5. Basic Design Data

The Air conditioning system is designed as per the latest American Society of Heating, Air Conditioning and Refrigeration Engineers Standards.

Based on the data furnished in the Design Basis, the air conditioning area works out to about2, 40,000 SFT as such, A centralized air conditioning system is planned with a water Cooled Centrifugal chiller (1 No.) + Air cooled Screw Chillers (2 No.), all high side equipment like chillers, pump sets and cooling tower in Ninth Floor (Terrace Floor) of the building.

A chilled water / Condenser water piping system from the chillers installed as shown in the drawings will convey chilled / Condenser water to all the building as shown in the drawings.

All toilets have been designed with forced mechanical exhaust system. Exhaust system has been designed for 12 Air Changes per hour as per ASHRAE standards.

All the equipment shall be possible to hook up to the centralized IIBMS System.

Site Location and Orientation

Site Location – Hyderabad
Geographical Location - 17.86^{0}N
Altitude - 545 m above mean sea level

Outdoor Design Condition

Summer: 106 deg F DBT, 78 deg F WBT & 28 % RH
Monsoon: 85 deg F DBT, 81 deg F WBT & 82 % RH
Winter: 55 deg F DBT, 48 deg F WBT & 60% RH

Indoor Design Condition

Dry Bulb Temperature: 24 ± 2 deg C
Wet Bulb Temperature: 16.7 deg. C
Relative Humidity: Not Exceeding 60%
The air conditioning system for the Office / Training, Cafeteria etc. shall be designed to cater for the Comfort Cooling application only.
Data center: 20 ± 2 deg C

Codes or Standards

The design is based on the following standards, codes and/or regulations:

AMCA: Air Movement and Control Association

- Publication 200 "Air System"
- Publication 2011-90" Fans & Systems"
- Publication 301-90 Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers.

- Fundamentals
- Refrigeration
- Applications
- Systems & Equipment
- Standard 52.1-92 Methods of Testing Air Cleaning Devices Used in General Ventilation.

SMACNA: Sheet Metal and Air Conditioning Contractors National Association.

Fresh Air:

Ideal 'air conditioning' equipment should sanities cool, heat, humidify/dehumidify, evenly distribution air through the area and all; cost effectively.

The world focus has shifted from the environment to 'Invironment'. This is a new terminology, being used increasingly to focus on the Indoor Air Quality (IAQ) and its effect on human health. While the outdoor environment continues to be of concern, the indoor environment is receiving increased attention as more information has become available on the presence and effect of indoor contaminants.

We have considered the following cfm / person, the desired rate of fresh air to maintain good Indoor Air Quality (IAQ).

"Ventilation for Acceptable Indoor Air Quality"

Office Area - 5.0 cfm/ person + 0.06 cfm / sqft + 30% Extra as per Green Building Norm
Cafeteria - 7.5 cfm/ person + 0.18 cfm / sqft + 30% Extra as per Green Building Norm
Sports areas - 7.5 cfm/ person + 0.18 cfm / sqft + 30% Extra as per Green Building Norm

6. Load Calculations

The purpose of heating and cooling load calculations then is to quantify the heating and or cooling loads in the space to be conditioned. Rough estimates of load may be made during the concept of design phase. Today's energy and building codes also require detailed documentation to prove compliance.

The first step in the air conditioning of a star hotel is to estimate the amount of heat to be removed from the space to be conditioned. The importance of accurate load calculations for A/c design and selection of equipment can never be over emphasized, in fact ,it is on the precision and care exercised by the designer in the calculation of the cooling load for summer that a trouble free successful operation of an A/c plant after installation would depend.

The major components of load in buildings are due to the direct solar radiation through west glass, transmission through fabric or structure and fresh air ventilation.

1. Heat Transfer through Building Structure:

One of the most important heat gain or losses to be considered in the A/c of building is the heat transfer through walls, roofs, ceiling, floor, etc., the building structure. The load due to such heat transfer is often referred to as the fabric heat gain or loss. Heat transmission through walls and roofs of building structure is not steady due to the variation of the outside air temperature over a period of 24 hours and the variation of solar radiation intensity that is incident upon over a period of 24 hours, and therefore, difficult to evaluate the heat transmission into the conditioned space.

The phenomenon is further complicated by the fact that a wall has thermal capacity outside air and or inside at some later time. There are two methods for empirical calculation of heat transfer through the walls and the roof.

a. The decrement method and time lag method,
b. The equivalent temperature differential method.

Out of these two, the equivalent temperature differential method is commonly used by A/c engineers, as it is applicable to sunlit walls and roofs. According to equivalent temperature differential method, the heat transfer is given by:

Q=UA (T2-T1)
U=over all heat transfer coefficient,
A=area of wall,
(T_2-T_1)=Equivalent temperature difference

The equivalent temperature difference is considered to offset the discrepancies in temperature variation due to heat storage, different layers of composite wall materials and diffused solar radiation.

2. Heat Gain by the Solar Radiation:

The glass has high transitivity so that considerable amount of heat is poured directly into the A/c space by sun through the glass. This amount varies from hour to hour, day to day, and latitude to latitude. The details of solar radiation with respect to time of day and situation of glass area given in the ASHRAE guides. Solar radiation is often the largest component of the room sensible heat load for a building with considerable window area. It may be necessary to calculate loads for different hours of the day in order to find out maximum load.

3 Solar Heat Gain through Glass:

Glass which is transparent allows the sunrays to pass through it. This results in heat dissipation inside the room. The amount of heat dissipated into room depends upon the glass area that is exposed to sun. The solar heat gain through ordinary glass depends upon Earth's surface, (latitude) time of day, time of year, and facing direction of the window. The direct radiation component results in a heat gain to the conditioned space only when the window is in the direct rays of the sun, where as the diffused radiation component results in a heat gain, even when the window is not facing the sun.

The temperature is different for each direction. It's maximum in the heat direction. The heat gain is obtained by multiplying the glass area, with the temperature in that direction, the factor of glass, which is taken as 3.18 for ordinary glass.

4. Solar Heat Gain through Walls and Roofs:

Heat gain through the exterior construction (walls and roof) is normally calculated at the time of greatest heat flow. It is caused by the solar heat being absorbed at the exterior surface and by the temperature difference between the outdoor and indoor air. Both heat sources are highly variable throughout any one day and, therefore, result in unsteady state heat flow through the exterior construction. The heat flow through the structure may then be calculated, using the steady state heat flow equation with equivalent temperature difference (ETD).

Q = U*A*ETD
Q = heat flow rate KJ/Sec
U = transmission rate
A = Area of surface (Sq m)
ETD= Equivalent Temperature Difference (K)

HEAT LOAD CALCULATION SHEET								
			0	City:	HYDERABAD			
Room:	Reception area				DBT	WBT	RH	GR/LB
			0	ODC	106	78	28	100
Est.For	SUMMER	MAY		IDC	73	62	55	68
			13	Diff	33			32
	L	B	H	Area	Volume	AC/Hr	Occup.	F Air
Dimension	0	0	26	7068	183768	0.3	71	1011
SOLAR GAIN FROM GLASS					BTU/HR	WORKINGS		
NORTH	3626	11	0.28		11168			
SOUTH		11	0.28		0	SHF	0.96	
EAST	534	11	0.28		1645	ADP	54.83	
WEST	1388	165	0.28		64126	CFM	22953	
NORTH EAST		11	0.28		0			
SOUTH EAST		11	0.28		0	FLOOR ABOVE		13
SOUTH WEST		113	0.28		0	FLOOR BELOW		1
NORTH WEST		118	0.28		0	ROOF	2	
SOLAR & TRAN. FROM WALL & ROOF						SUMMARY		
NORTH	844	25	0.36		7596			
SOUTH	0	37	0		0	LOAD	38.78	TR
EAST	271	39	0.36		3805	AIR	22953	cfm
WEST	0	33	0		0	ADP	54.83	°F
NORTH EAST		31	0		0			
SOUTH E	0	39	0		0			
SOUTH W	0	35	0		0			
NORTH W	0	27	0		0			
ROOF	0	53	0		0			
TRANSMISSION GAIN						CHECK FIGURE		
ALL GLAS	5548	33	0.3		54925			
PARTITIO	0	0	0		0	AREA/TR	182	
PARTITIO	5500	28	0.4		61600			
CEILING		0	0		0	CFM/TR	592	
FLOOR	7068	28	0.48		94994	CFM/SFT	3.25	
INFILTRATION					0	LOAD SUMMARY		
OUTSIDE	1011	33	0.12	1.08	4323			
						RSH	396370	
PEOPLE	71	245			17317	RLH	17985	
LIGHTS	0.8	7068	1.25	3.4	24031	RTH	414355	
APPLIANC	2	1		3400	6800	GTH	465409	
TERMINA	0	0	0	0	0			
SUB TOTAL ROOM SENSIBLE HEAT					352329	**TR**	**38.78**	
ADD : 5% Safety+ADD FAN 7.5%					44041			
PREHEAT	0	0	0	0	0			
TOTAL ROOM SENSIBLE HEAT					396370			
INFILTRATION					0			
OUTSIDE	1011	32	0.12	0.68	2639	NOTES :		
PEOPLE	71	205			14489			
						ED	74.45	
SUB TOTAL ROOM LATENT HEAT					17129	LD	57.18	
ADD : 5% Safety					856	Glass Typ	#N/A	
TOTAL ROOM LATENT HEAT					17985	Solar Fac	0.28	
						"U" Value	1.7	W/m² - °I
ROOM TOTAL HEAT					414355			
						Offer :		
OA Sensi	1011	33	0.88	1.08	31700			
OA Laten	1011	32	0.88	0.68	19354			
GRAND TOTAL HEAT			38.78	TR	465409			

Figure 1: Sample Heat Load Calculation Excel Sheet

5. Transmission Heat Gain through Glass:

This is heat gain that is obtained due to the difference in outside and inside conditions. The amount of heat that is transmitted through the glass into the room depends upon the glass area, temperature difference and transmission coefficient of glass. Here total glass irrespective of the direction is taken into consideration in total glass area.

6. Occupancy Load:

The amount of heat given off by people depends on the degree of activity .The amount of heat liberated by the occupant when seated at rest in cinema theatre by 115w out of which 70w is of sensible heat and 45w is of latent heat at 25w.

The metabolic rate of women is about 85% of that for a male and for children about 75 to establish the proper heat gain the room design temperature and the activity level of the occupants must be known.

7. Lighting:

Lights generate sensible heat by the conversion of the electrical power input into light and heat. The heat is dissipated by radiation to the surrounding surfaces, by conduction into the adjacent materials and by convection to the surrounding air. Incandescent light convert approximately 10% of the power input into light while the rest is being generated as heat within the bulb and dissipated by radiation, convection and conduction. About 80% of the power input is dissipated by radiation and only about 10% by convection and conduction. Fluorescent lights converts about 25% of power to light and about 25% being dissipated by radiation through the surrounding surfaces. The other 50% is dissipated by conduction and convection. In addition, approximately 25% more heat is generated as heat in the ballast of the fluorescent lamp.

Fluorescent = total light watts*1.25
Incandescent = total light watts

8. Appliances:

Most applications contribute both sensible and latent heat to a space. Electric appliances contribute latent heat, only by virtue of the function they perform that is, drying, cooking, etc., whereas gas burning appliances , contribute additional moisture as a product of combustion. A properly designed hood with a positive exhaust system removes a considerable amount id the generated heat and moisture from most types of appliances.

9. Heat Gain Due to Miscellaneous Items:

Electric motors contribute sensible heat to the space by converting the electrical power input to heat. Some of this power is dissipated as heat in the motor frame and can be evaluated as Input*(1-motor efficiency).

The rest of the power input (brake horse power or motor input) is dissipated by the driven machine and in the drive mechanism. The driven machine utilizes this motor output to do work which may or may not result in a heat gain to the space.

7. Discussion of Design

With past experience and specific conditions, the given building with multi floors was designed in such a way that the complete building can operate with single central chilled water plant.

Plant has been located on terrace and utilized terrace space for air-conditioning system without any space loss in the floors are outside of the building.

With this we can minimize the piping and insulation quantities, pressure drop, and temperature drop and leakage tendency.

The tonnage is arrived with total heat load calculations and selected combination air cooled and water cooled chillers in view of Hyderabad conditions and better performance of the plant.

It has been designed with primary and secondary pumping system for power saving and easy operation.

Secondary pumps are integrated with pump logic control panel with variable frequency drive to run the pumps based on demand.

All the pumps will have stand by that is for primary, secondary and condenser water pumps.

Piping designed with two vertical risers directly to the AHU rooms by using minimum space by increasing work station area.
Each Floor is divided into four parts and given zoning numbers as per the requirement and every zone having AHU and feeding to the conditioned space.

Hub rooms also designed for the zones as per requirement (dual mode) and the same will operate with the designed AHU in day mode and DX mode for the night mode which will be operated from centralized VRF system.

Cafeterias are isolated for specific floor for better efficiency of air conditioning.

Based on load conditions chillers can run in combination to achieve the comfort conditions in the floor.

i.e., whenever central ac is in operation, the same can be feed into the floor areas.hub rooms and rest of the time taken care by VRF system to give 24X7 air conditioning.

Data center is also designed with dual mode in day mode the load is taken care by central plant and night mode is operated by DX mode which is designed separately.

Entire system is designed in such a way that it is very economical, user friendly in operation and easy maintenance.

8. Conclusion and Recommendation

A central air conditioning for proposed building is designed with R134a as refrigerant.

The results of the design are given below:

- Total estimated load required for the proposed hotel is 1447 tons and equipment selected 1380 tons with 5% diversity load.
- Chillers are designed as 350 tons X 2 nos air cooled and 680 tons x1 no water cooled for easy operation and better load bifurcation when floor are partial load also.
- Type of high side equipment chosen is Carrier chiller package which is integrated unit consisting of the evaporator, condenser, compressor, cooling tower and working performance is illustrated.
- In this work, it is suggested to install 12 units of different capacity and total of 125 hp (100 tons) capacity of variable refrigerant system (VRF) with R410A refrigerant as a stand by units for whole Hub rooms for night mode operation and better feasible in power consumption and energy saving in all respects.
- At part load conditions the variable refrigerant flow (VRF) system operates more satisfactorily compared to chilled water air conditioning system.
- Though the initial cost of the VRF system is high compared to chilled water system but the maintenance cost is very less.

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