Cairo University
Faculty of Engineering
Mech. Power Department

دبلوم تطبيقات التحكم الأوتوماتيكى فى نظم القوى الميكانيكية

Abstract: This project presents many detailed analysis and typical calculations used to design Air Handling Unit for 2 Computer Server Rooms. The analysis includes essential design requirements such as: Selecting proper HVAC system to be used, Calculation of all types of thermal &latent heat loads of AHU, both selecting & sizing of various components to be installed in the AHU. Selecting both of the two IRC (Individual Room Controller) & the CTU (Central Thermostat Unit) is included in order to optimize hard specific requirements of permanent -full time operation of the AHU for 24hrs, 7days/week, 365 days/year.

MEP 599 Diploma Project-Fall 2022-2023

Design of an Air Handling Unit for Server Rooms

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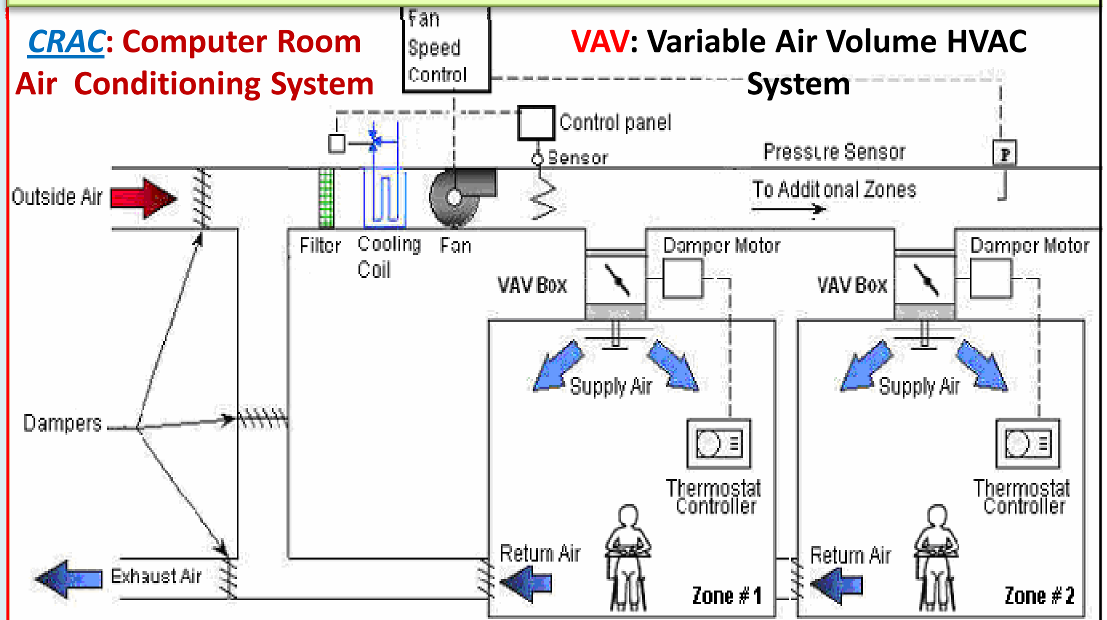
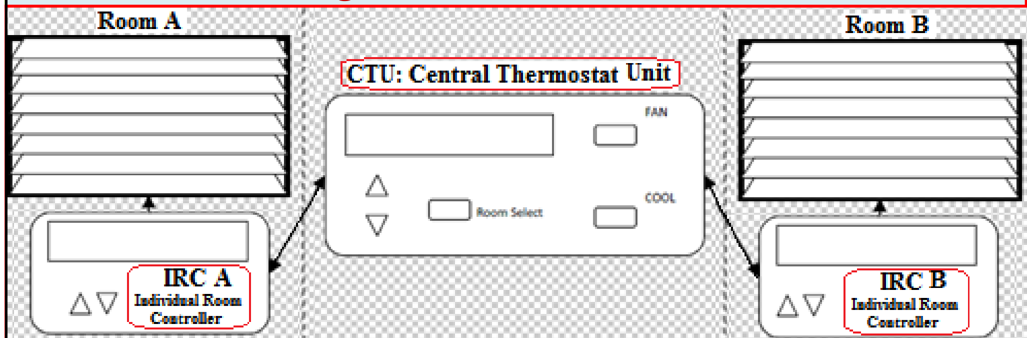
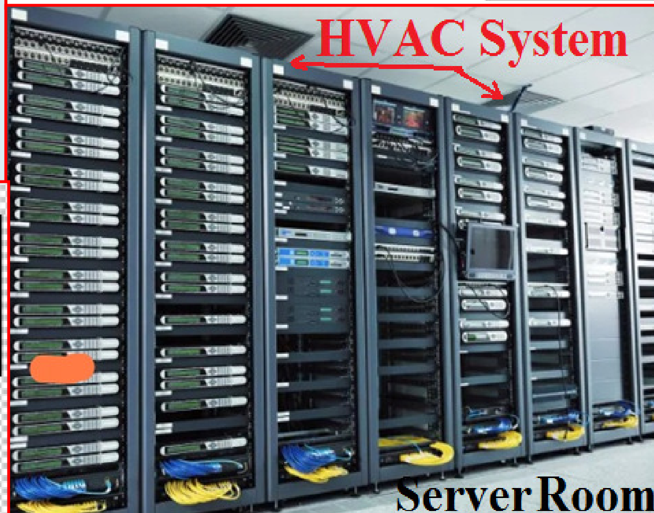
During this project, we show typical calculations to design an air distribution machine (VAV type) to feed two server rooms, where the temperature and humidity can be controlled in each room separately. The parts of the AHU machine and the function of each part are also clarified. More explanations are given for the calculation steps of the required capacity of each part based on the calculation of maximum thermal loads and through the use of a commercial PC program (HAP Program). The AHU design calculations were done by a 2nd commercial software, the Airo Vision Program. We have also examined and studied the control parts of the AHU machine to achieve the required temperatures and humidity, whether controlling the air or the water used to cool this air. In this project we also discussed and examined the new type of cooling system for server rooms known as computer room air conditioning (CRAC).

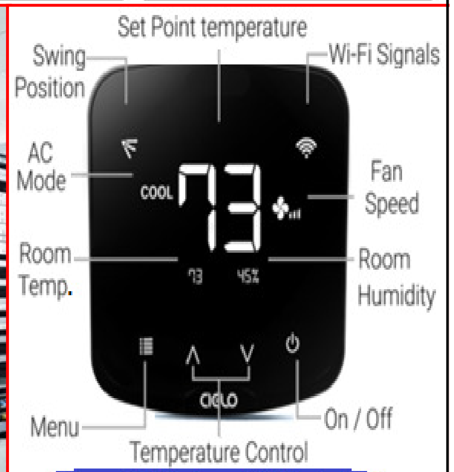
CRAC: Computer Room Air Conditioning System

VAV: Variable Air Volume HVAC System



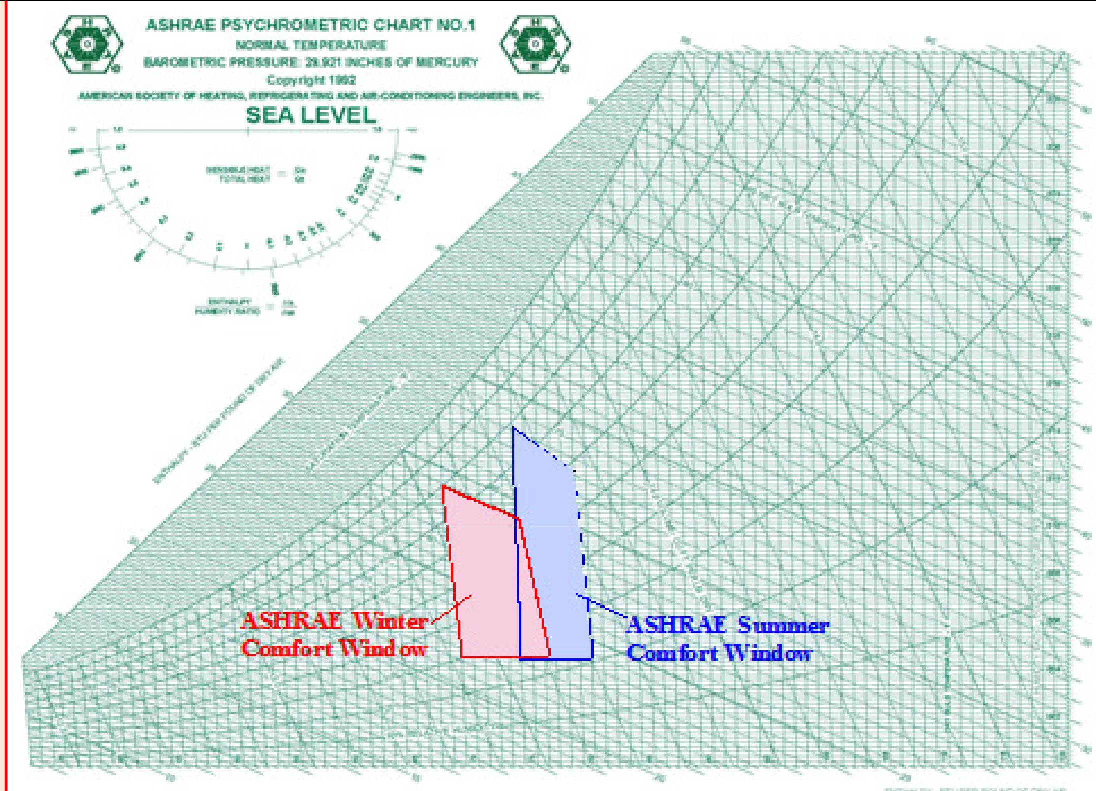




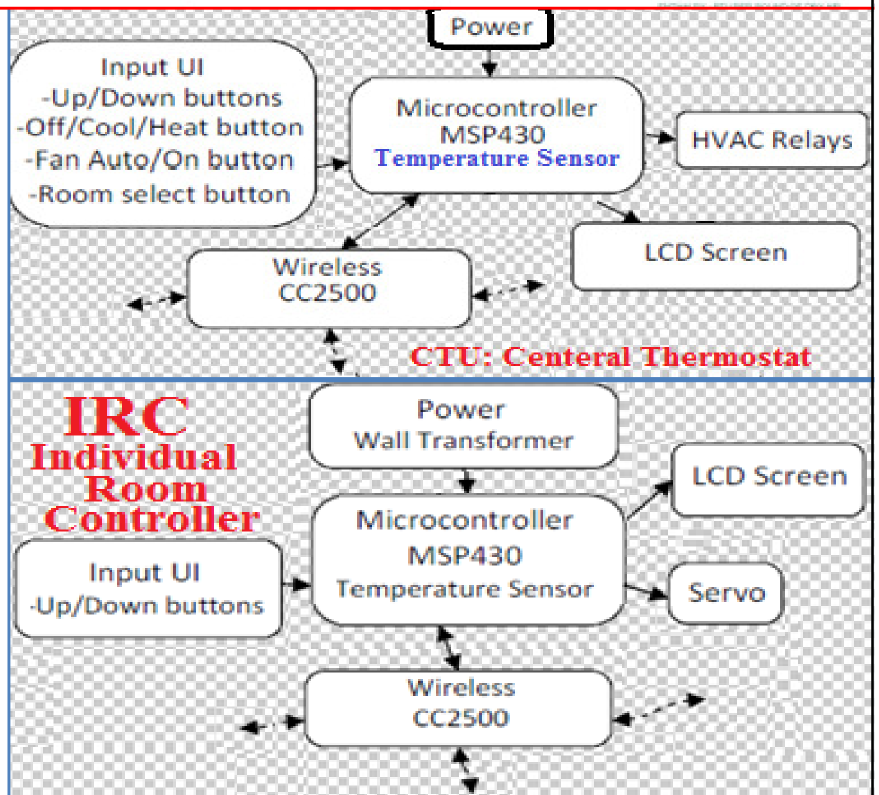


Thermostat-like Smart AC Controller

Project Overview: Variable air volume (VAV) system is used to simultaneously meet variety of cooling & heating loads in a relatively efficient manner. The system achieves this by varying distribution of air depending on the cooling or heating loads of each area. Air flow variation allows for adjusting the temp. in single zone without changing the temp. of air in whole system, minimizing any instances of overcooling or overheating. This flexibility has made this one of the most popular HVAC systems for large buildings with varying conditioning needs such as office buildings or schools. In the schematic above, the VAV system brings outside air and return air to the Air Handling Unit where both are mixed. The mixed air is drawn through a cooling coil, which drops the temperature to a fixed supply air temperature. The temperature in the individual rooms (#1 & #2) is measured by Thermostats, which directly control the dampers in the VAV units. The supply air fan is Speed controlled by a variable speed drive, that controls the air volume flow rate by keeping the duct static pressure constant. *The pressure is measured by the sensor (P) located approximately 2/3rd of the way down the main duct starting air handling unit.* As the zone dampers throttle back, the duct pressure rises, and the fan is controlled to reduce the duct pressure.



What is CRAC? A computer room air conditioning (CRAC) unit is a device that monitors and maintains the temperature, air distribution and humidity in a data center, network or server room. CRAC units replace the air-conditioning units used in the past to cool data centers. By comparison, CRAC systems have better air filtration, better humidity control mechanisms and higher airflow than typical AC systems. CRAC units help prevent low humidity and water vapor from forming. Low humidity can cause static electricity buildup, which can damage electronics, and water vapor buildup, which can cause short circuits and corrode equipment. CRAC units work via a refrigeration cycle where air is blown over a cooling coil filled with refrigerant. Refrigerant in the cooling coil is kept cold by a compressor. Excess heat is expelled as air, water or a glycol mixture. Older CRAC units can only turn on and off, while newer units enable different airflow variations. There are a variety of ways that CRAC units can be situated. One popular CRAC setup is having cooling air dispensed through an elevated floor. Also called raised flooring, the cooled air rises through the perforated floor sections, forming cold aisles. The cold air flows through the racks, where it picks up heat before exiting from the rear of the racks. The warm exit air forms hot aisles behind the racks, and the hot air returns to the CRAC intakes, which are positioned above the floor.



COOLING LOAD CALCULATIONS: It's meant by conditioning a space to provide a comfort conditions to this space, so the heat that generated into the space must be removed. To remove that heat a suitable air conditioning machine will use. By calculating the cooling load or the heat that must be removed the air conditioning machine power will be specified. Outside weather conditions and the sun combine to produce a cooling or heating load through the building envelop. The load depends on:1-The thermal characteristics of the walls, roof, fenestration, floor, interior building furnishings, and construction..2-The driving force resulting from the difference between the outside conditions (including solar) and the inside conditions. Cooling loads result from many conduction, convection, and radiation heat transfer processes through the building envelope and from internal sources and system components. Building components or contents that may affect cooling loads include the following: External: Walls, roofs, windows, partitions, ceilings, and floors. Internal: Lights, people, appliances, and equipment Infiltration: Air leakage and moisture migration. System: Outside air, duct leakage, reheat, and fan and pump energy These all parameter are discussed with introducing some of design criteria and introducing how to insure complete comfort condition inside the building.

Outdoor Design Conditions:

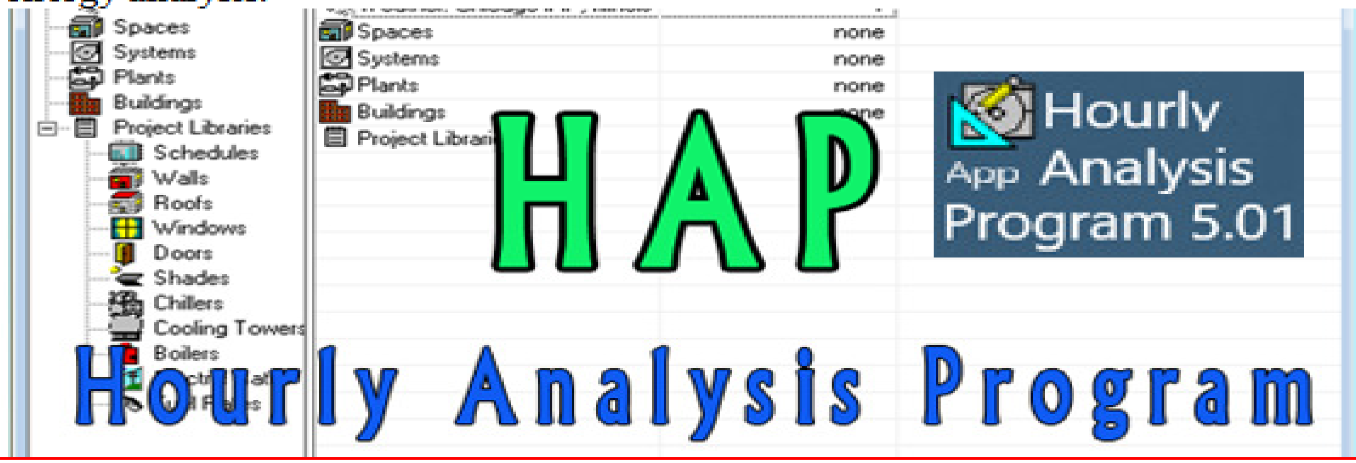
Outside Conditions	ASHRAE Handbook		Design Values	
	Summer	winter	Summer	winter
Dry bulb Temperature (°C)	36.3	-5.4	42.1	-2.8
Wet bulb Temperature (°C)	20.3	15.9	23.3	15.9
Daily Range (°C)	11.8	12.7	11.8	12.7
Elevation (ft)	4753			
Latitude (deg)	21.48N			
Longitude (deg)	40.55E			
Time zone (hr)	3			
Standard pressure at station elevation (kPa)	85.09			

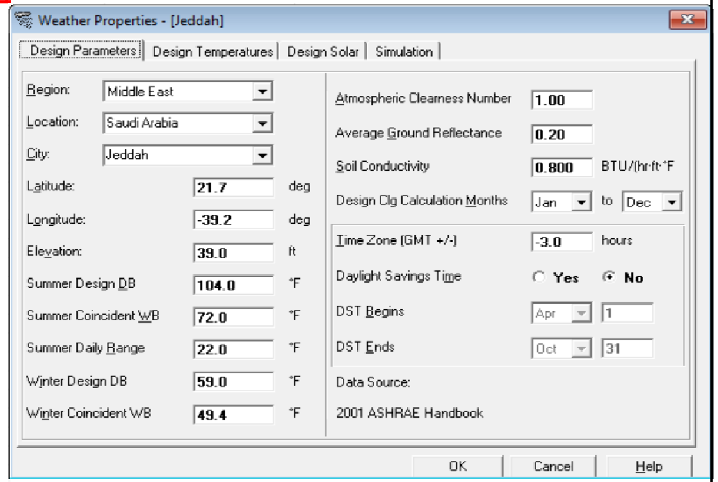
Inside Design Conditions (ASHRAE Standard55).

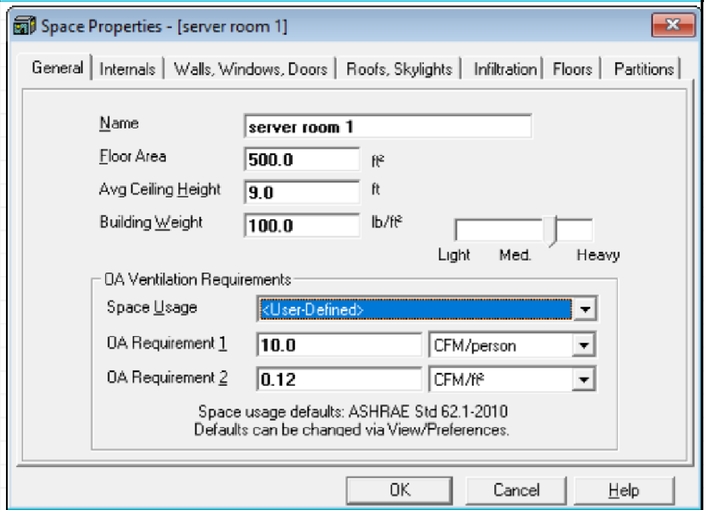
Space	ASHRAE Recommendation		Present Design	
	Temperature	Relative Humidity	Temperature	Relative Humidity
Office space	23 to 26 °C	50 to 60 %	24±1 °C	55 ±5%
Control room	23 to 26 °C	50 to 60 %	24±1 °C	55 ±5%
Lobbies and Corridors	23 to 26 °C	40 to 50 %	24±1 °C	45 ±5%
Telecom Room	°C(25-20)	%(55-40)	±1 °C24	50±5%
Power Room	°C(25-20)	(55-40)%	24±1 °C	50%5±

Load estimation by using HAP:

HAP is a computer tool which assists engineers in designing HVAC systems for commercial buildings. HAP is two tools in one. First it is a tool for estimating loads and designing systems. Second, it is a tool for simulating energy use and calculating energy costs. HAP uses the ASHRAE-endorsed transfer function method for load calculations and detailed 8,760 hour-by-hour energy simulation techniques for the energy analysis.







HAP is a computer tool which assists engineers in designing HVAC systems for commercial buildings. HAP is two tools in one. First it is a tool for estimating loads and designing systems. Second, it is a tool for simulating energy use and calculating energy costs. In this capacity it is useful for LEED®, schematic design and detailed design energy cost evaluations. HAP uses the ASHRAE-endorsed transfer function method for load calculations and detailed 8,760 hour-by-hour energy simulation techniques for the energy analysis.

AIROVISION TECHNICAL SUBMITTAL

Carrier

In this chapter we discuss the FAHU structure, different types of each component and the main purpose of it. To do this we should first build an FAHU by either ways manual design or through computer tools. In this case we have used PC tool called Eurovision by Carrier as shown below.

SOFTWARE NAME : AiroVision™ - Version 3.60 (13.02.2020), Patch R8C60

REPORT DATE :

EUROVENT CERTIFIED PERFORMANCE

Eurovent Number : 14.02.004

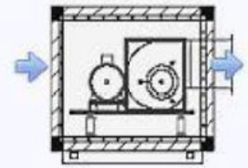
EN 1886:2017 R/J Casing Leakage Class L2 (-400 Pa), L2 (+400 Pa)

Max. Internal Leakage Rate: 0.0002 % of Supply Airflow

Main Project	AHU Project	AHU Name	AHU 1
Sub Project	Project 2023	Location	
Product Code	39HQM 1012	Quantity	1
Project Date		Last Update	
Created at Company		Created By	
Modified at Company		Modified By	

Fan Specifications

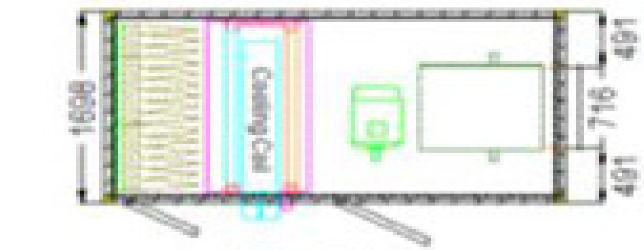
Blower Brand :	1) Yilida
Blower Type :	0) Forward
Discharge Direction :	2) THF
Preview :	



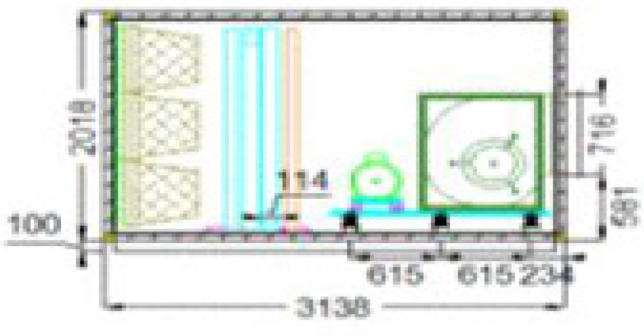
☐ Direct Driven

☐ Twin Fans ☐ Stand-By Motor

OUTLINE DRAWING



Top View



S1
(1538.5 kg)

GENERAL SPECIFICATIONS

GENERAL SPECIFICATIONS

ErP Code	: NRVU-BVU	
MB Code	: PU-DS-60-08-ST	
Roof Selection	: No	
Access Location	: Right Type	
AHU SFP (E)	: 1.68	kW/(m³/s)
AHU Temp. range	: -30 C / +80 C	
Unit Orientation	: Horizontal	
AHU Weight	: 1538.5	kg
Low Height ES	: No	
Top Layer Model	: -	
Unit Dimension (Include Base)		
Total Height	: 2118	mm
Total Width	: 1698	mm
Total Length	: 3138	mm
Base Height	: 100 mm	GI

DESIGN AIR SIDE CRITERIA

Supply Air Volume	: 12000	CFM
Fresh Air Volume	: 100	%
Return Air Volume	: 0	%
Exhaust Air Volume	: 0	CFM
Season	: Summer	
AHU Velocity SP(EX)	: 1.93 (-)	m/s
Coil Face Velocity	: 2.4	m/s
Filter Face Velocity	: 2.04	m/s

PANEL STRUCTURE & MATERIAL

Code	: 0.8GI-0.8GI-100GI
Inner Skin Materi:	: 0.8 mm GI
Inner Skin Coating	: No
Outer Skin Material	: 0.8 mm GI
Outer Skin Coating	: RAL 7035
PU Material	: Injected Polyurethane

Note: SP = Supply AHU, EX = Exhaust AHU
ES = Exhaust Section

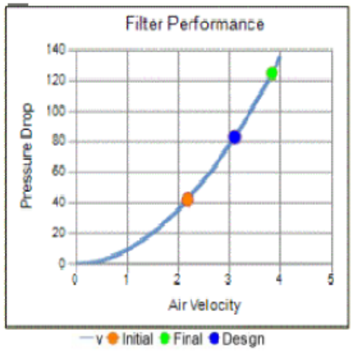
TEMPERATURE PROFILE

Season		SUMMER		WINTER		Unit
Air Properties		Fresh Air	Return Air	Fresh Air	Return Air	
Dry Bulb Temp.	:	46.0	24.4	-	-	°C
Wet Bulb Temp.	:	32.0	19.0	-	-	°C
Relative Humidity	:	38.21	60.40	-	-	%

1 PRIMARY (COMBINED FILTER)

FILTER SPECIFICATIONS

Filter Type	: Syn Pleated 50mm	
ISO 16890	: Coarse 75%	
Mounting Type	: Rail	
Initial PD.	: 42	Pa
Final PD.	: 125	Pa
Design PD.	: 83	Pa
User PD.	: 0	Pa
EN 779 (MERV)	: G4 (MERV8)	
Air Flow	: 12000	CFM
Filter Area	: 2.612	m²
Filter Velocity	: 2.17	m/s



STRUCTURE & SECTION INFO

Section Length	: 640	mm
Frame Material	: AL	
Spare Filter	: No	
Door Size	: Standard factory	
Door Type	: Hinged	
Annual Energy Consumption	: 595	Watt. hr.

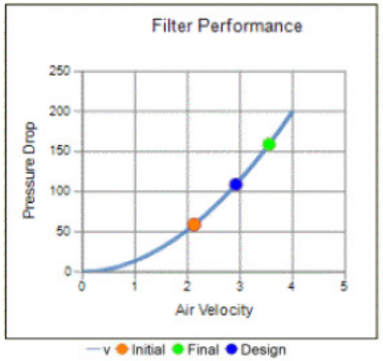
2 SECONDARY (COMBINED FILTER)

FILTER SPECIFICATIONS

Filter Type	: Soft Bag Filter	
ISO 16890	: ePM2.5 70%	
Mounting Type	: Rail	
Initial PD.	: 59	Pa
Final PD.	: 159	Pa
Design PD.	: 109	Pa
User PD.	: 0	Pa
EN 779 (MERV)	: F7 (MERV13)	

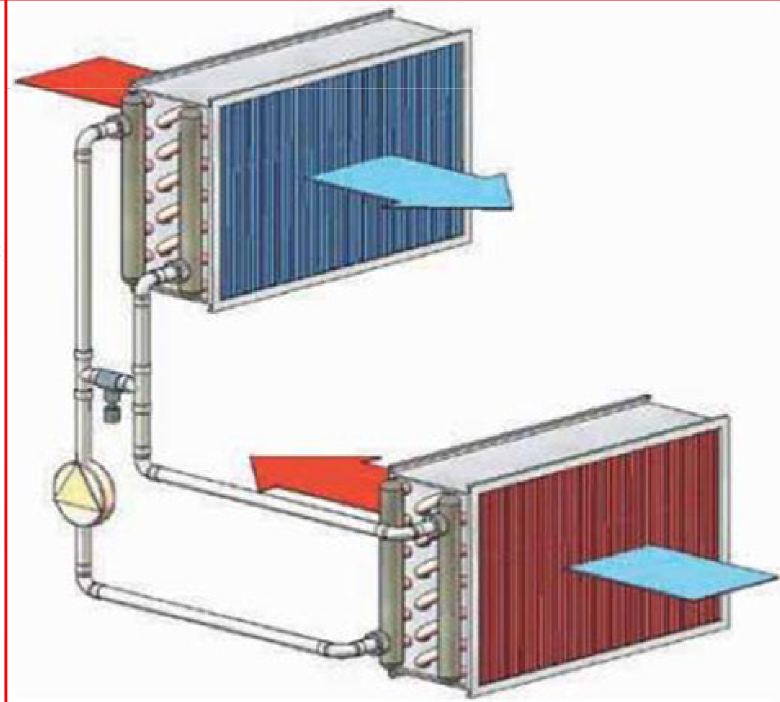
AIR FLOW INFO

Air Flow	: 12000	CFM
Filter Area	: 2.676	m²
Filter Velocity	: 2.12	m/s



STRUCTURE & SECTION INFO

Section Length	: 640	mm
Door Type	: Hinged	
Door Size	: Standard factory	
Has Door	: Yes	
Has Additional Door	:	
Frame Material	: GI	
Spare Filter	: No	
Annual Energy Consumption	: 1708	Watt. hr.



Plug fans