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Design of HVAC System for KLN Prasad Auditorium with High Energy Efficiency Ratio (EER) using VRF System

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Abstract: In this project the designing of HVAC for auditorium is done by using VRF system. In a VRF system multiple indoor Air handling units may be connected to one outdoor unit. The outdoor unit has one or more compressors that are inverter driven, so there can be varied by changing the frequency of the power supply of the compressor. The term variable refrigerant flow refers to the ability of the system to control the amount of refrigerant flowing to the evaporators (indoor units). By this arrangement it provides an individualized comfort control, and simultaneously heating and cooling in different zones. The carpet area of the auditorium is about 630000 square feet and it also has the capacity of 500 people inside the auditorium. The VRF system is designed in AutoCAD and heat load calculation is to be taken out from hourly analysis program and duct size in mc quay duct sizer.

I. INTODUCTION

A. Introduction

There is presently a large variety of heating, ventilation, and air conditioning (HVAC) network which is entering in private and business structures. The majority of these types have been outstanding and broadly starting in the United States (U.S.) for a very long time. Variable refrigerant Flow is also known as (VRF), however it is familiar with the U.S. showcase in 2002 as a capable option and remain a moderately unclear choice for giving heating and cooling in the assembled condition. The essential objective of this task is to address the execution of VRF frameworks set in benefit in chilly climate atmospheres. Since utilities had a troublesome time computing to reserve funds and giving the related momentum to VRF frameworks through their request side administration (DSM) programs, an institutionalized technique for evaluating investment funds was produced and connected to vitality utilization estimations to confirm and measure vitality funds contrasted with benchmark levels. Space molding in Minnesota is to represent approximately 38% of building vitality utilize—or 15% of the state's aggregate vitality utilization. It is foreseen that this report will fill in as appositive state assessment device for building engineers, proprietors, utility DSM program administrators, and other key option for deciding whether VRF innovation is a suitable alternative for the current application.

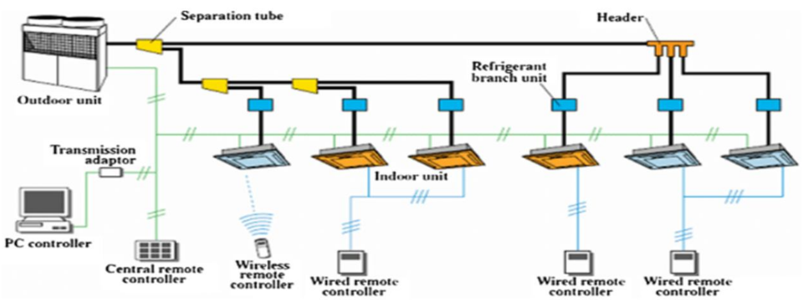

Fig 1.1: VRF outdoor and indoor units

B. Variable Refrigerant Flow

Variable refrigerant flow idea was started in 1982 by Daikin in Japan, which named and ensured the expression "variable refrigerant volume" (VRV). This constrained whatever is left of the business to build up a nonspecific name for this innovation—VRF.VRF is a HVAC framework arrangement in which heat is transmitted through refrigerant lines between an open air gathering unit and a system of indoor evaporators. The expression "variable refrigerant" is utilized to present the framework's capacity to continuously balance the rate at which refrigerant is distributed inside the framework.

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Figure 1.2:Two outdoor condensing units installed on a rooftop

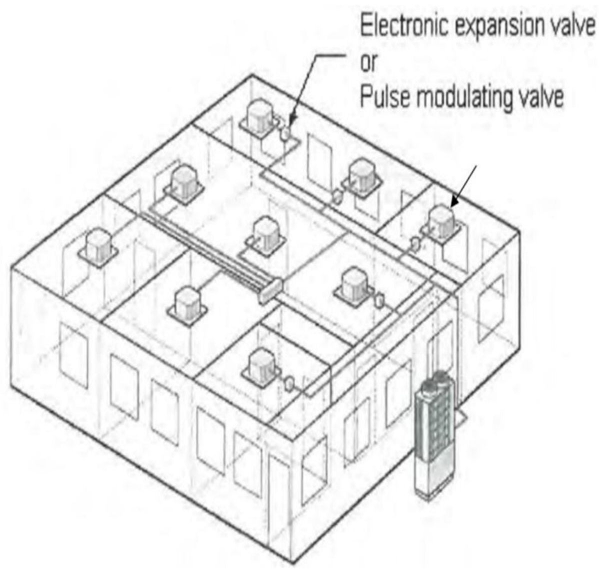

Figure 1.2: Centralized configuration of a typical VRF system

II. LITERATURE REVIEW

A. System Operation

Multi-split variable refrigerant (VRF) frameworks use one open air to join with various indoor vaporizing units. Indoor units can be duct and ductless or might be joined to channels which convey the required measure of ventilation air to each zone. The ducted choices will be utilized as a part of this other option to keep up tenant solace and security through suitable ventilation. The measure of R-134A refrigerant sent to each indoor unit is regulated in view of client contribution at the zone level, which enables each zone to be heated or cooled to the tenant's particulars. The stream of refrigerant is regulated through an inverter-driven parchment blower in the open air unit. This expanded controllability makes a VRF framework perfect for zones, for example, quiet rooms or workplaces, where it is alluring for the tenant to have temperature control.

B. Ventilation and Humidity Control

Since VRF frameworks are intended to deal with 100% of the heating and cooling of the zones, the main wind current vital is what is required for sufficient ventilation and to control the relative humidity of each zone. A constant open air taking care of unit is utilized to meet ventilation and moistness essential control by sending the ventilation air at legitimate stickiness to the zone-level air-to-refrigerant warmth exchangers.

C. Heating or Cooling Operation Only

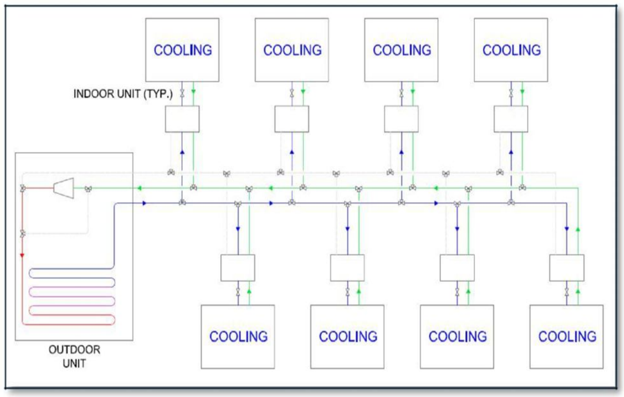

Figure 2.1: VRF S schematic: Cooling Operation Only

D. Heating Operation Only

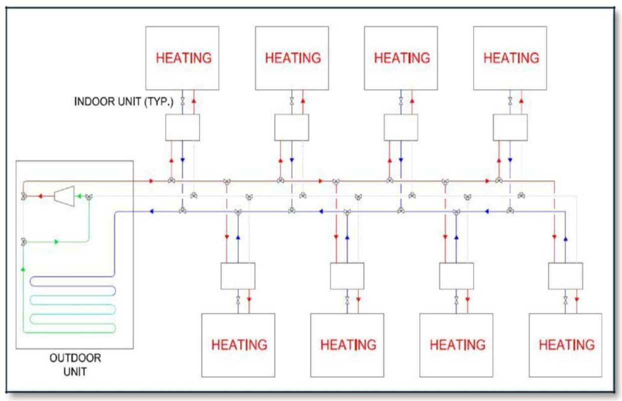

Figure 2.2: VRF S schematic: Heating Operation Only

E. System Design

The first outline loads were changed to determining the new zoning for the VRF framework and another heap estimating was performed. The aggregate space still served by the VAV framework (appeared in white in Figure 2.5) has a fundamentally decreased heating and cooling load, which takes into account the clearance of the biggest housetop air dealing with unit, RTU-1. The rooms initially served by RTU-1 and not served by the VRF framework would now be able to be served by RTUs 2 and 3 without expanding the limit of those units. The cut sheets for these indoor units are given in table 2.1.

Table 2.1: VRF Condensing Unit schedule

Tag	Design Cooling Load (Tons)	Design Heating Load (MBh)	Unit Cooling Capacity (Tons)	Unit Heating Capacity (MBh)	Refrigerant	Input Power (kW)	Weight (lbs)
CU-1	10.8	54.0	12.0	162.0	410-A	10.8	1146
CU-2	6.7	35.1	8.0	108.0	410-A	8.6	573
CU-3	6.8	35.1	8.0	108.0	410-A	8.6	573
CU-4	10.3	51.1	12.0	162.0	410-A	10.8	1146
CU-5	7.5	33.0	10.0	135.0	410-A	10.9	573
CU-6	7.9	30.0	10.0	135.0	410-A	10.9	573

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The outside functioning units were estimated in view of the most extreme heating and cooling required for all zones associated with that unit. Warmth recuperation between zones was displayed in the Trace show, which diminishes the aggregate yearly vitality utilized by each zone. The plan cooling and heating limits of the new open air units are appeared in Table 2.2underneath and cut sheets for each size of outside unit are likewise appeared in VRF System Evaluation

F. Energy Evaluation

One of the principle favorable circumstances to VRF frameworks, other than expanded inhabitant controllability, is the vitality reserve funds related with bring down wind currents (less fan vitality required) and heat improve between zones (less heating or cooling vitality required). In NBRRH, the cooling task submerge in the heat Texas atmosphere, so the greater part of the heating and cooling funds happen in cooling activity.

Table 2.2: VRF Energy S savings

	Cooling (Ton)	Heating (MBh)	Cooling (Ton)	Heating (MBh)
VRF-1	11.6	28.6	10.8	54.0
VRF-2	7.1	17.1	6.7	35.1
VRF-3	7.2	17.1	6.8	35.1
VRF-4	11.0	27.3	10.3	51.1
VRF-5	8.1	13.5	7.5	33.0
VRF-6	8.4	20.9	7.9	30.0

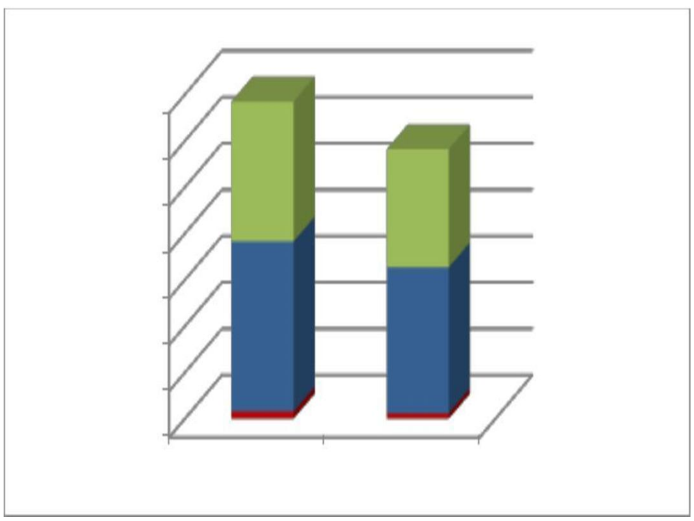


Figure 2.3: VRF Equipment Energy Consumption Comparison

G. Energy Effiency Ratio

A room A/C and cooling system's effectiveness is estimated by the vitality productivity proportion (EER). The EER is the proportion of the cooling limit (in British thermal units [Btu] every hour) to the power contribution (in watts). The higher the EER rating, the more effective the A/C and cooling system. When purchasing another room, A/C and cooling system, search for the vitality star name when buying air conditioning.

EER FORMULA
EER = COOLING OUTPUT IN WATTS
POWER OUTPUT IN WATTS

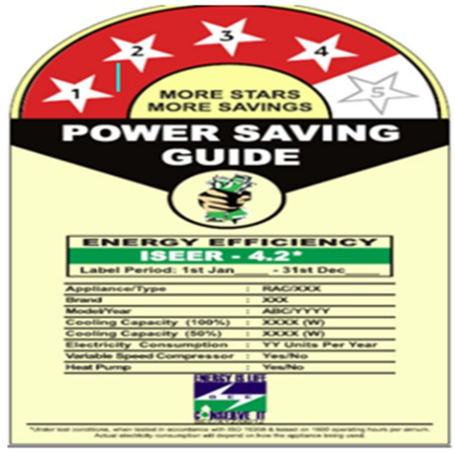


Figure 2.4: Energy effiency ratio star rating

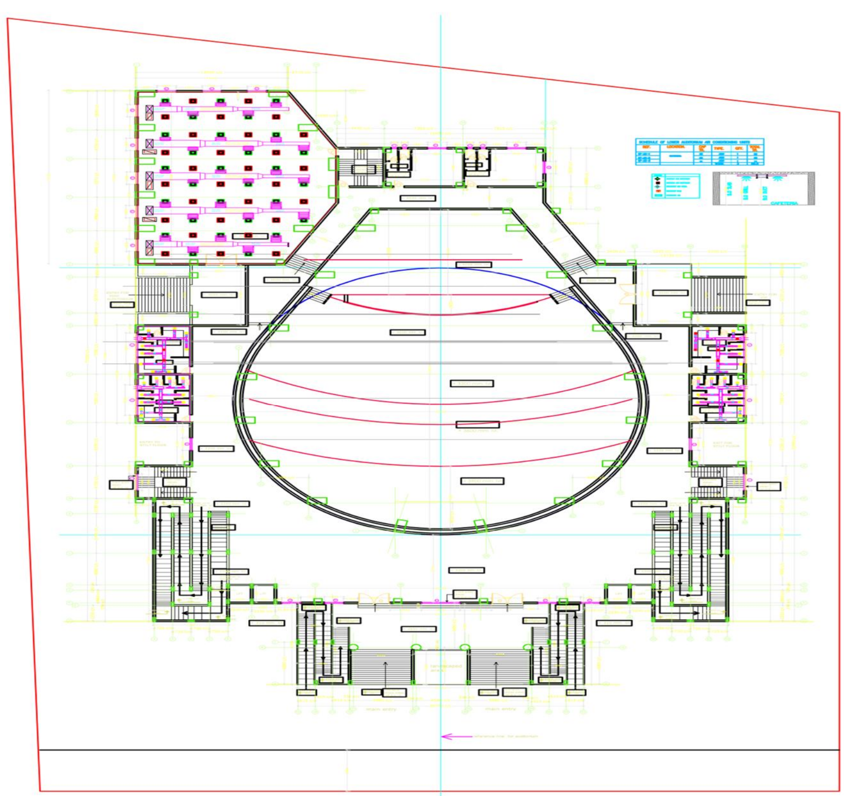
III. OUTLINE OF AUDITORIUM

A. Building Profile

In this project the designing of variable refrigerant flow is for auditorium and it is situated in metro Politian region Hyderabad, India. it is a commercial building which Uses for programs and seminars. In this auditorium the cafeteria, projector room and toilets are composed inside the building. The confronting heading of the building is north side, and different sides are of glass outline which faces south side. The portions of wall are on east and west side Plan: As shown. The area of auditorium room is 75000 square feet. Within territory of theater in which air conditioning and cooling is provided is 63000 square feet. The region of cafeteria is 6200 square feet. The area like corridor, staircase doesn't need air conditioning.

B. Occupancy

According to the plan 500 peoples can sit at a time in auditorium building and in cafeteria 120 persons can sit comfortably and have a meal.



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IV. HEAT LOAD CALCULATIONS

As we talked about past section, heating and the cooling load figuring's are for the most part completed to evaluate the required limit of tonnage and solace of heating and cooling frameworks, which can be keep up the required conditions in the determined space. To get the capacity of the required cooling/heating limits for the most part one needs to have finish data in regards to the plan of the indoor and open air conditions, disclaimer of the building, determinations of the zone which must be adapted, (for example, the action level, inhabitance, different apparatuses and gear which are utilized as a part of the region to be work etc….) and if some other exceptional necessities or interesting uses of the specific application

Air System Sizing Summary for AUDITORIUM

Project Name: KLN ABDULLAH
Prepared by: ABDULLAH
07/08/2018
06:07PM

Air System Information

Air System Name	AUDITORIUM		Number of zones	1	
Equipment Class	AHU		Floor Area	63000.0	ft²
Air System Type	SZCAV		Location	HYDERABAD, India	

Sizing Calculation Information
Zone and Space Sizing Method:

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

Central Cooling Coil Sizing Data

Total coil load	160	Tons	Load occurs at	Jul 1800	
Total coil load	1884.9	MBH	OA DB / WB	108.8 / 76.0	°F
Sensible coil load	1433.4	MBH	Entering DB / WB	85.4 / 68.5	°F
Coil CFM at Jul 1800	64000	CFM	Leaving DB / WB	58.0 / 56.5	°F
Max block CFM	184385	CFM	Coil ADP	55.0	°F
Sum of peak zone CFM	184385	CFM	Bypass Factor	0.100	
Sensible heat ratio	0.760		Resulting RH	43	%
ft²/Ton	401.1		Design supply temp.	58.0	°F
BTU/(hr-ft²)	29.9		Zone T-stat Check	1	OK
Water flow @ 10.0 °F rise	N/A		Max zone temperature deviation	8.9	°F

Central Heating Coil Sizing Data

Max coil load	70.2	MBH	Load occurs at	Des Htg	
Coil CFM at Des Htg	184385	CFM	BTU/(hr-ft²)	1.1	
Max coil CFM	184385	CFM	Ent. DB / Lvg DB	69.6 / 70.0	°F
Water flow @ 20.0 °F drop	N/A				

Supply Fan Sizing Data

Actual max CFM	184385	CFM	Fan motor BHP	0.00	BHP
Standard CFM	173610	CFM	Fan motor kW	0.00	kW
Actual max CFM/ft²	2.93	CFM/ft²	Fan static	0.00	in wg

Outdoor Ventilation Air Data

Design airflow CFM	6280	CFM	CFM/person	13.65	CFM/person
CFM/ft²	0.10	CFM/ft²			

Air System Sizing Summary for CAFETERIA

Project Name: KLN ABDULLAH
Prepared by: ABDULLAH
06/24/2018
10:23PM

Air System Information

Air System Name	CAFETERIA		Number of zones	1	
Equipment Class	PKG ROOF		Floor Area	6200.0	ft²
Air System Type	SZCAV		Location	HYDERABAD, India	

Sizing Calculation Information
Zone and Space Sizing Method:

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

Central Cooling Coil Sizing Data

Total coil load	55	Tons	Load occurs at	JUL 1100	
Total coil load	284.1	MBH	OA DB / WB	105.2 / 75.1	°F
Sensible coil load	244.6	MBH	Entering DB / WB	79.8 / 68.6	°F
Coil CFM at Aug 1100	15215	CFM	Leaving DB / WB	64.0 / 62.9	°F
Max block CFM	15215	CFM	Coil ADP	62.2	°F
Sum of peak zone CFM	15215	CFM	Bypass Factor	0.100	
Sensible heat ratio	0.861		Resulting RH	67	%
ft²/Ton	261.9		Design supply temp.	58.0	°F
BTU/(hr-ft²)	45.8		Zone T-stat Check	1 of 1	OK
Water flow @ 10.0 °F rise	N/A		Max zone temperature deviation	0.0	°F

Central Heating Coil Sizing Data

Max coil load	39.2	MBH	Load occurs at	Des Htg	
Coil CFM at Des Htg	15215	CFM	BTU/(hr-ft²)	6.3	
Max coil CFM	15215	CFM	Ent. DB / Lvg DB	68.6 / 71.1	°F
Water flow @ 20.0 °F drop	N/A				

Supply Fan Sizing Data

Actual max CFM	15215	CFM	Fan motor BHP	0.00	BHP
Standard CFM	14326	CFM	Fan motor kW	0.00	kW
Actual max CFM/ft²	2.45	CFM/ft²	Fan static	0.00	in wg

Outdoor Ventilation Air Data

Design airflow CFM	2172	CFM	CFM/person	9.84	CFM/person
CFM/ft²	0.35	CFM/ft²			

Cost Estimation: In vitality utilization data as per the machine utilization it shows the use of day, month and year. Presently multi day it is exceptionally useful for taken toll estimation.

A. Energy Consumption Information Of Scroll Compressor

Required Data Entry Energy Consumption Information	
Equipment Name	SCROLL COMPRESSOR
Equipment Quantity	1
Consumption	*in* 3516 Watts *or* Kilowatts *or* Horsepower or Ton
Run Time Usage Hours Per Day	10
KWH Billing Rate	$ 0.09350
Calculated Resulting Cost	
Cost Calculations For	1 - SCROLL COMPRESSOR
Total KWH Per Day	35.16
Total Cost Per Day	$ 3.29
Total Cost Per Month	$ 99.94
Total Cost Per Year	$ 1199.92
Clear All Values	About

B. Energy Consumption Informatin Of Screw Compressor

Required Data Entry Energy Consumption Information	
Equipment Name	SCREW COMPRESSOR
Equipment Quantity	1
Consumption	*in* 5000 Watts *or* Kilowatts *or* Horsepower or Ton
Run Time Usage Hours Per Day	10
KWH Billing Rate	$ 0.09350
Calculated Resulting Cost	
Cost Calculations For	1 - SCREW COMPRESSOR
Total KWH Per Day	50
Total Cost Per Day	$ 4.68
Total Cost Per Month	$ 142.12
Total Cost Per Year	$ 1706.38
Clear All Values	About

V. CONCLUSION

In this project the designing of HVAC system for auditorium using VRF system is done. A VRF system offers a flexible installation and energy saving cooling and heating comfort should be considered as an alternative to conventional systems for those applications where zoning or a part load operations is required. In this auditorium at a carpet area of 63000 square feet the ton of refrigeration is 215 Tr and 270 hp. The air flow rate of 64000 cfm (cubic feet per minute) is obtained. There are 6 air handling units and each ahu is connected to a single duct by this the diffusers are attached and the area is conditioned. The occupancy inside the auditorium is 500 people and 120 in cafeteria, R134a refrigerant is used in this vrf system. The energy effiency ratio is taken out from scroll and screw compressors, and it shows that screw compressor is more efficient than scroll compressor. This project is evaluated with energy efficiency ratio.

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