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Cooling Load Calculation during Summer & Duct Design and Duct Drafting for Commercial Project

S. M Azfar Hashmi[#1], Chanduri Rajendra Prasad[*2], Syed Faheem[#3], Syed Obaid Ur Rahman[#4], Syed Mujeeb Ali[#5]

Mechanical Engineering Department of lords institute of engineering and technology, Jawaharlal Nehru Technological University, Hyderabad, Talengana, India

ABSTRACT

Human comfortness is essential now a day because of the improvement in life style and increasing central air conditioning is more reliable for easy operation with a lower maintenance cost. With large buildings such as commercial complex, auditorium, office buildings are provided with central air conditioning system. Educational and research institutions also need human comfortness, as the population of student community increase year by year. The effective designing of ducting in central air conditioning can provide human comfort, low power consumption, capital cost and improve asthetic of building . This project establishes the results of duct designing for air conditioning using ASHRAE for a commercial building. Duct design items such as duct size, CFM each space pressure drop at each diffuser, elbow, T, taper reducer and duct class, duct material . Using ASHRAE and SMACNA fundamental hand book, maintaining ASHRAE and SMACNA standard.

Keywords : Overall heat transfer coefficient,HAP (Hourly analysis program),Duct designing,Duct drafting

I. INTRODUCTION

Heating, ventilation and air conditioning (HVAC) is the technology of indoor and vehicular environmental comfort. Its goal is to provide thermal comfort and acceptable indoor air quality. HVAC system design is a sub discipline of mechanical engineering, based on the principles of thermodynamics, fluid mechanics, and heat transfer. Refrigeration is sometimes added to the field's abbreviation as *HVAC&R* or *HVACR*, or ventilating is dropped as in *HACR*.

Energy efficiency can be improved more by installing central heating systems which allows more granular application of heat. Zones can be controlled by multiple thermostats. The HVAC industry is a worldwide enterprise, with roles including operation and maintenance, system design and construction, equipment manufacturing and sales, and in education and research. The HVAC industry was historically regulated by the manufacturers of HVAC equipment, but regulating and standards organizations such as *HARDI*, *ASHRAE* , *SMACNA* , *ACCA* , Uniform Mechanical Code, International Mechanical Code, and *AMCA* have been established to support the industry and encourage high standards and achievement.

The starting point in carrying out an estimate both for cooling and heating depends on the exterior climate and interior specified conditions. However, before taking up the heat load calculation, it is necessary to find fresh air requirements for each area in detail, as pressurization is a building environment standards. It establishes the general principles of building environment design. It considers the need to provide a healthy indoor environment for the occupants as well as the need to protect the environment for future generations and promote collaboration among the various parties involved in building environmental design for sustainability. ISO16813 is applicable to new construction and the retrofit of existing buildings.

The building environmental design standard aims to:

- Provide the constraints concerning sustainability issues from the initial stage of the design process, with building and plant life cycle to be considered together with owning and operating costs from the beginning of the design process.

- Assess the proposed design with rational criteria for indoor air quality, thermal comfort, acoustical comfort, visual comfort, energy efficiency and HVAC system controls at every stage of the design process.

II. METHODS AND MATERIAL

A. Methodology

- Commercial building plan of 11634.5 square feet
- Calculation of floor, roof, wall and windows areas.
- Calculation of temperature difference (ΔT).
- Thermal resistance of wall, roof and windows.
- H.A.P 4.61.
- Overall heat transfer co – efficient.
- Ton of refrigerant.

B. Psychometric condition during summer in Hyderabad

Dry Bulb Temperature- 105°F
Relative Humidity-70-80%

As the above conditions for the citizens of Hyderabad is not comfortable. So, the air should be dehumidified and should bring the temperature at 72°F-76°F, and relative humidity to 50%-60%. For this cooling is required in a space.

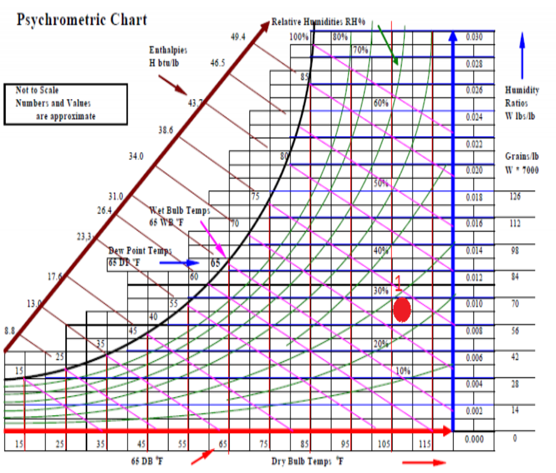


Figure 1: psychometric properties of air during summer

C. Design

For estimating cooling loads, one must consider the unsteady state processes, as the peak cooling load occurs during the day time and the outside conditions also vary significantly throughout the day due to solar radiation. In addition, all internal sources add on to the cooling loads and neglecting them would lead to underestimation of the required cooling capacity and the possibility of not being able to maintain the required indoor conditions. Thus, cooling load calculations are inherently more complicated as it involves solving unsteady equations with unsteady boundary conditions and internal heat sources.

D. Cooling Load Calculation By Using HAP

(heat load calculation i.e. heat gain through all the sources)

- Application for summer
- Process is directly to cooling and dehumidification (required in wet summer)
- Cooling and humidification (required in dry summer like in desert areas where there is no water available for evaporation).

DEFINITION: The room cooling load is a rate at which the heat must be removed from the room air in order to maintain it at desired temperature and humidity.

E. Civil structure of building

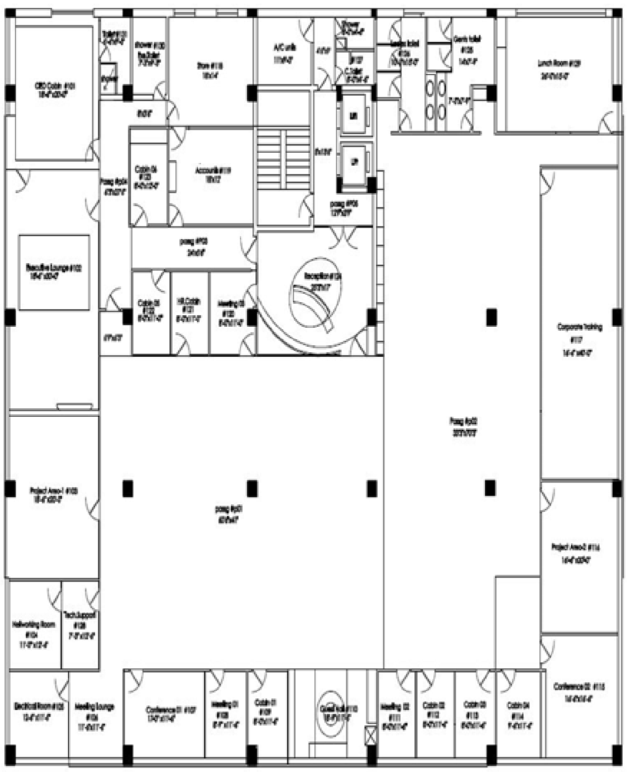


Figure 2: Civil structure of building

F. Gathering Data

The second step in the design process is to gather information necessary to model heat transfer processes in the building and to analyze operation of the HVAC equipment which heats and cools the building. This involves gathering data for the building, its environment and its HVAC equipment. Below, gathering of weather data, data for spaces in the building and data for the HVAC system will be discussed.

G. Gathering Weather Data

ASHRAE design weather conditions for Hyderabad will be used for this analysis. In addition to the ASHRAE data, we will use the period Mar through July as the design cooling months. This means cooling sizing calculations will only be performed for this range of months. We could use January through December as the calculation period. However, design weather conditions in Hyderabad are such that peak loads are most likely to occur during the summer or fall months. So we can reduce the set of calculation months to Mar through July to save calculation time without sacrificing reliability.

H. Gathering Space Data

1. Walls

One common wall construction is used for all exterior walls. The construction, consists of 8-inch lightweight concrete block. The exterior surface absorption is in the "dark" category. The overall U-value is 0.37 BTU/(hr-sqft-F). The overall weight is 87.3 lb/sqft.

2. Roofs

One uniform horizontal roof construction is used for this portion of the school building. The roof construction consists of half inch cement plaster,4" Concrete block, half inch cement plaster. The exterior surface absorption is in the "dark" category. The overall U-value is 0.541 BTU/(hr-sqft-F). The overall weight is 43.6 lb/sqft. Note that in HAP the roof assembly must include all material layers from the exterior surface to the interior surface adjacent to the conditioned space.

3. Lighting

Recessed, unvented fluorescent lighting fixtures are used for all rooms in this portion of the school building. A lighting density of 1.00 W/sqft is used. For offices, storage rooms and practice rooms we will use design day lighting levels of 100% from 0700 through 1700, the standard occupancy period for the offices, and 5% from 1800 through 2100 when lighting is reduced or operated intermittently for custodial work. This lighting profile applies for the days the building is in session. For weekends and holidays lighting levels of 0% are used.

4. Occupants

The maximum number of occupants varies by space and will be discussed later in this section. For all rooms "seated at rest" activity level will be used (230) BTU/hr/person sensible, 120 BTU/hr/person latent). For the music room the "office work" activity level will be used due to the higher level of activity in this room (245 BTU/hr/person sensible, 205 BTU/hr/person latent). For all rooms we will use design day occupancy levels of 100% for 0700 through 1700, the normal hours of operation for the building. Occupancy during the period 1800 through 2100 is very infrequent and will be ignored. Thus, occupancy levels of 0% will be used for all other hours of the day. This occupancy profile applies for days the school is in session. For weekends and holidays 0% occupancy is used for all hours.

5. SPACE DIMENSIONS

Table 1. Space Dimensions

S.NO	ROOM NAME	R.NO.	R.DIMENSIONS	R.AREA (Sqft)	Wall Exposure	Glass				Wall				Partition wall Area	Chairs	Persons
						North	South	East	West	North	South	East	West			
1	C.E.O.CHAMBER	101	18'-6"X20'-0"	370	South & West	-	74	-	108	-	156	-	120	-	6	7
2	Executie Lounge	102	18'-6"X30'-0"	555	South	-	360	-	-	-	-	-	-	-	11	13
3	Project Area 01	103	18'-6"X20'-0"	370	South	-	240	-	-	-	-	-	-	-	12	14
4	Network Room	104	11'-0"X12'-6"	137.5	South	-	-	-	-	-	150	-	-	-	-	-
5	Electrical Room	105	12'-6"X11'-6"	144	South & East	-	-	-	-	-	138	150	-	-	-	-
6	Meeting Lounge	106	11'-6"X11'-6"	133	East	-	-	138	-	-	-	-	-	-	5	6
7	Conference 01	107	17'-0"X11'-6"	196	East	-	-	204	-	-	-	-	-	-	10	12
8	Meeting Room 01	108	8'-9"X11'-6"	101	East	-	-	105	-	-	-	-	-	-	4	5
9	Cabin 01	109	8'-0"X11'-6"	92	East	-	-	96	-	-	-	-	-	-	3	4
10	Guest Hall	110	18'9"X11'-6"	216	East	-	-	225	-	-	-	-	-	-		
11	Meeting Room 02	111	8'-0"X11'-6"	92	East	-	-	96	-	-	-	-	-	-	4	5
12	Cabin 02	112	8'-0"X11'-6"	92	East	-	-	96	-	-	-	-	-	-	3	4
13	Cabin 03	113	8'-0"X11'-6"	92	East	-	-	96	-	-	-	-	-	-	3	4
14	Cabin 04	114	9'-6"X11'6"	110	East	-	-	-	-	-	-	114	-	-	4	5
15	Conference 02	115	16'-6"X16'-6"	273	East	-	-	-	-	198	-	198	-	-	15	17
16	Project Area 02	116	16'-6"X20'-0"	330	North	153	-	-	-	87	-	-	-	-	14	14
17	Corporate Training	117	16'-6"X40'-0"	660	North	480	-	-	-	-	-	-	-	-	25	25
18	Store Room	118	18'-0"X14'-0"	252	West	-	-	-	36	-	-	-	136	North-60	-	-
19	Accounts	119	18'-0"X12'-0"	216	-	-	-	-	-	-	-	-	-	North-144	8	8
20	Meeting Room 03	120	8'-0"X11'-0"	88	-	-	-	-	-	-	-	-		-	5	6
21	H.R.CABin	121	8'-0"X11'-0"	88	-	-	-	-	-	-	-	-		-	4	5
22	Cabin 05	122	8'-0"X11'-0"	88	-	-	-	-	-	-	-	-		-	4	5
23	Cabin 06	123	8'-0"x12'-0"	96	-	-	-	-	-	-	-	-		-	4	5
24	Reception Area	124	25'-3"X17'-0"	430	West	-	-	-	-	-	-	-		132	8	16
25	Gents Toilet	125	(14'x7'9")+(7'3"x7'9")	165	West	-	-	-	-	-	-	-	168	-	-	8
26	Ladies Toilet	126	10'-0"X15'-0"	150	West	-	-	-	-	-	-	-	120	-	-	8
27	C.Toilet & shower	127	(8'-0"X9'-0")+(4'6"x	113	West - East	-	-	-	-	-	-	-	96	96	-	2
28	Technical Supports	128	7'-3"X12'-6"	91	-	-	-	-	-	-	-	-	-	-	2	3
29	Lunch Room	129	26'-0"X15'-0"	390	West - North	-	-	-	231	180	-	-	81	-	32	40
30	Shower & Exe- toilet	130	7'-3"X9'-3"	67	west	-	-	-	-	-	-	-	87	-	-	2
31	Toilet	131	6'-6"X9'-3"	60	west	-	-	-	-	-	-	-	72	-	-	3
32	Passage Area	P01	(60'6"x41')+(5'9"x6	2521	-	-	-	-	-	-	-	-	-	-	19	-
33	Passage Area	P02	33'3"x70'3"	2402	-	-	-	-	-	-	-	-	-	South-144	-	-
34	Passage Area	P03	24'x5'6"	132	-	-	-	-	-	-	-	-	-	-	-	-
35	Passage Area	P04	(3'6"x8')+(6'3"x27'6	200	-	-	-	-	-	-	-	-	-	-	-	-
36	Passage Area	P05	(7'9"x4'3")+(5'x17'9	122	-	-	-	-	-	-	-	-	-	213, N-156, w-15	-	-

I. Gathering Air System Data

One air handling system will provide cooling and heating to the rooms in this wing of the commercial Building. Therefore, we will define one HAP air system to represent this equipment.

1. Equipment Type

A VAV rooftop unit will be used.

2. Ventilation

Outdoor ventilation airflow will be calculated using the ASHRAE Standard 62.1-2007 method. “Constant” control for ventilation will be used so the system uses the design flow of outdoor air at all times. Ventilation dampers are closed during the unoccupied period and the damper leak rate is 5%.

3. Cooling Coil

The system provides a constant 55 F supply air temperature to zone terminals. The DX cooling coil is permitted to operate in all months. The bypass factor for the cooling coil is 0.038 which is representative of the type of equipment we expect to select.

4. Preheat Coil

The rooftop unit contains a preheat coil to maintain minimum supply duct temperatures during the winter. The preheat coil is located downstream of the point where return air and outdoor ventilation air mix. The preheat set point is 52 F. The gas-fired heat exchanger in the rooftop unit is used for this purpose. The coil is permitted to operate in all months.

5. Supply Fan

The supply fan in the rooftop unit will be forward curved with variable frequency drive. The total static pressure for the system is estimated to be 3 in wg. The overall fan efficiency is 48%. The coil configuration is draw-thru.

6. Zoning

A zone is a region of the building with one thermostatic control. One zone will be created for each classroom. The music room and its adjacent office, storage room and practice room will all be part of a single zone. Each corridor will also be zone. Therefore, a total of 9 zones will be created: one each for the six classrooms, one for the music room and two for the corridors.

7. Thermostats

Thermostat settings of 75 F occupied cooling, 80 F unoccupied cooling, 70 F occupied heating and 65 F unoccupied heating will be used in all zones. The throttling range will be 1.5 F. The schedule for fan and thermostat operation for the design day will designate 0700 through 2100 as “occupied” hours. This covers both the 0700-1700 operating hours for the school and the 1800-2100 period when custodial staff is present. All other hours will be “unoccupied”. This profile applies for the school year which runs from August through June. During the shutdown month of July all hours will be designated as “unoccupied”.

8. Supply Terminals

All zones use parallel fan powered mixing box terminals with 0.5 in wg total fan static, 50% overall fan efficiency and a 95 F heating supply temperature. Minimum supply airflow for the terminals is based on ASHRAE Standard 62.1-2007 requirements. We will specify minimum zone airflow as zero so the program will automatically use the Standard 62.1-2007 requirement to set the minimum damper position. The heat source for the reheat coils is electric resistance.

9. Sizing Criteria

Required zone airflow rates will be based on the peak sensible load in each zone. Required space airflow rates will be based on peak space loads for the individual spaces. Safety factors will be specified as zero. A margin of safety will be applied later during equipment selection.

After weather, space and HVAC system data has been gathered, it is entered into HAP. This is the third step in the design process. After entering the data into HAP the report will be generated by HAP it self.

III. RESULTS AND DISCUSSION

J. Report

Table 2. Air system sizing summery for AHU-001

Air System Sizing Summary for GF AHU -- 001

Project Name: MAJOR PROJECT FINAL YEAR — 04-08-2017 03:13PM

Prepared by:

Air System Information

Air System Name	GF AHU -- 001	Number of zones	8
Equipment Class	CW AHU	Floor Area	5074.0 ft²
Air System Type	VAV	Location	hyderabad, India

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM	Peak zone sensible load	Calculation Months	Mar to Jul
Space CFM	Individual peak space loads	Sizing Data	Calculated

Central Cooling Coil Sizing Data

Total coil load	31.5 Tons	Load occurs at	Jul 1500
Total coil load	377.9 MBH	OA DB / WB	105.0 / 71.7 °F
Sensible coil load	353.8 MBH	Entering DB / WB	98.1 / 68.6 °F
Coil CFM at Jul 1500	7706 CFM	Leaving DB / WB	52.8 / 51.8 °F
Max block CFM at Mar 1400	9311 CFM	Coil ADP	51.0 °F
Sum of peak zone CFM	10023 CFM	Bypass Factor	0.038
Sensible heat ratio	0.936	Resulting RH	45 %
ft²/Ton	161.1	Design supply temp.	55.0 °F
BTU/(hr-ft²)	74.5	Zone T-stat Check	8 of 8 OK
Water flow@ 10.0 °F rise	75.63 gpm	Max zone temperature deviation	0.0 °F

Supply Fan Sizing Data

Actual max CFM at Mar 1400	9311 CFM	Fan motor BHP	7.65 BHP
Standard CFM	8725 CFM	Fan motor kW	6.07 kW
Actual max CFM/ft²	1.84 CFM/ft²	Fan static	3.00 in wg

Outdoor Ventilation Air Data

Design airflow CFM	1367 CFM	CFM/person	17.30 CFM/person
CFM/ft²	0.27 CFM/ft²		

Table 3. Zone sizing summery for AHU-001

Zone Sizing Summary for GF AHU -- 001

Project Name: MAJOR PROJECT FINAL YEAR — 04-08-2017 03:13PM

Prepared by:

Air System Information

Air System Name	GF AHU -- 001	Number of zones	8
Equipment Class	CW AHU	Floor Area	5074.0 ft²
Air System Type	VAV	Location	hyderabad, India

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM	Peak zone sensible load	Calculation Months	Mar to Jul
Space CFM	Individual peak space loads	Sizing Data	Calculated

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Air Flow (CFM)	Minimum Air Flow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	33.8	1756	105	Mar 1500	11.3	370.0	4.74
Zone 2	43.8	2277	195	Mar 1200	15.2	555.0	4.10
Zone 3	30.0	1560	210	Mar 1200	10.1	370.0	4.22
Zone 4	11.4	593	30	Jul 1600	6.1	252.0	2.35
Zone 5	9.1	475	195	Jul 1500	4.6	312.0	1.52
Zone 6	9.5	492	240	Jul 1500	3.9	264.0	1.86
Zone 7	12.3	642	240	Jul 1600	7.3	430.0	1.49
Zone 8	42.9	2229	151	Jul 1500	35.3	2521.0	0.88

Table 4. Space load and Airflow for AHU-001

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
R-101	1	33.8	Mar 1500	1756	11.3	370.0	4.74
Zone 2							
R-102	1	43.8	Mar 1200	2277	15.2	555.0	4.10
Zone 3							
R-103	1	30.0	Mar 1200	1560	10.1	370.0	4.22
Zone 4							
R-118	1	11.4	Jul 1600	593	6.1	252.0	2.35
Zone 5							
R-119	1	5.9	Jul 1500	306	3.2	216.0	1.42
R-123	1	3.3	Jul 1500	169	1.4	96.0	1.77
Zone 6							
R-121	1	3.1	Jul 1500	161	1.3	88.0	1.83
R-122	1	3.1	Jul 1500	161	1.3	88.0	1.83
R-120	1	3.3	Jul 1500	171	1.3	88.0	1.94
Zone 7							
R-124	1	12.3	Jul 1600	642	7.3	430.0	1.49
Zone 8							
R-132	1	42.9	Jul 1500	2229	35.3	2521.0	0.88

Table 5. Air system sizing summery for AHU-002

Air System Sizing Summary for GF AHU -- 002

Project Name: MAJOR PROJECT FINAL YEAR — 04-08-2017 03:20PM

Prepared by:

Air System Information

Air System Name	GF AHU -- 002	Number of zones	10
Equipment Class	CW AHU	Floor Area	5441.5 ft²
Air System Type	VAV	Location	hyderabad, India

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM	Peak zone sensible load	Calculation Months	Mar to Jul
Space CFM	Individual peak space loads	Sizing Data	Calculated

Central Cooling Coil Sizing Data

Total coil load	47.2 Tons	Load occurs at	Jul 1500
Total coil load	566.9 MBH	OA DB / WB	105.0 / 71.7 °F
Sensible coil load	533.1 MBH	Entering DB / WB	90.3 / 66.1 °F
Coil CFM at Jul 1500	14032 CFM	Leaving DB / WB	52.8 / 52.0 °F
Max block CFM at Jun 1500	15905 CFM	Coil ADP	51.3 °F
Sum of peak zone CFM	17716 CFM	Bypass Factor	0.038
Sensible heat ratio	0.941	Resulting RH	45 %
ft²/Ton	115.2	Design supply temp.	55.0 °F
BTU/(hr-ft²)	104.2	Zone T-stat Check	10 of 10 OK
Water flow@ 10.0 °F rise	113.43 gpm	Max zone temperature deviation	0.0 °F

Supply Fan Sizing Data

Actual max CFM at Jun 1500	15905 CFM	Fan motor BHP	13.07 BHP
Standard CFM	14904 CFM	Fan motor kW	10.37 kW
Actual max CFM/ft²	2.92 CFM/ft²	Fan static	3.00 in wg

Outdoor Ventilation Air Data

Design airflow CFM	1858 CFM	CFM/person	16.74 CFM/person
CFM/ft²	0.34 CFM/ft²		

Table 6. Zone sizing summery for AHU-002

Zone Sizing Summary for GF AHU -- 002

Project Name: MAJOR PROJECT FINAL YEAR — 04-08-2017 03:20PM

Prepared by:

Air System Information

Air System Name	GF AHU -- 002	Number of zones	10
Equipment Class	CW AHU	Floor Area	5441.5 ft²
Air System Type	VAV	Location	hyderabad, India

Sizing Calculation Information

Zone and Space Sizing Method:

Zone CFM	Peak zone sensible load	Calculation Months	Mar to Jul
Space CFM	Individual peak space loads	Sizing Data	Calculated

Zone Sizing Data

Zone Name	Maximum Cooling Sensible (MBH)	Design Air Flow (CFM)	Minimum Air Flow (CFM)	Time of Peak Load	Maximum Heating Load (MBH)	Zone Floor Area (ft²)	Zone CFM/ft²
Zone 1	15.5	806	150	Jul 1400	5.3	184.0	4.38
Zone 2	12.3	638	75	Jul 1400	3.9	92.0	6.93
Zone 3	26.4	1375	150	Jul 1400	9.0	216.0	6.36
Zone 4	82.3	4278	405	Mar 0800	19.0	522.0	8.20
Zone 5	13.4	695	46	Jul 1600	9.2	372.5	1.86
Zone 6	13.4	697	255	Jul 1600	7.3	273.0	2.55
Zone 7	21.7	1131	210	Jun 1600	9.5	330.0	3.43
Zone 8	55.3	2878	375	Jun 1600	22.0	660.0	4.36
Zone 9	40.9	2125	144	Jul 1500	33.4	2402.0	0.88
Zone 10	59.5	3093	31	Mar 1500	13.3	390.0	7.93

Table 7. Space load and Airflow for AHU-002

Space Loads and Airflows

Zone Name / Space Name	Mult.	Cooling Sensible (MBH)	Time of Load	Air Flow (CFM)	Heating Load (MBH)	Floor Area (ft²)	Space CFM/ft²
Zone 1							
R-112	1	12.3	Jul 1400	641	3.9	92.0	6.96
R-113	1	3.2	Jul 1500	168	1.4	92.0	1.83
Zone 2							
R-111	1	12.3	Jul 1400	638	3.9	92.0	6.93
Zone 3							
R-110	1	26.4	Jul 1400	1375	9.0	216.0	6.36
Zone 4							
R-109	1	12.1	Jul 1400	628	3.9	92.0	6.83
R-108	1	16.9	Mar 0800	878	3.6	101.0	8.69
R-107	1	32.9	Mar 0800	1710	6.9	196.0	8.72
R-106	1	22.2	Mar 0800	1152	4.7	133.0	8.66
Zone 5							
R-104	1	4.4	Mar 1600	227	3.3	137.5	1.65
R-105	1	6.4	Jul 1600	330	4.5	144.0	2.29
R-128	1	2.8	Jul 1500	144	1.3	91.0	1.58
Zone 6							
R-115	1	13.4	Jul 1600	697	7.3	273.0	2.55
Zone 7							
R-116	1	21.7	Jun 1600	1131	9.5	330.0	3.43
Zone 8							
R-117	1	55.3	Jun 1600	2878	22.0	660.0	4.36
Zone 9							
R-133	1	40.9	Jul 1500	2125	33.4	2402.0	0.88
Zone 10							
R-129	1	59.5	Mar 1500	3093	13.3	390.0	7.93

Table 8. cooling plant sizing summery for CH-001

Cooling Plant Sizing Summary for CH--001

MAJOR PROJECT FINAL YEAR — 04-07-2017 08:08PM

1. Plant Information:

Plant Name	CH--001
Plant Type	Generic Chilled Water
Design Weather	hyderabad, India

2. Cooling Plant Sizing Data:

Maximum Plant Load	78.7 Tons
Load occurs at	Jul 1500
ft²/Ton	133.6 ft²/Ton
Floor area served by plant	10515.5 ft²

3. Coincident Air System Cooling Loads for Jul 1500

Air System Name	Mult.	System Cooling Coil Load (Tons)
GF AHU -- 001	1	31.5
GF AHU -- 002	1	47.2

System loads are for coils whose cooling source is ' Chilled Water ' or ' Any ' .

K. Duct Designing &Terminal Selection of AHU001

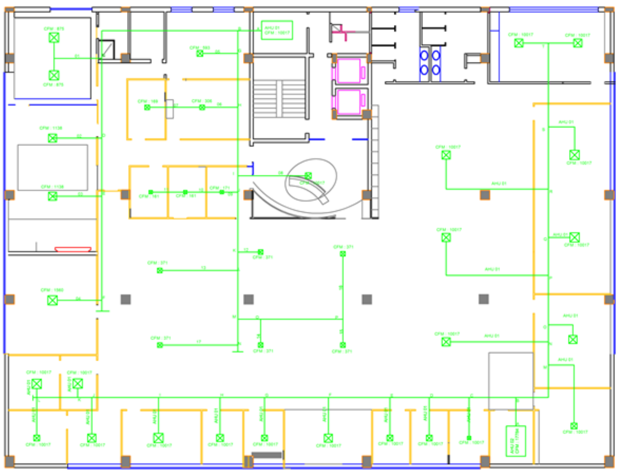


Figure 2. Single line drawing of AHU-001 & AHU-002

1. Main duct designing of AHU-001

Application: Commercial

Height of Main Duct: 18’’ & 16’’ (as per clearance above false ceiling).

Velocity: 2500 – 4000 FPM ~3000 FPM.

For section A to B

Q = 10017 CFM
V = 3000 FPM
From the friction chart in ASHRAE Hand Book we get
F = 0.445’’ Wg/100’

Round duct size 25’’
Rectangular duct size from equivalent rectangular duct dimension table 40’’X 14’’.

For section B to C

Q = 5585 CFM
V = 2600 FPM
From the friction chart in ASHRAE Hand Book we get
F = 0.441’’ Wg/100’
Total friction for duct B to C
F_p = (F/100) X length of duct
F_p = (0.441’’/100) X 34’ =0.149’’ Wg
$P_s = 0.9 \times \{(3000/4000)^2 - (2600/4000)^2\}$ = 0.126’’ Wg
P_s is less than F_p so it is not accepted, now chose more less velocity to increase static pressure.

Q = 5585 CFM
V = 2400 FPM
From the friction chart in ASHRAE Hand Book we get
F = 0.359’’ Wg/100’
Total friction for duct B to C
F_p = (0.359’’/100) X 34’ =0.122’’ Wg
$P_s = 0.9 \times \{(3000/4000)^2 - (2400/4000)^2\}$ = 0.182’’ Wg
Now p_s is greater than F_p, it is accepted so from the friction chart in ASHRAE Hand Book we get the duct dia 21’’

From equivalent rectangular duct dimension table we get duct size 26’’X 14’’.

Similarly proceeding further in tabular form below.

Table 9. Main duct designing of AHU-001

(AHU 01) MAIN DUCT DESIGNING BY STATIC REGAIN METHOD									
Sections	CFM	Velocity (FPM)	Friction (Wg/100’)	Length of Duct (Ft)	Friction pressure (Wg)	Static Pressure (Wg)	Equivalent Duct Dia (Inches)	Rect Duct Size (Inches)	Selected or Not
A to B	10017	3000	0.445	6	0.026	NA	24.7	14X40	•
B to C	5585	2600	0.441	34	0.149	0.126	19.8	14X24	X
B to C	5585	2400	0.359	34	0.122	0.182	20.7	14X26	•
C to D	3836	2200	0.362	17.25	0.062	0.05	17.9	14X19	X
C to D	3836	2000	0.284	17.25	0.048	0.99	18.8	14X22	•
D to E	2698	1800	0.27	12.5	0.035	0.042	16.6	14X16	•
E to F	1560	1600	0.28	22.5	0.063	0.03	13.4	14X11	X
E to F	1560	1400	0.2	22.5	0.045	0.072	14.3	14X12	•
B to G	4432	2800	0.613	5	0.03	0.06	17	14X18	•
G to H	3839	2600	0.554	11.5	0.063	0.062	16.5	14X19	X
G to H	3839	2400	0.452	11.5	0.051	0.117	17.1	14X18	•
H to I	3364	2200	0.392	14.75	0.057	0.054	16.7	14X19	X
H to I	3364	2000	0.308	14.75	0.045	0.099	16.6	14X18	•
I to J	2722	1800	0.268	3.5	0.0093	0.045	16.4	14X18	•
J to K	2229	1600	0.225	13	0.029	0.03	16	14X16	•
K to L	1858	1400	0.18	4.5	0.0081	0.03	14.4	14X14	•
L to M	1478	1200	0.14	10.75	0.015	0.02	14	14X12	•
M to N	371	600	0.058	5.5	0.0031	0.018	8.2	14X8	•
M to O	1107	1000	0.106	5	0.0053	0.027	14.2	14X12	•
O to P	742	800	0.078	17.75	0.0138	0.018	13	14X10	•
TOTAL STATIC PRESSURE				=		2.477			

2. Terminal Branch Designing

Branch 1
Q = 1749 CFM
H = 14’’ – 2’’ = 12’’ (height)
F = 0.06’’ wg/100’
From the friction chart in ASHRAE Hand Book we get
V = 900 FPM
Duct Dia = 19’’ & Duct size = 28’’ X 10’’.

Similarly proceeding further in tabular form below.

Table 10. Branch duct designing

BRANCH DUCT DESIGNING WITH EQUAL FRICTION METHOD						
S.NO	CFM	HEIGHT	FRICTION (wg/100")	VELOCITY (FPM)	DUCT DIA	DUCT SIZE
1	1749	12"	0.06"	900	19"	26"X 12"
2	1138	10"	0.06"	800	16"	24"X 10"
3	1138	10"	0.06"	800	16"	24"X 10"
4	1560	12"	0.2"	1400	14"	14"X 12"
5	593	10"	0.06"	700	13"	14"X 10"
6	475	10"	0.06"	600	12"	12"X 10"
7	169	6"	0.06"	500	8"	10"X 6"
8	642	10"	0.06"	700	13"	14"X 10"
9	493	10"	0.06"	700	12"	12"X 10"
10	322	10"	0.06"	600	10"	10"X 10"
11	161	6"	0.06"	500	8"	10"X 6"
12	371	10"	0.06"	600	12"	10"X 10"
13	371	10"	0.06"	600	12"	10"X 10"
14	371	10"	0.06"	600	12"	10"X 10"
15	371	10"	0.06"	600	12"	10"X 10"
16	371	10"	0.06"	600	12"	10"X 10"
17	371	10"	0.06"	600	12"	10"X 10"

3. Diffuser Selection

Diffuser 1
Q = 875 CFM
V = 450 FPM (velocity should be taken as branch velocity)
From the duct sizer we get
Neck Size = 12” X 12”
Face Size = 15”X 15” (as per manufacturer).

Diffuser 2
Q = 875 CFM
V = 450 FPM (velocity should be taken as branch velocity)
From the duct sizer we get
Neck Size = 12” X 12”
Face Size = 15”X 15”.

Similarly proceeding further in tabular form below.

Table 11. Diffuser Selection

DIFFUSER SELECTION BY DUCT SIZER				
S.NO	CFM	VELOCITY (FPM)	NECK SIZE	FACE SIZE
1	875	450	12"X 12"	15"X 15"
2	875	450	12"X 12"	15"X 15"
3	1138	800	15"X 15"	18"X 18"
4	1138	800	15" X 15"	18"X 18"
5	1560	900	18"X 18"	21"X 21"
6	593	700	12"X 12"	15"X 15"
7	306	600	9"X 9"	12"X 12"
8	169	500	9"X 9"	12"X 12"
9	642	700	12"X 12"	15"X 15"
10	171	650	6"X 6"	9"X 9"
11	161	600	6"X 6"	9"X 9"
12	161	500	6"X 6"	9"X 9"
13	371	600	9"X 9"	12"X 12"
14	371	600	9"X 9"	12"X 12"
15	371	600	9"X 9"	12"X 12"
16	371	600	9"X 9"	12"X 12"
17	371	600	9"X 9"	12"X 12"
18	371	600	9"X 9"	12"X 12"

L. Duct Designing &Terminal Selection of AHU002

1. Main duct designing of AHU-002

Application : Commercial
Height of Main Duct : 18'' & 16'' (as per clearance above false ceiling).
Velocity : 2500 – 4000 FPM ~3000 FPM.
Table 12. Main duct designing of AHU-001

(AHU 02) MAIN DUCT DESIGNING BY STATIC REGAIN METHOD									
Sections	CFM	Velocity (FPM)	Friction (Wg/100')	Length of Duct (Ft)	Friction pressure (Wg)	Static Pressure (Wg)	Equivalent Duct Dia (Inches)	Rect Duct Size (Inches)	Selected or Not
A to B	17784	3000	0.314	4	0.0125	NA	33	18X54	•
B to C	7861	2800	0.432	8.5	0.036	0.063	23	18X24	•
C to D	7693	2600	0.362	8.5	0.03	0.062	23	18X24	•
D to E	7052	2400	0.312	8.5	0.026	0.056	23	18X24	•
E to F	6414	2200	0.265	13.25	0.035	0.051	23	18X24	•
F to G	5039	2000	0.241	13.75	0.033	0.047	22	18X22	•
G to H	4411	1800	0.2	9.5	0.019	0.04	21	18X22	•
H to I	3533	1600	0.17	13.25	0.022	0.038	20	18X20	•
I to j	1823	1400	0.182	14.25	0.025	0.033	16	18X12	•
J to k	671	1200	0.229	3	0.006	0.029	10	18X6	•
K to L	557	1000	0.162	8.75	0.014	0.027	10	18X6	•
B to M	9923	2800	0.375	3	0.01125	0.063	26	18X32	•
M to N	9226	2600	0.325	6.75	0.021	0.062	25	18X32	•
N to O	8518	2400	0.278	5.75	0.015	0.056	25	18X32	•
O to P	7387	2200	0.243	12.25	0.029	0.051	25	18X30	•
P to Q	6679	2000	0.203	9.75	0.019	0.047	25	18X30	•
Q to R	5240	1800	0.18	9.75	0.017	0.04	23	18X26	•
R to S	4532	1600	0.146	8	0.011	0.038	23	18X24	•
S to T	3093	1400	0.132	24.25	0.032	0.033	20	18X20	•
		TOTAL STATIC PRESSURE		=		1.394			

2. Terminal Branch Designing

Table 13. Branch duct designing

BRANCH DUCT DESIGNING WITH EQUAL FRICTION METHOD						
S.NO	CFM	HEIGHT	FRICTION (wg/100")	VELOCITY (FPM)	DUCT DIA	DUCT SIZE
1	168	6"	0.06"	500	8"	10"X 6"
2	641	10"	0.06"	700	13"	14"X 10"
3	638	10"	0.06"	700	13"	14"X 10"
4	1375	14"	0.06"	900	18"	18"X 14"
5	628	10"	0.06"	700	13"	14"X 10"
6	878	14"	0.06"	800	15"	16"X 14"
7	1710	14"	0.06"	900	19"	20"X 14"
8	1152	14"	0.06"	800	16"	16"X 14"
9	330	8"	0.06"	600	10"	10"X 8"
10	227	8"	0.06"	500	9"	10"X 18"
11	114	6"	0.06"	500	7"	10"X 6"
12	697	10"	0.06"	700	14"	10"X 16"
13	1131	14"	0.06"	800	16"	16"X 14"
14	708	10"	0.06"	700	14"	16"X 10"
15	1439	14"	0.06"	800	18"	20"X 14"
16	708	10"	0.06"	700	14"	16"X 10"
17	1439	14"	0.06"	800	18"	20"X 14"
18	708	10"	0.06"	700	14"	16"X 10"
19	1546	10"	0.06"	900	18"	20"X 10"
20	1546	10"	0.06"	900	18"	20"X 10"

3. Diffuser Selection

Table 14.Diffuser Selection

DIFFUSER SELECTION BY DUCT SIZER				
S.NO	CFM	VELOCITY (FPM)	NECK SIZE	FACE SIZE
1	168	500	9"X 9"	12"X 12"
2	641	700	12"X 12"	15"X 15"
3	638	700	12"X 12"	15" X 15"
4	1375	900	18"X 18"	21"X 21"
5	628	700	12"X 12"	15" X 15"
6	878	800	15" X 15"	18"X 18"
7	1710	900	18"X 18"	21"X 21"
8	1152	800	15" X 15"	18"X 18"
9	330	600	9"X 9"	12"X 12"
10	227	500	9"X 9"	12"X 12"
11	114	500	6"X 6"	9"X 9"
12	697	700	12"X 12"	15" X 15"
13	1131	800	15" X 15"	18"X 18"
14	708	700	12"X 12"	15" X 15"
15	1439	800	18"X 18"	21"X 21"
16	708	700	12"X 12"	15" X 15"
17	1439	800	18"X 18"	21"X 21"
18	708	700	12"X 12"	15" X 15"
19	1546	800	18"X 18"	21"X 21"
20	1546	800	18"X 18"	21"X 21"

Table 15. total cooling load of the building

Cooling Plant Sizing Summary for CH--001

MAJOR PROJECT FINAL YEAR — 04-07-2017 08:08PM

1. Plant Information:
Plant Name CH--001
Plant Type .... Generic Chilled Water
Design Weather .... hyderabad, India

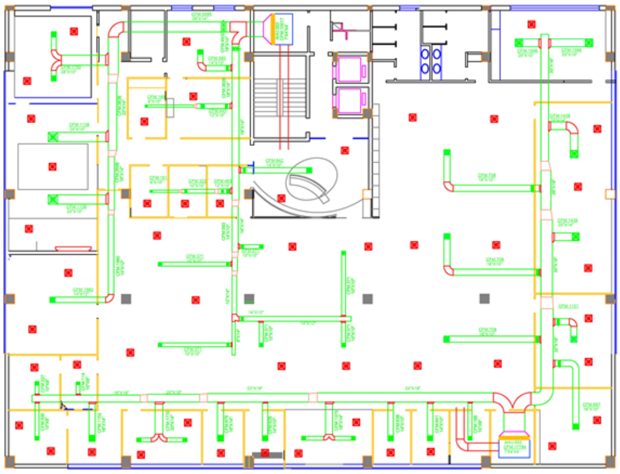
2. Cooling Plant Sizing Data:
Maximum Plant Load .... 78.7 Tons
Load occurs at .... Jul 1500
ft²/Ton .... 133.6 ft²/Ton
Floor area served by plant .... 10515.5 ft²

3. Coincident Air System Cooling Loads for Jul 1500

Air System Name	Mult.	System Cooling Coil Load (Tons)
GF AHU -- 001	1	31.5
GF AHU -- 002	1	47.2

System loads are for coils whose cooling source is ' Chilled Water ' or ' Any ' .

Figure 3. Double line drawing of AHU-001 & AHU-002



IV. CONCLUSION

This project briefly explains how to perform cooling load calculation in H.A.P 4.61 for humidifying the air and bring the psychometric properties at a comfort zone for human body in summer season.

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