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Preparation of Fan Coil Unit using Revit Software

A. Vijay kumar[1], O. Ajay kumar[2], K. Bala Kumar[2], M. Dinesh kumar[2]

[1]Assistant Professor, [2]UG Student
[1,2]Mechanical Engineering, Guru nanak Institute of technology, Ibrahimpatnam, Hyderabad, India

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ABSTRACT

This project "Fan coil unit preparation by using Revit software" deals with the study of air conditioner and water conditioner system in a single unit. The main object behind this project is to supply chilled water through MS pipes based on load calculations by considering the required standards. In this pipe design calculations are done by using the AUTODESK REVIT MEP software to design pipes with proper adjustments and fittings. This fan coil unit system is to be designed only for places where natural ventilation is available. The multifunctional system which can provide cold water, refrigeration effect and air conditioning effect with regular air or space conditioning system. Fan coil unit is based on indirect refrigeration system mostly used as secondary refrigeration system. In this project we have using water as primary refrigerant. Along with this, air and water systems are used primarily for perimeter building spaces with high sensible loads and where close control of humidity is not a primary criterion. These systems work well in the residential buildings, office buildings, hospitals, schools, apartment buildings, and other buildings where their capabilities can meet the project design intent and criteria. In most climates, these systems are designed to provide all of the required heating and cooling needs for perimeter spaces, and simultaneous heating and cooling in different spaces during intermediate seasons.

***Keywords*— Refrigeration, ventilation, air conditioning effect**

I. INTRODUCTION

A fan coil unit (FCU) is a simple device consisting of a heating and/or cooling heat exchanger or 'coil' and fan. It is part of an HVAC system found in residential, commercial, and industrial buildings. A fan coil unit is a diverse device sometimes using ductwork, and is used to control the temperature in the space where it is installed, or serve multiple spaces. It is controlled either by a manual on/off switch or by a thermostat, which controls the throughput of water to the heat exchanger using a control valve and/or the fan speed.

Due to their simplicity and flexibility, fan coil units can be more economical to install than ducted 100% fresh air systems (VAV) or central heating systems with air handling units or chilled beams. Various unit configurations are available, including horizontal (ceiling mounted) or vertical (floor mounted).

Noise output from FCUs, like any other form of air conditioning, is principally due to the design of the unit and the building materials around it. Some offer noise levels as low as NR25 or NC25

The output from an FCU can be established by looking at the temperature of the air entering the unit and the temperature of the air leaving the unit, coupled with the volume of air being moved through the unit. This is a simplistic statement, and there is further reading on sensible heat ratios and the specific heat capacity of air, both of which have an effect on thermal performance.

II. principle of operation

Fan Coil Unit falls principally into two main types: blow through and draw through. As the names suggest, in the first type the fans are fitted such that they blow through the heat exchanger, and in the other type the fans are fitted after the coil such that they draw air through it. Draw through units are considered thermally superior, as ordinarily they make better use of the heat exchanger. However, they are more expensive, as they require a chassis to hold the fans whereas a blow-through unit typically consists of a set of fans bolted straight to a coil. A fan coil unit may be concealed or exposed within the room or area that it serves.

An exposed fan coil unit may be wall-mounted, freestanding or ceiling mounted, and will typically include an appropriate enclosure to protect and conceal the fan coil unit itself, with return air grille and supply air diffuser set into that enclosure to distribute the air.

A concealed fan coil unit will typically be installed within an accessible ceiling void or services zone. The return air grille and supply air diffuser, typically set flush into the ceiling, will be ducted to and from the fan coil unit and thus allows a great degree of flexibility for locating the grilles to suit the ceiling layout and/or the partition layout within a space. It is quite common for the return air not to be ducted and to use the ceiling void as a return air plenum.

The coil receives hot or cold water from a central plant, and removes heat from or adds heat to the air through heat transfer. Traditionally fan coil units can contain their own internal thermostat, or can be wired to operate with a remote thermostat. However, and as is common in most modern buildings with a Building Energy Management System (BEMS), the control of the fan coil unit will be by a local digital controller or outstation (along with associated room temperature sensor and control valve actuators) linked to the BEMS via a communication network, and therefore adjustable and controllable from a central point, such as a supervisors head end computer.

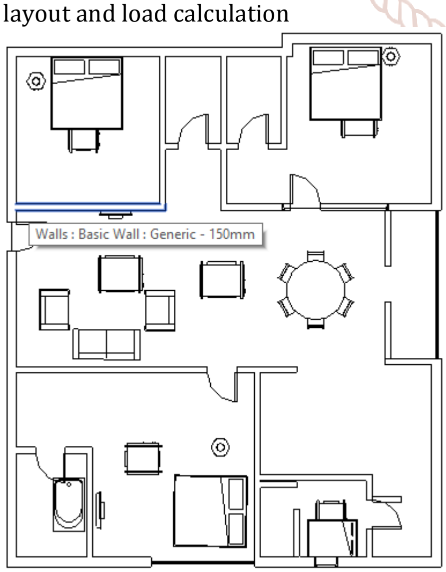
Fan coil units circulate hot or cold water through a coil in order to condition a space. The unit gets its hot or cold water from a central plant, or mechanical room containing equipment for removing heat from the central building's closed-loop. The equipment used can consist of machines used to remove heat such as a chiller or a cooling tower and equipment for adding heat to the building's water such as a boiler or a commercial water heater.

III. chiller

A chiller is a machine that removes heat from a liquid via a vapor-compression or absorption refrigeration cycle. This liquid can then be circulated through a heat exchanger to cool equipment, or another process stream (such as air or process water). As a necessary by-product, refrigeration creates waste heat that must be exhausted to ambience, or for greater efficiency, recovered for heating purposes.

Chilled water is used to cool and dehumidify air in mid- to large-size commercial, industrial, and institutional facilities. Water chillers can be water-cooled, air-cooled, or evaporative cooled. Water-cooled systems can provide efficiency and environmental impact advantages over air-cooled systems.

building layout and load calculation



Location and Thermal Conditions

Building Location : Hyderabad
Orientation : Equal share of walls of all sides
Application : Residential Building
Latitude : 17.86ºN

Material (Civil Building)

Many materials are used for the building such as material for walls (i.e Concrete hollow blocks, Cement, sand etc). Window materials (types of glass) Doors (type of door, i.e wooden, glass etc), material for roof, floor, and partition wall. So for this 3 floor project specifications we have list of materials to be utilized by civil contractor.

Window spacing
Ordinary glass- outside awing (vented sides top) medium color. Dimensions of window (L×B): 5ft×3ft.

Door Materials

Wooden Door are utilized for this project. Dimension of Door
(L×B): **7ft ×3ft).**

Masonry Wall Material

Solid brick by falls and commands of the 123/18” plastic on wall sepsis’s board

Masonry Partition Wall Material

Concrete blocks of with light weight aggregate of 1/2” plaster 6” thick

Masonry Floor Material

Slab of sand aggregate of 8” thick and ½” light weight plastic with no furring

Transmission Coefficient

Transmission coefficient value changes for each type of material used for civil building. So as per ISHRAE/ASHRAE standards, see below data table of transmission coefficient for different materials used for our project.

Transmission coefficient	Coefficient factor
Glass	0.2
Masonry Wall	0.31
Roof	0.30
Partition Wall	0.20
Floor	0.33

Building Information

1. Lighting load for the application will be provided by the client and concern department for electrical. If client doesn’t provide that considered from the standard electrical data book.

A. 1.For residential:
B. 1 to 1.25w/s.ft
C. 2. For commercial:
D. 1.25 to 1.5w/s.ft
E. 3. For industrial:
F. 1.5 to 2.0 w/s.ft

2. Equipment Load

A. Equipment load is categorized either w.r.t the wattage of the Equipment per area depending on the application.
B. The standard equipment load varies from 0.5w/s.ft to 0.9 w/s.ft depending on application

3. People Load

A. The no of people occupying the space for residential application is considered w.r.t type for other application the no of people is considered from seating arrangement is given then no of people is considered as 1 person for 30.

Manual calculation for residential building

Outdoor heat load calculation

Master bedroom

For wall (south facing)

Q- u*a*(to-tr)

Q=0.31*104.99*(106-75)

Q=1008.99 btu/hr

West facing

Q=0.31*145.49*31

Q=1398.20 btu/hr

For glass (south facing)

Q=a*sc*scr

Q=81*31*0.56

Q=1406.6 btu/hr

Internal load

Outside air= volume of room*no. Of air changes/60

3042.45*2/60=101.42cfm

Bf(bypass factor)=0.3

Cf(contact factor)=0.7

Sensible heat=cfm*tem diff*bf*1.08

101.42*31*0.15*1.08=509.30

Internal heat

Infiltration=temp diff*7*1.08

People load

No.people*245

3*245=735

Light load

Total area*watt*3.41

33.05*2*3.41=2305.5

Equpment load

Total area*load*3.41

338.05*3.7*3.41

Total sencible heat load

Outdoor load+ equpment load+ light load+people load

=19456.02

Latent heat

Cfm*temp diff*0.68

101.42*30*0.68

1448.21

Room latent heat

Infiltration

7*30*0.68

Outside air

Room area*30*0.68*bf

101.42*30*0.68*0.3

People load

No of people*205

3*205=615

Grand total heat – 25470.74

Ton Of Refrigeration

Tr = grand total head/12000

25470.74/12000=2.12 tr

Air flow – ershl/1.08*(db-adp)

20903.9/1.0*31=1075.30 cfm

Manual load calculation table

	formulae	hall&dining	master bedroom	bedroom-2	bedroom-3	bedroom-4	kitchen
Area	I*B	418.17	338.05	196.87	267.18	111.86	121.81
outdoor load(wall)	Q=A*U*TEMP DIFF	902.56	4257.65	2292.4	2882.97	1218.04	706.28
outdoor load(glass)	Q=A*U*TEMP DIFF	2031.12	1406.16	0	273.42	156.24	0
roof	Q=A*U*TEMP DIFF	4018.61	324.66	1891.92	22567.75	1074.95	1170.6
outdside air	VOLUME*2/60	125.45	101.42	593.2	80.15	33.56	36.54
infiltration	7*TEMP DIFF*1.08	68.67	234.36	142.8	234.36	68.67	234.36
people load	NO OF PEOPLE*245	1960	735	735	735	245	735
lighting load	A*WATT*3.41	2851.92	2305.5	1342.65	1822.17	762.89	830.74
equipment load	A*LOAD*3.41	5304.57	4288.23	2497.34	3389.23	1418.97	1545.2
ETSHL	OUTDR+INDOOR SH	20441.48	19456.02	10545	13960.75	5992.26	6148.1
latent heat	A-TEMP DIFF*CF*0.68	1791.42	1448.21	843.39	1144.6	479.2	521.83
sensible heat	A-TEMP DIFF*CF*1.08	2940.04	2376.87	1384.15	1878.49	786.44	856.42
grand total heat(GTH)	ERSH*RLH	28686.56	25470.74	13947.39	188604	8073.89	8813.6
TR in tonns	GTH/12000	2.39	2.12	1.2	1.57	0.67	0.73
air flow in CFM	ERSHL/1.09(DB-ADP)	1051.51	1075.3	542.43	79.17	308.24	316.26

Vi. COOLING LOAD CALCULATION SHEET

E-20 Hall & Dining Sheet

Area-418.17sft

Item	Area or Quantity			Sun Gain or Temp. Diff.			Factor	Btu/Hour	W
PROJECT	residential building								
LOCATION	Hyderabad								
ROOM HEAT									
ROOM SENSIBLE HEAT									
Solar Gain - Glass									
Glass - N	0.00	SqFt	x	0.00	F	x	0.65	0.00	0.00
Glass - NE		SqFt	x		F	x		0.00	0.00
Glass - E	117.00	SqFt	x	31.00	F	x	0.56	2,031.12	0.00
Glass - SE		SqFt	x		F	x		0.00	0.00
Glass - S	0.00	SqFt	x	31.00	F	x	0.56	0.00	0.00
Glass - SW		SqFt	x		F	x		0.00	0.00
Glass - W	0.00	SqFt	x		F	x		0.00	0.00
Glass - NW		SqFt	x		F	x		0.00	0.00
Skylight		SqFt	x		F	x		0.00	0.00
Solar & Transmission Gain - Walls & Roof									
Wall - N	0.00	SqFt	x	0.00	F	x	0.00	0.00	0.00
Wall - NE		SqFt	x		F	x			
Wall - E	0.00	SqFt	x	0.00	F	x	0.00	0.00	0.00
Wall - SE		SqFt	x		F	x			
Wall - S	0.00	SqFt	x	31.00	F	x	0.31	0.00	0.00
Wall - SW		SqFt	x		F	x			
Wall - W	96.00	SqFt	x	31.00	F	x	0.31	922.56	270.31
Wall - NW		SqFt	x		F	x			
Roof	418.17	SqFt	x	31.00	F	x	0.31	4,018.61	1,177.45
Transmission Gain - Except Walls & Roof									
All Glass	0.00	SqFt	x	0.00	F	x	0.00	0.00	0.00
Partition	0.00	SqFt	x	26.00	F	x	0.94	0.00	0.00
Ceiling	0.00	SqFt	x	26.00	F	x	0.16	0.00	0.00
Floor	0.00	SqFt	x	26.00	F	x	0.33	0.00	0.00
INFILTRATION AND BY PASSED AIR									
Infiltration	7.00	CFM	x	31.00	T.Diff	x	1.08	234.36	68.67
Outside Air	125.45	CFM	x	31.00	T.Diff	x	0.075x 1.08	1,260.02	369.19
Internal Heat									
People	8.00	Nos.	x	245.00	Btu/Hour Per Person			1,960.00	574.28
Lighting	418.17	SqFt	x	2.00	W/SqFt	x	3.41	2,851.92	835.61
Equipments	418.17	SqFt	x	3.72	W/SqFt	x	3.41	5,304.57	1,554.24
Power	0.00	kW/Hp	x	0.00				0.00	0.00
Sub Total								18,583.16	5,444.87
Factor							5-10%	1,858.32	544.49
Effective Room Sensible Heat								**20,441.48**	5,989.35
ROOM LATENT HEAT									
Infiltration	7.00	CFM	x	30.00	Gr/Lb	x	0.68	142.80	41.84
Outside Air	125.45	CFM	x	30.00	Gr/Lb	x	BFx0.68	767.75	224.95
People	8.00	Nos.	x	205.00	Btu/Hour Per Person			1,640.00	480.52
Sub Total								2,550.55	747.31
Factor							5-10%	127.53	37.37
Effective Room Latent Heat								**2,678.08**	784.68
EFFECTIVE ROOM TOTAL HEAT									
OUTSIDE AIR HEAT									
Sensible	125.45	CFM	x	31.00	F(TD)	x	CF x 1.08	2,940.04	861.43
Latent	125.45	CFM	x	30.00	Gr/Lb	x	CF x 0.68	1,791.42	524.89
OUTSIDE AIR TOTAL HEAT								4,731.46	1,386.32
GRAND SUB-TOTAL HEAT								27,851.02	8,160.35
Factor							5 - 10%	835.53	244.81
GRAND TOTAL HEAT								28,686.56	8,405.16
TONS=GRAND TOTAL HEAT/12000								2.39	2.39

FLOOR	Ground Floor-Corridor					
Room	hall&dining					
AREA (SqFt)	418.17					
Height (Ft)	9.00					
Volume (CuFt)	3,763.49					
Estimate for	Summer					
Design Conditions	DB (F)	WB (F)	RH (%)	SH Gr/Lb		
Ambient	106.00	78.00	28.00	98.00		
Room	75.00	61.00	50.00	68.00		
Difference	31.00	-	-	30.00		
By Pass Factor (BF)					=	0.30
Contact Factor (CF = 1 - BF)					=	0.70
CFM Ventilation						
CFM Per Person	25.00	No	=	1.00	=	25.00
CFM Per SqFt	0.18	Sqft	x	418.17	=	75.27
Air Change Per Hour (CFM)			=	2.00		
CFM Cu.ft	3,763.49	x	2.00	x1/60	=	125.45
CFM Infiltration						
window	0.00	x	0.00	cfm/window	=	0.00
Revolving Doors (People)		x		cfm/door	=	0.00
Open Doors	1.00	x	5.00	cfm/door	=	5.00
Crack (feet)		x		cfm/ft	=	0.00
Total						5.00
Supply CFM from Machine						
Effective Room Sensible Heat Factor =						
Effective Room Sensible Heat/Eff Room Total Heat					=	0.88
Apparatus Dew Point (ADP)						
Indicated ADP (°F)					=	N
Selected ADP (°F)					=	22.00
Dehumidified Rise						
(Room DB - ADP) x CF					=	37.10
DEHUMIDIFIED Cfm (AIR QUANTITY)						
Effective Room Sensible Heat						
Dehumidified Rise x 1.08			=	510.17		CFM
			=	239.78		L/s
TOTAL HEAT CAPACITY						
1.28						
SENSIBLE HEAT CAPACITY						
Grand Sensible Heat			=	2.39		TR
12,000.00				956.22		cfm

Master bedroom

Item	Area or Quantity			Sun Gain or Temp. Diff.			Factor	Btu/Hour	W
PROJECT	residential building								
LOCATION	Hyderabad								
ROOM HEAT									
ROOM SENSIBLE HEAT									
Solar Gain - Glass									
Glass - N	0.00	SqFt	x	0.00	F	x	0.65	0.00	0.00
Glass - NE		SqFt	x		F	x		0.00	0.00
Glass - E	0.00	SqFt	x	37.00	F	x	0.56	0.00	0.00
Glass - SE		SqFt	x		F	x		0.00	0.00
Glass - S	81.00	SqFt	x	31.00	F	x	0.56	1,406.16	0.00
Glass - SW		SqFt	x		F	x		0.00	0.00
Glass - W	0.00	SqFt	x		F	x		0.00	0.00
Glass - NW		SqFt	x		F	x		0.00	0.00
Skylight		SqFt	x		F	x		0.00	0.00
Solar & Transmission Gain - Walls & Roof									
Wall - N	0.00	SqFt	x	0.00	F	x	0.00	0.00	0.00
Wall - NE		SqFt	x		F	x			
Wall - E	0.00	SqFt	x	0.00	F	x	0.00	0.00	0.00
Wall - SE		SqFt	x		F	x			
Wall - S	104.99	SqFt	x	31.00	F	x	0.31	1,008.99	295.63
Wall - SW		SqFt	x		F	x			
Wall - W	145.49	SqFt	x	31.00	F	x	0.31	1,398.20	409.67
Wall - NW		SqFt	x		F	x			
Roof	338.05	SqFt	x	31.00	F	x	0.31	3,248.66	951.86
Transmission Gain - Except Walls & Roof									
All Glass	0.00	SqFt	x	0.00	F	x	0.00	0.00	0.00
Partition	83.99	SqFt	x	26.00	F	x	0.94	2,043.98	598.89
Ceiling	0.00	SqFt	x	26.00	F	x	0.16	0.00	0.00
Floor	0.00	SqFt	x	26.00	F	x	0.33	0.00	0.00
INFILTRATION AND BY PASSED AIR									
Infiltration	7.00	CFM	x	31.00	T.Diff	x	1.08	234.36	68.67
Outside Air	101.42	CFM	x	31.00	T.Diff	x	0.075x 1.08	1,018.66	298.47
Internal Heat									
People	3.00	Nos.	x	245.00	Btu/Hour Per Person			735.00	215.36
Lighting	338.05	SqFt	x	2.00	W/SqFt	x	3.41	2,305.50	675.51
Equipments	338.05	SqFt	x	3.72	W/SqFt	x	3.41	4,288.23	1,256.45
Power	0.00	kW/Hp	x	0.00				0.00	0.00
Sub Total								17,687.75	5,182.51
Factor							5-10%	1,768.77	518.25
Effective Room Sensible Heat								**19,456.52**	5,700.76
ROOM LATENT HEAT									
Infiltration	7.00	CFM	x	30.00	Gr/Lb	x	0.68	142.80	41.84
Outside Air	101.42	CFM	x	30.00	Gr/Lb	x	BFx0.68	620.66	181.85
People	3.00	Nos.	x	205.00	Btu/Hour Per Person			615.00	180.20
Sub Total								1,378.46	403.89
Factor							5-10%	68.92	20.19
Effective Room Latent Heat								**1,447.38**	424.08
EFFECTIVE ROOM TOTAL HEAT									
OUTSIDE AIR HEAT									
Sensible	101.42	CFM	x	31.00	F(TD)	x	CF x 1.08	2,376.76	696.39
Latent	101.42	CFM	x	30.00	Gr/Lb	x	CF x 0.68	1,448.21	424.32
OUTSIDE AIR TOTAL HEAT								3,824.97	1,120.72
GRAND SUB-TOTAL HEAT								24,728.87	7,245.56
Factor							5 - 10%	741.87	217.37
GRAND TOTAL HEAT								25,470.74	7,462.93
TONS=GRAND TOTAL HEAT/12000								2.12	2.12

FLOOR	Ground Floor-Corridor					
Room	master bedroom					
AREA (SqFt)	338.05					
Height (Ft)	9.00					
Volume (CuFt)	3,042.45					
Estimate for	Summer					
Design Conditions	DB (F)	WB (F)	RH (%)	SH Gr/Lb		
Ambient	106.00	78.00	28.00	98.00		
Room	75.00	61.00	50.00	68.00		
Difference	31.00	-	-	30.00		
By Pass Factor (BF)					=	0.30
Contact Factor (CF = 1 - BF)					=	0.70
CFM Ventilation						
CFM Per Person	25.00	No	=	3.00	=	75.00
CFM Per SqFt	0.18	Sqft	x	338.05	=	60.85
Air Change Per Hour (CFM)			=	2.00		
CFM Cu.ft	3,042.45	x	2.00	x1/60	=	101.42
CFM Infiltration						
window	0.00	x	0.00	cfm/window	=	0.00
Revolving Doors (People)		x		cfm/door	=	0.00
Open Doors	1.00	x	5.00	cfm/door	=	5.00
Crack (feet)		x		cfm/ft	=	0.00
Total						5.00
Supply CFM from Machine						
Effective Room Sensible Heat Factor =						
Effective Room Sensible Heat/Eff Room Total Heat					=	0.93
Apparatus Dew Point (ADP)						
Indicated ADP (°F)					=	N
Selected ADP (°F)					=	22.00
Dehumidified Rise						
(Room DB - ADP) x CF					=	37.10
DEHUMIDIFIED Cfm (AIR QUANTITY)						
Effective Room Sensible Heat						
Dehumidified Rise x 1.08			=	485.59		CFM
			=	228.23		L/s
TOTAL HEAT CAPACITY						
1.21						
SENSIBLE HEAT CAPACITY						
Grand Sensible Heat			=	2.12		TR
12,000.00				849.02		cfm

BEDROOM-2

Item	Area or Quantity			Sun Gain or Temp. Diff.			Factor	Btu/Hour	W
PROJECT	residential building								
LOCATION	Hyderabad								
ROOM HEAT									
ROOM SENSIBLE HEAT									
Solar Gain - Glass									
Glass - N	0.00	SqFt	x	0.00	F	x	0.65	0.00	0.00
Glass - NE		SqFt	x		F	x		0.00	0.00
Glass - E	0.00	SqFt	x	37.00	F	x	0.56	0.00	0.00
Glass - SE		SqFt	x		F	x		0.00	0.00
Glass - S	0.00	SqFt	x	31.00	F	x	0.56	0.00	0.00
Glass - SW		SqFt	x		F	x		0.00	0.00
Glass - W	0.00	SqFt	x		F	x		0.00	0.00
Glass - NW		SqFt	x		F	x		0.00	0.00
Skylight		SqFt	x		F	x		0.00	0.00
Solar & Transmission Gain - Walls & Roof									
Wall - N	113.99	SqFt	x	31.00	F	x	0.31	1,095.48	320.98
Wall - NE		SqFt	x		F	x			
Wall - E	0.00	SqFt	x	31.00	F	x	0.00	0.00	0.00
Wall - SE		SqFt	x		F	x			
Wall - S	0.00	SqFt	x	31.00	F	x	0.31	0.00	0.00
Wall - SW		SqFt	x		F	x			
Wall - W	124.50	SqFt	x	31.00	F	x	0.31	1,196.42	350.55
Wall - NW		SqFt	x		F	x			
Roof	196.87	SqFt	x	31.00	F	x	0.31	1,891.92	554.33
Transmission Gain - Except Walls & Roof									
All Glass	0.00	SqFt	x	0.00	F	x	0.00	0.00	0.00
Partition	0.00	SqFt	x	26.00	F	x	0.94	0.00	0.00
Ceiling	0.00	SqFt	x	26.00	F	x	0.16	0.00	0.00
Floor	0.00	SqFt	x	26.00	F	x	0.33	0.00	0.00
INFILTRATION AND BY PASSED AIR									
Infiltration	7.00	CFM	x	31.00	T.Diff	x	1.08	234.36	68.67
Outside Air	59.06	CFM	x	31.00	T.Diff	x	0.075x 1.08	593.20	173.81
Internal Heat									
People	3.00	Nos.	x	245.00	Btu/Hour Per Person			735.00	215.36
Lighting	196.87	SqFt	x	2.00	W/SqFt	x	3.41	1,342.65	393.40
Equipments	196.87	SqFt	x	3.72	W/SqFt	x	3.41	2,497.34	731.72
Power	0.00	kW/Hp	x	0.00				0.00	0.00
Sub Total								9,586.37	2,808.81
Factor							5-10%	958.64	280.88
Effective Room Sensible Heat								**10,545.00**	3,089.69
ROOM LATENT HEAT									
Infiltration	7.00	CFM	x	30.00	Gr/Lb	x	0.68	142.80	41.84
Outside Air	59.06	CFM	x	30.00	Gr/Lb	x	BFx0.68	361.45	105.91
People	3.00	Nos.	x	205.00	Btu/Hour Per Person			615.00	180.20
Sub Total								1,119.25	327.94
Factor							5-10%	55.96	16.40
Effective Room Latent Heat								**1,175.22**	344.34
EFFECTIVE ROOM TOTAL HEAT									
OUTSIDE AIR HEAT									
Sensible	59.06	CFM	x	31.00	F(TD)	x	CF x 1.08	1,384.15	405.56
Latent	59.06	CFM	x	30.00	Gr/Lb	x	CF x 0.68	843.39	247.11

FLOOR	Ground Floor-Corridor					
Room	bedroom -2					
AREA (SqFt)	196.87					
Height (Ft)	9.00					
Volume (CuFt)	1,771.83					
Estimate for	Summer					
Design Conditions	DB (F)	WB (F)	RH (%)	SH Gr/Lb		
Ambient	106.00	78.00	28.00	98.00		
Room	75.00	61.00	50.00	68.00		
Difference	31.00	-	-	30.00		
By Pass Factor (BF)					=	0.30
Contact Factor (CF = 1 - BF)					=	0.70
CFM Ventilation						
CFM Per Person	25.00	No	=	3.00	=	75.00
CFM Per SqFt	0.18	Sqft	x	196.87	=	35.44
Air Change Per Hour (CFM)			=	2.00		
CFM Cu.ft	1,771.83	x	2.00	x1/60	=	59.06
CFM Infiltration						
window	0.00	x	0.00	cfm/window	=	0.00
Revolving Doors (People)		x		cfm/door	=	0.00
Open Doors	0.00	x	5.00	cfm/door	=	0.00
Crack (feet)		x		cfm/ft	=	0.00
Total						0.00
Supply CFM from Machine						
Effective Room Sensible Heat Factor =						
Effective Room Sensible Heat/Eff Room Total Heat					=	0.90
Apparatus Dew Point (ADP)						
Indicated ADP (°F)					=	N
Selected ADP (°F)					=	22.00
Dehumidified Rise						
(Room DB - ADP) x CF					=	37.10
DEHUMIDIFIED Cfm (AIR QUANTITY)						
Effective Room Sensible Heat						
Dehumidified Rise x 1.08			=	263.18		CFM
			=	123.69		L/s
TOTAL HEAT CAPACITY						
0.66						
SENSIBLE HEAT CAPACITY						
Grand Sensible Heat			=	1.20		TR
12,000.00				478.87		cfm

BEDROOM-3

PROJECT	residential building									
LOCATION	Hyderabad									
Item	Area or Quantity			Sun Gain or Temp. Diff.			Factor	Btu/Hour	W
ROOM HEAT									
ROOM SENSIBLE HEAT									
Solar Gain - Glass									
Glass - N	0.00	SqFt	x	0.00	F	x	0.65	0.00	0.00
Glass - NE		SqFt	x		F	x		0.00	0.00
Glass - E	0.00	SqFt	x	37.00	F	x	0.56	0.00	0.00
Glass - SE		SqFt	x		F	x		0.00	0.00
Glass - S	0.00	SqFt	x	31.00	F	x	0.56	0.00	0.00
Glass - SW		SqFt	x		F	x		0.00	0.00
Glass - W	15.75	SqFt	x	31.00	F	x	0.56	273.42	0.00
Glass - NW		SqFt	x		F	x		0.00	0.00
Skylight		SqFt	x		F	x		0.00	0.00
Solar & Transmission Gain - Walls & Roof									
Wall - N	158.25	SqFt	x	31.00	F	x	0.31	1,520.75	445.58
Wall - NE		SqFt	x		F	x			
Wall - E	141.75	SqFt	x	31.00	F	x	0.31	1,362.22	399.13
Wall - SE		SqFt	x		F	x			
Wall - S	0.00	SqFt	x	31.00	F	x	0.31	0.00	0.00
Wall - SW		SqFt	x		F	x			
Wall - W	0.00	SqFt	x	31.00	F	x	0.31	0.00	0.00
Wall - NW		SqFt	x		F	x			
Roof	267.18	SqFt	x	31.00	F	x	0.31	2,567.60	752.31
Transmission Gain - Except Walls & Roof									
All Glass	0.00	SqFt	x	0.00	F	x	0.00	0.00	0.00
Partition	0.00	SqFt	x	26.00	F	x	0.94	0.00	0.00
Ceiling	0.00	SqFt	x	26.00	F	x	0.16	0.00	0.00
Floor	0.00	SqFt	x	26.00	F	x	0.33	0.00	0.00
INFILTRATION AND BY PASSED AIR									
Infiltration	7.00	CFM	x	31.00	T.Diff	x	1.08	234.36	68.67
Outside Air	80.15	CFM	x	31.00	T.Diff	x	0.075x 1.08	805.03	235.87
Internal Heat									
People	3.00	Nos.	x	245.00	Btu/Hour Per Person			735.00	215.36
Lighting	267.18	SqFt	x	2.00	W/SqFt	x	3.41	1,822.17	533.90
Equipments	267.18	SqFt	x	3.72	W/SqFt	x	3.41	3,389.23	993.04
Power	0.00	kW/Hp	x	0.00				0.00	0.00
Sub Total								12,709.78	3,723.96
Factor							5-10%	1,270.98	372.40
Effective Room Sensible Heat								13,980.75	4,096.36
ROOM LATENT HEAT									
Infiltration	7.00	CFM	x	30.00	Gr/Lb	x	0.68	142.80	41.84
Outside Air	80.15	CFM	x	30.00	Gr/Lb	x	BFx0.68	490.54	143.73
People	3.00	Nos.	x	205.00	Btu/Hour Per Person			615.00	180.20
Sub Total								1,248.34	365.76
Factor							5-10%	62.42	18.29
Effective Room Latent Heat								1,310.76	384.05
EFFECTIVE ROOM TOTAL HEAT									
OUTSIDE AIR HEAT									
Sensible	80.15	CFM	x	31.00	F(TD)	x	CF x 1.08	1,878.49	550.40
Latent	80.15	CFM	x	30.00	Gr/Lb	x	CF x 0.68	1,144.60	335.37
OUTSIDE AIR TOTAL HEAT								3,023.09	885.76
GRAND SUB-TOTAL HEAT								18,314.60	5,366.18
Factor							5 - 10%	549.44	160.99
GRAND TOTAL HEAT								18,864.04	5,527.16
TONS=GRAND TOTAL HEAT/12000								1.57	1.57

FLOOR	Ground Floor-Corridor					
Room	bedroom -3					
AREA (SqFt)	267.18					
Height (Ft)	9.00					
Volume (CuFt)	2,404.62					
Estimate for	Summer					
Design Conditions	DB (F)	WB (F)	RH (%)	SH Gr/Lb		
Ambient	106.00	78.00	28.00	98.00		
Room	75.00	61.00	50.00	68.00		
Difference	31.00	-	-	30.00		
By Pass Factor (BF)					=	0.30
Contact Factor (CF = 1 - BF)					=	0.70
CFM Ventilation						
CFM Per Person	25.00	No	=	3.00	=	75.00
CFM Per SqFt	0.18	Sqft	x	267.18	=	48.09
Air Change Per Hour (CFM)			=	2.00		
CFM Cu.ft	2,404.62	x	2.00	x1/60	=	80.15
CFM Infiltration						
window	0.00	x	0.00	cfm/window	=	0.00
Revolving Doors (People)		x		cfm/door	=	0.00
Open Doors	0.00	x	5.00	cfm/door	=	0.00
Crack (feet)		x		cfm/ft	=	0.00
Total						0.00
Supply CFM from Machine						
Effective Room Sensible Heat Factor =						
Effective Room Sensible Heat/Eff Room Total Heat					=	0.91
Apparatus Dew Point (ADP)						
Indicated ADP (°F)					=	N
Selected ADP (ºF)					=	22.00
Dehumidified Rise						
(Room DB - ADP) x CF					=	37.10
DEHUMIDIFIED Cfm (AIR QUANTITY)						
Effective Room Sensible Heat						
Dehumidified rise x 1.08			=	348.93	CFM	
			=	164.00	L/s	
TOTAL HEAT CAPACITY						
0.87						
SENSIBLE HEAT CAPACITY						
Grand Sensible Heat			=	1.57	TR	
12,000.00				628.80	cfm	

BEDROOM-4

PROJECT	residential building								
LOCATION	Hyderabad								
Item	Area or Quantity			Sun Gain or Temp. Diff.			Factor	Btu/Hour	W
ROOM HEAT									
ROOM SENSIBLE HEAT									
Solar Gain - Glass									
Glass - N	0.00	SqFt	x	0.00	F	x	0.65	0.00	0.00
Glass - NE		SqFt	x		F	x		0.00	0.00
Glass - E	0.00	SqFt	x	37.00	F	x	0.56	0.00	0.00
Glass - SE		SqFt	x		F	x		0.00	0.00
Glass - S	9.00	SqFt	x	31.00	F	x	0.56	156.24	0.00
Glass - SW		SqFt	x		F	x		0.00	0.00
Glass - W	0.00	SqFt	x	31.00	F	x	0.56	0.00	0.00
Glass - NW		SqFt	x		F	x		0.00	0.00
Skylight		SqFt	x		F	x		0.00	0.00
Solar & Transmission Gain - Walls & Roof									
Wall - N	0.00	SqFt	x	31.00	F	x	0.00	0.00	0.00
Wall - NE		SqFt	x		F	x			
Wall - E	0.00	SqFt	x	0.00	F	x	0.00	0.00	0.00
Wall - SE		SqFt	x		F	x			
Wall - S	126.75	SqFt	x	31.00	F	x	0.31	1,218.04	356.89
Wall - SW		SqFt	x		F	x			
Wall - W	0.00	SqFt	x	31.00	F	x	0.31	0.00	0.00
Wall - NW		SqFt	x		F	x			
Roof	111.86	SqFt	x	31.00	F	x	0.31	1,074.95	314.96
Transmission Gain - Except Walls & Roof									
All Glass	0.00	SqFt	x	0.00	F	x	0.00	0.00	0.00
Partition	0.00	SqFt	x	26.00	F	x	0.94	0.00	0.00
Ceiling	0.00	SqFt	x	26.00	F	x	0.16	0.00	0.00
Floor	0.00	SqFt	x	26.00	F	x	0.33	0.00	0.00
INFILTRATION AND BY PASSED AIR									
Infiltration	7.00	CFM	x	31.00	T.Diff	x	1.08	234.36	68.67
Outside Air	33.56	CFM	x	31.00	T.Diff	x	0.075x 1.08	337.08	98.76
Internal Heat									
People	1.00	Nos.	x	245.00	Btu/Hour Per Person			245.00	71.79
Lighting	111.86	SqFt	x	2.00	W/SqFt	x	3.41	762.89	223.53
Equipments	111.86	SqFt	x	3.72	W/SqFt	x	3.41	1,418.97	415.76
Power	0.00	kW/Hp	x	0.00				0.00	0.00
Sub Total							0.00	5,447.51	1,596.12
Factor							5-10%	544.75	159.61
Effective Room Sensible Heat								5,992.26	1,755.73
ROOM LATENT HEAT									
Infiltration	7.00	CFM	x	30.00	Gr/Lb	x	0.68	142.80	41.84
Outside Air	33.56	CFM	x	30.00	Gr/Lb	x	BFx0.68	205.37	60.17
People	1.00	Nos.	x	205.00	Btu/Hour Per Person			205.00	60.07
Sub Total								553.17	162.08
Factor							5-10%	27.66	8.10
Effective Room Latent Heat								580.83	170.18
EFFECTIVE ROOM TOTAL HEAT									
OUTSIDE AIR HEAT									
Sensible	33.56	CFM	x	31.00	F(TD)	x	CF x 1.08	786.44	230.43
Latent	33.56	CFM	x	30.00	Gr/Lb	x	CF x 0.68	479.20	140.40
OUTSIDE AIR TOTAL HEAT								1,265.64	370.83
GRAND SUB-TOTAL HEAT								7,838.73	2,296.75
Factor							5 - 10%	235.16	68.90
GRAND TOTAL HEAT								8,073.89	2,365.65
TONS=GRAND TOTAL HEAT/12000								0.67	0.67

FLOOR	Ground Floor-Corridor					
Room	bedroom 4					
AREA (SqFt)	111.86					
Height (Ft)	9.00					
Volume (CuFt)	1,006.71					
Estimate for	Summer					
Design Conditions	DB (F)	WB (F)	RH (%)	SH Gr/Lb		
Ambient	106.00	78.00	28.00	98.00		
Room	75.00	61.00	50.00	68.00		
Difference	31.00	-	-	30.00		
By Pass Factor (BF)					=	0.30
Contact Factor (CF = 1 - BF)					=	0.70
CFM Ventilation						
CFM Per Person	25.00	No	=	1.00	=	25.00
CFM Per SqFt	0.18	Sqft	x	111.86	=	20.13
Air Change Per Hour (CFM)			=	2.00		
CFM Cu.ft	1,006.71	x	2.00	x1/60	=	33.56
CFM Infiltration						
window	0.00	x	0.00	cfm/window	=	0.00
Revolving Doors (People)		x		cfm/door	=	0.00
Open Doors	1.00	x	5.00	cfm/door	=	5.00
Crack (feet)		x		cfm/ft	=	0.00
Total						5.00
Supply CFM from Machine						
Effective Room Sensible Heat Factor =						
Effective Room Sensible Heat/Eff Room Total Heat					=	0.91
Apparatus Dew Point (ADP)						
Indicated ADP (°F)					=	N
Selected ADP (ºF)					=	22.00
Dehumidified Rise						
(Room DB - ADP) x CF					=	37.10
DEHUMIDIFIED Cfm (AIR QUANTITY)						
Effective Room Sensible Heat						
Dehumidified rise x 1.08			=	149.55	CFM	
			=	70.29	L/s	
TOTAL HEAT CAPACITY						
0.37						
SENSIBLE HEAT CAPACITY						
Grand Sensible Heat			=	0.67	TR	
12,000.00				269.13	cfm	

VII. gpm and cfm values

GPM means gallon per meter

GPM= TR * 24/temperature difference

ROOM NAME	AREA	TR	CFM	GPM
HALL&DINING	418.17	2.39	1051.51	5.7
MASTER BEDROOM	338.05	2.12	1075.3	5.088
BEDROOM-2	196.87	1.2	542.43	2.88
BEDROOM-3	267.18	1.37	719.17	3.2
BEDROOM-4	111.86	0.67	308.24	1.608
KITCHEN	121.81	0.73	316.26	1.752
TOTAL		**8.48**	**4012.91**	**20.228**

CHILLER COOLING CAPACITY CALCULATIONS

$Q = \dot{m} \times Cp \times \Delta T$

Q = (999.78kg/m3 x 0.0995m3/s) x 4.19kJ/kg/K x ((12*c+273.15K) – (6*c+273.15K))

Q = 2,500kW of cooling

VIII. PIPE SIZING AND DESIGN

S.NO	1	2	3	4	5	6
ROOM NAME	HALL	MASTER BEDROOM	BEDROOM2	BEDROOM3	BEDROOM4	MAIN PIPE
PIPE(in)	1.25	1	0.75	0.75	0.5	1.5
OUTER DIA(in)	1.6	1.05	1.05	1.05	0.84	1.9
INNER DIA(in)	1.3	0.24	0.8	0.8	0.62	1.61
C/S AREA(sq.in)	0.6	0.3	0.3	0.3	0.25	0.7
VELOCITY(ft/sq.sec)	1.57	3.06	1.57	2.27	1.7	3.47
FRICTION	0.03	0.03	0.03	0.03	0.03	0.03
HEAD LOSS	1.04	6.68	2.018	3.8	3.328	3.5
ELBOW LOSS(ft)	0.042	0.247	0.065	0.136	0.09	0.115

PIPE SPECIFICATION

Material used: carbon steel

Operated temperature:4-18 Degree C

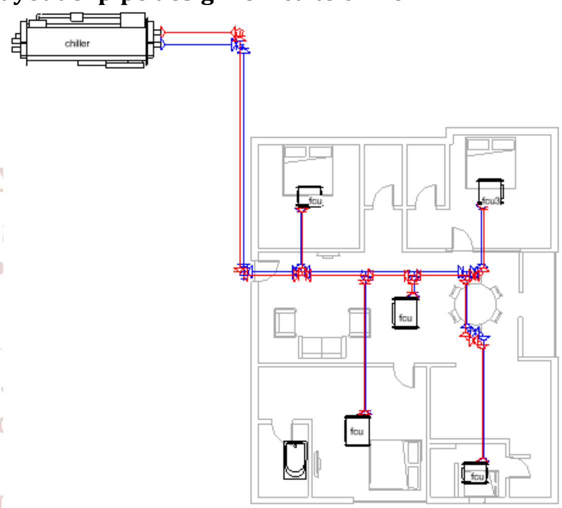
Operated fluid velocity 1.2-5 m/sec

Fluid type: water

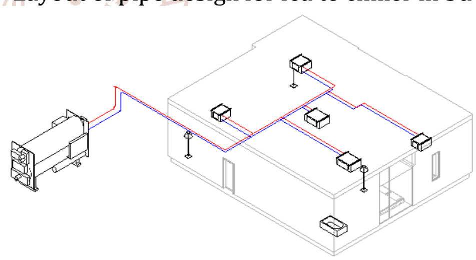
Fluid density: 990 kg/cubic metre

Pipe friction factor: 0.03

Layout of pipe design for fcu to chiller



Layout of pipe design for fcu to chiller in 3d view



HEATING &COOLING ANALYSIS

Project Summary

Location and Weather	
Project	Project Name
Address	## Street City, State Zip
Calculation Time	Monday, April 8, 2019 8:45 PM
Report Type	Standard
Latitude	12.98°
Longitude	77.58°
Summer Dry Bulb	35 °C
Summer Wet Bulb	23 °C
Winter Dry Bulb	15 °C
Mean Daily Range	10 °C

Building Summary

Inputs	
Building Type	Dining Family
Area (SF)	1,352
Volume (CF)	16,240.23
Calculated Results	
Peak Cooling Total Load (W)	**18,159**
Peak Cooling Month and Hour	April 1:00 PM
Peak Cooling Sensible Load (W)	15,678
Peak Cooling Latent Load (W)	2,480
Maximum Cooling Capacity (W)	18,159
Peak Cooling Airflow (L/s)	952.8
Peak Heating Load (W)	**2,541**
Peak Heating Airflow (L/s)	271.5
Checksums	
Cooling Load Density (W/m²)	144.56
Cooling Flow Density (L/(s·m²))	7.58
Cooling Flow / Load (L/(s·kW))	52.47
Cooling Area / Load (m²/kW)	6.92
Heating Load Density (W/m²)	20.23
Heating Flow Density (L/(s·m²))	2.16

Zone Summary - Default

Inputs	
Area (SF)	52
Volume (CF)	624.24
Cooling Setpoint	23 °C
Heating Setpoint	21 °C
Supply Air Temperature	12 °C
Number of People	2
Infiltration (L/s)	0.0
Air Volume Calculation Type	Fan Coil System
Relative Humidity	46.00% (Calculated)
Psychrometrics	
Psychrometric Message	None
Cooling Coil Entering Dry-Bulb Temperature	28 °C
Cooling Coil Entering Wet-Bulb Temperature	19 °C
Cooling Coil Leaving Dry-Bulb Temperature	12 °C
Cooling Coil Leaving Wet-Bulb Temperature	13 °C
Mixed Air Dry-Bulb Temperature	28 °C
Calculated Results	
Peak Cooling Load (W)	**731**
Peak Cooling Month and Hour	April 1:00 PM
Peak Cooling Sensible Load (W)	636
Peak Cooling Latent Load (W)	95
Peak Cooling Airflow (L/s)	38.6
Peak Heating Load (W)	**139**
Peak Heating Airflow (L/s)	14.9
Peak Ventilation Airflow (L/s)	0.0
Checksums	
Cooling Load Density (W/m²)	151.43
Cooling Flow Density (L/(s·m²))	8.00
Cooling Flow / Load (L/(s·kW))	52.85
Cooling Area / Load (m²/kW)	6.60
Heating Load Density (W/m²)	28.86
Heating Flow Density (L/(s·m²))	3.08
Ventilation Density (L/(s·m²))	0.00
Ventilation / Person (L/s)	0.0

Components	Cooling		Heating	
	Loads (W)	Percentage of Total	Loads (W)	Percentage of Total
Wall	85	11.59%	95	68.06%
Window	0	0.00%	0	0.00%
Door	0	0.00%	0	0.00%
Roof	318	43.48%	45	31.94%
Skylight	0	0.00%	0	0.00%
Partition	0	0.00%	0	0.00%
Infiltration	0	0.00%	0	0.00%
Ventilation	0	0.00%	0	0.00%
Lighting	64	8.69%		
Power	75	10.31%		
People	176	24.09%		
Plenum	0	0.00%		
Fan Heat	13	1.84%		
Reheat	0	0.00%		
Total	**731**	**100%**	**139**	**100%**

Default Spaces

Space Name	Area (SF)	Volume (CF)	Peak Cooling Load (W)	Cooling Airflow (L/s)	Peak Heating Load (W)	Heating Airflow (L/s)
1 Space	52	624.24	718	38.6	139	14.9

Zone Summary - 2

Inputs	
Area (SF)	1,300
Volume (CF)	15,615.99
Cooling Setpoint	23 °C
Heating Setpoint	21 °C
Supply Air Temperature	12 °C
Number of People	43
Infiltration (L/s)	0.0
Air Volume Calculation Type	Fan Coil System
Relative Humidity	46.00% (Calculated)
Psychrometrics	
Psychrometric Message	None
Cooling Coil Entering Dry-Bulb Temperature	28 °C
Cooling Coil Entering Wet-Bulb Temperature	19 °C
Cooling Coil Leaving Dry-Bulb Temperature	12 °C
Cooling Coil Leaving Wet-Bulb Temperature	13 °C
Mixed Air Dry-Bulb Temperature	28 °C
Calculated Results	
Peak Cooling Load (W)	**17,428**
Peak Cooling Month and Hour	April 1:00 PM
Peak Cooling Sensible Load (W)	15,043
Peak Cooling Latent Load (W)	2,385
Peak Cooling Airflow (L/s)	914.1
Peak Heating Load (W)	**2,401**
Peak Heating Airflow (L/s)	256.6
Peak Ventilation Airflow (L/s)	0.0
Checksums	
Cooling Load Density (W/m²)	144.29
Cooling Flow Density (L/(s·m²))	7.57
Cooling Flow / Load (L/(s·kW))	52.45
Cooling Area / Load (m²/kW)	6.93
Heating Load Density (W/m²)	19.88
Heating Flow Density (L/(s·m²))	2.12
Ventilation Density (L/(s·m²))	0.00
Ventilation / Person (L/s)	0.0

Components	Cooling		Heating	
	Loads (W)	Percentage of Total	Loads (W)	Percentage of Total
Wall	796	4.57%	845	35.17%
Window	711	4.08%	440	18.31%
Door	81	0.46%	104	4.34%
Roof	7,272	41.72%	1,013	42.18%
Skylight	0	0.00%	0	0.00%
Partition	0	0.00%	0	0.00%
Infiltration	0	0.00%	0	0.00%
Ventilation	0	0.00%	0	0.00%
Lighting	1,698	9.74%		
Power	2,017	11.57%		
People	4,536	26.03%		
Plenum	0	0.00%		
Fan Heat	318	1.83%		
Reheat	0	0.00%		
Total	**17,428**	**100%**	**2,401**	**100%**

2 Spaces

Space Name	Area (SF)	Volume (CF)	Peak Cooling Load (W)	Cooling Airflow (L/s)	Peak Heating Load (W)	Heating Airflow (L/s)
2 Space	151	1,815.07	1,975	105.5	321	34.3
4 Space	257	3,089.98	3,399	181.6	448	47.9
5 Space	649	7,795.53	8,549	456.8	1,075	114.9
6 Space	54	643.79	719	38.4	136	14.5
7 Space	189	2,271.61	2,468	131.9	420	44.9

IX. RESULTS

Below results will show that CFM flow rate and TR values of all the Rooms are listed below.

ROOM NAME	AREA	TR	CFM	GPM
HALL&DINING	418.17	2.39	1051.51	5.7
MASTER BEDROOM	338.05	2.12	1075.3	5.088
BEDROOM-2	196.87	1.2	542.43	2.88
BEDROOM-3	267.18	1.37	719.17	3.2
BEDROOM-4	111.86	0.67	308.24	1.608
KITCHEN	121.81	0.73	316.26	1.752
TOTAL		**8.48**	**4012.91**	**20.228**

Below results will show that FCU size according to TR and CFM are listed below

Sno	Room name	TR	CFM	FCU size(lps)
1	hall& dining	2.39	1051.51	564
2	aster bedroo	2.12	1075.3	564
3	bedroom2	1.2	542.43	282
4	bedroom3	1.37	719.17	376
5	bedroom4	0.67	308.24	282

X. CONCLUSION

From the above calculations the estimated values are 4012.91 CFM air supply and 8.48 TR capacity machine required. For this Chiller unit was used to maintain proper air conditioning. It is suitable for 3000-5000 CFM flow rate and 8-12 TR capacity. In this work the calculated CFM values of each room in each floor by using the E-20 Excel sheets and TR values of each room were calculated.

The Capacity of unit required is 8.48 TR approximately but used 8-12 TR machine to avoid the fluctuations in the working.

Based on the obtained CFM for each room and for all the floors the PIPE Design was done by using AUTO_ DESK REVIT software. All the diagrams were shown in the civil plan. Thus we can reach to a conclusion that our estimated values are enough to establish the air conditioning system in the specified location. By using HVAC system energy consumption of the building is reduced as possible by avoiding unnecessary losses. This is one of the most well designed and most useful methods in the present-day installations.

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