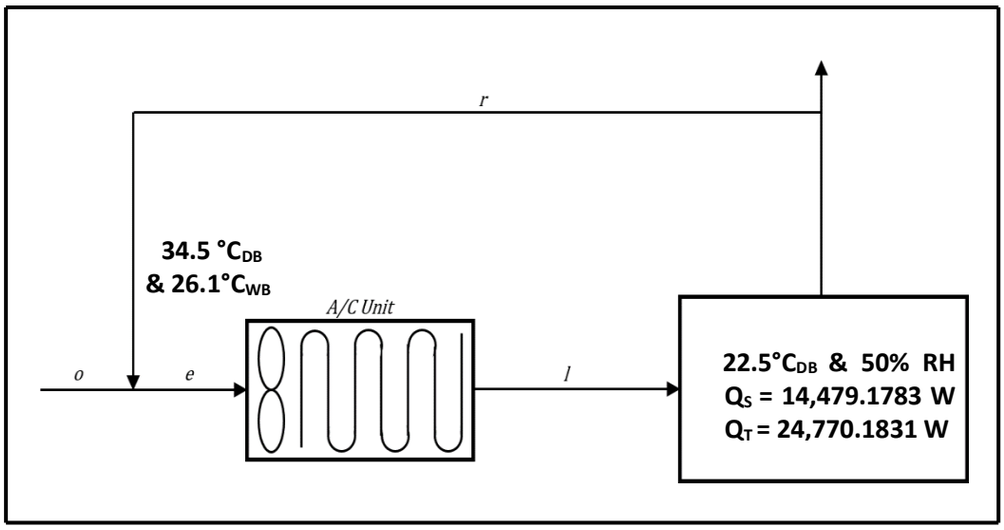


Figure 12.0 Flow Diagram at Ground Floor

Total Sensible Heat Load: 60,346.5268 W

Total Latent Heat Load: 22,546.97898 W

Sensible Heat Factor: 0.60

Entering Coil Condition:

T_e= 23.7 °C

H_e= 47.9056 kJ/kg

W_e= 0.0094 kg_a/ kg_v

Leaving Coil Condition:

T_l= 11.8°C

h_l= 29.4156 kJ/kg

Total Capacity of AC Unit: 92.4161 kW

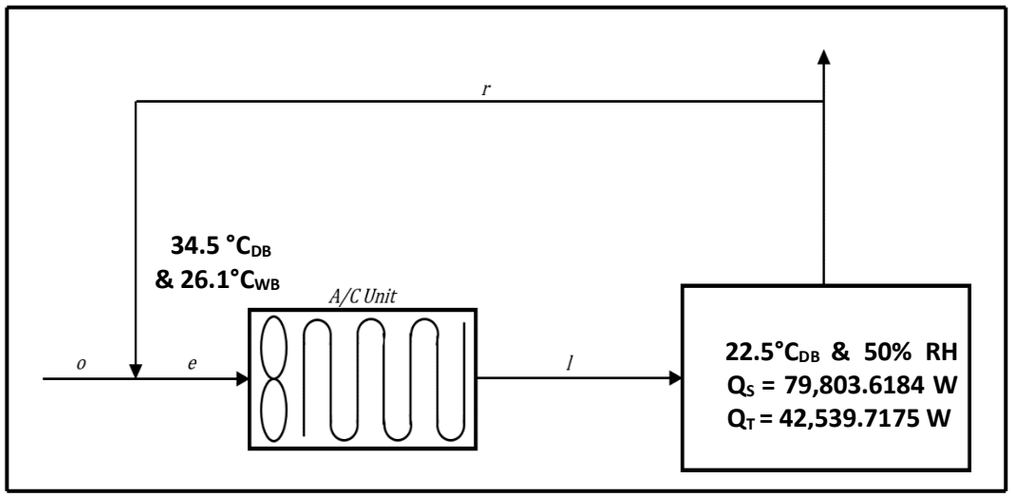


Figure 13.0 Flow Diagram at Second Floor

Total Sensible Heat Load: 79,803.6184 W

Total Latent Heat Load: 42.539.7175 W

Sensible Heat Factor: 0.66

Entering Coil Condition:

T_e= 24.66 °C

H_e= 50.8804 kJ/kg

W_e= 0.0102 kg_a/ kg_v

Leaving Coil Condition:

T_l= 11.12 °C

h_l= 26.64490 kJ/kg

Total Capacity of AC Unit: 160.153 kW

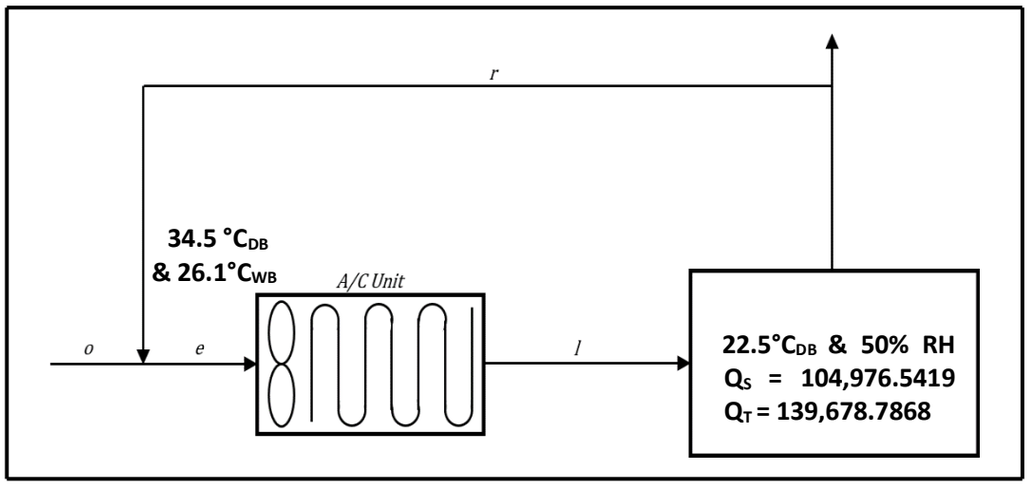


Figure 14.0 Flow Diagram at Third Floor

Total Sensible Heat Load: 104,976.5419 W

Total Latent Heat Load: 34,702. 24492 W

Sensible Heat Factor: 0.75

Entering Coil Condition:

T_e= 23.7 °C

H_e= 47.9056 kJ/kg

W_e= 0.0094 kg_a/ kg_v

Leaving Coil Condition:

T_l= 11.9 °C

h_l= 29.5528 kJ/kg

Total Capacity of AC Unit: 159.5619 kW

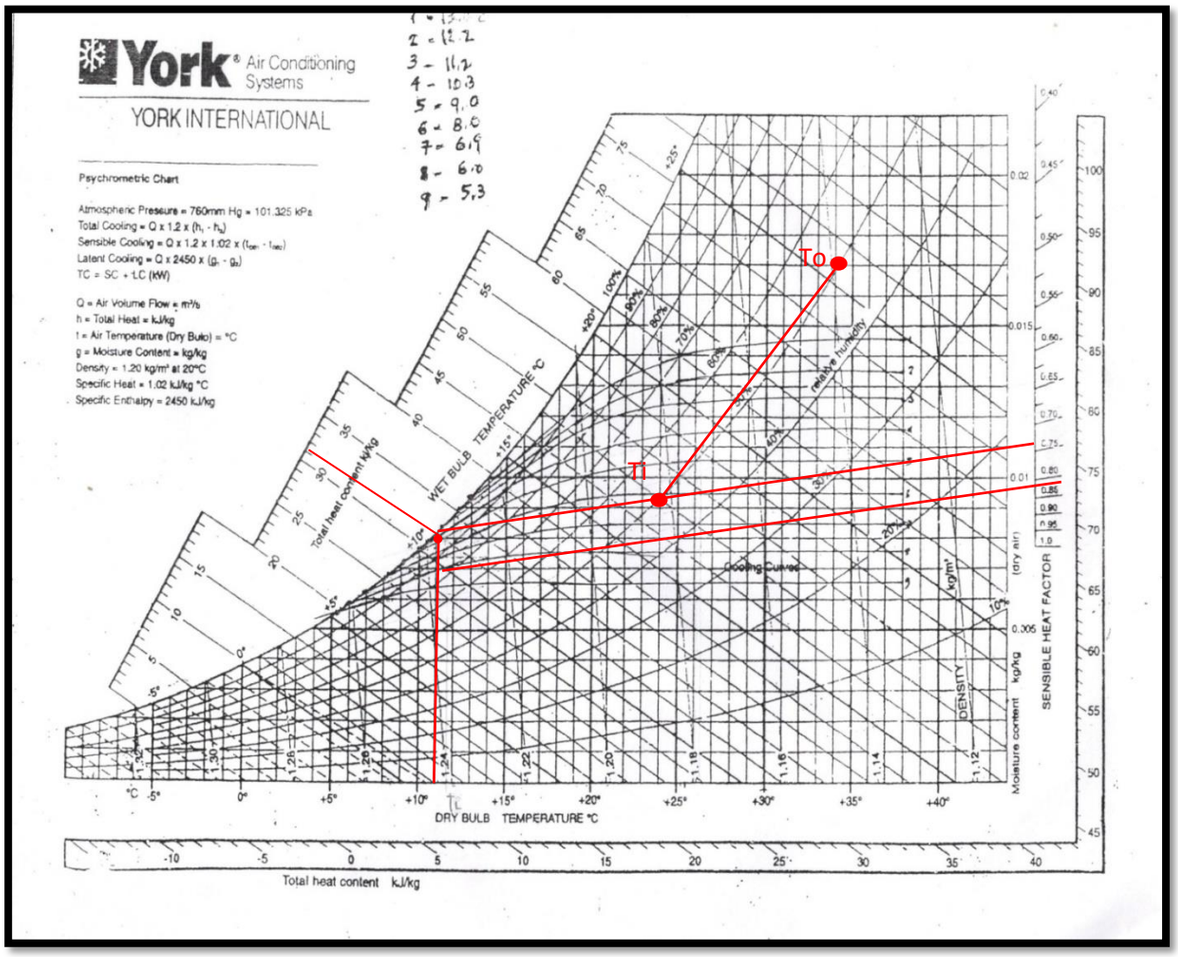


Figure 15.0 Psychrometric Chart Representation

There is a given condition for outdoor air which has dry bulb temperature of 34.5 °C and a wet bulb temperature of 26.1 °C. There is also given indoor condition which has 50 % relative humidity of air and has dry bulb temperature of 24 °C. These values are plotted on the psychrometric chart as located at T_i and T_o. The sensible heat ratio is obtained through total sensible heat load and latent heat load. The SHR is plotted and extended by making a line and then constructed a parallel line from SHR to return condition. The enthalpy leaving is computed from manual computation and extended this line from a psychrometric chart until parallel line is intersected. The temperature leaving dry bulb temperature is then obtained through the intersected point. These parameters are required to get the capacity of a zone leading to equipment selection and make an engineering decision in selecting equipment. .

Table 17.0
Duct Sizing

Duct Section	Flow (L/s)	Duct Width (mm)	Duct Height (mm)	Duct Length (mm)	Equivalent Length (mm)	Total Length (m)	Velo-city (m/s)	Friction Loss (Pa/m)	Total Loss (Pa)
AHU-A	5648.5	900	650	1900	9800	11.7	7.5	1.219	14.2623
A-B	4841.4456	750	700	5920	83740	89.66	6	1.172	105.0815
B-C	4034.3912	650	600	9540	29810	39.35	6	1.185	46.62975
C-D	2017.63	550	500	15730	27000	42.73	5	1.119	47.81487
D-E	1008.81	400	400	4140	5040	9.18	4.5	1.165	10.6947
E-Diffuser	504.41	350	300	2200	0	2.2	3	0.905	1.991
							Total Loss (Pa)		**226.4741**

This table shows the zone with corresponding section. The duct width and duct height are determined based on the flow rate. The total length is the summation of duct length and equivalent length which is used to get the total pressure loss by multiplying to its friction loss of duct.

Table 18.0
Fan Sizing

EQUIPMENT TAG NO.	AIRFLOW (L/S)	Total Pressure (kPa)	Power (kW)	Duct length (m)
Exh-1	45	0.34	0.017	1.76
Exh-2	45	0.34	0.017	1.76
Exh-3	45	0.34	0.017	1.54
Exh-4	45	0.34	0.017	1.54
Exh-5	192	0.34	0.121	1.76
Exh-6	192	0.34	0.121	1.76
Exh-7	45	0.34	0.017	1.24
Exh-8	64	1.27	0.054	4.23
Exh-9	45	0.34	0.017	3.76
Exh-10	45	0.34	0.017	7.58
Exh-11	45	0.34	0.017	1.24
Exh-12	219	0.43	0.224	1.24
Exh-13	45	0.34	0.017	2.54
Exh -14	45	0.34	0.017	2.54
Exh-15	45	0.34	0.017	3.69
Exh-16	45	0.34	0.017	5.42
Exh-17	45	0.34	0.017	7.89
Exh-18	45	0.34	0.017	3.25
Exh-19	45	0.34	0.017	3.25
Exh-20	45	0.34	0.017	3.25
Exh-21	45	0.34	0.017	3.25
Exh-22	45	0.34	0.017	5.43

E-23	45	0.34	0.017	4.65
E-24	45	0.34	0.017	3.68
E-25	45	0.34	0.017	3.68
E-26	76	0.34	0.017	5.62
E-27	45	0.34	0.017	3.23
E-28	45	0.34	0.017	4.60
E-29	45	0.34	0.017	2.34
E-30	45	0.34	0.017	2.34
E-31	45	0.34	0.017	2.34
E-32	45	0.34	0.017	2.34
E-33	45	0.34	0.017	1.24
E-34	45	0.34	0.017	3.23
E-35	45	0.34	0.017	5.42
E-36	45	0.34	0.017	6.79
E-37	45	0.34	0.017	7.23
E-38	45	0.34	0.017	5.83
E-39	45	0.34	0.017	6.32
E-40	45	0.34	0.017	6.56
E-41	45	0.34	0.017	2.34
E-42	45	0.34	0.017	2.34
E-43	45	0.34	0.017	2.34
E-44	45	0.34	0.017	2.34
E-45	45	0.34	0.017	1.23
E-46	45	0.34	0.017	1.56
E-47	45	0.34	0.017	1.84
E-48	45	0.34	0.017	2.95
E-49	45	0.34	0.017	4.31
E-50	45	0.34	0.017	2.47
E-51	45	0.34	0.017	2.56
E-52	45	0.34	0.017	2.56
E-53	45	0.34	0.017	4.60
E-54	45	0.34	0.017	4.60
E-55	45	0.34	0.017	2.32
E-56	45	0.34	0.017	2.32
E-57	45	0.34	0.017	4.60
E-58	45	0.34	0.017	4.60
E-59	45	0.34	0.017	2.57
E-60	45	0.34	0.017	6.84
E-61	45	0.34	0.017	5.43
E-62	45	0.34	0.017	2.41
E-63	45	0.34	0.017	2.41
E-64	45	0.34	0.017	4.68
E-65	45	0.34	0.121	5.79
E-66	45	0.34	0.121	4.62
E-67	45	0.34	0.017	4.62
E-68	45	0.34	0.017	4.62
E-69	45	0.34	0.017	6.21

This table shows the exhaust fan present in a specific area. The airflow was calculated by using air change per hour and the volume of an area. The power and total pressure is presented in the catalogue of exhaust fan. The duct

length is measured up to the roof deck and exhaust is terminated at the highest point of the building.

Table 19.0

Pipe Sizing Design

	L/s	Nominal Diamater (in)	Velocity (ft/s)	Pressure Gradient (Pa/m)	Equivalent Length of Pipe (m)	Pressure Drop (Pa)
chiller - pump	19.1489	5	4.87	160.98	104	16742.14
pump - A	19.1489	5	4.87	160.98	75.034	12079.13
A-B	14.8983	4	5.95	309.70	12.265	3798.49
B-C	6.78	3	4.66	273.99	4.96	1359.01
C-D	6.78	3	4.66	273.99	11.11	3044.07
D-E	6.6	3	4.54	260.55	1.41	367.38
E-F	6.6	3	4.49	255.35	3.81	972.90
F-G	6.46	3	4.44	250.35	5.51	1379.44
G-H	5.68	3	3.91	196.98	3.66	720.96
H-I	4.96	3	3.41	153.23	6.06	928.59
I-J	4.82	3	3.32	145.38	2.16	314.03
J-K	4.68	3	3.22	137.44	7.36	1011.54
K-L	4.57	3	3.14	131.75	2.21	291.16
L-M	4.47	3	3.07	126.45	7.71	974.94
M-N	4.25	3	2.92	115.27	7.11	819.55
N-O	4.18	3	2.88	111.83	4.21	470.82
O-P	4.1	3	2.82	107.91	1.71	184.53
P-Q	3.96	3	2.72	101.24	4.26	431.28
Q-R	3.82	3	2.63	94.76	9.51	901.21
R-S	3.61	3	2.48	85.45	4.31	368.27
S-T	3.5	3	2.41	80.74	11.01	888.91
T-U	3.43	3	2.36	77.79	12.74	991.09
U-AHU	3.43	2 1/2	3.64	226.61	1.5	339.92
						49379.3422

Table 20.0

Summary Equipment

TAG no.	Selection Parameter	Brand/Model	Equipment Specification	Page No.
CH-1	608 Kw	Carrier/0700A	668.1 kW Air Cooled	73
AHU-1	478.6 kW, 7778 L/s	York/YSM-B	478.6 kW Horizontal Standard Unit	75
FCU-A1	4.31 KW	Daikin/FWMJCC5BV1	4.5	81
FCU-A2	2.12 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A3	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-A4	2.32 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A5	2.32 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A6	2.32 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A7	2.32 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A8	2.32 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A9	2.21 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A10	2.21 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A11	2.21 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A12	2.21 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A13	2.21 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A14	2.21 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A15	2.36 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A16	2.36 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A17	2.36 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A18	2.36 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A19	4.02 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-A20	4.02 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-A21	5.96 KW	Daikin/FWMJC6BV1	6	81
FCU-A22	2.36 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A23	2.36 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A24	4.05 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-A25	4.05 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-A26	2.32 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A27	2.32 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A28	2.47 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A29	2.47 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A30	2.12 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A31	2.12 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A32	2.47 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A33	2.47 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A34	2.25 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A35	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-A36	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-A37	2.28 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A38	2.45 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A39	2.47 KW	Daikin/FWMJCC2BV1	2.5	81

FCU-A40	2.47 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A41	2.25 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A42	2.25 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A43	2.25 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A44	2.25 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A45	2.25 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A46	2.43 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A47	2.36 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-A48	2.2 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-B1	2.42 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-B2	4.04 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B3	4.04 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B4	4.04 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B5	4.04 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B6	4.05 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B7	4.05 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B8	4.05 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B9	4.05 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B10	4.05 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B11	7.33 KW	Daikin/FWMJC8BV1	7.3	83
FCU-B12	7.33 KW	Daikin/FWMJC8BV1	7.3	83
FCU-B13	4.05 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B14	4.05 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B15	4.05 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B16	4.05 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B17	4.05 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B18	4.05 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B19	2.03 KW	Daikin/FWMJCC2BV1	2.1	79
FCU-B20	2.03 KW	Daikin/FWMJCC2BV1	2.1	79
FCU-B21	2.03 KW	Daikin/FWMJCC2BV1	2.1	79
FCU-B22	4.43 KW	Daikin/FWMJCC5BV1	4.5	81
FCU-B23	4.43 KW	Daikin/FWMJCC5BV1	4.5	81
FCU-B24	2.32 KW	Daikin/FWMJCC2BV1	2.5	79
FCU-B25	2.32 KW	Daikin/FWMJCC2BV1	2.5	79
FCU-B26	7.46 KW	Daikin/FWMJC9BV1	8.8	83
FCU-B27	7.46 KW	Daikin/FWMJC9BV1	8.8	83
FCU-B28	7.46 KW	Daikin/FWMJC9BV1	8.8	83
FCU-B29	7.46 KW	Daikin/FWMJC9BV1	8.8	83
FCU-B30	2.03 KW	Daikin/FWMJCC2BV1	2.5	79
FCU-B31	2.03 KW	Daikin/FWMJCC2BV1	2.5	79
FCU-B32	2.03 KW	Daikin/FWMJCC2BV1	2.5	79
FCU-B33	2.03 KW	Daikin/FWMJCC2BV1	2.5	79
FCU-B34	4.43 KW	Daikin/FWMJCC5BV1	4.5	81
FCU-B35	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B36	4.4 KW	Daikin/FWMJCC5BV1	4.5	81
FCU-B37	4.02 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-B38	7.27 KW	Daikin/FWMJC8BV1	7.3	83
FCU-B39	5.67 KW	Daikin/FWMJC6BV1	6	83
FCU-C1	5.81 KW	Daikin/FWMJC6BV1	6	83
FCU-C2	5.81 KW	Daikin/FWMJC6BV1	6	83
FCU-C3	5.81 KW	Daikin/FWMJC6BV1	6	83
FCU-C4	5.81 KW	Daikin/FWMJC6BV1	6	83

FCU-C5	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-C6	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-C7	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-C8	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-C9	5.81 KW	Daikin/FWMJC6BV1	6	83
FCU-C10	5.81 KW	Daikin/FWMJC6BV1	6	83
FCU-C11	5.81 KW	Daikin/FWMJC6BV1	6	83
FCU-C12	7.62 KW	Daikin/FWMJC9BV1	8.8	83
FCU-C13	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-C14	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-C15	5.42 KW	Daikin/FWMJC6BV1	6	83
FCU-C16	7.46 KW	Daikin/FWMJC9BV1	8.8	83
FCU-C17	5.31 KW	Daikin/FWMJC6BV1	6	83
FCU-C18	5.31 KW	Daikin/FWMJC6BV1	6	83
FCU-C19	5.31 KW	Daikin/FWMJC6BV1	6	83
FCU-C20	5.31 KW	Daikin/FWMJC6BV1	6	83
FCU-C21	5.31 KW	Daikin/FWMJC6BV1	6	83
FCU-C22	5.31 KW	Daikin/FWMJC6BV1	6	83
FCU-C23	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-C24	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-C25	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-C26	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-C27	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-C28	4.08 KW	Daikin/FWMJCC4BV1	4.1	81
FCU-C29	2.42 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-C30	2.42 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-C31	2.42 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-C32	2.42 KW	Daikin/FWMJCC2BV1	2.5	81
FCU-C33	2.42 KW	Daikin/FWMJCC2BV1	2.5	81
D-1	430.64 L/s	OC WaterLoo/DF	504.409 L/s	85
D-2	1110.64 L/s	OC WaterLoo/DF	1210.582 L/s	85
D-3	302.6454	OC WaterLoo/DF	302.6454 L/s	85
D-4	598.90 L/s	OC WaterLoo/DF	605.2908 L/s	85
D-5	598.90 L/s	OC WaterLoo/DF	605.2908 L/s	85
D-6	975.69 L/s	OC WaterLoo/DF	1008.818 L/s	85
D-7	975.69 L/s	OC WaterLoo/DF	1008.818 L/s	85
D-8	975.69 L/s	OC WaterLoo/DF	1008.818 L/s	85
D-9	365.76 L/s	OC WaterLoo/DF	403.5272 L/s	85
D-10	365.76 L/s	OC WaterLoo/DF	403.5272 L/s	85
D-11	365.76 L/s	OC WaterLoo/DF	403.5272 L/s	85
D-12	156.87 L/s	OC WaterLoo/DF	201.7636 L/s	85
D-13	430.64 L/s	OC WaterLoo/DF	504.409 L/s	85
D-14	786.78 L/s	OC WaterLoo/DF	807.0544 L/s	85
D-15	786.78 L/s	OC WaterLoo/DF	807.0544 L/s	85
D-16	156.87 L/s	OC WaterLoo/DF	201.7636 L/s	85
D-17	156.87 L/s	OC WaterLoo/DF	201.7636 L/s	85
D-18	156.87 L/s	OC WaterLoo/DF	201.7636 L/s	85
D-19	156.87 L/s	OC WaterLoo/DF	201.7636 L/s	85

This table shows the equipment schedule which consists of chilled water, fan coil unit, diffuser, and air handling unit. There are corresponding L/s in the catalogue that would be helpful in selecting the equipment.

Bill of Materials

Table 21.0 Chiller Cost

Chiller						
Item	**Area Served**	**kW**	**Specification**	**Unit Price**	**QTY**	**Total**
CH-1	Roofdeck	668.1	Air Cooled Chiller	₱35,600	1	600,000

This table shows for the total cost of a unit equipment of a chiller.

Table 21.1 AHU Cost

Air Handling Unit						
Item	**Area Served**	**L/s**	**Specification**	**Unit Price**	**QTY**	**Total**
AHU-1	Ground Floor	7778	Horizontal Standard AHU	₱50,900	1	50,900

This table shows for the total cost of a unit equipment of air handling unit.

Table 21.2 FCU Cost at Ground Floor

Fan Coil Unit (Ground Floor)						
Item	**Area Served**	**TOR**	**Specification**	**Unit Price**	**QTY**	**Total**
FCU-A1	Supply Room	1.5	Ceiling Cassette Chilled Water Fan Coil Unit	₱49,500	1	49,500
FCU-A2	Maintenance Office	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A3	Pharmacy	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A4	Medical Record's Office	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A5	Medical Records	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A6	PHILHEALTH	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A7	Doctor's on Duty	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A8	OPD clinic dental 1	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A9	OPD clinic dental 2	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A10	OPD Clinic Pedia 1	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A11	OPD Clinic Pedia 2	1	Ceiling Cassette Chilled Water	₱29,500	1	29,500

			Fan Coil Unit			
FCU-A12	Radiologist Office	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A13	Dark Room	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A14	X-ray Room	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A15	Linen Office	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A16	Cooking Area	2.5	Ceiling Cassette Chilled Water Fan Coil Unit	₱63,500	1	29,500
FCU-A17	Dietician's Office	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A18, FCU-A19	Dietary	1.5	Ceiling Cassette Chilled Water Fan Coil Unit	₱49,500	2	99,000
FCU-A20, FCU-21, FCU-22, FCU-23	Staff Dining	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	2	59,000
FCU-A24	Administrative Office	1.5	Ceiling Cassette Chilled Water Fan Coil Unit	₱49,500	1	49,500
FCU-A25	Social Welfare	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A26	Admin's Office	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A27, FCU-28, FCU-29, FCU-30, FCU31, FCU-32, FCU-33, FCU-34, FCU-35	Canteen	1.5	Ceiling Cassette Chilled Water Fan Coil Unit	₱49,500	9	445,500
FCU-A36	OPD Clinic OB-gyne	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A37	Ultrasound	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A38	OPD Records	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A39	OPD info and admitting	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A40	Cashier	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500

FCU-A41	Billing	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A42	Admitting	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A43	OPD Clinic Medical 1	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A44	OPD Clinic Medical 2	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A45	OPD Clinic Surgery 1	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A46	OPD Clinic Surgery 2	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A47	OPD info and admitting	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-A48	OPD Records	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
					Total	**1,617,000**

This table shows for the total cost of a unit equipment of Ceiling Fan Coil unit in ground floor.

Table 21.3 FCU Cost Second Floor

Fan Coil Unit (Second Floor)						
Item	**Area Served**	**TOR**	**Specification**	**Price/unit**	**QTY**	**Total**
FCU-B1, FCU-B2	5-Bed Ward 1	2.5	Ceiling Cassette Chilled Water Fan Coil Unit	₱63,500	2	127,000
FCU-B3, FCU-B4	5-Bed Ward 2	2.5	Ceiling Cassette Chilled Water Fan Coil Unit	₱63,500	2	127,000
FCU-B5, FCU-B6	5-Bed Ward 3	2.5	Ceiling Cassette Chilled Water Fan Coil Unit	₱63,500	2	127,000
FCU-B7, FCU-B8	5-Bed Ward 4	2.5	Ceiling Cassette Chilled Water Fan Coil Unit	₱63,500	2	127,000
FCU-B9	Private Room 1	1	Wall Mounted Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B10	Private Room 2	1	Wall Mounted Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B11	Chief Nurse	2.5	Ceiling Cassette Chilled Water Fan Coil Unit	₱63,500	1	63,500
FCU-B12	Treatment	1.5	Ceiling Cassette	₱49,500	1	49,500

	Room		Chilled Water Fan Coil Unit			
FCU-B13	Private Room 3	1	Wall Mounted Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B14	Private Room 4	1	Wall Mounted Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B15	Private Room 5	1	Wall Mounted Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B16	Private Room 6	1	Wall Mounted Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B17	Private Room 7	1	Wall Mounted Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B18	Private Room 8	1	Wall Mounted Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B19	Reception	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B20, FCU-B21	Chief of Hospital	2	Ceiling Cassette Chilled Water Fan Coil Unit	₱54,500	2	109,000
FCU-B22, FCU-B23	Conference Room	2	Ceiling Cassette Chilled Water Fan Coil Unit	₱54,500	2	109,000
FCU-B24, FCU-B25	Chief of Clinics	2	Ceiling Cassette Chilled Water Fan Coil Unit	₱54,500	2	109,000
FCU-B26	3-Bed Ward 1	2	Ceiling Cassette Chilled Water Fan Coil Unit	₱54,500	1	29,500
FCU-B27	3-Bed Ward 2	2	Ceiling Cassette Chilled Water Fan Coil Unit	₱54,500	1	29,500
FCU-B28	3-Bed Ward 3	2	Ceiling Cassette Chilled Water Fan Coil Unit	₱54,500	1	29,500
FCU-B29	3-Bed Ward 4	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B30	CSSR	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B31	Autoclave Area	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B32, FCU-B33	Sterile Room	2	Ceiling Cassette Chilled Water Fan Coil Unit	₱54,500	2	109,000
FCU-B34, FCU-B35	Lounge Area	2	Ceiling Cassette Chilled Water Fan Coil Unit	₱54,500	2	109,000

FCU-B36	Pre-Mature Nursery	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B37	Pathologic Nursery	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B38	Anesthesia Office	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-B39	Clean-up Room	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
					Total	**1,726,500**

This table shows for the total cost of a unit equipment of Ceiling and Wall Mounted Fan Coil unit in second floor.

Table 21.4 FCU Cost at Third Floor

Fan Coil Unit (Third Floor)						
Item	**Area Served**	**TOR**	**Specification**	**Price/unit**	**QTY**	**Total**
FCU-C1,FCU-C2	5- BedWard 1	3	Ceiling Cassette Chilled Water Fan Coil Unit	₱67,500	2	135,500
FCU-C3,FCU-C4	5- BedWard 2	3	Ceiling Cassette Chilled Water Fan Coil Unit	₱67,500	2	135,500
FCU-C5	Private Room 1	1.5	Wall Mounted Chilled Water Fan Coil Unit	₱49,500	1	49,500
FCU-C6	Private Room 2	1.5	Wall Mounted Chilled Water Fan Coil Unit	₱49,500	1	49,500
FCU-C7	Private Room 3	1.5	Wall Mounted Chilled Water Fan Coil Unit	₱49,500	1	49,500
FCU-C8	Private Room 4	1.5	Wall Mounted Chilled Water Fan Coil Unit	₱49,500	1	49,500
FCU-C9	Private Room 5	1.5	Wall Mounted Chilled Water Fan Coil Unit	₱49,500	1	49,500
FCU-C10	Private Room 6	1.5	Wall Mounted Chilled Water Fan Coil Unit	₱49,500	1	49,500
FCU-C11	Chief Nurse	3	Ceiling Cassette Chilled Water Fan Coil Unit	₱67,500	1	67,500
FCU-C12	3- Bed Ward 1	2.5	Ceiling Cassette Chilled Water Fan Coil Unit	₱63,500	1	63,500
FCU-C13	Private Room 7	1.5	Wall Mounted Chilled Water Fan Coil Unit	₱49,500	1	49,500
FCU-C14	Private Room	1.5	Wall Mounted	₱49,500	1	49,500

	8		Chilled Water Fan Coil Unit			
FCU-C15	Treatment Room	2	Ceiling Cassette Chilled Water Fan Coil Unit	₱54,500	1	54,500
FCU-C16	3- Bed Ward 2	2.5	Ceiling Cassette Chilled Water Fan Coil Unit	₱63,500	1	63,500
FCU-C17	Private Room 9	1.5	Wall Mounted Chilled Water Fan Coil Unit	₱49,500	1	49,500
FCU-C18	Private Room 10	1.5	Wall Mounted Chilled Water Fan Coil Unit	₱49,500	1	49,500
FCU-C19,FCU-C20	5- BedWard 3	3	Ceiling Cassette Chilled Water Fan Coil Unit	₱67,500	2	135,500
FCU-C21,FCU-C22	5- BedWard 4	3	Ceiling Cassette Chilled Water Fan Coil Unit	₱67,500	2	135,500
FCU-C23	Private Room 11	1.5	Wall Mounted Chilled Water Fan Coil Unit	₱49,500	1	49,500
FCU-C24	Private Room 12	1.5	Wall Mounted Chilled Water Fan Coil Unit	₱49,500	1	49,500
FCU-C25	Private Room 13	1	Wall Mounted Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-C26	Private Room 14	1	Wall Mounted Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-C27	Private Room 15	1	Wall Mounted Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-C28	Private Room 16	1	Wall Mounted Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-C29	Admitting	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-C30	Billing	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-C31	Cashier	1	Ceiling Cassette Chilled Water Fan Coil Unit	₱29,500	1	29,500
FCU-C32,FCU-33	Personel's Dining	3.5	Ceiling Cassette Chilled Water Fan Coil Unit	₱71,500	2	143,500
					Total	**1,735,000**

This table shows for the total cost of a unit equipment of Ceiling and Wall Mounted Fan Coil unit in second floor.

Table 21.5 Diffuser Cost

Diffuser						
Item	**Area Served**	**L/s**	**Specification**	**Price/unit**	**QTY**	**Total**
D-1	Minor Operating Room	506	Flange Horizontal Blow Diffuser	2742	1	2742
D-2	Examination or Treatment Area	1260	Flange Horizontal Blow Diffuser	3800	1	3800
D-3	Cadaver Holding Room	352	Flange Horizontal Blow Diffuser	3000	2	6000
D-4,D-5	Work Area Laboratory	608	Flange Horizontal Blow Diffuser	2840	2	5680
D-6,D-7	Delivery Room	1080	Flange Horizontal Blow Diffuser	3555	1	3555
D-8	Major Operating room	1080	Flange Horizontal Blow Diffuser	3555	1	3555
D-9	Labor Room	405	Flange Horizontal Blow Diffuser	2650	2	5300
D-10,D11	Work Area Inside	405	Flange Horizontal Blow Diffuser	2650	1	2650
D-12	Breastfeeding room	211	Flange Horizontal Blow Diffuser	2540	1	2540
D-13	Pre-operation Area	506	Flange Horizontal Blow Diffuser	2742	2	5484
D-14,D-15	Recovery Room	827	Flange Horizontal Blow Diffuser	3480	1	3480
D-16	Isolation Room 1	211	Flange Horizontal Blow Diffuser	2540	1	2540
D-17	Isolation Room 2	211	Flange Horizontal Blow Diffuser	2540	1	2540
D-18	Isolation Room 3	211	Flange Horizontal Blow Diffuser	2540	1	2540
D-19	Isolation Room 4	211	Flange Horizontal Blow Diffuser	2540	1	2540
						54946

This table shows for the total cost of a unit equipment of diffuser with corresponding air flow rate.

CHAPTER IV
OBSERVATION, COMMENTS AND RECOMMENDATIONS

A. OBSERVATION

The proponents were asked to design an Air Conditioning System for a centralized building which is hospital building. The three-storey hospital design is a challenging because it is a sequential process and complex interactions of Air-Conditioning System with the other architectural and engineering elements that make up the building. The design process requires familiarity with specialized set of criteria, regulations, codes and design standards. Also, the assumptions made is based on the references and ASHRAE standards for HVAC design of hospital. The chosen system for Air Conditioning is the chilled water type which consists of different units of fan coil unit and air handling unit. The gathered data of information necessary to design and selecting materials or equipment is made by engineering decision that will be appropriate for the type of building. The climatic conditions and designed temperatures is firstly considered in determining the heat load of a building. Also, the humidity, building capacity, ventilation system, lighting are other factors to determine the total heat load of the system.

In designing Air-Conditioning System, the analysis and familiarity of floor plan is required because of the routing of duct and pipes. Moreover, the proponents used software such as MCQUAY to easily determine the sizes of ducts and pipes. It is observed that the duct-sizing approaches uses equal friction and also the velocity limitations is decided that is based in ASHRAE standards due to the common imposition of background noise level criteria. The mechanical equipment (chillers, AHU, FCU, Duct, Supply and return pipe, fresh air fan, exhaust fan, damper, diffusers and other mechanical equipment are designed and layout to ensure indoor air quality.

The mechanical equipment is placed on the desired space that applies an engineering decision and technique in proper positioning to provide an environmental comfort and ventilation for facilities. These includes the intake of outdoor air to meet ventilation requirements, thermal mixing of air with recirculated air from occupied zones, thermal conditioning and filtration to protect the equipment and remove contaminants.

B. COMMENTS

Once the total heat load is determined, the proponents selected the maximum cooling capacity that will be suited in an entire area. The selection of catalogue is quite challenging because of its initial cost and the required capacity. Engineering decision is important in designing an Air Conditioning System in terms of identification of choices or options in selecting equipment and the final output of that system.

C. RECOMMENDATION

1. Knowledge on the types of Air-Conditioning System and different A/C equipment must be acquired before doing the design project. This will give ideas on how the project must be done. Also, having prior knowledge on the subject makes it easy to imagine how the system will work.

2. Make sure to provide all the necessary information of the building such as its layout, building components, elevation and orientation to make calculation more accurate and credible. Also, provide ASHRAE standards, codes and references in getting the design parameters for Air-Conditioning System of Hospital.

3. If possible, ask assistance on experienced people regarding the design project. Ask help regarding to the different design considerations and proper choosing of mechanical equipment.

4. The capacity of the chilled water system, which consists of chilled water pumps, cooling tower, piping shall be based on the sum of the total cooling requirements of all connected air handling units.

5. Duct systems should be designed in accordance with the general rules outlined in the latest ASHRAE guide and data books, manuals and design guide for proper sizing of ducts.

6. Avoid piping routing through rooms containing electrical or communication equipment.

7. Equipment selection shall correspond to the manual calculations of heat load and psychrometric calculations.

CHAPTER V- BIBLIOGRAPHY

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VI. APPENDICES

A. Sample Calculation

A.1 Load Calculation

Climatic Conditions

Details:

Location: 13°45'21" North Latitude
121°04'419" East Longitude

Outdoor Design: Dry-Bulb Temperature = 34.5
Wet-Bulb Temperature = 26.1°C

Daily Range: 8.1 °C

Design Month: May

Indoor Design: a. Dry-Bulb Temperature = 24^0C,

50 % RH Indoor Design: b. Dry-Bulb Temperature = 22.5^0C,

50 % RH Indoor Design: c. Dry-Bulb Temperature = 22^0C,

50 % RH Service Schedule: 24 hrs

Wall Construction: Type F Permanent Light Color

Roof Construction: Permanently light colored with suspended ceiling

Temperatures: tav = to – ½ (Daily Range) = 34.5 – ½ (8.1)

tav = 30.45º

a. ΔT = (to- ti) = (34.5 – 24) **= 9.9ºC**

b. ΔT = (to- ti) = (34.5 – 21.5) **= 13ºC**

c. ΔT = (to- ti) = (34.5 – 22) **= 11.9ºC**

1. **External wall load:**

$\mathbf{Q_w = UA\ CLTD_{adj}}$

For 22^0C, Minor Operating Room

- Area (m^2)
  N: 13.6 m^2
- Cooling Load Temperature Difference
  $\mathbf{CLTD_{ADJ} = (CLTD_{SEL} + LM)k + (25 - t_i) + (t_{AV} - 29)}$
  Where tav = 30.45^0C

N: (13 – 0.55)(0.65) + (25-22) + (30.45-29)

N= 20.3425

- Heat transfer coefficient:

  U= 2.7144 W/ m^2K

- Thermal Heat Load, Q_W (W)

  Q_W= 479.9059 W

2. Glass Load

$Q_G = Q_{SG} + Q_{TH}$

Q_{SG}= (SHGF)(SC)(A)(CLF)

Q_{TH}= (U)(A)(ΔT)

For 22ºC, Minor Operating Room

- Area (m^2)

  N: 1.6 m^2

- Solar Heat Gain, Q_{SG} (W)

  N: (120)(0.91)(1.6 m^2)(0.55)

  Q_{SG}= 96.096 W

- Conduction Heat Load, Q_{TH}

  N: (2.8211 W/ m^2K)(1.6 m^2)(34.5 – 22) ºC

  Q_{TH}= 56.422 W

  Q_G= 152.518 W

3. Roof Load

Q_S= (U)(A)($CLTD_{ADJ}$)

For 22.5ºC, 5-Bed Ward 1

- Area (m^2)

  34.2769 m^2

- Cooling Load Temperature Difference

$CLTD_{ADJ}$ = [($CLTD_{MAX}$ + LM)k + (25 – t_i) + (t_{AV}-29)]f

Where tav = 30.45ºC

$CLTD_{MAX}$= 18

k= 0.75, medium color

f= 0.75, positive ventilation

$CLTD_{ADJ}$ = [(18 + 0)0.75 + (25 – 22.5) + (30.45-29)]0.75

$CLTD_{ADJ}$= 13.0875

Q_S= 2.58438(34.2769 m^2)(13.0875)

Q_S= 1159.35 W

4. Infiltration Load

Q_S = 1.232 (L/s) (t_o- t_i)

Q_L = 3000 (L/s) (ω_o- ω_i)

For 22.5°C, Emergency Room

- **Infiltration Rate, L/s**

L/s = NV / 3.6

**wind speed from ASHRAE Meteo, v = 3 m/s*

number of air changes, N = a +bv+ c(to – ti)

N=0.15+(0.01)(3)+0.007(34.5-22.5)

N = 0.264

volume of conditioned space, V = (floor area)(building height)

V = 131.4 m^2 (4m)

V = 525.5 m^3

L/s = (0.264) (525.5) / 3.6

L/s = 38.5366

For Humidity ratio of Outside Air, w_o

Ho= cpT + woHg

Where:

Cp= 1.0062 kJ/kg-K

t_{DB} = 34.5°C

h_{DB} = h @ 34.5°C = 2564.5 kJ/kg

h_{WB} = h @ 26.1°C = 81.2256 kJ/kg

$$w_o = \frac{81.2256\frac{kJ}{Kg} - 1.0062(34.5)}{2565.5\ kJ/kg}$$

w_o= 0.018136752

For Humidity ratio of inside air, w_i

w_i = 0.622 RhP_{sat} – P_t (RhP_{sat})

where:

Psat = P @ 22.5°C = 2.72585 kPa

w_i= 0.622(0.50) (2.72585 kPa) / 101.325 kPa – (0.50) (2.72585 kPa)

w_i =0.00848061kg/kg

Sensible Heat Load (Q_S)

Q_s= 1.232(38.5366) (34.5°C - 24 °C)

Q_s= 569.4 W

Latent Heat Load (Q_L)

Q_L= 3000 (38.5366) (0.018136752 - 0.00848061)

Q_L= 1115.709 W

5. VENTILATION LOAD

Q_S= 1.232 (L/s) (t_o- t_i)

Q_L = 3000 (L/s) (ω_o- ω_i)

For 22°C, Minor Operating Room

L/s = N (L/s per person)

Where L/s per person= 15

Number of occupants= 3 persons

L/s= 3(15)= 45

Q_S= 1.232 (45 L/s) (34.5 – 22)°C

Qs= 693 W

Q_L= 3000 (45 L/s) (34.5 – 22)°C

Q_L= 1338.7939 W

6. Lighting Load

Q_S = (lamp rating)(F_u)(F_{sa})(CLF)

For 24 °C, Canteen

Where:

Lamp rating= 2362.09 W

F_u=0.5

F_{sa}=1.2

CLF= 0.94

Q_S= (2362.09 W)(0.5)(1.2)(0.94)

Q_S= 1332.219 W

7. Occupant Load

Q_S = (gain per person)(sensible heat gain)(no.of people)(CLF)

Q_L = (gain per person)(latent heat gain)(CLF)

For 24 °C, Canteen

Where:

Gain per person= 100

Sensible heat gain= 0.6

Latent heat gain= 0.4

No. of people= 20

CLF= 0.92

Q_S= (100)(0.6)(20)(0.92)

Q_S= 1104 W

Q_L= (100)(0.4)(0.92)

Q_L= 36.8 W

8. Partition Load

8.1 Wall Partition: Q_S = U A ΔT

For 24 °C, Canteen

Where: Wall Partition of Canteen and Hallway

Area= 10.2 m^2

ΔT= (28 - 24) °C= 4°C

Q_S= (2.7144)(10.2 m^2) (4)

Q_S= 41.53032 W

8.2 Door Partition: Q_S = U A ΔT

For 24 °C, Canteen

Where: Door Partition of Canteen and Hallway

Area= 4 m^2

ΔT= (28 - 24) °C= 4 °C

Q_S= (2.3576)(4 m2)(4)

Q_S=37.7216

9. Miscellaneous loads

Q_S= (W)(C_S)(CLF)

Q_L= W(C_L)

For 24 °C, Cooking Area

Where:

W= 2580 W

Sensible Heat Gain= 0.33

CLF= 0.96

Latent Heat Gain= 0.16

Q_S=(2580 W)(0.33)(0.96)

Q_S= 817.344 W

Q_L=(2580 W)(0.16)(1)

Q_L= 412.8 W

A.2 Duct Sizing Calculation

Computing for L/s for Major Operating Room:

$$\frac{L}{s} = \frac{Cooling\ Capacity\ (v)}{\rho\ (To - Ti)}$$

Where:

Cooling Capacity= 17.5835 kW

For density of air at 22 °C:

$$\rho = \frac{P}{RT}$$

$$\rho = \frac{101.325\ kPa}{0.287\ \frac{kJ}{kg}\ (22+273\ K)}$$

ρ= 1.1968 kg/m^3

v at 22 °C = 0.8583 kg/m^3

$$\frac{L}{s} = \frac{(17.5835\ kW\ (1000\ L/\mathrm{m3})}{1.1968\ kg/\mathrm{m3}(34.5\ ℃ - 22\ ℃)}$$

$$\frac{L}{s} = 1008.82\ \frac{L}{s}$$

From A-B

Pipe diameter (m)= Found in Figure 8, Nominal Diameter = 830 mm

Q= 5648.5 L/s

$$v = \frac{5.6485\ m3/s)}{\frac{\pi}{4}\ (0.9\ m)^2}$$

v= 10.331 m/s

Pressure Gradient (Pa/m)

From Figure 8:

Friction loss= 1.2 Pa/m

Equivalent Length= Total Length of pipe

Pressure loss on Converging or Diverging Nozzle or Reducer

For welded pipe and flange connected pipe DN ≥ 60

$$P_1 - P_2 = \frac{v1^2\ \rho}{2}\ [(\frac{A1}{A2})^2 - 1]$$

Where:

v= 10.331 m/s

ρ= 1.1968 kg/m^3

D_1 = 900 mm

D_2 = 650 mm

$$P_1 - P_2 = \frac{(10.331\ \frac{m}{s})^2 (1.1968\ \frac{kg}{m3})}{2}\ [(\frac{0.900\ m}{0.650\ m})^4 - 1]$$

$P_1 - P_2$= 170.8761759 Pa

Length= $\frac{170.8761759 \text{ Pa}}{1.2 \ \frac{Pa}{m}}$

Length= 142.3968132 m

Branch Take Off

For straight through section:

P $_{loss}$= $\frac{0.4\, Vd^2}{2}$ ρ (1 - $\frac{Vd}{Vu}$)^2

where:

v_d = 7.1846 m/s

v_u= 10.331 m/s

ρ= 1.1968 kg/m^3

Pressure gradient= 2.1 Pa/m

P $_{loss}$= $\frac{0.4\, V(7.1846m)^2}{2}$ (1.1968 $\frac{kg}{m3}$)(1 - $\frac{7.1846m}{10.331\frac{m}{s}}$)^2

Length= 1.146 m

Turns

For 90 ° Elbow of Circular Duct

P $_{loss}$= $\frac{V^2}{2}$ (geometry factor)

Where v= 10.331 m/s

Geometry factor= 1.3

Pressure gradient= 2.1 Pa/m

P $_{loss}$= $\frac{(10.331\,\frac{m}{s})^2}{2}$ (0.24)

P $_{loss}$ = 12.8075 Pa

Length= $\frac{12.8075\ Pa}{1.2\ Pa/m}$

Length= 10.6729 m

Total length= 154.2157 m

Pressure drop = Pressure gradient * Total length

Pressure drop= (1.2 $\frac{Pa}{m}$)(154.2157 m)

Pressure Drop= 185.0588 Pa

A.3 Pipe Sizing Calculation

For pump – chiller

Pipe Diameter (m)

Nominal Diameter (m) = 125 mm

Inside Diameter (m) = 128.2 mm

Water Velocity, obtained from software McQuay:

V = 1.484 m/s

Pressure Gradient, Obtained from software McQuay:

P = 160.98 (Pa/m)

Equivalent Length (m)

Equivalent Length = Total length of Pipe Pressure Loss on Converging or Diverging Nozzle or Reducer

For welded pipe and flange connected pipe DN ≥ 60

$$P_1 - P_2 = \frac{v_1^2 \rho}{2}[\left(\frac{A_1}{A_2}\right)^2 - 1]$$

Where: v_1 = 1.484 m/s

ρ = 1000 kg/m^3

D_1 = 128.2 mm = 0.1282m

D_2 = 102.3 mm = 0.1023m

Pressure Gradient = 160.98 Pa/m

$$P_1 - P_2 = \frac{1.484^{\,2}(1000)}{2}[\left(\frac{.1282}{.1023}\right)^4 - 1]$$

$$Length = \frac{1614.606892}{160.9821}$$

Length = 10.03m

Equivalent length = 2m+3*5.2m+43m+4.4m+10.03m

Equivalent length = 75.03m

Pressure Drop (m)

Pressure drop = Pressure Gradient * Equivalent length

Where: Pressure Gradient = 160.9821 Pa/m

Equivalent Length = 75.03m

Pressure drop = 160.9821 Pa/m (75.03m)

Pressure drop = 12078.48696 Pa

A.4 PUMP CALCULATION

Computation for pump 2 Chiller 1

Solving for TDH

TDH = Pressure drop x 2

= (49379.3422) (2)

TDH = 98758.6844 Pa (assuming no pressure drop @ chiller of air pressure)

$$TDH = \frac{98.7586844}{999.90001\ x\ \frac{9.81}{1000}}$$

TDH = 10.06814999m

Solving for Power of the Pump

$$\eta = \frac{QP}{BP}$$

$$0.75 = \frac{98.7586844\ KPA\ (.0191489\frac{m^3}{s})}{BP}$$

BP = 2.521493562 kW

A.5 Fan Sizing Calculation

For exhaust calculation at maintenance office comfort room:

Q= V* ACH

Where:ρ

ACH= 10

V= 11.35 m^3

Q= (11.35 m^3) (10 $\frac{air\ change}{hr}$) ($\frac{1\ hr}{3600\ s}$)

Q= 0.0315 $\frac{m3}{s}$ x $\frac{1000\ L}{1\ m3}$

Q= 31.5 L/s

B. Code and Standard

ANSI/ASHRAE STANDARD 62.1- Ventilation for Acceptable Indoor Air Quality

ASHRAE HANDBOOK, FUNDAMENTALS VOLUME- American Society of Heating, Refrigerating, and Air-Conditioning Engineers document titled "ASHRAE Handbook: Fundamentals"

ASHRAE STANDARD 170-Ventilation of Health Care Facilities

ASHRAE STANDARD 62- Ventilation for Acceptable Indoor Air Quality

ANSI-ASHRAE/IES Standard 90.1- 2016 - Performance Rating Method Reference Manual

ASHRAE STANDARD 90.1- Energy Standard for buildings except low-rise residential buildings

ASHRAE STANDARD 41.6- Standard Method for measurement for moist air properties

ASHRAE STANDARD 41.2- Standard Method for Temperature Measurement

ASHRAE 183- Peak Load Calculations

ASHRAE 90.1-Energy Cost Budget

C. Tables and Charts

Table 4-4 Thermal resistance of unit areas of selected building materials at 24°C mean temperature

	$1/k$, m · K/W	R, m² · K/W
Exterior material		
Face brick	0.76	0.068
Common brick	1.39	
Stone	0.55	
Concrete block, sand and gravel aggregate, 200 mm		0.18
Lightweight aggregate, 200 mm		0.38
" " 150 mm		0.29
Stucco	1.39	
Siding, asbestos-cement, 6 mm, lapped		0.04
Asphalt insulating, 13 mm		0.14
Wood plywood, 10 mm		0.10
Aluminum or steel, backed with insulating board, 10 mm		0.32
Sheathing		
Asbestos-cement	1.73	
Plywood	8.66	
Fiberboard, regular density, 13 mm		0.23
Hardboard, medium density	9.49	
Particle board, medium density	7.35	
Roofing		
Asphalt shingles		0.08
Built-up roofing, 10 mm		0.06
Concrete		
Sand and gravel aggregate	0.55	
Lightweight aggregate	1.94	
Insulating materials		
Blanket and batt, mineral fiber, 75–90 mm		1.94
135–165 mm		3.35
Board and slab, glass fiber, organic bond	27.7	
Expanded polystyrene, extruded	27.7	
Cellular polyurethane	43.8	
Loose fill, mineral fiber, 160 mm		3.35
Cellulosic	21.7–25.6	
Interior materials		
Gypsum or plaster board, 15 mm		0.08
16 mm		0.10
Plaster materials, cement plaster	1.39	
Gypsum plaster, lightweight, 16 mm		0.066
Wood, soft (fir, pine, etc.)	8.66	
Hardwood (maple, oak, etc.)	6.31	

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Table 4-4 Thermal resistance of unit areas of selected building materials at 24°C mean temperature (cont.)

	$1/k$, m · K/W	R, m² · K/W
Air resistance		
Surface, still air (surface emissivity of 0.9) horizontal, heat flow up		0.11
Horizontal heat flow down		0.16
Vertical, heat flow horizontal		0.12
Surface, moving air, heating season, 6.7 m/s		0.029
" " " cooling season, 3.4 m/s		0.044
Air space, surface emissivity of 0.8, horizontal		0.14
Vertical		0.17
Surface emissivity of 0.2, horizontal		0.24
Vertical		0.36

Flat glass

	U, W/m² · K†	
	Summer	Winter
Single glass	5.9	6.2
Double glass, 6-mm air space	3.5	3.3
13-mm air space	3.2	2.8
Triple glass, 6-mm air spaces	2.5	2.2
13-mm air spaces	2.2	1.8
Storm windows, 25 to 100-mm air space	2.8	2.3

† Includes inside and outside air film resistance

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Table 4-14 Cooling-load temperature difference for flat roofs,[4] K

Roof type†	Mass per unit area, kg/m²	Heat capacity, kJ/m² • K	Solar time 7	8	9	10	11	12	13	14	15	16	17	18	19	20
Roofs without suspended ceilings																
1	35	45	3	11	19	27	34	40	43	44	43	39	33	25	17	10
2	40	75	-1	2	8	15	22	29	35	39	41	41	39	34	29	21
3	90	90	-2	1	5	11	18	25	31	36	39	40	40	37	32	25
4	150	120	1	0	2	4	8	13	18	24	29	33	35	36	35	32
5	250	230	4	4	6	8	11	15	18	22	25	28	29	30	29	27
6	365	330	9	8	7	8	8	10	12	15	18	20	22	24	25	26
Roofs with suspended ceilings																
1	45	50	0	5	13	20	28	35	40	43	43	41	37	31	23	15
2	50	85	1	2	4	7	12	17	22	27	31	33	35	34	32	28
3	100	100	0	0	2	6	10	16	21	27	31	34	36	36	34	30
4	150	130	6	4	4	4	6	9	12	16	20	24	27	29	30	30
5	260	240	12	11	11	11	12	13	15	16	18	19	20	21	21	21
6	360	340	13	13	13	12	12	13	13	14	15	16	16	17	18	18

Notes: 1. Directly applicable for the following conditions: inside temperature = 25°C; outside temperature, maximum = 35°C, average = 29°C; daily range = 12°C; and solar radiation typical of July 21 at 40° north latitude. Exact values for the *U* value appropriate for the design conditions being considered should be used for calculations.

2. Adjustments to these CLTD values should be made as follows if the indoor or outdoor design conditions differ from those specified in note 1:

$$CLTD_{adj} = CLTD + (25 - t_i) + (t_{av} - 29)$$

where t_i = inside design dry-bulb temperature, °C

t_{av} = average outdoor dry-bulb temperature for design day, °C

3. For roof constructions not listed choose the roof from the table which is of approximately the same density and heat capacity.

4. When the roof has additional insulation, for each $R = 1.2\ m^2 \cdot K/W$ in additional insulation use the CLTD for the next thermally heavier roof. For example, for a type 3 roof with an additional $R = 1.2$ insulation, use the type 4 roof CLTD.

† 1 = Sheet steel with 25 to 50 mm insulation, 2 = 25 mm wood with 25 mm insulation, 3 = 100 mm lightweight concrete, 4 = 150 mm lightweight concrete, 5 = 100 mm heavyweight concrete, 6 = roof terrace system.

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Table 4-15 Cooling-load temperature difference for sunlit walls[4]

Wall type†	Mass per unit area kg/m²	Heat capacity, kJ/m²·K	Solar time	Orientation N	NE	E	SE	S	SW	W	NW
			7	4	15	17	10	1	1	1	1
			8	5	20	26	18	3	3	3	3
			9	5	22	30	24	7	4	5	4
			10	7	20	31	27	12	6	6	6
			11	8	16	28	28	17	9	8	8
			12	10	15	22	27	22	14	10	10
			13	12	14	19	23	25	21	15	12
G	50	15	14	13	15	17	20	26	28	23	15
			15	13	15	17	18	24	33	31	20
			16	14	14	16	16	21	35	37	26
			17	14	14	15	15	17	34	40	31
			18	15	12	13	13	14	29	37	31
			19	12	10	11	11	11	20	27	23
			20	8	8	8	8	8	13	16	14
			$CLTD_{max}$	15	22	31	28	26	35	40	31
			7	1	3	4	2	1	1	2	1
			8	2	8	9	6	1	1	2	1
			9	3	13	16	10	2	2	2	2
			10	4	16	21	15	4	3	3	3
			11	5	17	24	20	7	4	4	4
			12	6	16	25	23	11	6	6	6
			13	8	16	24	24	15	10	8	7
F	200	130	14	9	15	22	23	19	14	11	9
			15	11	15	20	22	21	20	16	12
			16	12	15	19	20	22	24	22	15
			17	12	15	18	19	21	28	27	19
			18	13	14	17	17	19	30	32	24
			19	13	13	15	16	17	29	33	26
			20	13	12	13	14	15	25	30	24
			$CLTD_{max}$	13	17	25	24	22	30	33	26
			7	2	3	3	3	2	4	4	3
			8	2	5	6	4	2	3	3	3
			9	3	8	10	7	2	3	3	3
			10	3	11	15	10	3	3	4	3
			11	4	13	18	14	5	4	4	4
			12	5	14	20	17	7	5	5	5
			13	6	14	21	19	10	7	6	6
E	300	230	14	7	14	21	20	14	10	8	7
			15	8	14	20	20	16	14	11	9
			16	10	15	19	20	18	18	15	11
			17	10	14	18	19	19	21	20	14
			18	11	14	18	18	18	24	24	18
			19	12	14	17	17	17	25	27	21
			20	12	13	15	16	16	24	27	21
			$CLTD_{max}$	12	15	21	20	19	25	27	21

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Table 4-11 Shading coefficients[4]

Type of glass	Thickness, mm	Shading Coefficient: No indoor shading	Venetian blinds: Medium	Venetian blinds: Light	Roller shades: Dark	Roller shades: Light
Single glass						
Regular sheet	3	1.00	0.64	0.55	0.59	0.25
Plate	6-12	0.95	0.64	0.55	0.59	0.25
Heat-absorbing	6	0.70	0.57	0.53	0.40	0.30
	10	0.50	0.54	0.52	0.40	0.28
Double glass						
Regular sheet	3	0.90	0.57	0.51	0.60	0.25
Plate	6	0.83	0.57	0.51	0.60	0.25
Reflective	6	0.2-0.4	0.2-0.33			

Table 4-12 Cooling-load factors for glass with interior shading, north latitudes[4]

Solar Time h	Window facing: N	NE	E	SE	S	SW	W	NW	Hor.
6	0.73	0.56	0.47	0.30	0.09	0.07	0.06	0.07	0.12
7	0.66	0.76	0.72	0.57	0.16	0.11	0.09	0.11	0.27
8	0.65	0.74	0.80	0.74	0.23	0.14	0.11	0.14	0.44
9	0.73	0.58	0.76	0.81	0.38	0.16	0.13	0.17	0.59
10	0.80	0.37	0.62	0.79	0.58	0.19	0.15	0.19	0.72
11	0.86	0.29	0.41	0.68	0.75	0.22	0.16	0.20	0.81
12	0.89	0.27	0.27	0.49	0.83	0.38	0.17	0.21	0.85
13	0.89	0.26	0.24	0.33	0.80	0.59	0.31	0.22	0.85
14	0.86	0.24	0.22	0.28	0.68	0.75	0.53	0.30	0.81
15	0.82	0.22	0.20	0.25	0.50	0.83	0.72	0.52	0.71
16	0.75	0.20	0.17	0.22	0.35	0.81	0.82	0.73	0.58
17	0.78	0.16	0.14	0.18	0.27	0.69	0.81	0.82	0.42
18	0.91	0.12	0.11	0.13	0.19	0.45	0.61	0.69	0.25

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Table 4-13 Solar position angles for the twenty-first day of month[4]

Month	Angle	Solar time, A.M. 5	6	7	8	9	10	11	12
32° north latitude									
Dec	β				10	20	28	33	35
	φ				54	44	31	16	0
Jan, Nov	β			1	13	22	31	36	38
	φ			65	56	46	33	18	0
Feb, Oct	β			7	18	29	38	45	47
	φ			73	64	53	39	21	0
Mar, Sep	β			13	25	37	47	55	58
	φ			82	73	62	47	27	0
Apr, Aug	β		6	19	31	44	56	65	70
	φ		100	92	84	74	60	37	0
May, Jul	β		10	23	35	48	61	72	78
	φ		107	100	93	85	73	52	0
Jun	β	1	12	24	37	50	62	74	81
	φ	118	110	103	97	89	80	61	0
40° north latitude									
Dec	β				5	14	21	25	27
	φ				53	42	29	15	0
Jan, Nov	β				8	17	24	28	30
	φ				55	44	31	16	0
Feb, Oct	β			4	15	24	32	37	39
	φ			72	62	50	35	19	0
Mar, Sep	β			11	23	33	42	48	50
	φ			80	70	57	42	23	0
Apr, Aug	β		7	19	30	41	51	59	62
	φ		99	89	79	67	51	29	0
May, Jul	β	2	13	24	35	47	57	66	70
	φ	115	106	97	87	76	61	37	0
Jun	β	4	15	26	37	49	60	69	73
	φ	117	108	100	91	80	66	42	0
		7	6	5	4	3	2	1	12
		Solar time, P.M.							

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Table 4-6 Cooling-load factors for lighting[4]

No. of hours after lights are turned on	Fixture X†, hours of operation		Fixture Y†, hours of operation	
	10	16	10	16
0	0.08	0.19	0.01	0.05
1	0.62	0.72	0.76	0.79
2	0.66	0.75	0.81	0.83
3	0.69	0.77	0.84	0.87
4	0.73	0.80	0.88	0.89
5	0.75	0.82	0.90	0.91
6	0.78	0.84	0.92	0.93
7	0.80	0.85	0.93	0.94
8	0.82	0.87	0.95	0.95
9	0.84	0.88	0.96	0.96
10	0.85	0.89	0.97	0.97
11	0.32	0.90	0.22	0.98
12	0.29	0.91	0.18	0.98
13	0.26	0.92	0.14	0.98
14	0.23	0.93	0.12	0.99
15	0.21	0.94	0.09	0.99
16	0.19	0.94	0.08	0.99
17	0.17	0.40	0.06	0.24
18	0.15	0.36	0.05	0.20

† Fixture description: X, recessed lights which are not vented. The supply and return air registers are below the ceiling or through the ceiling space and grille. Y, vented or free-hanging lights. The supply air registers are below or through the ceiling with the return air registers around the fixtures and through the ceiling space.

Table 4-7 Heat gain from occupants

Activity	Heat gain, W	Sensible heat gain %
Sleeping	70	75
Seated, quiet	100	60
Standing	150	50
Walking, 3 km/h	305	35
Office work	150	55
Teaching	175	50
Retail shop	185	50
Industrial	300-600	35

Table 4-8 Space per occupant[2]

Type of space	Occupancy
Residence	2-6 occupants
Office	10-15 m^2 per occupant
Retail	3-5 m^2 per occupant
School	2.5 m^2 per occupant
Auditorium	1.0 m^2 per occupant

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Table 4-9 Sensible-heat cooling-load factors for people[4]

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

Table 4-5 Infiltration constants for infiltration in Eq. (4-1)

Quality of construction	*a*	*b*	*c*
Tight	0.15	0.010	0.007
Average	0.20	0.015	0.014
Loose	0.25	0.020	0.022

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Lat	Month	N	NNE NNW	NE NW	ENE WNW	E W	ESE WSW	SE SW	SSE SSW	S	HOR
0	Dec	-1.66	-2.77	-2.77	-2.77	-1.11	0.00	1.66	3.33	5.00	-0.55
	Jan/Nov	-1.66	-2.77	-2.22	-2.22	-0.55	0.00	1.11	2.22	3.88	-0.55
	Feb/Oct	-1.66	-1.11	-1.11	-1.11	-0.55	-0.55	0.00	-0.55	0.00	0.00
	Mar/Sept	-1.66	0.0	0.55	-0.55	-0.55	-1.66	-1.66	-2.77	-4.44	0.00
	Apr/Aug	2.77	2.22	1.66	0.00	-1.11	-2.77	-3.19	-4.44	-4.44	-1.11
	May/Jul	5.55	3.88	2.77	0.00	-1.66	-3.88	-4.44	-5.00	-4.44	-2.22
	Jun	6.66	5.00	2.77	0.00	-1.66	-3.88	-5.00	-5.55	-4.44	-2.77
8	Dec	-2.22	-3.33	-3.33	-3.33	-1.66	0.00	2.22	4.44	6.66	-2.77
	Jan/Nov	-1.66	-2.77	-3.33	-2.77	-1.11	0.00	1.66	3.33	5.55	-2.22
	Feb/Oct	-1.66	-2.22	-1.66	-1.66	-0.55	-0.55	0.55	1.11	2.22	-0.55
	Mar/Sept	-1.66	-1.11	-0.55	-0.55	-0.55	-1.11	-1.11	-1.66	-2.22	0.00
	Apr/Aug	1.11	1.11	1.11	0.00	-0.55	-2.22	-2.77	-3.88	-3.88	-0.55
	May/Jul	3.88	2.77	2.22	0.00	-1.11	-2.77	-3.88	-5.00	-3.88	-1.66
	Jun	5.00	3.33	2.22	0.00	-1.11	-3.33	-4.44	-5.00	-3.88	-1.66
16	Dec	-2.22	-3.33	-4.44	-3.88	-2.22	-0.55	2.22	5.00	7.22	-5.0
	Jan/Nov	-2.22	-3.33	-3.33	-3.33	-2.22	-0.55	2.22	4.44	6.66	-3.88
	Feb/Oct	-1.66	-2.77	-2.77	-2.22	-1.11	0.00	1.11	2.77	3.88	-2.22
	Mar/Sept	-1.66	-1.66	-1.11	-1.11	-0.55	-0.55	0.00	0.00	0.00	-0.55
	Apr/Aug	-0.55	0.00	-0.55	-0.55	-0.55	-1.66	-1.66	-2.77	-3.33	0.00
	May/Jul	2.22	1.66	1.66	0.00	-0.55	-2.22	-2.77	-3.88	-3.88	0.00
	Jun	3.33	2.22	2.22	1.11	-0.55	-2.22	-3.19	-4.44	-3.88	0.00
24	Dec	-2.77	-3.88	-5.0	-5.55	-3.88	-1.66	1.66	5.00	7.22	-7.22
	Jan/Nov	-2.22	-3.33	-3.88	-5.00	-3.33	-1.66	1.66	5.00	7.22	-6.11
	Feb/Oct	-2.22	-2.77	-3.33	-3.33	-1.66	-0.55	1.66	3.88	5.55	-3.88
	Mar/Sept	-1.66	-2.22	-1.66	-1.66	-0.55	-0.55	0.55	1.11	2.22	-1.33
	Apr/Aug	-1.11	-0.55	0.00	-0.55	-0.55	-1.11	-0.55	-1.11	-1.66	0.00
	May/Jul	0.55	1.11	1.11	0.00	0.00	-1.66	-1.66	-2.77	-3.33	0.55
	Jun	1.66	1.66	1.66	0.55	0.00	-1.66	-2.22	-3.33	-3.33	0.55
32	Dec	-2.77	-3.88	-5.55	-6.11	-3.88	-2.77	1.11	5.00	6.66	-9.44
	Jan/Nov	-2.77	-3.88	-5.00	-6.11	-3.88	-2.22	1.11	5.00	6.66	-8.33
	Feb/Oct	-2.22	-3.33	-3.88	-4.44	-2.22	-1.11	2.22	4.44	6.11	-5.55
	Mar/Sept	-1.66	-2.22	-2.22	-2.22	-1.11	-0.55	1.66	2.77	3.88	-2.77
	Apr/Aug	-1.11	-1.11	-0.55	-1.11	0.00	-0.55	0.00	0.55	0.55	-0.55
	May/Jul	0.55	0.55	0.55	0.00	0.00	-0.55	-0.55	-1.66	-1.66	0.55
	Jun	0.55	1.11	1.11	0.55	0.00	-1.11	-1.11	-2.22	-2.22	1.11

Table ex-1 CLTD Correction Factors For Latitude and Month applied to Walls and Roofs, North Latitude.

LM = Correction for latitude and month
K = Correction for color
K = 1.0 if permanently dark color or light industrial area
K = 0.5 if permanently light colored (rural area)
f = 1.0 if no attic,
f = 0.75 if positive ventilation
K = 0.65 permanently light colored rural area
K = 0.75 if permanent medium color

For infiltration rate:

Table 10.0 Infiltration constant for infiltration Equation above

Quality of Construction	a	b	c
Tight	0.150	0.010	0.007
Average	0.200	0.015	0.014
Loose	0.250	0.020	0.022

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Function	Estimated Occupancy per 100 m^2 floor area	Outdoor air requirements per person, lit/sec	
		Smoking	Non-smoking
Offices	7	10	2.5
Meeting & waiting space	60	17.5	3.5
Lobbies	30	7.5	2.5
Classrooms	50	8	4.7
Laboratories	30	10	4.7
Training shops	30	10	4.7
Music rooms	50	8	4.7
Libraries	20	8	3.3
Locker rooms	-	$2.5/m^2$	$2.5/m^2$
Corridors	-	$0.5/m^2$	$0.5/m^2$
Auditoriums	150	8	2.35
Smoking lounges	70	30	4.7
Amphitheaters	92	8	4.7
Hospital, nursing etc			
Foyers	46	13	9
Hallways	46	13	9
Single/dual bedroom	13	8	4.7
Wards	18	8	4.7
Food service center	18	16	15
Operating rooms	-	-	9

Table 2 Outdoor Air Ventilation

Caringal

Table 1 Resistance of unit areas of some building materials

Exterior Materials	D,kg/m^3	1/K,m^{2o}K/W	R,m^{2o}K/W
Face Brick	2080	0.76	
Common Brick	1923	1.39	
Granite K = 1.818	1700	0.55	
Stone	1700	0.55	
Concrete block, sand & gravel aggregate, 200mm	980		0.18
Light weight aggregate, 200mm	640		0.38
Stucco	1860	1.39	
Siding, asbestos-cement, 6mm, lapped	1160		0.04
Asphalt insulating, 13mm	900		0.14
Wood, plywood, 10mm	593		0.10
Aluminum or steel, back with insulating board, 10mm	2700		0.32
Sheathing Materials:			
Asbestos Cement	1180	1.73	
Plywood	580	8.66	
Fiber board, regular density, 13mm	580		0.23
Hard board, medium Density	600	9.49	
Particle board , Medium density	550	7.35	
Roofing Materials:			
Asphalt shingles	1000		0.08
Build-up roofing, 10mm	1100		0.06
Concrete Materials:			
Sand and gravel aggregate	2200	0.55	
Light weight aggregate	2000	1.94	
Insulating Materials:			
Blanket and batt, mineral fiber, 75-90mm	30		1.94
135-165mm	30		3.35
Board and slab, glass fiber, organic bond	24	27.7	
Expanded polystyrene, extruded	24	27.7	
Cellular polyurethane	24	43.8	
Loose fill, mineral fiber 160mm	20		3.35
Cellulosic	20	21.7-25.6	
Interior Materials:			
Gypsum board or plastic board, 15mm	1600		0.08
Plaster Materials, cement Plaster	1598	1.39	
Gypsum plaster, light weight, 16mm	1600		0.066
Wood, soft (fir, pine, etc.)	590	8.66	
Hard wood (maple, oak, etc.)	600	6.31	
Ceramic Tiles, K = 1.78	1500	0.561	
Air Resistance:			
Surface still air(surface emissivity -0.9) hor. Heat flow up			0.1100
Horizontal Heat flow down			0.1600
Vertical Heat flow horizontal			0.1200
Surface moving air, heating season, v =6.7m/sec			0.029
Surface moving air, cooling season, v = 3.4m/sec			0.044
Air space, surface emissivity 0.8, horizontal			0.1400
Air space, surface emissivity 0.8, vertical			0.1700
Air space, surface emissivity 0.2, horizontal			0.2400
Air Space, surface emissivity 0.2, vertical			0.3600
Flat glass over all coefficient o heat transfer for summer and winter			
Glass, single	U = 5.9 for Summer , 6.2 winter		
Double glass, 6mm air space	U = 3.5 for Summer , 3.3 winter		
13mm air space	U = 3.2 for Summer , 2.8 winter		
Tripple glass, 6mm air space	U = 2.5 for Summer , 2.2 winter		
13mm air space	U = 2.2 for Summer , 1.8 winter		
Storm Windows 25 to 100mm air space	U = 2.8 for Summer , 2.3 winter		

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

0 Deg

	N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SWW	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	622	441	208	117	117	805
July	343	517	634	672	615	470	243	120	120	820
Aug.	237	423	590	681	669	552	353	123	120	871
Sep.	126	265	514	672	729	672	514	265	126	924
Oct.	117	126	407	628	745	751	637	426	208	943
Nov.	110	110	278	553	726	789	726	545	349	934
Dec.	107	107	224	517	713	798	757	618	435	909

20 Deg

	N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SEW	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	343	896
Apr.	120	290	524	672	719	636	498	287	183	905
May	148	388	581	685	685	581	391	170	133	899
June	186	436	596	681	663	546	341	142	133	880
July	151	391	574	672	669	565	375	167	136	877
Aug.	126	287	511	630	684	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	796	722	666	726
Dec.	85	85	110	385	590	751	801	790	713	685

4 Deg

	N	NNE/ NNW	NE NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SEW	S	HOR
Jan.	104	104	249	536	722	795	514	609	443	902
Feb.	110	110	388	628	764	782	678	480	278	950
Mar.	120	343	514	681	764	716	558	303	136	951
Apr.	174	394	596	704	704	599	398	136	120	905
May	293	486	631	684	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	758	754	653	467	271	928
Nov.	107	107	349	530	713	782	732	599	439	896
Dec.	104	104	196	495	697	789	764	650	505	874

24 Deg

	N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SEW	S	HOR
Jan.	85	85	129	404	599	757	798	790	716	675
Feb.	95	95	252	521	694	770	767	672	606	786
Mar.	107	142	391	615	758	748	675	530	433	868
Apr.	117	278	502	689	719	669	553	338	237	893
May	136	349	542	675	688	599	416	211	145	890
June	174	401	581	675	669	565	349	174	136	880
July	142	366	555	663	672	584	407	205	145	877
Aug.	120	274	492	640	694	644	511	323	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

8 Deg

	N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W/	ESE/ WSW	SE/ SW	SSE/ SEW	S	HOR
Jan.	101	101	224	514	707	789	764	640	511	868
Feb.	107	107	360	609	754	782	691	521	347	928
Mar.	117	211	492	678	760	726	581	347	174	947
Apr.	139	349	581	697	710	615	423	167	123	912
May	233	461	625	694	639	527	308	123	120	874
June	284	489	631	685	631	445	259	123	123	849
July	243	457	615	678	644	511	294	126	123	858
Aug.	148	369	565	675	681	547	404	161	129	890
Sep.	120	288	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

28 Deg

	N (Shade)	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SEW	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	128	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	153	877
July	129	360	536	656	678	599	442	252	180	870
Aug.	120	262	470	628	694	653	543	379	287	838
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	343	571	732	779	767	741	615
Dec.	75	76	76	312	543	716	782	792	774	565

12 Deg

	N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SEW	S	HOR
Jan.	98	98	199	489	685	776	779	689	574	827
Feb.	107	107	331	587	741	782	713	558	420	902
Mar.	114	182	487	688	757	735	599	391	230	957
Apr.	126	341	562	691	716	631	448	202	126	915
May	189	439	612	694	669	546	334	126	126	883
June	237	470	625	685	644	508	284	126	126	864
July	199	439	603	678	653	530	322	129	129	868
Aug.	135	344	549	669	688	603	436	196	148	890
Sep.	119	139	448	634	722	700	574	382	230	905
Oct.	107	107	325	548	716	751	691	543	410	883
Nov.	101	101	199	483	675	760	767	659	565	820
Dec.	98	98	148	445	653	764	792	704	622	789

32 Deg

	N (Shade)	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SEW	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	481	631	716	691	590	445	343	855
May	120	329	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	826
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	285	511	686	776	795	795	486

16 Deg

	N	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SEW	S	HOR
Jan.	95	95	174	464	663	770	792	704	628	782
Feb.	104	104	303	548	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	343	142	912
May	164	416	596	688	678	565	363	142	128	890
June	208	448	612	685	653	527	312	129	129	874
July	174	416	580	675	663	549	350	139	133	874
Aug.	129	316	530	659	691	644	451	233	145	880
Sep.	114	158	423	618	716	707	603	421	205	890
Oct.	104	104	300	548	704	748	710	577	473	832
Nov.	95	95	190	467	686	760	779	694	618	776
Dec.	91	91	139	416	686	760	801	735	669	738

36 Deg

	N (Shade)	NNE/ NNW	NE/ NW	ENE/ WNW	E/ W	ESE/ WSW	SE/ SW	SSE/ SEW	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	722	630	606	751
Apr.	110	240	454	618	738	697	618	492	426	827
May	120	338	530	644	694	644	521	366	308	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	485	599	688	669	596	476	413	811
Sep.	98	98	300	527	663	719	704	631	590	736
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	439

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TABLE E-1

Outdoor Air Requirements for Ventilation of Health Care Facilities (Hospitals, Nursing

Application	Estimated Maximum** Occupancy P/1000 ft² or 100 m²	Outdoor Air Requirements cfm/ person	L/s · person	cfm/ft²	L/s · m²	
Patient rooms	10	25	13			Special requ
Medical procedure	20	15	8			tionships ma
Operating rooms	20	30	15			rates and filt
Recovery and ICU	20	15	8			contaminant
Autopsy rooms	20			0.50	2.50	Air shall not
Physical therapy	20	15	8			

29.12

Table 6 Recommended Heat Gain from Typical Medical Equipment

Equipment	Nameplate, W	Peak, W	Average, W
Anesthesia system	250	177	166
Blanket warmer	500	504	221
Blood pressure meter	180	33	29
Blood warmer	360	204	114
ECG/RESP	1440	54	50
Electrosurgery	1000	147	109
Endoscope	1688	605	596
Harmonical scalpel	230	60	59
Hysteroscopic pump	180	35	34
Laser sonics	1200	256	229
Optical microscope	330	65	63
Pulse oximeter	72	21	20
Stress treadmill	N/A	198	173
Ultrasound system	1800	1063	1050
Vacuum suction	621	337	302
X-ray system	968		82
X-ray system	1725	534	480
X-ray system	2070		18

Source: Hosni et al. (1999)

Type of Building	Type of Room	Area per Person	
		(m^2)	(ft^2)
Apartments			100 - 400
Assembly building	Lecture room	0.6	
	Library	5	
	Cinema	0.6	
	Concert hall	0.6	
	Theater	0.6	
Banks			50 - 150
Bars			15 - 50
Cafeterias			10 - 50
Churches			5 - 20
Clubhouses			15 - 50
Cocktail Lounges			15 - 50
Computer Rooms			80 - 150
Court Houses			50 - 150
Dental Centers	Clinic and Offices		50 - 150
Department Stores			15 - 75
Dining Halls			10 - 50
Drug Store			15 - 50
Factories	Assembly hall	2 - 5	
Factories	Light manufacturing	10 - 20	
Factories	Heavy manufacturing	20 - 30	
Fire Stations			100 - 500
Hotels	Rooms	5	
	Lobby	0.6	
	Assembly room	1.5	
Hospitals	General Areas		50 - 150
	Patient Rooms		80 - 150
Kindergarten		2 - 3	
Kitchens			50 - 150
Libraries			30 - 100
Luncheonettes			10 - 50
Lunch Rooms			10 - 50
Malls			50 - 100
Medical Centers	Clinic and Offices		50 - 150

TABLE 9.5.1 Lighting Power Densities Using the Building Area Method

Building Area Type[a]	*LPD* (W/ft^2)
Automotive facility	0.9
Convention center	1.2
Courthouse	1.2
Dining: bar lounge/leisure	1.3
Dining: cafeteria/fast food	1.4
Dining: family	1.6
Dormitory	1.0
Exercise center	1.0
Gymnasium	1.1
Health-care clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing facility	1.3
Motel	1.0
Motion picture theater	1.2
Multifamily	0.7
Museum	1.1
Office	1.0
Parking garage	0.3
Penitentiary	1.0
Performing arts theater	1.6
Police/fire station	1.0
Post office	1.1
Religious building	1.3
Retail	1.5
School/university	1.2
Sports arena	1.1
Town hall	1.1
Transportation	1.0
Warehouse	0.8
Workshop	1.4

[a] In cases where both a general building area type and a specific building area type are listed, the specific building area type shall apply.

Table A-2 Moist Air: Thermodynamics Properties of Saturated Air at atmospheric pressure of 101.325 Kpa

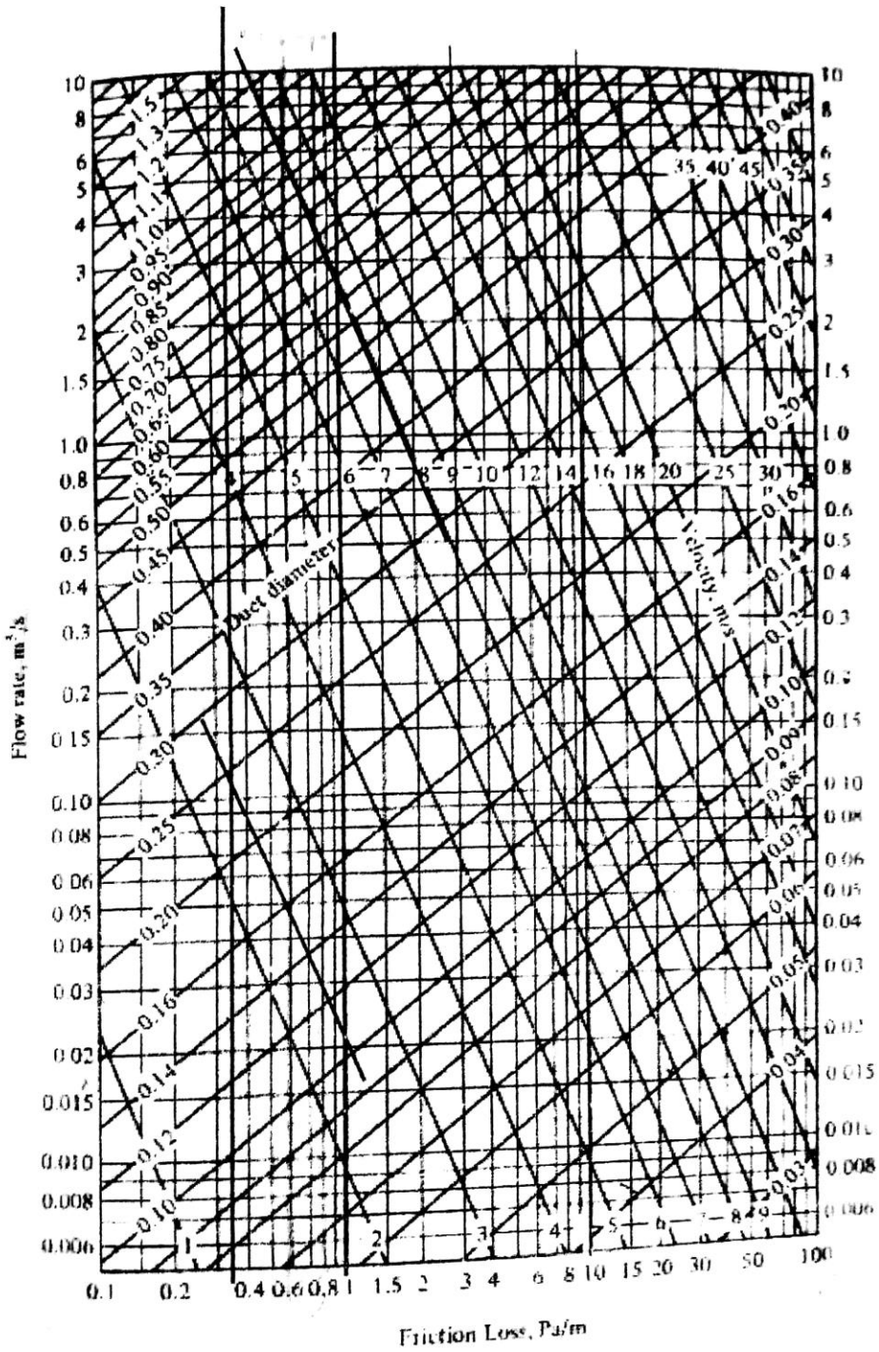
Temperature, T, °C	Vapor Pressure Kpa	Humidity Ratio Kg/Kg	Specific Volume m^3/Kg	Enthalpy, KJ/Kg
-40	0.01283	0.000079	0.6597	-40.041
-35	0.02233	0.000138	0.6740	-34.868
-30	0.03798	0.000234	0.6884	-29.600
-25	0.06324	0.000390	0.7028	-24.187
-20	0.10318	0.000637	0.7173	-18.546
-18	0.12482	0.000771	0.7231	-16.203
-16	0.15056	0.000930	0.7290	-13.795
-14	0.18107	0.001119	0.7349	-11.314
-12	0.21716	0.001342	0.7409	-8.745
-10	0.25071	0.001606	0.7469	-6.073
-8	0.30975	0.001916	0.7529	-3.285
-6	0.36846	0.002280	0.7591	-0.360
-4	0.43716	0.002707	0.7653	2.724
-2	0.51735	0.003206	0.7716	5.991
0	0.61072	0.003788	0.7781	9.470
1	0.6566	0.00407	0.7813	11.200
2	0.7055	0.00438	0.7845	12.978
3	0.7575	0.00471	0.7878	14.807
4	0.8130	0.00505	0.7911	16.692
5	0.8719	0.00542	0.7944	18.634
6	0.9347	0.00582	0.7978	20.639
7	1.0013	0.00624	0.8012	22.708
8	1.0722	0.00668	0.8046	24.848
9	1.1474	0.00716	0.8081	27.059
10	1.2272	0.00766	0.8116	29.348
11	1.3119	0.00820	0.8152	31.716
12	1.4017	0.00876	0.8188	34.172
13	1.4969	0.00937	0.8225	36.719
14	1.5977	0.01001	0.8262	39.362
15	1.7044	0.01069	0.8300	42.105
16	1.8173	0.01141	0.8338	44.955
17	1.9367	0.01218	0.8377	47.918
18	2.0630	0.01299	0.8417	50.998
19	2.1964	0.01384	0.8457	54.205
20	2.3373	0.01475	0.8498	57.544
21	2.4861	0.01572	0.8540	61.021
22	2.6431	0.01674	0.8583	64.646
23	2.8086	0.01781	0.8626	68.425
24	2.9832	0.01896	0.8671	72.366
25	3.1671	0.02016	0.8716	76.481
26	3.3609	0.02144	0.8763	80.777
27	3.5649	0.02279	0.8811	85.263
28	3.7797	0.02422	0.8860	89.952
29	4.0055	0.02572	0.8910	94.851
30	4.2431	0.02732	0.8961	99.977
31	4.4928	0.02900	0.9014	105.337
32	4.7552	0.03078	0.9068	110.946
33	5.0308	0.03266	0.9124	116.819
34	5.3201	0.03464	0.9182	122.968
35	5.6237	0.03674	0.9241	129.411
36	5.9423	0.03895	0.9302	136.161
37	6.2764	0.04129	0.9365	143.239
38	6.6265	0.04376	0.9430	150.660
39	6.9935	0.04636	0.9497	158.445
40	7.3778	0.04911	0.9567	166.615
41	7.7803	0.05202	0.9639	175.192
42	8.2016	0.05509	0.9713	184.200
43	8.6424	0.05833	0.9790	193.662

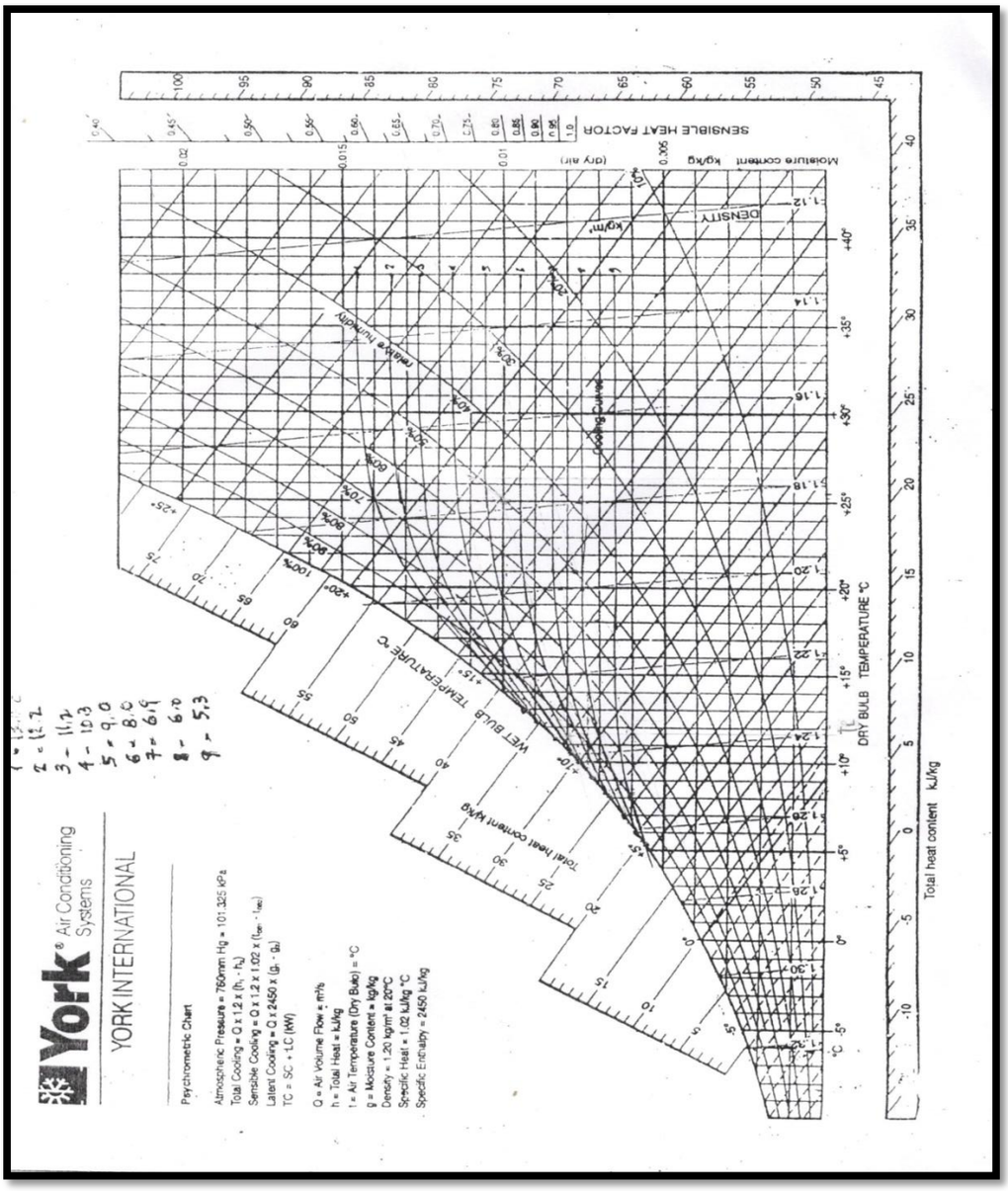
Table A-1 Water: Properties of Liquid and saturated Vapor

Temperature, t °C	Saturation Pressure, Kpa	Specific Volume, m^3/Kg		Enthalpy, KJ/Kg		Entropy, KJ/Kg °K	
		Liquid	Vapor	liquid	Vapor	liquid	Vapor
0	0.6108	0.0010002	206.3	- 0.04	2501.6	- 0.0002	9.1557
2	0.7055	0.0010001	179.9	8.39	2505.2	0.0306	9.1047
4	0.8129	0.0010000	157.3	16.80	2508.9	0.0611	9.0526
6	0.9345	0.0010000	137.8	25.21	2512.6	0.0913	9.0015
8	1.0720	0.0010001	121.0	33.60	2516.2	0.1213	8.9513
10	1.2270	0.0010003	106.4	41.99	2519.9	0.1510	8.9020
12	1.4014	0.0010004	93.84	50.38	2523.6	0.1805	8.8536
14	1.5973	0.0010007	82.90	58.75	2527.2	0.2098	8.8060
16	1.8168	0.0010010	73.38	67.13	2530.9	0.2388	8.7593
18	2.062	0.0010013	65.09	75.50	2534.5	0.2677	8.7135
20	2.337	0.0010017	57.84	83.86	2538.2	0.2963	8.6684
22	2.642	0.0010022	51.49	92.23	2541.8	0.3247	8.6241
24	2.982	0.0010026	45.93	100.59	2545.5	0.3530	8.5806
26	3.360	0.0010032	41.03	108.95	2549.1	0.3810	8.5379
28	3.778	0.0010037	36.73	117.31	2552.7	0.4088	8.4959
30	4.241	0.0010043	32.93	125.66	2556.4	0.4365	8.4546
32	4.753	0.0010049	29.57	134.02	2560.0	0.4640	8.4140
34	5.318	0.0010056	26.60	142.38	2563.6	0.4913	8.3740
36	5.940	0.0010063	23.97	150.74	2567.2	0.5184	8.3348
38	6.624	0.0010070	21.63	159.09	2570.8	0.5453	8.2962
40	7.375	0.0010078	19.55	167.45	2574.4	0.5721	8.2583
42	8.198	0.0010086	17.69	175.31	2577.9	0.5987	8.2209
44	9.100	0.0010094	16.04	184.17	2581.5	0.6252	8.1842
46	10.086	0.0010103	14.56	192.53	2585.1	0.6514	8.1481
48	11.162	0.0010112	13.23	200.89	2588.6	0.6776	8.1125
50	12.335	0.0010121	12.05	209.26	2592.2	0.7035	8.0776
52	13.613	0.0010131	10.98	217.62	2595.7	0.7293	8.0432
54	15.002	0.0010140	10.02	225.98	2599.2	0.7550	8.0093
56	16.511	0.0010150	9.159	234.35	2602.7	0.7804	7.9759
58	18.147	0.0010161	8.381	242.72	2606.2	0.8058	7.9431
60	19.920	0.0010171	7.679	252.09	2609.7	0.8310	7.9108
62	21.84	0.0010182	7.044	259.46	2613.2	0.8560	7.8790
64	23.91	0.0010193	6.469	267.84	2616.6	0.8809	7.8477
66	26.15	0.0010205	5.948	276.21	2620.1	0.9057	7.8168
68	28.56	0.0010217	5.476	284.59	2623.5	0.9303	7.7864
70	31.16	0.0010228	5.046	292.97	2626.9	0.9548	7.7565
72	33.96	0.0010241	4.646	301.35	2630.3	0.9792	7.7270
74	36.96	0.0010253	4.300	309.74	2633.7	1.0034	7.6979
76	40.19	0.0010266	3.976	318.13	2637.1	1.0275	7.6693
78	43.65	0.0010279	3.680	326.52	2640.4	1.0514	7.6410
80	47.36	0.0010292	4.409	334.92	2643.8	1.0753	7.6132
82	51.33	0.0010305	3.162	343.31	2647.1	1.0990	7.5850
84	55.57	0.0010319	2.935	351.71	2650.4	1.1225	7.5588
86	60.11	0.0010333	2.727	360.12	2653.6	1.1460	7.5321
88	64.95	0.0010347	2.536	368.53	2656.9	1.1693	7.5058
90	70.11	0.0010361	2.361	376.94	2660.1	1.1925	7.4799
92	75.61	0.0010376	2.200	385.36	2663.4	1.2156	7.4543
94	81.46	0.0010391	2.052	393.78	2666.6	1.2386	7.4291
96	87.69	0.0010406	1.915	402.20	2669.7	1.2615	7.4042
98	94.30	0.0010421	1.789	410.63	2672.9	1.2842	7.3796
100	101.33	0.0010437	1.673	419.06	2676.0	1.3069	7.3554
102	108.78	0.0010453	1.566	427.50	2679.1	1.3294	7.3315
104	116.68	0.0010469	1.466	435.95	2682.2	1.35181.	7.3078
106	125.04	0.0010485	1.374	444.40	2685.3	3742	7.2845
108	133.90	0.0010502	1.289	452.85	2688.3	1.3964	7.2615
110	143.26	0.0010519	1.210	461.32	2691.3	1.4185	7.2388
112	153.16	0.0010536	1.137	469.78	2694.3	1.4405	7.2164
114	163.62	0.0010553	1.069	478.26	2697.2	1.4624	7.1942
116	174.65	0.0010571	1.005	486.74	2700.2	1.4842	7.1723
118	186.28	0.0010588	0.9463	495.23	2703.1	1.5060	7.1507
120	198.54	0.0010606	0.8915	503.72	2706.0	1.5276	7.1293

44	9.1036	0.06176	0.9871	203.610
45	9.5856	0.06537	0.9954	214.067
46	10.0896	0.06920	1.0041	225.068
47	10.6161	0.07324	1.0130	236.643
48	11.1659	0.07751	1.0224	248.828
49	11.7402	0.08202	1.0322	261.667
50	12.3397	0.08680	1.0424	275.198
52	13.6176	0.09720	1.0641	304.512
54	15.0072	0.10887	1.0879	337.182
56	16.5163	0.12198	1.1141	373.679
58	18.1531	0.13674	1.1429	414.572
60	19.9263	0.15341	1.1749	460.536
62	21.8447	0.17228	1.2105	512.391
64	23.0184	0.19375	1.2504	571.144
66	26.1565	0.21825	1.2953	638.003
68	28.5701	0.24638	1.3462	714.531
70	31.1693	0.27884	1.4043	802.643
75	38.5562	0.38587	1.5925	1092.010
80	47.3670	0.55201	1.8792	1539.414
85	57.8096	0.83634	2.3633	2302.878
90	70.1140	1.41604	3.3412	3856.547
95	84.5450	3.13300	6.2967	8454.900

6. The use of air flow chart and pressure drop for duct sizing




York® Air Conditioning Systems
YORK INTERNATIONAL
Psychrometric Chart
Atmospheric Pressure = 760mm Hg = 101.325 kPa
Total Cooling = Q x 1.2 x (h1 - h2)
Sensible Cooling = Q x 1.2 x 1.02 x (t1 - t2)
Latent Cooling = Q x 2450 x (g1 - g2)
TC = SC + LC (kW)
Q = Air Volume Flow = m³/s
h = Total Heat = kJ/kg
t = Air Temperature (Dry Bulb) = °C
g = Moisture Content = kg/kg
Density = 1.20 kg/m³ at 20°C
Specific Heat = 1.02 kJ/kg °C
Specific Enthalpy = 2450 kJ/kg
SENSIBLE HEAT FACTOR
Moisture content kg/kg (dry air)
DENSITY
kg/m³
Relative humidity
Cooling Curve
WET BULB TEMPERATURE °C
Total heat content kJ/kg
DRY BULB TEMPERATURE °C
Total heat content kJ/kg

D. Catalogue

CARRIER CHILLER CATALOGUE

AQUAFORCE®

30KA
Air-Cooled Liquid Chiller

Nominal cooling capacity: 336~1484kW

Model	30KA	0350A	0450A	0500A	0550A	0700A	0750A	0800A	0900A	1000A	1050A	1100A
Nominal cooling capacity*	kW	336.0	426.0	500.0	560.0	668.1	722.0	774.0	890.0	990.0	1076	1120
Compressor power input	kW	99.4	125.7	151.7	171.2	192.8	220.6	238.3	270.6	297.0	331.4	349.3
Total power input	kW	105.6	134.7	160.7	183.0	207.4	235.2	252.9	288.0	317.2	351.6	369.5
Nominal COP	kW/kW	3.182	3.162	3.111	3.060	3.221	3.070	3.060	3.090	3.121	3.060	3.032
IPLV.IP**	kW/kW	4.500	4.495	4.502	4.439	4.615	4.603	4.449	4.404	4.447	4.471	4.424
Compressor		Semi-hermetic screw compressor										
CircuitA		1	1	1	1	1	1	1	1	1	1	1
CircuitB		1	1	1	1	1	1	1	1	1	1	1
Minimum capacity	%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
Refrigerant		R134a										
CircuitA	kg	64	85	85	85	100	114	114	110	140	175	175
CircuitB	kg	64	70	80	80	95	97	100	110	129	107	111
Control		Touch pilot system										
Condenser		Cu/Al heat exchanger										
Fans		V generation FlyingBird axial fan										
Quantity		4	6	6	8	10	10	10	12	14	14	14
Total air flow	l/s	20042	30063	30063	40084	50105	50105	50105	60127	70148	70148	70148
Fan speed	rpm	950										
Evaporator		Flooded multi-pipe										
Water content	l	54	63	69	78	93	99	117	127	157	174	174
Nominal water flow	l/s	16.02	20.31	23.83	26.69	31.85	34.41	36.89	42.42	47.19	51.29	53.39
Nominal water pressure drop	kPa	19.5	37.8	40.0	55.1	45.7	45.6	36.5	48.4	38.7	47.8	51.4
Max. water-side pressure (without hydronic module)	kPa	1000										
Water connection		Victaulic										
Nominal Diameter	DN	125	125	125	125	150	150	150	150	200	200	200
Electrical data												
Nominal power supply		400V-3Ph-50Hz										
Control power supply		Star-delta start										
Start-up method		24V via internal transformer										
Fan and control power	kW	6.2	9.0	9.0	11.8	14.6	14.6	14.6	17.4	20.2	20.2	20.2
Nominal unit current draw,	A	177.2	226.1	269.8	307.0	348.0	396.0	425.0	483.0	533.0	590.0	620.0
Maximum uint current draw	A	225.7	295.4	324.2	365.0	429.0	482.0	511.0	600.0	695.0	719.0	763.0
Maximum start-up current	A	295.4	513.4	513.4	591.0	627.0	790.0	822.0	920.0	973.0	1053.0	1053.0
Max operation power	kW	138	180	198	223	262	294	312	366	424	438	465
Unit length	mm	3715	4801	4801	4801	6126	6298	6298	7410	8410	8410	8410
Unit width	mm	2253										
Unit height	mm	2379										
Shipping weight	kg	3556	4562	4641	4696	5388	5731	5828	6473	7088	7627	7991
Operating weight (Standard)	kg	3410	4425	4510	4595	5224	5561	5658	6298	6927	7466	7830

AIR HANDLING UNIT CATALOGUE

Model	Airflow (m3/h)	Rows	Return Air Condition						Fresh Air Condition					
			Cooling Capacity kW	Water Flow Rate L/s	Water Pressure Drop kPa	Heating Capacity kW	Water Flow Rate L/s	Water Pressure Drop kPa	Cooling Capacity kW	Water Flow Rate L/s	Water Pressure Drop kPa	Heating Capacity kW	Water Flow Rate L/s	Water Pressure Drop kPa
YSM-B 02H	2000	4	11.2	0.53	24.5	18.9	0.46	12.6	25.2	1.21	46.1	25.5	0.62	11.5
		6	14.7	0.70	54.5	22.4	0.54	25.3	30.9	1.48	71.2	32.0	0.78	16.5
YSM-B 03H	3000	4	17.6	0.84	37.8	28.2	0.68	19.9	41.3	1.97	75.8	40.1	0.97	19.0
		6	22.1	1.05	84.7	33.4	0.81	40.3	47.7	2.26	53.2	47.4	1.15	13.0
YSM-B 04H	4000	4	23.0	1.09	49.8	35.8	0.86	26.6	49.7	2.35	35.3	50.3	1.22	9.6
		6	27.9	1.32	35.9	42.0	1.02	17.8	63.8	3.04	65.0	61.2	1.49	16.0
YSM-B 05H	5000	4	29.6	1.41	66.1	45.9	1.12	34.9	65.0	3.13	52.0	64.6	1.58	13.5
		6	36.0	1.71	44.9	53.6	1.30	22.4	81.8	3.93	86.4	77.7	1.88	20.2
YSM-B 06H	6000	4	34.8	1.65	66.4	54.4	1.32	35.0	76.8	3.68	43.5	76.6	1.86	11.3
		6	43.2	2.05	47.9	63.8	1.55	23.9	97.0	4.62	92.5	92.5	2.25	22.4
YSM-B 07H	7000	4	40.3	1.90	43.1	63.1	1.54	24.2	91.5	4.38	67.0	90.1	2.19	17.1
		6	51.0	2.42	74.5	74.9	1.82	36.6	110.2	5.28	54.1	106.7	2.59	13.2
YSM-B 08H	8000	4	46.6	2.22	39.5	72.6	1.77	21.4	105.5	5.07	57.4	103.9	2.54	14.6
		6	59.3	2.84	64.8	86.8	2.11	31.1	126.5	6.06	38.1	122.8	3.00	9.5
YSM-B 10H	10000	4	58.0	2.78	53.9	88.1	2.15	28.8	143.1	6.78	83.9	130.0	3.15	18.4
		6	71.3	3.39	86.1	108.1	2.64	41.9	174.4	8.34	57.8	153.0	3.70	11.5
YSM-B 12H	12000	4	67.0	3.21	27.1	107.1	2.61	14.9	163.0	7.78	39.6	151.5	3.68	9.0
		6	89.8	4.30	63.1	129.3	3.15	30.9	206.2	9.81	84.8	184.0	4.47	17.3
YSM-B 15H	15000	4	84.7	4.05	10.9	134.2	3.26	6.3	205.4	9.76	54.7	189.7	4.60	12.2
		6	101.5	4.83	8.9	158.5	3.83	5.1	248.7	11.79	46.5	222.6	5.39	9.8
YSM-B 18H	18000	4	104.4	4.95	12.5	162.7	3.95	7.2	250.0	11.89	63.1	229.5	5.57	14.0
		6	126.4	5.99	8.8	191.8	4.68	4.7	302.1	14.33	42.7	268.8	6.54	8.9
YSM-B 20H	20000	4	118.0	5.66	16.8	181.2	4.41	9.5	279.4	13.18	83.1	255.3	6.23	18.3
		6	144.4	6.81	12.0	213.8	5.20	6.1	337.5	16.24	56.1	299.0	7.29	11.6
YSM-B 22H	22000	4	129.8	6.22	17.2	199.3	4.86	9.8	307.3	14.50	85.6	280.8	6.85	18.8
		6	158.8	7.50	12.3	235.1	5.72	6.3	371.3	17.87	57.8	328.9	8.02	12.0
YSM-B 25H	25000	4	151.4	7.29	25.1	228.3	5.55	13.8	353.4	17.00	103.6	320.9	7.81	26.6
		6	185.2	8.76	17.5	269.0	6.55	8.9	426.5	20.45	82.2	375.5	9.17	16.9
YSM-B 28H	28000	4	170.4	8.18	27.8	256.1	6.22	15.2	396.8	19.02	114.8	359.8	8.73	29.4
		6	208.4	9.89	19.4	301.6	7.31	9.8	478.6	22.99	90.9	421.0	10.24	18.6
YSM-B 30H	30000	4	185.4	8.91	34.5	276.1	6.72	18.5	428.8	20.49	131.9	387.4	9.38	35.7
		6	226.7	10.78	23.9	324.8	7.89	11.9	516.6	24.50	101.8	452.8	10.97	22.6
YSM-B 33H	33000	4	207.1	9.87	45.4	304.2	7.40	23.6	439.0	20.96	36.8	412.9	10.07	8.3
		6	251.6	11.94	30.4	358.2	8.69	15.4	570.2	27.19	141.3	498.5	12.12	28.9
YSM-B 36H	36000	4	229.1	11.02	58.8	333.4	8.15	30.4	483.0	23.14	44.9	452.8	11.00	10.4
		6	278.2	13.31	39.4	392.1	9.57	19.4	625.5	29.96	179.3	545.0	13.28	36.1
YSM-B 40H	40000	4	249.5	11.85	57.0	359.6	8.70	28.6	500.4	23.71	61.3	506.0	12.29	16.3
		6	302.0	14.30	45.5	412.0	10.00	20.9	610.3	20.88	92.3	595.8	14.44	42.7
YSM-B 45H	45000	4	283.0	13.53	68.0	405.4	9.82	33.5	568.1	27.06	76.7	571.2	13.92	20.1
		6	341.7	16.15	54.0	464.3	11.28	24.8	690.1	23.61	110.1	671.5	16.40	50.5

Dimension-Horizontal Standard Unit (H1) (Cont.)

Model	Air Inlet Dimension mm		Base Height mm	Installation Location Dimension mm				Coil Connection Pipe mm (inch)			
								U			
	P	Q	R	S		T		4 Rows		6 Rows	
				25mm	50mm	25mm	50mm	Return Air	Fresh Air	Return Air	Fresh Air
YSM-B 02H	490	704	65	1096	1096	276	276	Ø48(1-1/2")	Ø48(1-1/2")	Ø48(1-1/2")	Ø48(1-1/2")
YSM-B 03H	519	804	65	1096	1096	376	376	Ø48(1-1/2")	Ø48(1-1/2")	Ø48(1-1/2")	Ø48(1-1/2")
YSM-B 04H	654	904	65	1156	1156	476	476	Ø48(1-1/2")	Ø48(1-1/2")	Ø60(2")	Ø60(2")
YSM-B 05H	654	954	65	1156	1156	526	526	Ø48(1-1/2")	Ø48(1-1/2")	Ø60(2")	Ø60(2")
YSM-B 06H	749	954	65	1156	1156	526	526	Ø60(2")	Ø60(2")	Ø60(2")	Ø60(2")
YSM-B 07H	749	1094	65	1236	1236	666	666	Ø60(2")	Ø60(2")	Ø60(2")	Ø60(2")
YSM-B 08H	879	1094	65	1236	1236	666	666	Ø76(2-1/2")	Ø76(2-1/2")	Ø89(3")	Ø89(3")
YSM-B 10H	1009	1204	65	1366	1366	776	776	Ø76(2-1/2")	Ø76(2-1/2")	Ø89(3")	Ø89(3")
YSM-B 12H	1009	1374	65	1366	1366	946	946	Ø89(3")	Ø89(3")	Ø89(3")	Ø89(3")
YSM-B 15H	1129	1514	65	1446	1446	1086	1086	Ø89(3")	Ø89(3")	Ø89(3")	Ø89(3")
YSM-B 18H	1259	1624	65	1446	1446	1196	1196	Ø76(2-1/2")	Ø76(2-1/2")	Ø89(3")	Ø89(3")
YSM-B 20H	1259	1794	65	1536	1536	1366	1366	Ø76(2-1/2")	Ø76(2-1/2")	Ø89(3")	Ø89(3")
YSM-B 22H	1389	1794	65	1536	1536	1366	1366	Ø76(2-1/2")	Ø76(2-1/2")	Ø89(3")	Ø89(3")
YSM-B 25H	1389	2024	100	1638	1638	1588	1588	Ø76(2-1/2")	Ø76(2-1/2")	Ø89(3")	Ø89(3")
YSM-B 28H	1519	2074	100	1638	1638	1638	1638	Ø76(2-1/2")	Ø76(2-1/2")	Ø89(3")	Ø89(3")
YSM-B 30H	1519	2214	100	1768	1768	1778	1778	Ø76(2-1/2")	Ø76(2-1/2")	Ø89(3")	Ø89(3")
YSM-B 33H	1519	2424	100	1768	1768	1988	1988	Ø89(3")	Ø89(3")	Ø89(3")	Ø89(3")
YSM-B 36H	1519	2634	100	1768	1768	2198	2198	Ø89(3")	Ø89(3")	Ø89(3")	Ø89(3")
YSM-B 40H	1829	2498	100	1897	1907	2262	2272	Ø76(2-1/2")	Ø76(2-1/2")	Ø76(2-1/2")	Ø76(2-1/2")
YSM-B 45H	1954	2638	100	1897	1907	2402	2412	Ø76(2-1/2")	Ø76(2-1/2")	Ø76(2-1/2")	Ø76(2-1/2")

Fan Coil Unit Catalogue (DAIKIN)

Wall Mounted Type Fan Coil Unit

FWMT-C

BRC52A62

BRC51A62

- Stylish Front Panel
- Quiet Operation
- Uniform Air Distribution
- 5 Selectable Fan Speeds
- Turbo/quiet Function Available
- Light Weight
- Easy Maintenance
- Microprocessor Control
- Automatic Air Swing
- Able To Communicate With Versatile NIM (Network Interface Module) For Fan Coil Units Networking
- Easy-To-Use Wireless Handset
- Wired Handset Available (Optional)

Specification for Wall Mounted Type

MODEL					FWMT02CV1	FWMT03CV1	FWMT04CV1	FWMT05CV1	FWMT06CV1
NOMINAL COOLING CAPACITY				Btu/h	8300	9200	11300	15500	18000
				W	2430	2700	3310	4540	5280
NOMINAL SENSIBLE COOLING CAPACITY				Btu/h	6300	6900	9000	11700	14000
				W	1850	2020	2640	3430	4100
NOMINAL HEATING CAPACITY (ENTERING WATER TEMP. = 50°C)				Btu/h	11000	12000	15000	20500	25000
				W	3220	3520	4400	6010	7330
NOMINAL TOTAL INPUT POWER				W	31	32	42	57	72
NOMINAL RUNNING CURRENT				A	0.20	0.20	0.21	0.30	0.34
POWER SOURCE				V/Ph/Hz	220-240 / 1 / 50				
REFRIGERANT TYPE					N/A				
INDOOR UNIT	CONTROL	AIR DISCHARGE			AUTOMATIC LOUVER (UP & DOWN)				
		OPERATION			LCD WIRELESS MICRO-COMPUTER REMOTE CONTROL				
	AIR FLOW	HIGH		CFM	260	280	370	510	620
		MEDIUM		CFM	230	250	320	450	520
		LOW		CFM	200	220	260	390	460
		QUIET		CFM	180	190	240	360	440
	NOMINAL WATER FLOW RATE			USGPM	1.85	2.03	2.51	3.43	4.01
				litres/min	7.00	7.68	9.50	13.00	15.18
	HEAD LOSS (COOLING)			kPa	34.0	24.0	31.0	30.0	36.0
	HEAD LOSS (HEATING) : 50°C			kPa	29.0	20.0	25.0	27.0	33.0
	MAX. WORKING PRESSURE			kPa	1608				
	SURFACE AIR VELOCITY			m/s	0.68	0.74	0.97	0.83	1.01
	SOUND PRESSURE LEVEL (H/M/L/Q)			dBA	34 / 29 / 25 / 24	35 / 30 / 25 / 24	42 / 39 / 32 / 29	42 / 38 / 34 / 32	46 / 42 / 39 / 37
	UNIT DIMENSION		H X W X D	mm	288 X 800 X 206			310 X 1065 X 224	
	PACKING DIMENSION		H X W X D	mm	344 x 874 x 274			386 X 1136 X 314	
	UNIT WEIGHT			kg	9			14	
	CONDENSATE DRAIN SIZE			mm	19.05				
	PIPE CONNECTION			mm	12.70				
	FAN	TYPE			CROSS FLOW FAN				
		DRIVE			DIRECT				
		FAN SPEED	HIGH	RPM	1030	1050	1310	1035	1250
			MEDIUM	RPM	890	910	1150	920	1070
			LOW	RPM	760	780	955	825	970
	FAN MOTOR	TYPE			INDUCTION				
		INDEX OF PROTECTION (IP)			IP20			IP44	
		INSULATION GRADE			E				
		RATED INPUT POWER	HIGH	W	31	32	42	57	72
			MEDIUM	W	29	31	37	50	68
			LOW	W	25	29	33	43	60
		RATED RUNNING CURRENT	HIGH	A	0.20	0.20	0.21	0.30	0.34
			MEDIUM	A	0.19	0.20	0.20	0.29	0.32
			LOW	A	0.17	0.19	0.19	0.26	0.31
		STARTING CURRENT		A	0.40	0.40	0.40	0.30	0.43
		MOTOR OUTPUT		W	18	18	18	26	30
		POLES			4				
	COIL	TUBE	MATERIAL		COPPER				
			DIAMETER	mm	7.00				
		FIN	MATERIAL		ALUMINIUM				
			FACE AREA	m²	0.18	0.18	0.18	0.29	0.29
			ROW		2				
		WATER VOLUME		litre	0.52	0.58	0.58	0.95	0.95
	AIR QUALITY	FILTER	TYPE		WASHABLE SARANET FILTER				
			QUANTITY	pc	2				
	CASING			COLOUR	WHITE				

Ceiling Casette Compact Type (600x600)

FWAUCC-A

- Aesthetically attractive and slim front panel
- 4 Way air discharge for better air distribution
- Compact design
- Easy installation and maintenance
- Built in high pressure head drain pump
- Washable sanitet air filter
- Easy-to-use wireless handset
- Wired handset available (optional)

Specification for Ceiling Cassette Compact Type

MODEL						FWMJCC2BV1	FWMJCC4BV1	FWMJCC5BV1
NOMINAL COOLING CAPACITY					Btu/h	8500	14000	15500
					W	2490	4100	4540
NOMINAL SENSIBLE COOLING CAPACITY					Btu/h	6500	10000	11500
					W	1910	2930	3370
NOMINAL HEATING CAPACITY (ENTERING WATER TEMP. = 50°C)					Btu/h	12000	16000	18000
					W	3520	4690	5280
NOMINAL TOTAL INPUT POWER					W	63	64	79
NOMINAL RUNNING CURRENT					A	0.28	0.28	0.35
POWER SOURCE					V/Ph/Hz	220-240 / 1 / 50		
REFRIGERANT TYPE						N/A		
INDOOR UNIT	CONTROL	AIR DISCHARGE				4 WAY AUTOMATIC LOUVER (UP & DOWN)		
		OPERATION				LCD WIRELESS MICRO-COMPUTER REMOTE CONTROL		
	AIR FLOW	HIGH			CFM	380	400	440
		MEDIUM			CFM	290	310	330
		LOW			CFM	230	220	280
	NOMINAL WATER FLOW RATE				USGPM	2.03	3.43	3.57
					litres/min	7.68	12.98	13.51
	HEAD LOSS (COOLING)				kPa	19.3	26.9	28.8
	HEAD LOSS (HEATING) : 50°C				kPa	16.8	23.9	26.5
	MAX. WORKING PRESSURE				kPa	1608		
	SURFACE AIR VELOCITY				m/s	0.75	0.76	0.83
	SOUND PRESSURE LEVEL (H/M/L)				dBA	42 / 35 / 29	45 / 38 / 30	48 / 40 / 36
	UNIT DIMENSION - ( ) WITH PANEL		H X W X D		mm	250 X 570 X 570 (295 X 640 X 640)		
	PACKING DIMENSION - ( ) PANEL		H X W X D		mm	316 X 630 X 630 (126 X 700 X 726)		
	UNIT WEIGHT (UNIT + PANEL)				kg	15 + 3	17 + 3	17 + 3
	CONDENSATE DRAIN SIZE				mm	19.05		
	PIPE CONNECTION				mm	19.05		
	FAN	TYPE				TURBO FAN		
		DRIVE				DIRECT		
		FAN SPEED	HIGH		RPM	725	810	900
			MEDIUM		RPM	565	630	700
			LOW		RPM	460	480	610
	FAN MOTOR	TYPE				INDUCTION		
		INDEX OF PROTECTION (IP)				IP20		
		INSULATION GRADE				B		
		RATED INPUT POWER	HIGH		W	63	64	79
			MEDIUM		W	51	58	73
			LOW		W	46	52	69
		RATED RUNNING CURRENT	HIGH		A	0.28	0.28	0.35
			MEDIUM		A	0.23	0.25	0.32
			LOW		A	0.21	0.24	0.31
		STARTING CURRENT			A	0.32	0.30	0.47
		MOTOR OUTPUT			W	17	23	28
		POLES				6		
	COIL	TUBE	MATERIAL			COPPER		
			DIAMETER		mm	7.00		
		FIN	MATERIAL			ALUMINIUM		
			FACE AREA		m^2	0.24	0.25	0.25
			ROW			1	2	2
		WATER VOLUME			litre	0.43	0.83	0.83
	AIR QUALITY	FILTER	TYPE			WASHABLE SARANET FILTER		
			QUANTITY		pc	1		
	CASING				COLOUR	LIGHT GREY		

Ceiling Casette Compact Type (900x900)

MODEL							FWMJC6BV1	FWMJC8BV1	FWMJC9BV1	FWMJC11BV1	FWMJC13BV1
NOMINAL COOLING CAPACITY						Btu/h	21000	25000	30000	38000	43000
						W	6150	7330	8790	11140	12600
NOMINAL SENSIBLE COOLING CAPACITY						Btu/h	16700	19200	22300	27400	31000
						W	4890	5630	6540	8030	9090
NOMINAL HEATING CAPACITY (ENTERING WATER TEMP. = 50°C)						Btu/h	28000	33600	38300	45500	52000
						W	8210	9850	11230	13340	15240
NOMINAL TOTAL INPUT POWER						W	95	126	167	186	227
NOMINAL RUNNING CURRENT						A	0.44	0.55	0.74	0.85	1.03
POWER SOURCE						V/Ph/Hz	220-240 / 1 / 50				
REFRIGERANT TYPE							N/A				
INDOOR UNIT	CONTROL	AIR DISCHARGE					4 WAY AUTOMATIC LOUVER (UP & DOWN)				
		OPERATION					LCD WIRELESS MICRO-COMPUTER REMOTE CONTROL				
	AIR FLOW	HIGH				CFM	750	860	890	1000	1140
		MEDIUM				CFM	620	700	720	840	1000
		LOW				CFM	480	540	570	680	840
		QUIET				CFM	320	380	420	540	700
	NOMINAL WATER FLOW RATE					USGPM	4.71	5.59	6.69	8.45	9.60
						litres/min	17.83	21.17	25.29	31.94	36.29
	HEAD LOSS (COOLING)					kPa	20	37	22	44	53
	HEAD LOSS (HEATING) : 50°C					kPa	19	33	19	38	47
	MAX. WORKING PRESSURE					kPa	1600				
	SURFACE AIR VELOCITY					m/s	0.91	1.04	1.14	1.03	1.17
	SOUND PRESSURE LEVEL (H/M/L/Q)					dBA	42/38/32/23	46/42/35/27	48/43/38/30	50/47/43/33	52/49/45/39
	UNIT DIMENSION - ( ) WITH PANEL				H X W X D	mm	265 X 820 X 820 (340 X 990 X 990)			300 X 820 X 820 (375 X 990 X 990)	
	PACKING DIMENSION - ( ) PANEL				H X W X D	mm	341 X 916 X 916 (125 X 1020 X 1020)			376 X 916 X 916 (125 X 1020 X 1020)	
	UNIT WEIGHT (UNIT + PANEL)					kg	26 + 4	26 + 4	28 + 4	32 + 4	32 + 4
	CONDENSATE DRAIN SIZE					mm	19.05				
	PIPE CONNECTION					mm	19.05				
	FAN	TYPE					TURBO FAN				
		DRIVE					DIRECT				
		FAN SPEED	HIGH			RPM	530	600	660	710	800
			MEDIUM			RPM	450	500	550	610	710
			LOW			RPM	360	400	450	510	610
	FAN MOTOR	TYPE					INDUCTION				
		INDEX OF PROTECTION (IP)					IP20				
		INSULATION GRADE					B				
		RATED INPUT POWER	HIGH			W	95	126	167	186	227
			MEDIUM			W	79	103	109	151	176
			LOW			W	67	89	86	118	144
		RATED RUNNING CURRENT	HIGH			A	0.44	0.55	0.74	0.85	1.03
			MEDIUM			A	0.40	0.45	0.49	0.71	0.82
			LOW			A	0.36	0.39	0.39	0.57	0.69
		STARTING CURRENT				A	0.44	0.71	0.89	1.02	1.28
		MOTOR OUTPUT				W	30	45	65	80	110
		POLES					8				
		TUBE	MATERIAL				COPPER				

OC-WaterLoo Catalogue

Diffusers

15

OC WATERLOO

Louvred Face Diffusers

DF / MD / DE / DFA

Introduction

The Waterloo Multicone D Series Diffuser, constructed from aluminium alloy extrusions with mitred and welded/cleated frames, are ideal for most commercial projects requiring high quality diffusers for integration with a variety of ceiling types. The range is available with 5 frame styles and 14 different air pattern control core designs for vertical and horizontal diffusion.

Product Description

DF/MD	Flanged horizontal blow diffuser
DF-T8	8mm drop tegular tile replacement 375 & 450mm neck sizes
DF-T16	16mm drop tegular tile replacement 375 & 450 square necks
DE	Recessed frame horizontal blow diffuser
DFA	Flanged adjustable diffuser for horizontal or vertical projection (4 way only)
OBSS	Opposed blade damper
OBLL	Lever operated damper via the diffuser face
PBD	Plenum box
NR/D	Top entry neck reducer

Features

- Five frame styles for integration with most ceilings
- 14 core styles to suit required air pattern
- Lightweight aluminium construction
- Fixed or adjustable patterns
- Suits 300, 500, 600 & 1200 ceiling grid systems

Finishes

PPG9010 (RAL 9010 Gloss - 80% Gloss White)
PPM9010 (RAL 9010 Matt - 20% Gloss White)
PPM9006 (RAL 9006 Matt - 30% Gloss Silver)
Other colours available on request

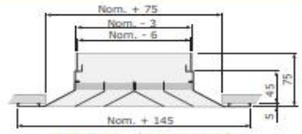
Weights

DF/MD/DE/DFA	12.5kg/m² face area
OBSS/ED	9.5kg/m² face area

Sizes

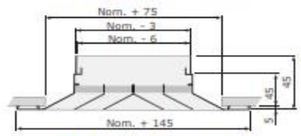
Series DF/DE	Minimum size - 150 x 150 duct size Maximum size - 1200 x 600 duct size
Series DF-T8/T16	Minimum size - 375 x 375 duct size (500mm tile replacement) Maximum size - 450 x 450 duct size (600mm tile replacement)
Series DFA	Minimum size - 150 x 150 duct size Maximum size - 600 x 600 duct size

Standard increments of 75mm only

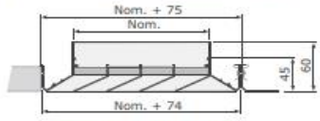


DF Typical lay-in grid

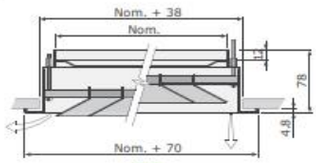
DF



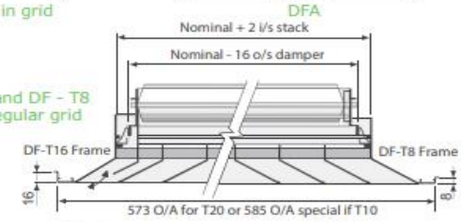
MD Typical lay-in grid



DE Typical clip in grid



DFA



DF - T16 and DF - T8
Typical tegular grid

OBLL damper
Lever operation at diffuser face.
Suitable for core 41 only

OBSS damper
Operated by screwdriver after removing core. Suitable for all types

Standard increments of 75mm only

Selection Criteria

Ceiling height 2.7m.
Temperature differential -10K
Radius of diffusion - Minimum and maximum throw which results in an average air velocity within the occupied zone of 0.25m/s and 0.10m/s respectively.
Noise level is based on diffuser sound power level less 8dB room absorption.

Selection Example DF11/300x300

Air flow rate	225 l/s
Throw	4.5 - 8.5 m
Total Pressure Loss	23 Pa
Noise level	35 dBA

Exhaust & OBSS corrections		
Supply diffuser	0dB	Pa x 1.0
Supply diffuser + OBSS	+ 3dB	Pa x 1.0
Exhaust diffuser	+ 3dB	Pa x 1.1
Exhaust diffuser + OBSS	+13dB	Pa x 1.15

Order Example

DF-41/300/300/PPM9010/OBSS

Type
Duct width
Duct height
Finish
Damper

DF / DE Supply		Core 41						
Total pressure drop (Pa)		150 x 150	225 x 225	300 x 300	375 x 375	450 x 450	525 x 525	600 x 600
9	l/s	34	76	135	211	304	413	540
	Min Max (m)	1.0-1.5	1.0-2.0	1.5-2.5	2.0-3.5	2.0-4.0	2.5-5.0	2.5-5.5
	L_w	-	-	-	-	23	24	25
15	l/s	45	101	180	282	405	551	720
	Min Max (m)	1.0-2.0	1.5-2.5	2.0-3.5	2.0-4.5	2.5-5.0	3.0-6.0	3.5-7.0
	L_w	-	24	27	28	30	31	32
23	l/s	56	127	225	352	506	689	900
	Min Max (m)	1.5-2.5	2.0-3.5	2.0-4.5	2.5-5.5	3.5-6.5	4.0-8.0	4.5-8.5
	L_w	26	30	33	34	36	37	38
33	l/s	68	152	270	422	608	827	1080
	Min Max (m)	1.5-3.0	2.0-4.0	2.5-5.0	3.5-6.5	4.0-8.0	4.5-9.0	5.0-10.5
	L_w	31	35	38	39	41	42	43
43	l/s	79	177	315	492	709	964	1260
	Min Max (m)	2.0-3.5	2.0-4.5	3.0-6.0	4.0-7.5	4.5-9.0	5.0-10.5	6.0-12.0
	L_w	35	39	42	43	45	46	47

Green Check Exhaust Fans Catalogue

*Amp and Watt draw is approximate and may vary based on motor manufacturer. Below performance is for 115V.

Model SP-VG Performance

Model	ENERGY STAR®	RPM	Amps*	Max. Input Watts		CFM / Static Pressure in Inches wg									
						0	0.1	0.125	0.25	0.375	0.5	0.625	0.75	0.875	1
SP-80(L)-VG	☆	935	0.1	6.1	CFM	80	80	80	80	78	66	38			
					Sones	<0.3	<0.3	<0.3	0.6	1.4	2.2	3.0			
SP-110(L)-VG	☆	940	0.2	8.4	CFM	110	110	110	109	100	62	28			
					Sones	<0.3	<0.3	<0.3	1.4	8.3	3.0	3.6			

Performance certified is for model SP exhaust for installation type B: Free inlet, Ducted outlet. Performance ratings include the effects of an inlet grille and backdraft damper. Speed (rpm) shown is nominal. Performance is based on actual speed of test. The sound ratings shown are loudness values in spherical fan sones at 5 ft *(1.5m)* in a spherical free field calculated per Annex B of AMCA 311. Values shown are for installation type B: free inlet spherical fan sone levels.

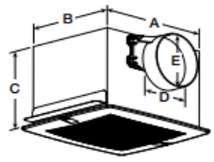
Model SP-A

Model SP-A Dimensions

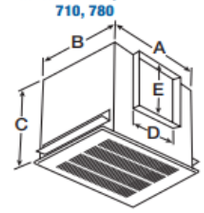
Model	A	B	C	D	E	Designer Grille	Decorative Grille	Unit Weight
50, 70, 90	13¼ *(337)*	10⅝ *(270)*	9 *(229)*	6 *(152)*		14⅞ x 13¼ *(378 x 337)*	15¼ *(387)* sq.	12 *(5)*
110, 125, 190	13¼ *(337)*	10⅝ *(270)*	9 *(229)*	8 *(203)*	6 *(152)*			17 *(8)*
200, 250, 290, 390	14 *(356)*	11⅞ *(302)*	11¼ *(286)*	8 *(203)*	8 *(203)*			24 *(11)*
410, 510	18 *(457)*	14⅜ *(365)*	14½ *(368)*	8 *(203)*	8 *(203)*	19⅜ x 16⅝ *(492 x 416)*	–	31 *(14)*
700	23⅝ *(600)*	11⅝ *(295)*	11⅝ *(295)*	19½ *(495)*	8 *(203)*	25⅛ x 13½ *(638 x 343)*		34 *(15)*
710, 780	18 *(457)*	14⅜ *(365)*	14½ *(368)*	10 *(254)*	8 *(203)*	19⅜ x 16⅝ *(492 x 416)*		34 *(15)*
900, 1050, 1410, 1550	23¾ *(603)*	14⅜ *(365)*	14½ *(368)*	17 7/16 *(443)*	8 *(203)*	25 x 16⅝ *(635 x 416)*		56 *(25)*

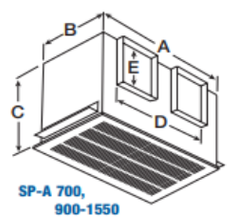
All dimensions are in inches *(millimetres)* and weight in pounds *(kilograms)*.
Outlet connection width is 1 in. *(25 mm)* - Mounting bracket width is 1½ in. *(38 mm)*.
For complete dimensional information, see CAPS submittal drawings.

SP-A 50-90



SP-A 110-510, 710, 780





SP-A 700, 900-1550

ENERGY STAR

amca SOUND AIR

c UL US LISTED

Model SP-VG and SP-A
Premium Plus and Premium Ceiling Exhaust Fan

GREENHECK
Building Value in Air.

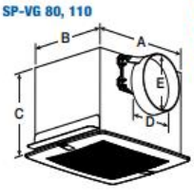
Model SP-VG

Model SP-VG Dimensions

Model	A	B	C	D	E	Designer Grille*	Decorative Grille	Unit Weight
80(L), 110(L)	11⅜ *(289)*	10½ *(267)*	7 ⅜ *(194)*	6 *(152)*	4 *(102)*	14⅞ x 13¼ *(378 x 337)*	15¼ *(387)* square	12 *(5)*

All dimensions are in inches *(millimeters)* and weight in pounds *(kilograms)*.
Outlet connection width is 1 in. *(25 mm)* - Mounting bracket width is 1½ in. *(38 mm)*.
For complete dimensional information, see CAPS submittal drawings.

SP-VG 80, 110



ENERGY STAR

amca SOUND AIR

c UL US LISTED

*Amp and Watt draw is approximate and may vary based on motor manufacturer. Below performance is for 115V.

Model SP-VG Performance

Model	ENERGY STAR®	RPM	Amps*	Max. Input Watts		CFM / Static Pressure in Inches wg									
						0	0.1	0.125	0.25	0.375	0.5	0.625	0.75	0.875	1
SP-80(L)-VG	☆	935	0.1	6.1	CFM	80	80	80	80	78	66	38			
					Sones	<0.3	<0.3	<0.3	0.6	1.4	2.2	3.0			
SP-110(L)-VG	☆	940	0.2	8.4	CFM	110	110	110	109	100	62	28			
					Sones	<0.3	<0.3	<0.3	1.4	8.3	3.0	3.6			

Performance certified is for model SP exhaust for installation type B: Free inlet, Ducted outlet. Performance ratings include the effects of an inlet grille and backdraft damper. Speed (rpm) shown is nominal. Performance is based on actual speed of test. The sound ratings shown are loudness values in spherical fan sones at 5 ft *(1.5m)* in a spherical free field calculated per Annex B of AMCA 311. Values shown are for installation type B: free inlet spherical fan sone levels.

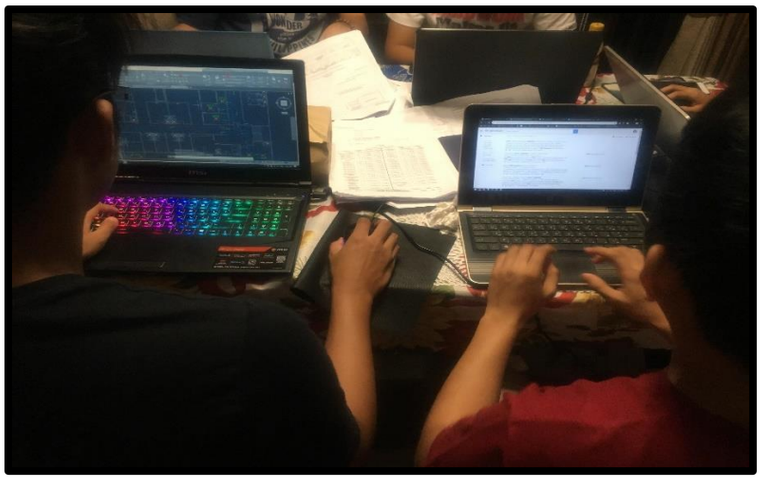
Model SP-A Premium Ceiling Exhaust Fan

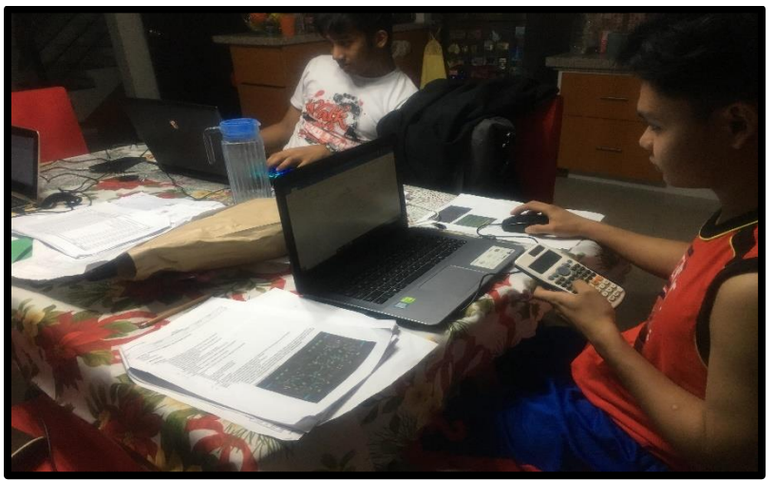
*Amp and Watt draw is approximate and may vary based on motor manufacturer. Below performance is for 115V.

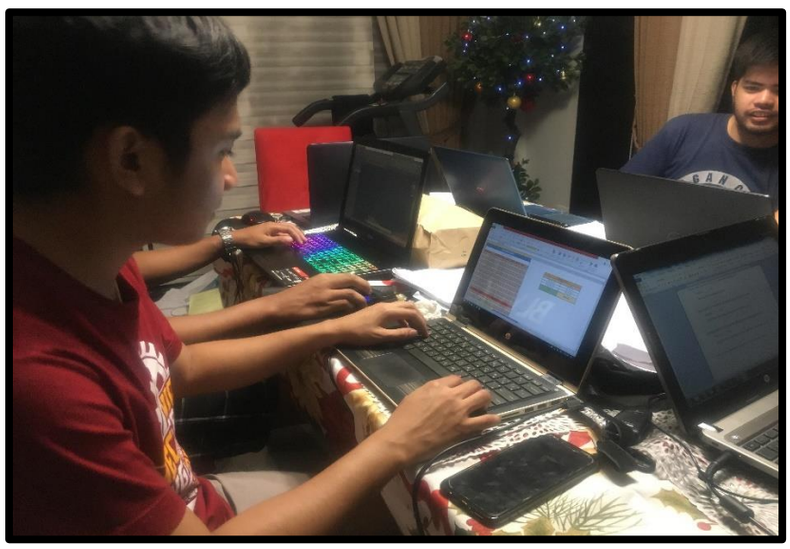
Model SP-A Performance

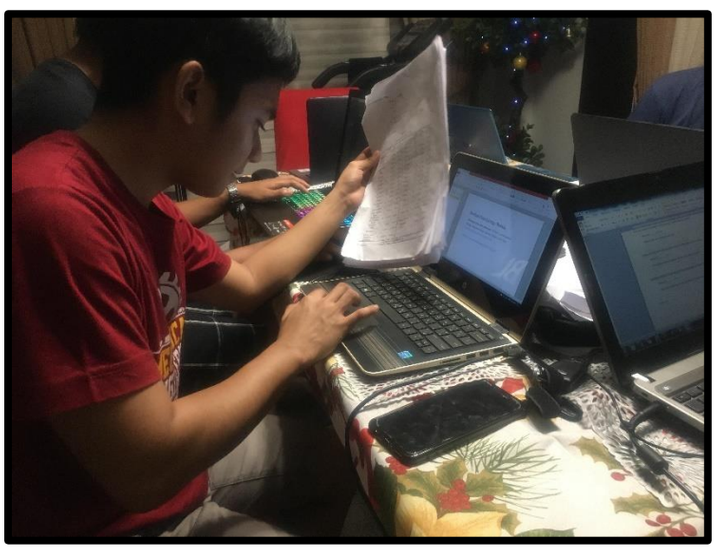
Model	ENERGY STAR®	RPM	Amps*	Max. Input Watts*		CFM / Static Pressure in Inches wg									
						0	0.1	0.125	0.25	0.375	0.5	0.625	0.75	0.875	1
SP-A50		700	0.31	18.3	CFM	76	51	48	31						
					Sones	0.5	0.7	0.8	1.3						
SP-A70	☆	850	0.14	15.9	CFM	91	77	74	55						
					Sones	<0.3	<0.3	<0.3	0.9						
					CFM/Watt*	5.72	5.03	4.93	4.04						
					Watts*	15.9	15.3	15.0	13.6						
SP-A90	☆	900	0.15	17.6	CFM	110	95	91	67						
					Sones	0.4	0.4	0.5	1.1						
					CFM/Watt*	6.25	5.59	5.42	4.32						
					Watts*	17.6	17.0	16.8	15.5						
SP-A110	☆	950	0.16	19.4	CFM	130	119	115	98						
					Sones	<0.3	<0.3	<0.3	0.5						
					CFM/Watt*	6.70	6.33	6.15	5.54						
					Watts*	19.4	18.8	18.7	17.7						
SP-A125	☆	1100	0.19	22.5	CFM	152	131	127	109						
					Sones	1.2	1.2	1.2	1.5						
					CFM/Watt*	6.76	5.90	5.72	5.07						
					Watts*	22.5	22.2	22.2	21.5						
SP-A190	☆	1400	0.45	54.4	CFM	226	208	204	180	138					
					Sones	3	2.5	2.5	3	2.5					
					CFM/Watt*	4.15	3.97	3.95	3.64	3.03					
					Watts*	54.4	52.4	51.7	49.4	45.6					
SP-A200	☆	900	0.47	56.1	CFM	267	246	242	224	199	162	109	68		
					Sones	2	2	2	2.5	3	3.5	4	4.5		
					CFM/Watt*	4.76	4.42	4.34	4.10	3.75	3.19	2.29	1.49		
					Watts*	56.1	55.7	55.7	54.7	53.1	50.8	47.6	45.7		
SP-A250	☆	1000	0.56	67	CFM	294	274	271	250	230	201	147	92		
					Sones	2.5	2.5	2.5	3	3.5	4	5	5		
					CFM/Watt*	4.39	4.18	4.12	3.89	3.67	3.36	2.65	1.80		
					Watts*	67.0	65.6	65.8	64.2	62.6	59.8	55.4	51.2		
SP-A290		1050	0.72	80.7	CFM	315	293	287	257	231	207	175	124		
					Sones	2.5	2.5	2.5	3.0	3.0	3.5	3.5	4.5		
SP-A390		1350	1.34	135	CFM	410	395	391	368	345	325	307	279		
					Sones	4.5	4.5	4.5	4.5	5.0	5.0	5.5	5.5		
SP-A410		1000	1.74	121	CFM	443	413	405	351	306					
					Sones	3.5	3.0	3.0	3.0	3.5					
SP-A510		1070	3.30	224	CFM	557	512	501	439	392	325				
					Sones	5.0	4.5	4.5	4.5	4.5	4.0				
SP-A700		1100	3.20	350	CFM	757	730	723	700	679	649	613	560	494	396
					Sones	5.0	5.0	5.0	5.5	5.5	6.0	6.0	6.5	6.5	6.5
SP-A710		1080	4.40	285	CFM	752	714	701	653	588	486	320			
					Sones	6.0	6.0	6.0	6.0	6.0	5.5	5.5			
SP-A780		1600	3.30	348	CFM	812	782	775	741	704	665	625	581		
					Sones	8.5	8.5	8.5	8.0	8.0	8.0	8.0	8.0		
SP-A900		950	4.00	285	CFM	955	907	896	841	773	701				
					Sones	4.0	5.0	5.0	5.0	5.0	5.0				
SP-A1050		1095	6.30	420	CFM	1125	1059	1043	964	885	796	662			
					Sones	6.0	6.0	6.0	6.0	5.5	5.5	5.5			
SP-A1410		1450	7.40	786	CFM	1455	1415	1404	1353	1307	1262	1218	1174		
					Sones	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0		
SP-A1550		1610	8.60	818	CFM	1607	1558	1558	1506	1449	1407	1369	1323		
					Sones	10.5	10.0	10.0	10.0	10.0	10.5	11.5	13.0		

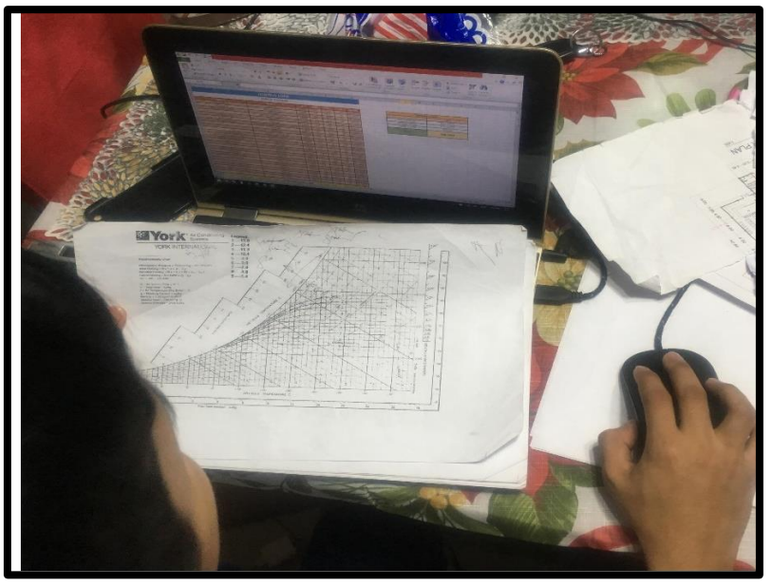
E. Project Documentation

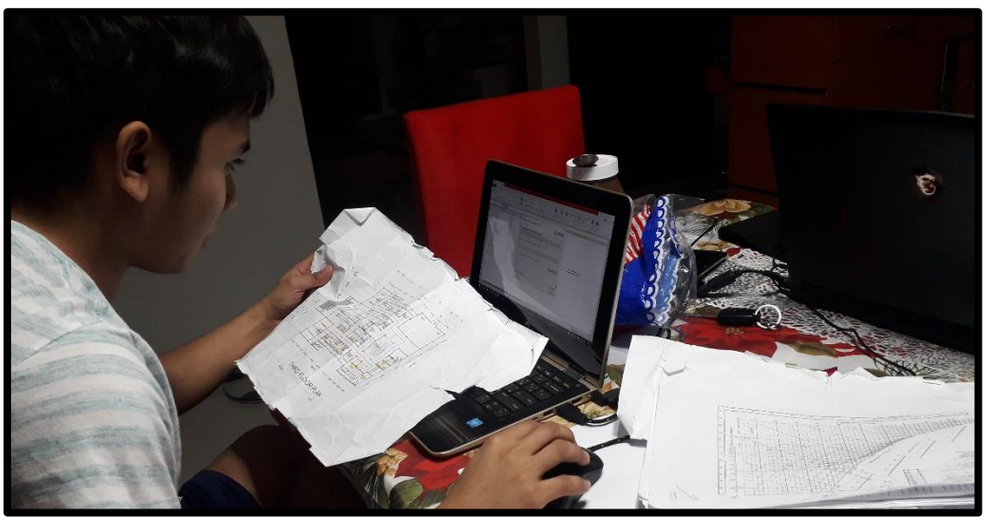












The three proponents carefully designed the three storey building of hospital and for Air Conditioning System and applied engineering decision in selecting mechanical equipments for comfortable environment.