



HEAT LOAD



FULL
Explanation

CALCULATION

PROCEDURE



EXPLAINED

PREPARED BY



What is HVAC Load Calculation.....?

- ❑ An HVAC Load Calculation is a mathematical process for measuring several aspects of a building in order to determine the best size, application and style of HVAC system.
- ❑ The purpose is to ensure energy efficiency while also maximizing comfort.
- ❑ Load calculations have been completed for several years, however, with new technology come quicker and more consistent methods to complete this important step.



Factors to considering during Cooling load requirement

❑ It is necessary for air conditioning designers to know about the heat source and their nature before designing of air conditioning system.

- ❖ Building detailed layout.
- ❖ Building orientation.
- ❖ Ambient condition.
- ❖ Use of Space.
- ❖ Physical dimension of space.
- ❖ Indoor design condition.
- ❖ Filtration level required.
- ❖ Glass area exposed to sun.
- ❖ Occupancy.
- ❖ Lighting load.
- ❖ Equipment load.
- ❖ Fresh air requirement.



HUMAN COMFORT

Application of HVAC System

- Residential
- Commercial
- Industrial
- Educational
- Pharmaceuticals
- Hospitals
- Malls/Offices
- And many more....



Air Conditioning Load Estimate

- ❑ The air conditioning load is to provide the basis of selecting the conditioning equipment.
- ❑ The load is designed for maximum conditions of heat such as :
 - Peak month.
 - Peak day and
 - Peak time of the year.
- ❑ The design load is divided into two types.

Outdoor Load

Indoor Load



HUMAN COMFORT

OUTDOOR LOADS :

- ❑ Heat flow through the exterior wall, ceilings, floors, windows and doors due to temperature difference between two sides.

LOAD DUE TO SOLAR RADIATION

- ❑ Heat from the Sun absorbed by the wall and roof and later transferred to room by conduction.
- ❑ Heat transmitted directly by radiation through glass of Window.
- ❑ Heat received from infiltration air from windows and doors due to frequent openings.



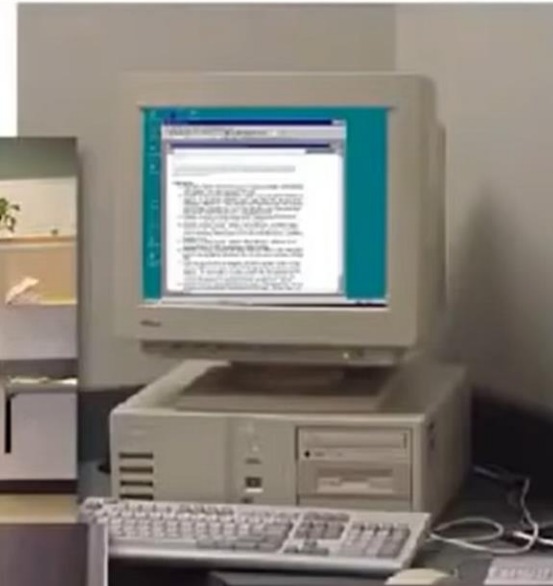
INDOOR LOADS :

- ☐ People
- ☐ Light
- ☐ Appliances
- ☐ Miscellaneous sources.

People



Appliances

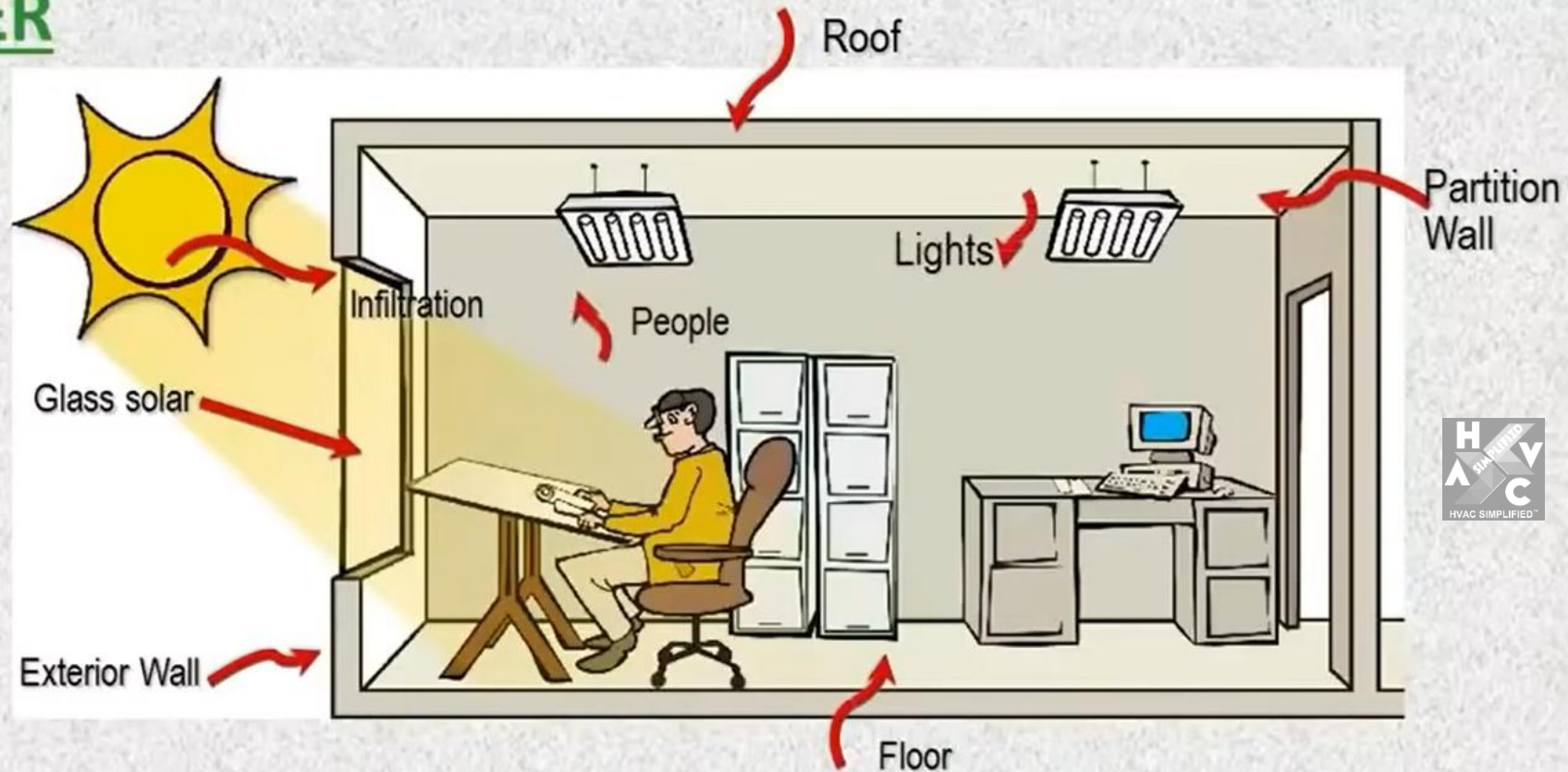


Equipment



Lights

HEAT TRANSFER



- Heat gain from outdoors through the roof, exterior walls, skylights, and windows. (This includes the effects of the sun shining on these exterior surfaces.)
- Solar radiation heat gain through skylights and windows.
- Conduction heat gain from adjoining spaces through the ceiling, interior partition walls, and floor.
- Internal heat gains due to people, lights, appliances, and equipment in the space.

EXAPMLE

E20 FORM

Table 1-T-100 : Cooling and Dehumidifying
Heat Load Estimate Form

Job Name				
Address				
Space Used for				
Size	x	= Sq.Ft.x	=	Cu.
Ft.				
Item	Area of quantity	Sun Gain or Temp. Diff.	Factor	Btu / Hour
SOLAR GAIN GLASS				
Glass	Sq. Ft. x	x		
Glass	Sq. Ft. x	x		
Glass	Sq. Ft. x	x		
Glass	Sq. Ft. x	x		
Sky Light	Sq. Ft. x	x		
SOLAR AND TRAINS GAIN - WALLS AND ROOF				
Wall	Sq. Ft. x	x		
Wall	Sq. Ft. x	x		
Wall	Sq. Ft. x	x		
Wall	Sq. Ft. x	x		
Wall	Sq. Ft. x	x		
Roof Sun	Sq. Ft. x	x		
Roof Shaded	Sq. Ft. x	x		
TRAIN GAIN EXCEPT WALLS AND ROOF				
All Glass	Sq. Ft. x	x		
Partition	Sq. Ft. x	x		
Ceiling	Sq. Ft. x	x		
Floor	Sq. Ft. x	x		
INFILTRATION AND OUTSIDE AIR				
Infiltration	Cfm x	X 1.08		
Outside Air	Cfm x °F	BF X 1.08		
INTERNAL HEAT				
People	People			
Power	H.P. / KW			
Lights	x 1.08			
Appliances Etc.	x			
ROOM SENSIBLE HEAT				
Supply	Supply			
Duct	Duct			
Heat Gain%	Leak Loss %			
EFFECTIVE ROOM SENSIBLE HEAT				
ROOM LATENT HEAT				
Infiltration	cfm x	gr/lb x 0.68		
Outside Air	cfm x	gr/lb x BF x 0.68		
People	People x			
Steam	Lb / hr x 1080			
Appliances, Etc.				
Vapor Train				
Room Latent Heat Sub Total				
Supply Duct Leakage Loss	% * SAFETY FACTOR %			
EFFECTIVE ROOM LATENT HEAT				
EFFECTIVE ROOM TOTAL HEAT				
Sensible : Cfm x °F x (1-BF) x 1.08				
Latent : cfm x gr / lb x (1-BF) x 0.68				
Grand Total Heat Sub Total				

Heat Gain%	Leak Loss			
TONS = GRAND TOTAL HEAT*				
Estimated for	Local Time	Peak Load	Local Time	
CONDITIONS	DB	WB	%RH	DP
Outside				
Room				
Difference		x x x	x x x	xx
Selected Room Conditions DB WB %RH				
People x $\frac{\text{VENTILATION}}{\text{INFILTRATION}}$ cfm Person				
Sq. Ft. x cfm / Sq. ft. = cfm Ventilation				
SWINGING				
REVOLVING DOORS - PEOPLE X CFM / PERSON =				
Open Doors x CFM / DOOR =				
Exhaust Fan				
Crack Feet x cfm / Ft =				
SENSIBLE HEAT FACTOR AND APPARATUS DEWPOINT				
$\frac{\text{Eff. room sens. heat}}{\text{Eff. room total heat}} =$ Sens Heat Factor (ESHF)				
Indicated adp °F Selected adp. °F				
(1 - BF) (Room Temp. ADP = Dehumidified rise				
$\frac{\text{Room Sensible Heat}}{1.08 \times \text{Dehumidified rise}} =$ Dehumidified cfm				



HEAT LOAD ESTIMATE FORM

Q = HEAT FLOW (BTU/HR)

$$Q = U \times A \times \Delta T$$



U – Overall heat transfer coefficient of the material. $[U = 1/\Sigma R]$

A – Area of the surface in Square Feet.

ΔT – Temperature Outside – Temperature Inside.

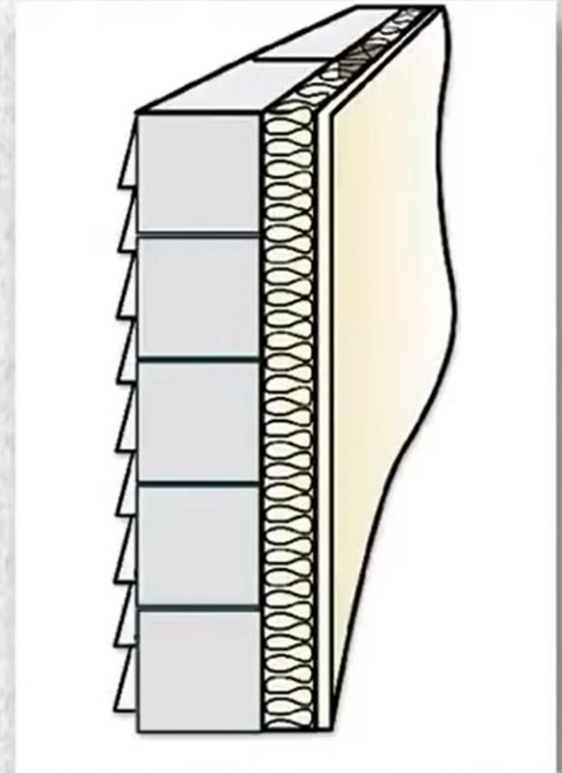
WALL / ROOF HEAT LOAD

$$Q = U \times A \times \Delta T$$

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GLASS HEAT LOAD

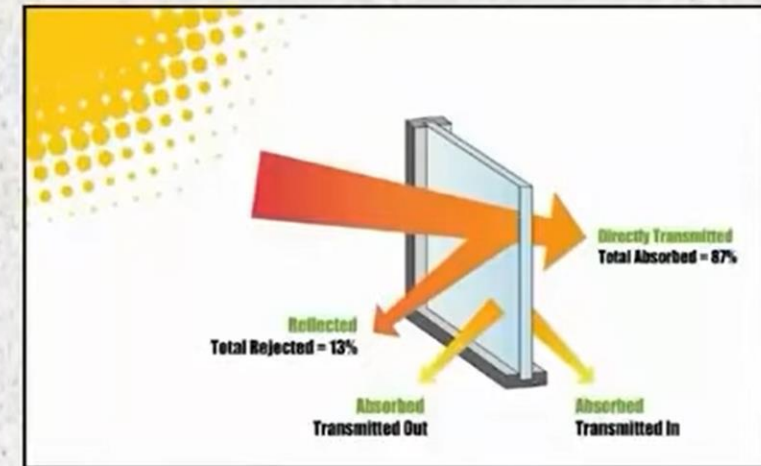
$$Q = A \times SC \times SCL$$

Q = heat gain by solar radiation through glass, Btu/hr [W]

A = total surface area of the glass, ft² [m²]

SC = shading coefficient of the window, dimensionless

SCL = solar cooling load factor, Btu/hr•ft² [W/m²]



HEAT LOAD CALCULATION

- A. SOLAR HEAT GAIN FOR (W) WALL, (F) FLOOR & (R) ROOF.
- B. SOLAR HEAT GAIN FOR (G) GLASS (WINDOWS).
- C. EFFECTIVE ROOM (E.R.S.H.L) SENSIBLE HEAT LOAD.
- D. EFFECTIVE ROOM (E.R.L.H.L) LATENT HEAT LOAD.
- E. EFFECTIVE ROOM (E.R.T.H.L) TOTAL HEAT LOAD.
- F. EFFECTIVE ROOM (E.R.S.H.F) SENSIBLE HEAT FACTOR.
- G. DEHUMIDIFIED (CFM) AIR FLOW.

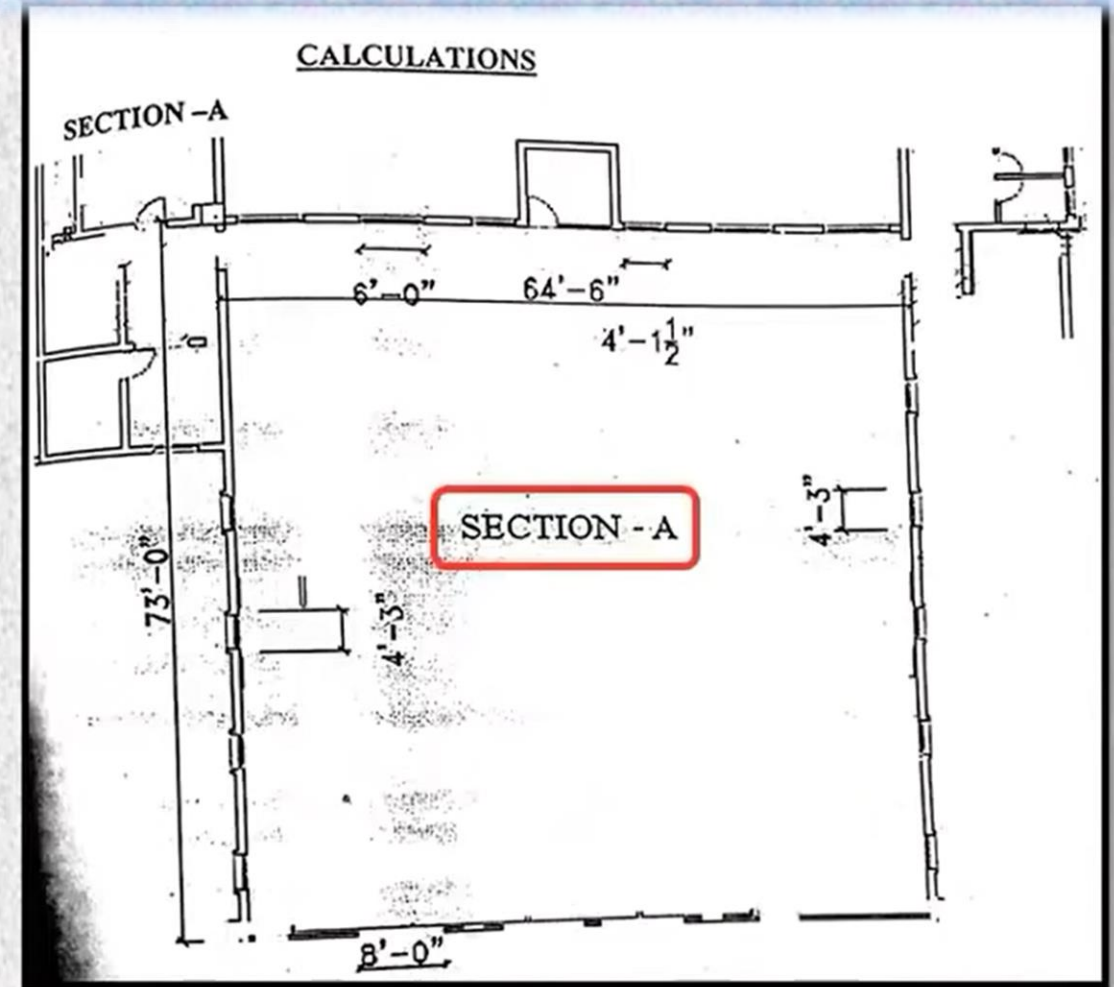


HEAT LOAD CALCULATION

A. SOLAR HEAT GAIN FOR WALL AND FLOOR

$$Q = U \times A \times \Delta T$$

Condition Of Wall	Area in Sq.Ft	Temperature Difference in F	U Factor	BTU/Hr
West Partition	730	29	0.36	7621.20
North Exposed	451.5	31	0.3	4198.95
South Partition	645	29	0.36	6733.80
Floor	4708.5	29	0.19	25943.84
Total				44497.79



SECTION - A

Number of Person = 110
Total Floor Area = 4708.5 Sq.Ft

HEAT LOAD CALCULATION

A. SOLAR HEAT GAIN FOR WALL AND FLOOR

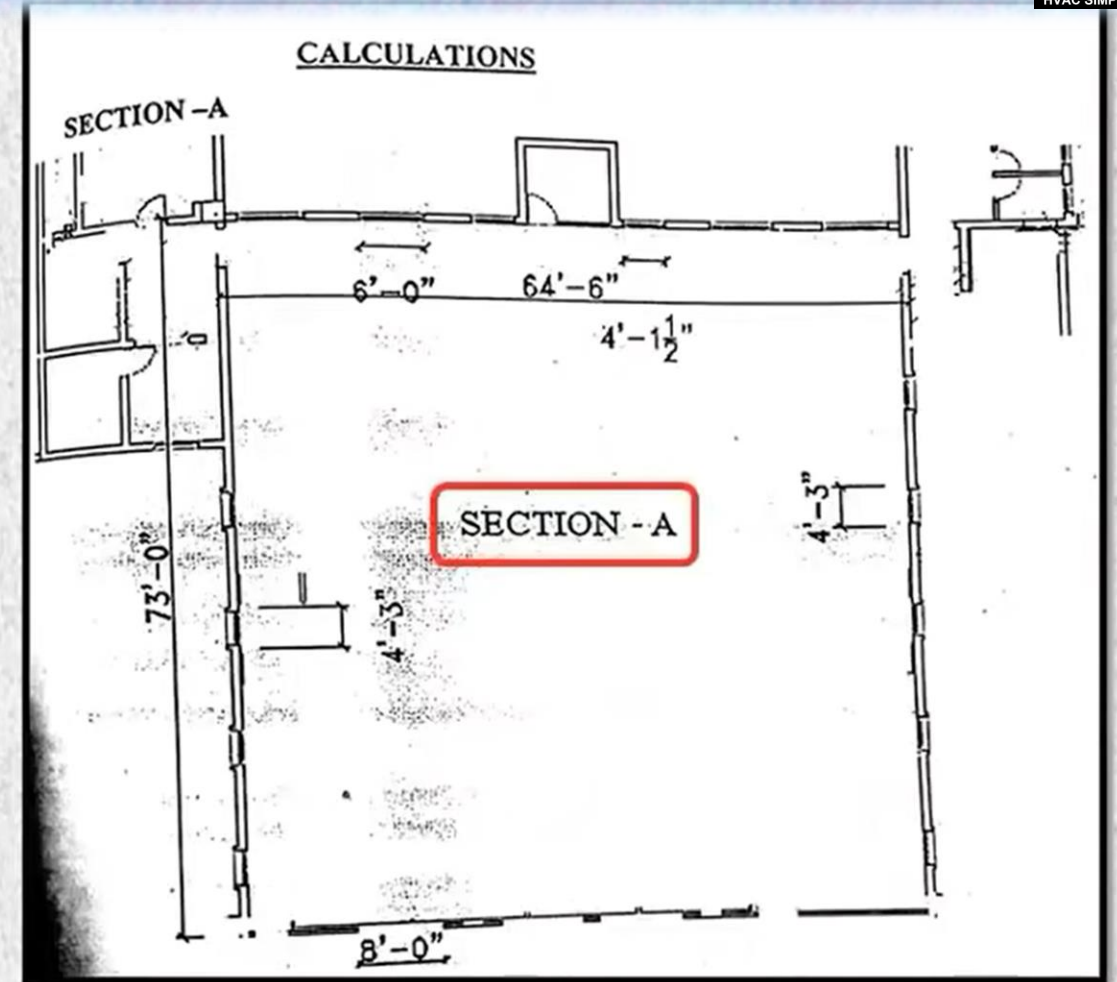
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South Partition	645	29	0.36	6733.80
Floor	4708.5	29	0.19	25943.84
			Total	44497.79

B. SOLAR HEAT GAIN FOR GLASS

$$Q = A \times SC \times SCL$$

Condition Of Wall	Area in Sq.Ft	SC	SCL	BTU/Hr
North Exposed	193.5	0.8	16.08	2489.28
			Total	2489.28



SECTION - A

Number of Person = 110

Total Floor Area = 4708.5 Sq.Ft

HEAT LOAD CALCULATION

C. EFFECTIVE ROOM SENSIBLE HEAT LOAD (E.R.S.H.L)

$$1. \text{ Outside Air} = \frac{\text{Volume of the room (ft}^3\text{) x No. of air changes}}{60} = \frac{4708.5 \times 10 \times 2}{60} = \mathbf{1569.5 \text{ CFM}}$$

$$2. Q_s (\text{Sensible Heat}) = \text{CFM} \times (\Delta t) \times (bf) \times 1.08 \\ = 1569.5 \times 34 \times 0.15 \times 1.08 \\ = \mathbf{8,644.8 \text{ btu/hr.}}$$

$$3. \text{ Internal Heat} = \text{No. of People} \times \text{Sensible Heat Gain.} \\ = 110 \times 245 \\ = \mathbf{17,150 \text{ btu/hr}}$$

$$4. \text{ Light Load} = \text{Total area (sq.ft)} \times \text{lighting load (watts)} \times 3.4 \\ = 4708.5 \times 2 \times 3.4 \\ = \mathbf{32,017.8 \text{ btu/hr}}$$

$$5. \text{ Equipment Load} = \text{No. of Equipment} \times \text{Load} \times \text{equipment load (watts)} \times 3.4 \\ = 90 \times 300 \times 3.4 \\ = \mathbf{91,800 \text{ btu/hr}}$$

$$6. \text{ Total Sensible Heat Load} = 44,497.78 + 2,492,28 + 8,644.8 + 17,150 + 32,017.8 + 91,800 = \mathbf{206,402.66 \text{ btu/hr}}$$

Safety Factor 8%

(A + B + C)

$$7. \text{ Effective Room Sensible Heat Load} = \mathbf{222,914.87 \text{ btu/hr}}$$

(Δt) = Outside Temperature – Inside Temperature

$$1.08 = (0.224 \times 60) / 13.5$$

Where :

13.5 = Specific Volume of moist air at 70F DBT,

0.224 = Specific heat of moist air at 70F and 50%RH

and

0.15 = bf

245 = Sensible Heat Contribution in Room (ASHRAE)



HEAT LOAD CALCULATION

D. EFFECTIVE ROOM LATENT HEAT LOAD (E.R.L.H.L)

$$\begin{aligned}
 1. Q_L (\text{Latent Heat}) &= \text{Outside air CFM} \times (\Delta w) \times (bf) \times 0.68 \\
 &= 1569.5 \times 36 \times 0.15 \times 0.68 \\
 &= \mathbf{5,763.204 \text{ btu/hr.}}
 \end{aligned}$$

(Δw) = Outside Humidity Ration – Indoor Humidity Ration
 0.15 = bf
 205 = Latent Heat Contribution in Room (ASHRAE)

$$\begin{aligned}
 2. \text{ Latent Heat Internal Load} &= \text{No. of People} \times \text{Latent Heat Gain.} \\
 &= 110 \times 205 \\
 &= \mathbf{22,550 \text{ btu/hr}}
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ Total Latent Heat Load} &= 5,763.204 + 22,550 = \mathbf{28,313.204 \text{ btu/hr}} \\
 (1 + 2) &\quad \text{Safety Factor 8\%}
 \end{aligned}$$

$$4. \text{ Effective Room Latent Heat Load} = \mathbf{30,578 \text{ btu/hr}}$$

HEAT LOAD CALCULATION

E. EFFECTIVE ROOM TOTAL HEAT LOAD (E.R.T.H.L)

$$\begin{aligned}
 \text{E.R.T.H.L} &= \text{E.R.S.H.L} + \text{E.R.L.H.L} \\
 &= 222,914.87 + 30,578 \\
 &= 253,492.87 \text{ btu/hr}
 \end{aligned}$$

$$\begin{aligned}
 \text{TR} &= \text{E.R.T.H.L} / 12,000 \\
 &= 253,492.87 / 12000 \\
 &= 21.12 \text{ TR (22 TR approx.)}
 \end{aligned}$$

$$\begin{array}{lcl}
 \text{F. } \underline{\text{EFFECTIVE ROOM SENSIBLE HEAT FACTOR}} & \frac{\text{E.R.S.H.L}}{\text{E.R.T.H.L}} & \frac{222,914.87}{253,492.87} = 0.88
 \end{array}$$

$$\begin{array}{lcl}
 \text{G. } \underline{\text{DEHUMIDIFIED (C.F.M)}} & \frac{\text{E.R.S.H.L}}{1.08 \times (\text{RT} - \text{ADP})} & \frac{222,914.87}{1.08 \times (72 - 54)} = 11466.81 \text{ CFM}
 \end{array}$$



HEAT LOAD CALCULATION

E. EFFECTIVE ROOM TOTAL HEAT LOAD (E.R.T.H.L)

$$\begin{aligned}
 \text{E.R.T.H.L} &= \text{E.R.S.H.L} + \text{E.R.L.H.L} \\
 &= 222,914.87 + 30,578 \\
 &= 253,492.87 \text{ btu/hr} \\
 \\
 \text{TR} &= \text{E.R.T.H.L} / 12,000 \\
 &= 253,492.87 / 12000 \\
 &= 21.12 \text{ TR (22 TR approx.)}
 \end{aligned}$$

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 \text{F. } \frac{\text{EFFECTIVE ROOM SENSIBLE HEAT FACTOR}}{} &= \frac{\text{E.R.S.H.L}}{\text{E.R.T.H.L}} = \frac{222,914.87}{253,492.87} = 0.88
 \end{aligned}$$

$$\begin{aligned}
 \text{G. } \frac{\text{DEHUMIDIFIED (C.F.M)}}{} &= \frac{\text{E.R.S.H.L}}{1.08 \times (\text{RT} - \text{ADP})} = \frac{222,914.87}{1.08 \times (72 - 54)} = 11466.81 \text{ CFM}
 \end{aligned}$$

Capacity : 22 TR
Air Flow : 11467 CFM

*Thank
you*