JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

HEAT LOAD CALCULATION FOR G+2 BANKING AND COMMERCIAL BUILDING-HVAC SYSTEM BY E20 SHEET

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Abstract : As the technology is developing in the field of refrigeration and air conditioning, remarkable comfort and saving are achieved. Maintaining the required low temperature for the common food we take will surely reduce the cost, as this process can be done at a time when the availability is plenty and the cost is low. The control of indoor climate is important throughout the world, today the air conditioning engineers, architects, contractors; technicians are modifying indoor climates in homes, factories, commercial establishments, hospitals and offices throughout the world.

The criticality of air conditioning became evident with the temperature and the humidity conditions became intolerable and industrial production become adversely affected and activities involving computers, electronics, aircraft products, precision manufacturing communication networks and operation in hospitals, in fact many areas of programming would come to a halt, so air conditioning is no longer a luxury but an essential part of modern living.

The E-20 name was derived from Carrier's System Design Manual and the Engineering Form E-20 which was used to calculate peak cooling and heating loads for buildings in the 1960's and a core engineering task and the first step in sizing and selecting HVAC equipment.

Office and commercial space has numerous HVAC applications. The main aim is to improve & extend the healthy life. In this project Banking and commercial Ground +2 floor project has taken for the estimation of heating load and dehumidified air quantity required for the air conditioning the cooling required spaces.

***Key Words*:** HVAC, Air Conditioning, Reduce Cost, heating loads for buildings, E-20 Sheet,

I. INTRODUCTION

In general air conditioning is defined as the simultaneous control of temperature, humidity, cleanliness and air motion. Depending upon the requirement, air conditioning is divided into the summer air conditioning and the winter air conditioning. The former uses a refrigeration system and a dehumidifier against a heat pump and a humidifier used in the latter.

In addition, air conditioning is also sub divided into the comfort and industrial air conditioning. The former deals with the human comfort which as well, requires noise control while the latter is meant for the production of an environment suitable for commercial products or commodities, production shop laboratories, manufacture of materials and precision devices, printing works, photographic products, cold storages, computers, etc.

Necessity of Air Conditioning:

Air conditioning and refrigeration are provided through the removal of heat. Heat can be removed through radiation, convection, and by heat pump systems through a process called the refrigeration cycle.

Dehumidification:

In an air conditioning system is provided by the evaporator. Since the evaporator operates at a temperature below dew point, moisture in the air condenses on the evaporator coil tubes. This moisture is collected at the bottom of the evaporator in a pan and removed by piping to a central drain or onto the ground outside.

Types of Air Conditioning Systems:

There are various types of air conditioners like window air conditioner, split air conditioner, packaged air conditioner and central air conditioning system. This series of articles describes all types of air conditioners.

Types of Air Conditioning Systems:

1 Window Air Conditioning System
2. Split Air Conditioner System
3. Central Air Conditioning Plants
4. Packaged Air Conditioners

CENTRAL AIR CONDITIONING: There are two types of central air conditioning system which are as follows:

a. Direct Expansion

b. Chilled water system

b. Chilled water system:

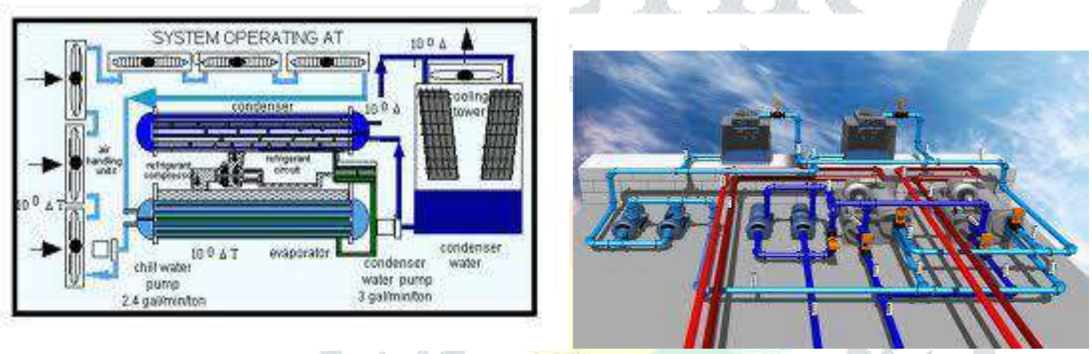


Fig. Chilled water system

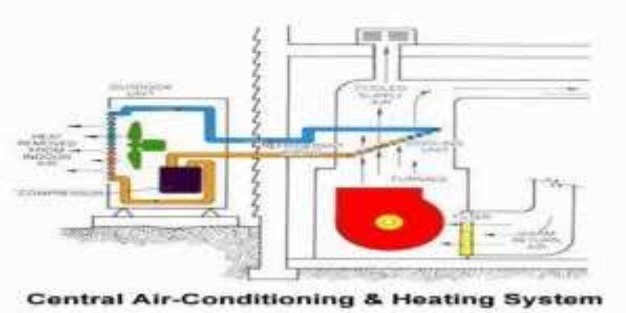
A chilled-water applied system uses chilled water to transport heat energy between the airside, chillers and the outdoors. These systems are more commonly found in large HVAC installations, given their efficiency advantages.

The components of the chillers (evaporator, compressor, an air- or water-cooled condenser, and expansion device) are often manufactured, assembled, and tested as a complete package within the factory. These packaged systems can reduce field labour, speed installation and improve reliability. Alternatively, the components of the refrigeration loop may be selected separately. While water-cooled chillers are rarely installed as separate components, some air cooled chillers offer the flexibility ,Cooling big halls, malls, huge spaces, galleries etc is usually only feasible with central conditioning units.

1) Central Air Conditioning Plants
2) Direct Expansion or DX Type of Central Air Conditioning Plant
3) Chilled Water Type of Central Air Conditioning Plant

Central air, a series of air ducts are routed directly to the fan in the furnace that blows the cool air so that the maximum amount of air can be placed throughout the building. There is also a fan in the hot side system that blows the hot air from the

The Working Principle of Central Air Conditioner:



Central Air Conditioning & Heating System

Types Of Central A/C System:

Central air conditioners are used as a more efficient way to keep a house or building cool. They are: split systems, unlike a window unit. The two sides are known as the hot side and the cold side. The hot side is placed outside the home, while the cold side is placed inside a furnace or another type of air handler.

Types Of Central A/C System:

There are two types of central air conditioning systems: Direct Expansion (DX) type of central air condition plants and Chilled Water type of the central air conditioning plants. This article describes the DX central air conditioning system

1) The Plant Room:

The plant room comprises of the important parts of the refrigeration system, the compressor and the Condenser. The compressor can be either semi-hermetically sealed or open type. The semi-hermetically sealed compressors are cooled by the air, which is blown by the fan, while open type compressor is water cooled. The open compressor can be driven directly by motor shaft by coupling or by the belt via pulley arrangement.

2) The Air Handling Unit Room:

The refrigerant leaving the condenser in the plant room enters the thermostatic expansion valve and then the air handling unit, which is kept in the separate room. filter and the large blower. After leaving the thermostatic expansion valve the refrigerant enters the cooling coil where it cools the air that enters the room to be air conditioned.

Load calculation considerations:

Factors which influence the load calculations to a greater extent than, normally are:-

Occupancy:

The single largest factor in such applications is the heat load from people. What should be the design occupancy of an auditorium? In performance auditoriums which include halls used for live shows, conferences and meetings, the seating capacity may not be the design occupancy, since the occupancy becomes a function of the usage pattern. In the auditoriums of educational institutions, it could range from almost daily to, a low of, just 15 to 20 days in a year. For the former usage pattern, occupancy may vary from virtually 0 to 100% whereas, for the latter pattern of usage, virtually 100% occupancy is to be expected. Maximum possible seating capacity should be used as a starting point and provision then made to allow for standing (in aisles) if permitted by local fire codes. On this number a designer can then apply a diversity factor. A diversity of 0.9 is generally safe.

Solar and Transmission gain:

The fabric gain in an auditorium is mostly from the sun-exposed roof since few auditoriums have windows for natural light and hence solar gain is virtually out of reckoning. Sunexposed roofs must be insulated – a minimum of 3" thick, foil-faced fibreglass may be applied to get a value smaller than 0.1 Btu/hour/sq. ft/°F. The attic space, if not used as a return air plenum, must be sealed and left "hot and stratified"

Stratification:

While calculating heat loads, the whole auditorium is reckoned as a single zone. On the other hand, in applications where the auditoriums are taller than 9 m and use side-wall grilles one can appreciate that a large volume of the auditorium does not participate in the air movement, and tends to become a stratified hot pocket. A designer can use this to select a smaller air conditioning system in which the plant capacity can be safely reduced by 40% to 50% of the heat load of the hot stratified pocket. (Generally the volume, 1.5m higher than the side wall grille up to the roof can be considered as the stratified zone for giving credit to the heat load – see calculations in the example

Storage Effect:

In general, the mass of the structural elements and furnishings per person is higher than in most other applications. This is an opportunity to use storage effect to advantage – to downsize the air conditioning plant.

Inside Conditions:

It is normal to aim at holding inside conditions to 23/24°C and RH between 40% and 60%. With good wide seats, at 900 mm centre lines, which keep the occupants far apart and with ceiling heights greater than 7.5 m it is often surprising to note that 25°C is also not uncomfortable. This is perhaps, because the influence of the occupants, around a subject by way of radiation temperature, gets diluted. (A person's skin temperature is close to 35°C as against a brick wall which may be at 25°C.

Outside Design Conditions:

The outside conditions used in the heat load should be taken at the time of the day when the peak load occurs. For movie houses featuring noon shows and matinee shows, the general outside design conditions used commonly become applicable. For performance auditoriums – with one show a day – generally the 8 p.m. load is the peak load.

Heat Load Calculations:

Some handbooks give simplified curves and procedures for estimating heat loads of the auditorium. One only needs to know outside design conditions, numbers of seats, cfm / person and the inside conditions. This data is keyed into a set of curves to get the auditorium heat load. The heat load for the foyer and other spaces cannot be calculated by this method. These curves are based on conditions in the US where generally the time between shows is larger than in India, due to which benefits of "fresh air flushing" and storage get lost.

Location and Thermal Conditions :

Building Location : Delhi
Orientation : Wall on all sides
Application : Commercial and Banking
Longitude :77.2315° E
Latitude :28.652° N
Elevation : 216 metre

Condition	*DBT(°F)*	*WBT(°F)*	*RH (%)*
Ambient/Surroundings	110	75	20
Room Thermal Conditions	75	62.5	50
Difference (Δ)	35	12.5	30

Note: Room Comfort thermal Conditions are 22 to 27 Degree centigrade @ Rh is up to 70%

ΔU	Coefficient Factor
ΔU Glass	0.65
ΔU Masonry Wall	0.43
ΔU Roof	0.28
ΔU Partition Wall	0.31
ΔU Floor	0.57
Transmission Co-efficient:	

CHANGE IN TEMPERATURE ΔT

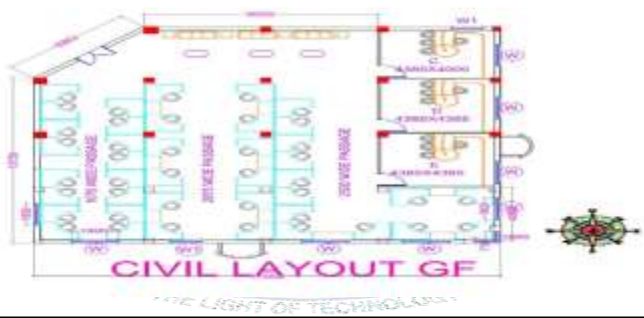
Similarly for different building materials temperature change will vary. See below calculation data table for our project load calculation based on different direction consideration **i.e.,** North, South, East, and West etc.

ΔT	Change in Temperature in °F				
Direction	**ΔT Wall**	**Direction**	**ΔT Glass**	**Condition**	**ΔT Roof**
North	27	North	14	Exposed to Sun	28
South	43	South	12		
East	29	East	12		
West	43	West	164		

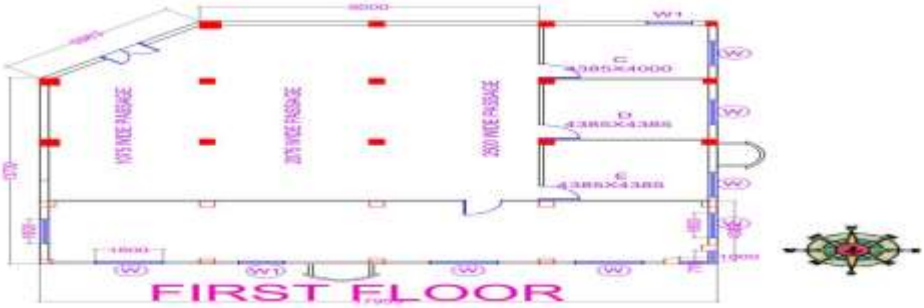
CORRECTION FACTOR FOR WALLS & PARTION WALLS:

This correction factor is used for walls and partition walls when exposed to sun.So, the change in temperature will be sum of correction factor and temperature average at 8AM to 4PM of any direction.So, for the basis of Load calculation for project, refer below Correction Factor forWall & Roof Temperature **(17°F)**

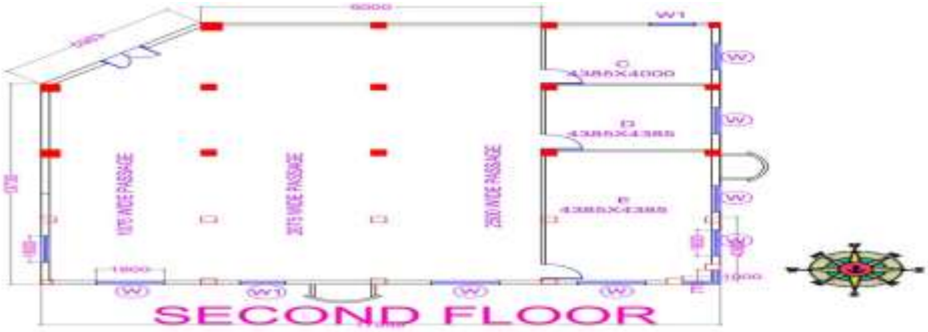
Civil Plan:



First Floor:



Second Floor:



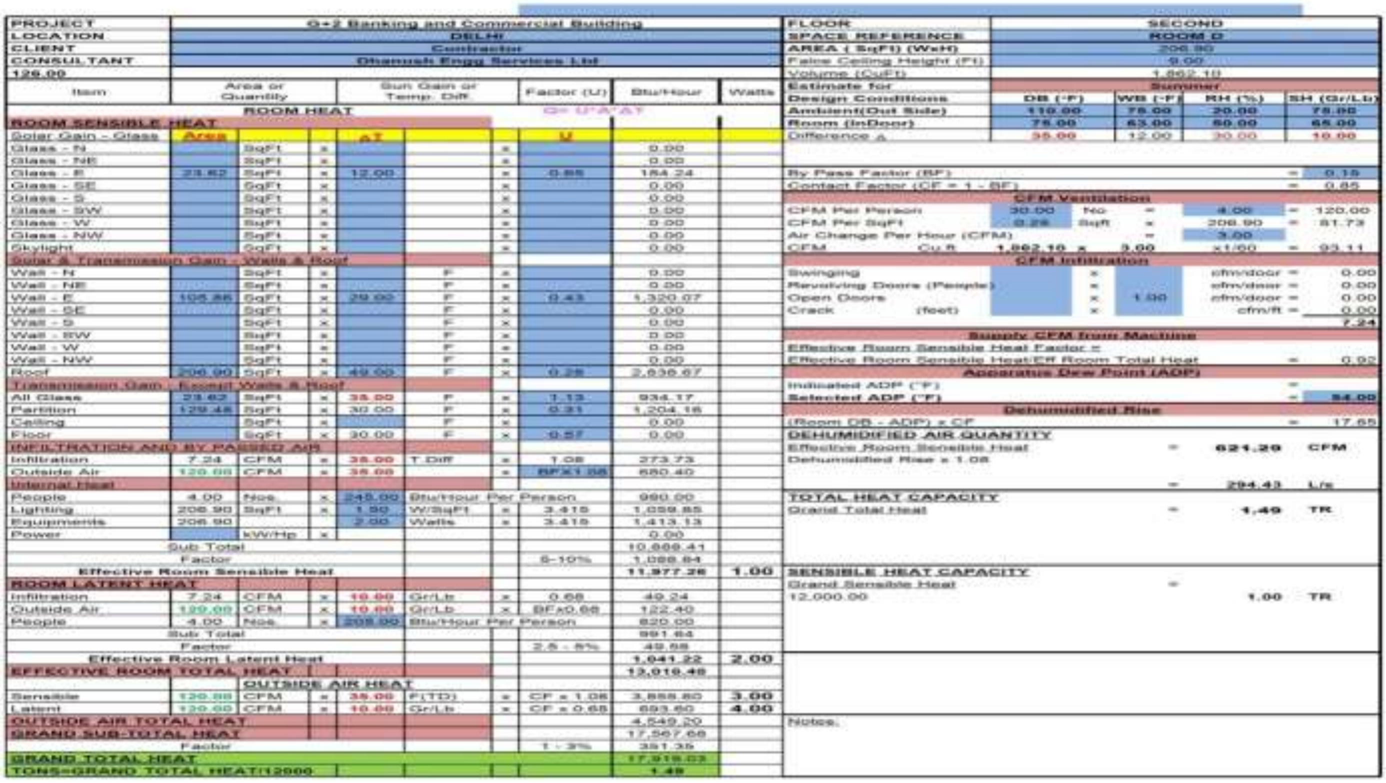
E-20 Forms

First Floor:

PROJECT	G+2 Banking and Commercial Building								
LOCATION	DELHI								
CLIENT	Contractor								
CONSULTANT	Dhanush Engg Services Ltd								
126.00									
Item	Area or Quantity			Sun Gain or Temp. Diff			Factor (U)	Btu/Hour	Watts
		ROOM HEAT					Q= U*A*ΔT		
ROOM SENSIBLE HEAT									
Solar Gain - Glass	Area			ΔT			U		
Glass - N		SqFt	x			x		0.00	
Glass - NE		SqFt	x			x		0.00	
Glass - E	23.62	SqFt	x	12.00		x	0.65	184.24	
Glass - SE		SqFt	x			x		0.00	
Glass - S		SqFt	x			x		0.00	
Glass - SW		SqFt	x			x		0.00	
Glass - W		SqFt	x			x		0.00	
Glass - NW		SqFt	x			x		0.00	
Skylight		SqFt	x			x		0.00	
Solar & Transmission Gain - Walls & Roof									
Wall – N		SqFt	x		F	x		0.00	
Wall - NE		SqFt	x		F	x		0.00	
Wall – E	105.86	SqFt	x	29.00	F	x	0.43	1,320.07	
Wall - SE		SqFt	x		F	x		0.00	
Wall – S		SqFt	x		F	x		0.00	
Wall – SW		SqFt	x		F	x		0.00	
Wall - W		SqFt	x		F	x		0.00	
Wall - NW		SqFt	x		F	x		0.00	
Roof		SqFt	x	49.00	F	x	0.28	0.00	
Transmission Gain - Except Walls & Roof									
All Glass	23.62	SqFt	x	35.00	F	x	1.13	934.17	
Partition	129.48	SqFt	x	30.00	F	x	0.31	1,204.16	
Ceiling		SqFt	x		F	x		0.00	
Floor	206.90	SqFt	x	30.00	F	x	0.57	3,537.99	
INFILTRATION AND BY PASSED AIR									
Infiltration	7.24	CFM	x	35.00	T.Diff	x	1.08	273.73	
Outside Air	120.00	CFM	x	35.00		x	BFX1.08	680.40	
Internal Heat									
People	4.00	Nos.	x	245.00	Btu/Hour Per Person			980.00	
Lighting	206.90	SqFt	x	1.50	W/SqFt	x	3.415	1,059.85	
Equipments	206.90			2.00	Watts	x	3.415	1,413.13	
Power		kW/Hp	x					0.00	
Sub Total								11,587.74	
Factor							5-10%	1,158.77	
Effective Room Sensible Heat								12,746.51	1.00
ROOM LATENT HEAT									
Infiltration	7.24	CFM	x	10.00	Gr/Lb	x	0.68	49.24	
Outside Air	120.00	CFM	x	10.00	Gr/Lb	x	BFx0.68	122.40	
People	4.00	Nos.	x	205.00	Btu/Hour Per Person			820.00	
Sub Total								991.64	
Factor							2.5 - 5%	49.58	
Effective Room Latent Heat								1,041.22	2.00
EFFECTIVE ROOM TOTAL HEAT								13,787.73	
		OUTSIDE AIR HEAT							
Sensible	120.00	CFM	x	35.00	F(TD)	x	CF x 1.08	3,855.60	3.00
Latent	120.00	CFM	x	10.00	Gr/Lb	x	CF x 0.68	693.60	4.00
OUTSIDE AIR TOTAL HEAT								4,549.20	
GRAND SUB-TOTAL HEAT								18,336.93	
Factor							1 - 3%	366.74	
GRAND TOTAL HEAT								18,703.67	
TONS=GRAND TOTAL HEAT/12000								1.56	

FLOOR	GROUND					
SPACE REFERENCE	ROOM D					
AREA (SqFt) (WxH)	206.90					
False Ceiling Height (Ft)	9.00					
Volume (CuFt)	1,862.10					
Estimate for	Summer					
Design Conditions	DB (°F)	WB (°F)	RH (%)	SH (Gr/Lb)		
Ambient(Out Side)	110.00	75.00	20.00	75.00		
Room (InDoor)	75.00	63.00	50.00	65.00		
Difference Δ	35.00	12.00	30.00	10.00		
By Pass Factor (BF)					=	0.15
Contact Factor (CF = 1 - BF)					=	0.85
CFM Ventilation						
CFM Per Person	30.00	No	=	4.00	=	120.00
CFM Per SqFt	0.25	Sqft	x	206.90	=	51.73
Air Change Per Hour (CFM)			=	3.00		
CFM Cu.ft	1,862.10 x	3.00		x1/60	=	93.11
CFM Infiltration						
Swinging		x		cfm/door	=	0.00
Revolving Doors (People)		x		cfm/door	=	0.00
Open Doors		x	1.00	cfm/door	=	0.00
Crack (feet)		x		cfm/ft	=	0.00
						7.24
Supply CFM from Machine						
Effective Room Sensible Heat Factor =						
Effective Room Sensible Heat/Eff Room Total Heat					=	0.92
Apparatus Dew Point (ADP)						
Indicated ADP (°F)					=	
Selected ADP (°F)					=	54.00
Dehumidified Rise						
(Room DB - ADP) x CF					=	17.85
DEHUMIDIFIED AIR QUANTITY						
Effective Room Sensible Heat / Dehumidified Rise x 1.08			=	661.19		CFM
			=	313.34		L/s
TOTAL HEAT CAPACITY						
Grand Total Heat			=	1.56		TR
SENSIBLE HEAT CAPACITY						
Grand Sensible Heat / 12,000.00			=	1.06		TR
Notes:						

Second Floor:



PROJECT	G+2 Banking and Commercial Building								
LOCATION	DELHI								
CLIENT	Contractor								
CONSULTANT	Dhanush Engg Services Ltd								
126.00									
Item	Area or Quantity			Sun Gain or Temp. Diff.			Factor (U)	Btu/Hour	Watts
ROOM HEAT							Q= U*A*ΔT		
ROOM SENSIBLE HEAT									
Solar Gain - Glass	Area			ΔT			U		
Glass - N		SqFt	x			x		0.00	
Glass - NE		SqFt	x			x		0.00	
Glass - E	23.82	SqFt	x	12.00		x	0.85	184.24	
Glass - SE		SqFt	x			x		0.00	
Glass - S		SqFt	x			x		0.00	
Glass - SW		SqFt	x			x		0.00	
Glass - W		SqFt	x			x		0.00	
Glass - NW		SqFt	x			x		0.00	
Skylight		SqFt	x			x		0.00	
Solar & Transmission Gain - Walls & Roof									
Wall - N		SqFt	x		F	x		0.00	
Wall - NE		SqFt	x		F	x		0.00	
Wall - E	105.86	SqFt	x	29.00	F	x	0.43	1,320.07	
Wall - SE		SqFt	x		F	x		0.00	
Wall - S		SqFt	x		F	x		0.00	
Wall - SW		SqFt	x		F	x		0.00	
Wall - W		SqFt	x		F	x		0.00	
Wall - NW		SqFt	x		F	x		0.00	
Roof	206.90	SqFt	x	49.00	F	x	0.28	2,838.67	
Transmission Gain - Except Walls & Roof									
All Glass	23.82	SqFt	x	35.00	F	x	1.13	934.17	
Partition	129.48	SqFt	x	30.00	F	x	0.31	1,204.16	
Ceiling		SqFt	x		F	x		0.00	
Floor		SqFt	x	30.00	F	x	0.57	0.00	
INFILTRATION AND BY PASSED AIR									
Infiltration	7.24	CFM	x	35.00	T.Diff	x	1.08	273.73	
Outside Air	120.00	CFM	x	35.00		x	BFX1.08	680.40	
Internal Heat									
People	4.00	Nos.	x	245.00	Btu/Hour Per Person			980.00	
Lighting	206.90	SqFt	x	1.50	W/SqFt	x	3.415	1,059.85	
Equipments	206.90			2.00	Watts	x	3.415	1,413.13	
Power		kW/Hp	x					0.00	
Sub Total								10,888.41	
Factor							5-10%	1,088.84	
Effective Room Sensible Heat								11,977.26	1.00
ROOM LATENT HEAT									
Infiltration	7.24	CFM	x	10.00	Gr/Lb	x	0.68	49.24	
Outside Air	120.00	CFM	x	10.00	Gr/Lb	x	BFx0.68	122.40	
People	4.00	Nos.	x	205.00	Btu/Hour Per Person			820.00	
Sub Total								991.64	
Factor							2.5 - 5%	49.58	
Effective Room Latent Heat								1,041.22	2.00
EFFECTIVE ROOM TOTAL HEAT								13,018.48	
OUTSIDE AIR HEAT									
Sensible	120.00	CFM	x	35.00	F(TD)	x	CF x 1.08	3,855.60	3.00
Latent	120.00	CFM	x	10.00	Gr/Lb	x	CF x 0.68	693.60	4.00
OUTSIDE AIR TOTAL HEAT								4,549.20	
GRAND SUB-TOTAL HEAT								17,567.68	
Factor							1 - 3%	351.35	
GRAND TOTAL HEAT								17,919.03	
TONS=GRAND TOTAL HEAT/12000								1.49	

FLOOR	SECOND				
SPACE REFERENCE	ROOM D				
AREA (SqFt) (WxH)	206.90				
False Ceiling Height (Ft)	9.00				
Volume (CuFt)	1,862.10				
Estimate for	Summer				
Design Conditions	DB (°F)	WB (°F)	RH (%)	SH (Gr/Lb)	
Ambient(Out Side)	110.00	75.00	20.00	75.00	
Room (InDoor)	75.00	63.00	50.00	65.00	
Difference Δ	35.00	12.00	30.00	10.00	
By Pass Factor (BF)				=	0.15
Contact Factor (CF = 1 - BF)				=	0.85
CFM Ventilation					
CFM Per Person	30.00	No. =	4.00	=	120.00
CFM Per SqFt	0.28	Sqft x	206.90	=	81.73
Air Change Per Hour (CFM)		=	3.00		
CFM Cu.ft	1,862.10 x	3.00	x1/60	=	93.11
CFM Infiltration					
Swinging		x		cfm/door =	0.00
Revolving Doors (People)		x		cfm/door =	0.00
Open Doors		x	1.00	cfm/door =	0.00
Crack (feet)		x		cfm/ft =	0.00
					7.24
Supply CFM from Machine					
Effective Room Sensible Heat Factor = Effective Room Sensible Heat/Eff Room Total Heat				=	0.92
Apparatus Dew Point (ADP)					
Indicated ADP (°F)				=	
Selected ADP (°F)				=	54.00
Dehumidified Rise					
(Room DB - ADP) x CF				=	17.65
DEHUMIDIFIED AIR QUANTITY					
Effective Room Sensible Heat / Dehumidified Rise x 1.08		=	621.29	CFM	
		=	294.43	L/s	
TOTAL HEAT CAPACITY					
Grand Total Heat		=	1.49	TR	
SENSIBLE HEAT CAPACITY					
Grand Sensible Heat / 12,000.00		=	1.00	TR	
Notes.					

Summary Result:

FIRST FLOOR

S. no	Room Name	TR WRT Cal	CFM WrT Cal	Rounded CFM	TOTAL TR	TOTAL CFM	AHU SPECIFICATIONS	Number of Diffusers		Size in Inches
								Inlet	outlet	
1	ROOM D	1.49	621.29	620	20.12	8070	COMPANY - BLUE STAR AHU MODEL - DHW-150 DIMENSIONS (W X L X H)	1	1	15" X 15"
2	ROOM E	3.12	1323.45	1320				2	2	15" X 15"

3	WORK STATION	15.51	6129.62	6130			(1875 X 1865 X 1495)	6	6	24" X 24"

SECOND FLOOR

S. no	Room Name	TR WRT Cal	CFM WrT Cal	Rounded CFM	TOTAL TR	TOTAL CFM	AHU SPECIFICATIONS	Number of Diffusers		Size in Inches
								Inlet	outlet	
1	ROOM D	1.23	459.32	460	16.95	5500	COMPANY - BLUE STAR AHU MODEL - DHW-100 DIMENSIONS (W X L X H) (1670 X 1510 X 1200)	1	1	12" X 12"
2	ROOM E	1.12	372.85	370				1	1	12" X 12"
3	ROOM F	5.57	2093.71	2090				2	2	24" X 24"
4	WORK STATION	9.03	2582.98	2580				2	2	24" X 24"

GROUND FLOOR

S. no	Room Name	TR WRT Cal	CFM WrT Cal	Rounded CFM	TOTAL TR	TOTAL CFM	AHU SPECIFICATIONS	Number of Diffusers		Size in Inches
								Inle	outlet	

								t		
1	ROOM D	1.56	661.19	660	21.85	8760	COMPANY - BLUE STAR AHU MODEL - DHW-150 DIMENSIONS (W X L X H) (1875 X 1865 X 1495)	1	1	15" X 15"
2	ROOM E	1.45	592.49	590				1	1	15" X 15"
3	WORK STATION	18.84	7511.18	7510				6	6	24" X 24"

Conclusion:

GROUND FLOOR TOTAL TR = 21.85 GROUND FLOOR TOTAL CFM = 8760FIRST FLOOR TOTAL TR = 16.95 FIRST FLOOR TOTAL CFM = 5500 SECOND FLOOR TOTAL TR = 20.12 SECOND FLOOR TOTAL CFM = 8070

The load calculation done for comfort and for commercial space, the load calculationsare done based on the E20 forms.

A wide range of methods from simple spread sheets to HAP software are used for predicting cooling/freezing times and heat loads. Although sophisticated, theory-basedmethods are becoming more practical with the fast progress in computer hardware andsoftware, simplified methods can still be useful in many cases.

Today, the field if air conditioning design is more technologically challenging than ever before. While design innovations and product improvements promise sleeker, more versatile, more powerful and more energy – efficient air conditioners, the challenge today lies identifying the most appropriate product, or mix of products, for the application at hand.

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