Small chilled water system design

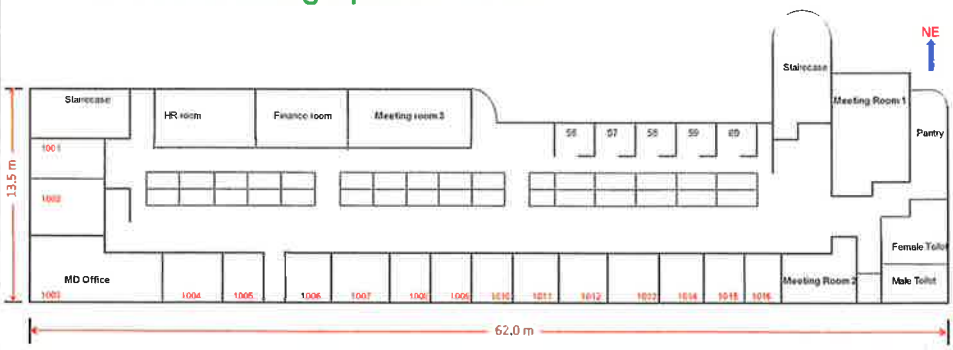
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Project Floor Plan

Office Building

- Air-conditioning space = 781m^2



2nd level office floor plan

With roof

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NEA Guidelines for Good Indoor Air Quality

Good Indoor Air Quality for Office Premises

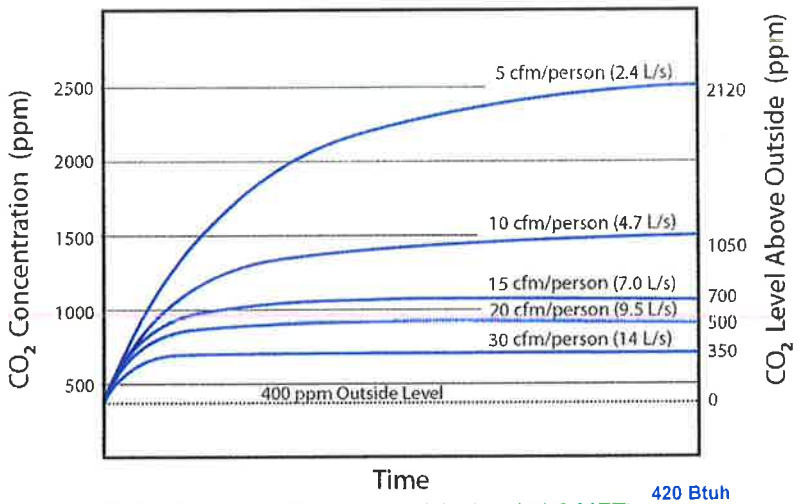
Parameter	Acceptable limit
Air Temperature	23 – 25 °C
Relative Humidity	≤ 65% for new ≤ 70% for old
Air Movement	< 0.3 m/s
Carbon Dioxide	700 + outdoor ppm
Carbon Monoxide	9 ppm
Formaldehyde	0.08 ppm
TVOC	1 ppm
Respirable Suspended Particle (PM4)	50 µg/m3
Particulate Matter 2.5 (PM2.5)	37.5 µg/m3
Total Bacteria Count	1,000 cfu/m^3 (colonial forming unit)

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CO2 Equilibrium Levels

Per Person Ventilation Rates



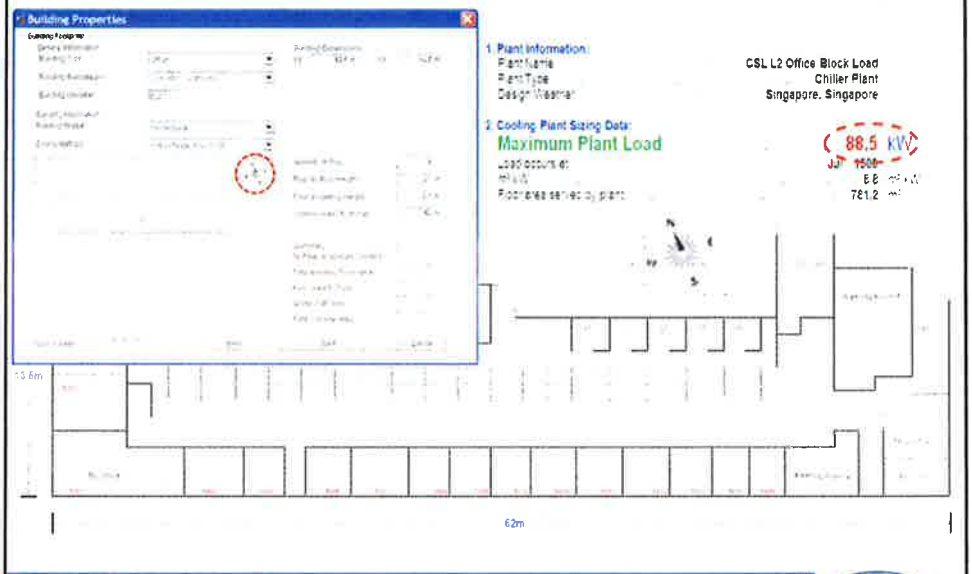
Note: Assumes office type activity level (1.2 MET)

420 Btuh
= 123 w

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Quick block load estimation



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Zone cooling load estimation

Common ventilation system

Air System Information

Air System Name	Air-cooled chilled-water system	Number of Zones	20
Equipment Class	TERM	Floor Area	781.2 m²
Air System Type	2P-FC	Location	Singapore Singapore

Sizing Calculation Information

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

Cooling Coil Sizing Data

Total coil load	10.2 kW	Design Coil Load	Jul 1500
Sensible coil load	7.8 kW	TA DB / WB	32.8 / 26.1 °C
Coil L/s at Jul 1500	714 L/s	Entering DB / WB	32.8 / 26.1 °C
Max coil L/s	714 L/s	Leaving DB / WB	23.7 / 23.1 °C
Sensible heat ratio	0.766	Bypass Factor	0.100
Water flow @ 5.6 °K rise	0.44 L/s		

Ventilation Fan Sizing Data

Actual max L/s	714 L/s	Fan motor BHP	0.33 BHP
Standard L/s	712 L/s	Fan motor kW	0.26 kW
Actual max L/s/m²	0.91 L/s/m²	Fan static	200 Pa

Outdoor Ventilation Air Data

Design airflow L/s	714 L/s	L/s/person	5.96 L/s person
L/s/m²	0.91 L/s/m²		

714 l/s = 2,570 CMH

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$\dot{m} c_p \Delta T = \frac{714}{1000} \times 1.225 \times 1.005 \times (32.8 - 23.7)$

≈ 7.99 kW

Zone cooling load estimation

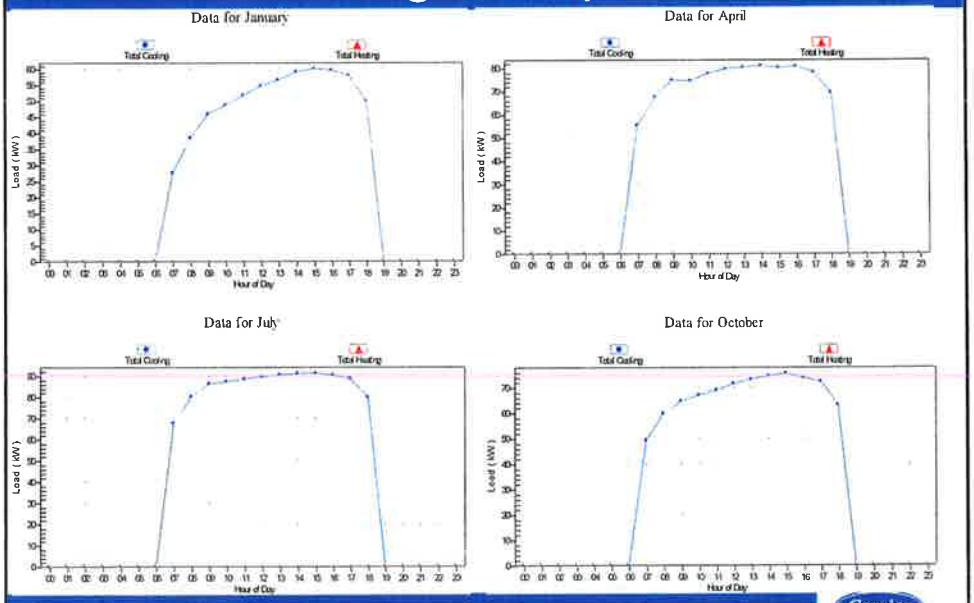
Terminal Unit Sizing Data - Cooling

	Zone Name	Zone Floor Area (m²)	Total Coil Load (kW)	Sens Coil Load (kW)	Time of Peak Load	Design Airflow (L/s)	Zone L/(s-m²)
1	Mtg Rm - A	25	3.6	2.1	Sep 1100	205	8.19
2	Mtg Rm - B	42	9	6.1	Jun 1100	562	13.39
3	Mtg Rm - C	25	6.2	4.7	Jun 1100	423	16.93
4	Office 1	15	2.6	2.3	Jul 1700	223	14.85
5	Office 2	16	2.7	2.3	Jul 1700	228	14.23
6	Office - MD	26	4.5	3.7	Aug 1700	356	13.77
7	Office 4	11	0.9	0.6	Aug 1300	60	5.47
8	Office 5	10	0.8	0.6	Aug 1300	55	5.37
9	Office 8	10	0.8	0.6	Aug 1300	55	5.57
10	Office 9	10	0.8	0.6	Aug 1300	56	5.67
11	Office 10	10	0.8	0.6	Aug 1300	55	5.57
12	Office 11	9	0.7	0.5	Aug 1300	50	5.6
13	Office 12	9	0.7	0.5	Aug 1300	50	5.6
14	Office 13	9	0.7	0.5	Aug 1300	50	5.6
15	Office 14	8	0.7	0.5	Aug 1400	48	6.02
16	Office 15	8	0.7	0.5	Aug 1400	48	6.02
17	Office 16	8	0.7	0.5	Aug 1400	48	6.02
18	Office - Finance	51	5.7	4.8	Jun 1100	435	14.02
19	Office - HR	51	5.7	4.8	Jun 1100	435	14.02
20	Office - General	488.2	35.4	24.1	Jun 1200	2397	4.93
	Total	781.2	83.7	60.9			
	Ventilation Air		10.2	7.8			
	Sum of Zones Peak & OA		93.9	68.7			

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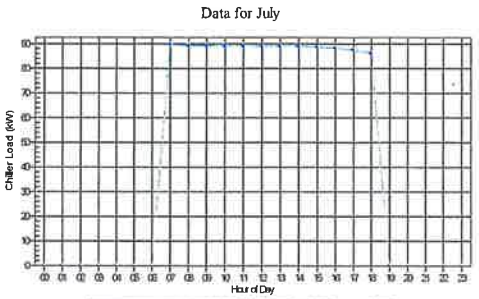
Building load profile



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Design load profile



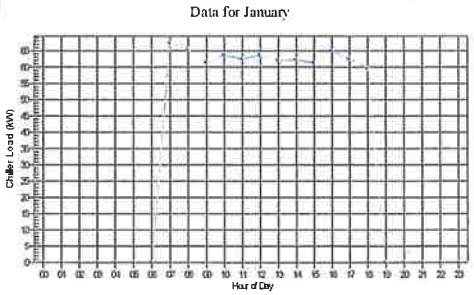
Maximum conditioning load = 90 kW

Chilled-water system selected:

SHSRB120A = 120 kW

(3 x 30RBM040)

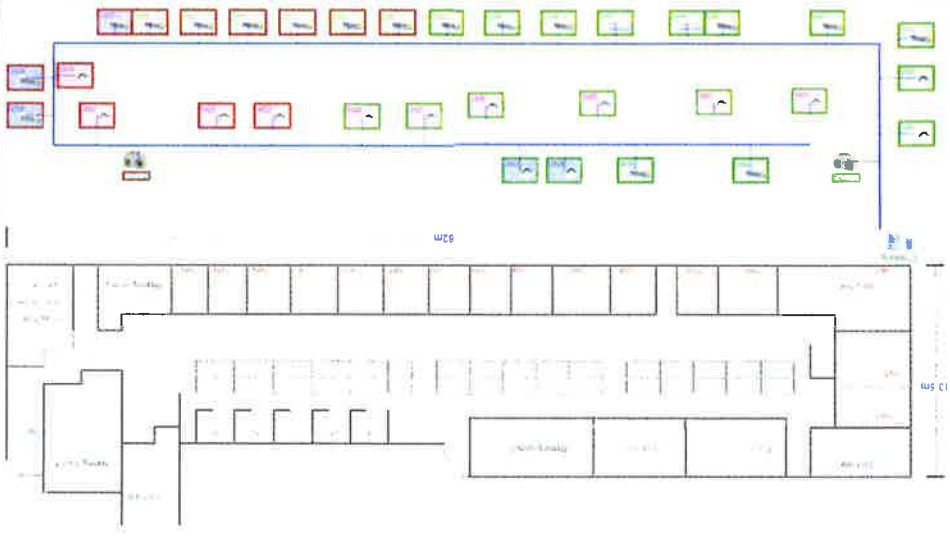




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Equipment layout

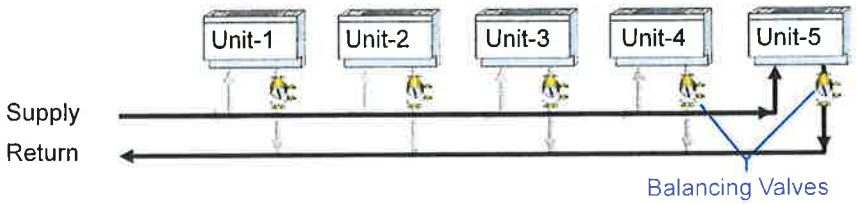


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Piping method

Direct Return horizontal distribution



Water enters Unit-1 from supply

Water leaves Unit-1 and returns directly to source

The first unit supplied is the first returned

Unequal circuit pressure drops result

Circuit pressure drop through
Unit-1 < Unit-2 < Unit-3 < Unit-4 < Unit-5

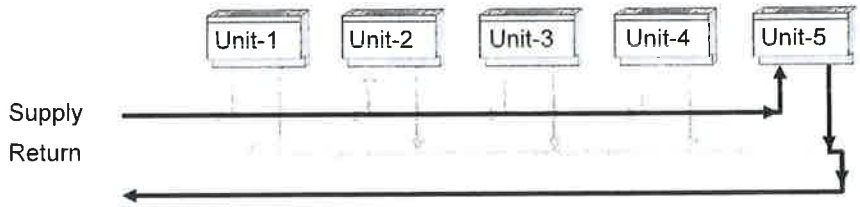
Balancing valves are a necessity

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Piping method

Reverse Return horizontal distribution



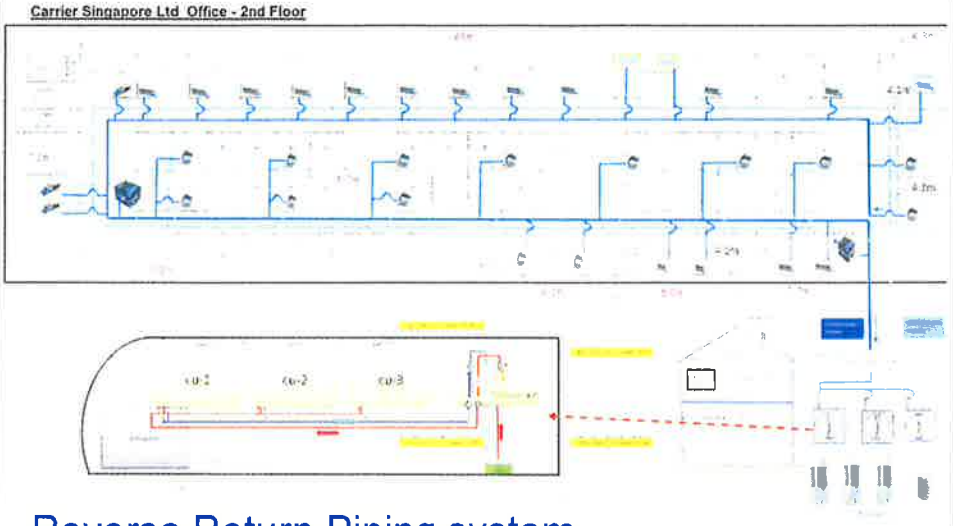
- Return header flow is same direction as supply flow
- Water leaves Unit-1 and goes all the way around in returning to source
- The first unit supplied is the last returned
- Circuit pressure drop through
  Unit-1 = Unit-2 = Unit-3 = Unit-4 = Unit-5
- Balancing valves may be eliminated

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Project piping method

Carrier Singapore Ltd Office - 2nd Floor



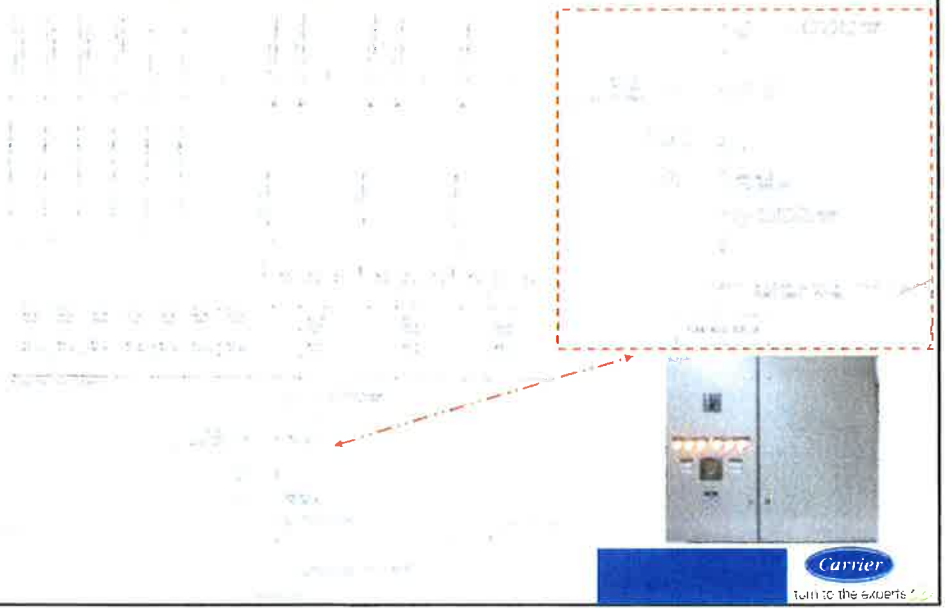
Reverse Return Piping system

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Electrical power supply

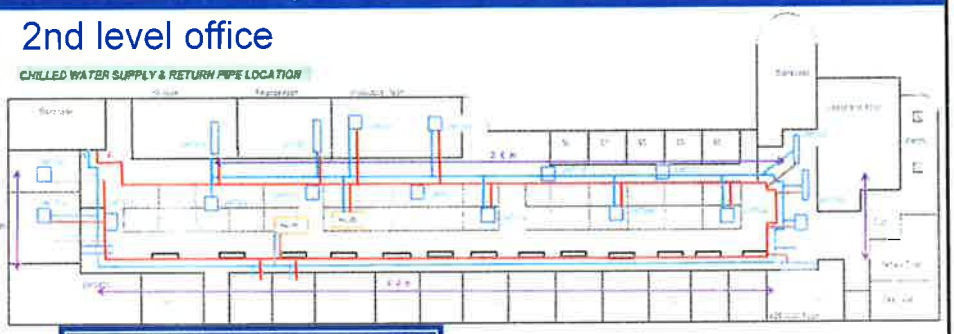
Electrical single line diagram



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Piping and FCU location

2nd level office





CHILLED WATER SUPPLY
R CHILLED WATER RETURN
Chilled water pipe length

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