HEAT LOAD CALCULATION OF AC 2 Tier SLEEPR COACH

AC airconditioned coach has to work under widely varying conditions of ambient temperature, latitude, passenger load etc. In deciding the capacity of the plant, certain assumptions regarding number of adverse conditions of the working are to be made and based on these assumptions the plant capacity required is worked out.

RDSO specification No. TRC-1-72 stipulates certain standard comfort conditions, volume of fresh air required per passenger per minute, coefficient of heat transfer for various parts of the coach etc.

Data and constants used and the assumptions made are,

ABBREVIATIONS :

T.D	=	Amb. Temp. diff.
T.D.S	=	Solar Temp. diff.
K	=	Coefficient of heat 'transfer-K cal/Hr/m2/°C
U	=	Coefficient of heat transfer for window due to solar heat gain.
G.D.	=	Grains difference.

COEFFICIENT OF HEAT TRANSFER (k) in k-Cal/Hr/m2/°C For,

Wall and end partitions	=	0.615
Roof	=	0.65
Floor	=	0.72
Window (Conduction) .	=	1.94

T.D. for end portions is always considered to be 3°C less than T.D. for other parts of the coach, since non-airconditioned space adjacent to the airconditioned compartments is considered to have a temperature of 3°C less than the ambient temperature.

Solar Temp.Difference (TDS)	Side wall	=	9° C
	Roof	=	10.55°C
	Window	=	95.55°C
Requirement of fresh air for non-smoking compartments	= 0.35m^3 /passenger/ minute.		
Quantity of ventilating air for 46 passengers (Q)	0.35x46	=	16.1 m^3 / minute
	16.1x35.3	=	568.33 Ft^3 / minute(CFM)

The following are the wattages considered for various-electrical appliances.
2 Flourescent tube light - 24 W.

Eventhough the wattage of the tube is 20 W, the choke also consumes energy. Hence, 1.2 times the wattage i.e. 1+2 x 20 = 24W has been considered for the purpose of heat load calculations.

Incandescent lamps	=	15W
Carriage Fan	=	29W

DATA COLLECTED FROM A.C. MANUAL

Heat transfer from equipments and fans	=	2545 BTU/HP/Hr
Heat transfer from fluorescent lights and incandescent lamps	=	3.4 BTU/Watt/Hr.
Sensible heat per passenger	=	205 BTU/Hr. (51.6 K.Cal/Hr)
Latent heat per passenger	=	195 BTU/Hr (49.12K.Cal/Hr)
1 Ton of refrigeration	=	12000 BTU/Hr. (3024 K.Cal/Hr)
1 k-calorie	=	3.97 BTU/Hr.

DIMENSIONS OF A.C. PORTION OF COACH -

Length of AC portion (A)	=	15.2 M
Width of roof (B)	=	3.245 M
Width of floor (C)	=	3.04 M
Height of A.C. portion (D)	=	2.03 M
Area of side wall (A x D)	=	30.856 M^2
Area of roof (A x B)	=	49.324 M^2
Area of floor (A x C)	=	46.208 M^2

Area of end partitions — 6.17 M^2
Height of window — 0.56 M
Width of window = 0.61 M
Area of window 0.56 X 0.61 = 0.3416 M^2
No. of windows per side wall = 16
Total area of windows per side wall = 0.56x0.61x16=5.466M^2
Area of side wall excluding windows = 30.856 - 5.466 = 25.2 39M^2.

CONNECTED ELECTRICAL LOADS INSIDE A.C. COMPARTMENT

Fluorescent lights 2' long = 30 Nos.
Incandescent lamps = 16 Nos.
Fans = 8 Nos.
Blower Fan motors (0.65 HP) = 2 Nos.

1. Heat gain due to conduction = AxKxTDX3.97 BTU/Hr.

Side wall	: 50.78 x 0.615 x 20 x 3.97	=	2479.64 BTU/Hr. (624.59 K.Cal/Hr.)
Roof	: 49.324 x 0.65 x 20x3.97	=	2545.61 BTU/Hr. (641.21 K.Cal/Hr.)
Floor	: 46.208 x 0.72 x 20x3.97	=	2641.62 BTU/Hr. (665.4 K.Cal/Hr.)
End partition	: 2 x 6.17 x O.615 x (20 – 3) 1 7x 3.97	=	512.288 BTU/Hr.
Window	: 5.466 x 2 x 1.94x20 x 3.97	=	1683.8 BTU/Hr.
Total	: 2479.64 + 2545.61 + 2641.62 + 512.288 + 1683.8	=	9862.954 BTU/Hr. ...(I)

2. Solar Heat Gain : A x K x TDS x 3.97

Side wall	: 25.39 x 0.615 x 9 x 3.97	=	557.92 BTU/Hr. (140.53 K.Cal/Hr.)
Roof	: 49.324 x 065 x 10.55 x 3.97	=	1342.81 BTU/Hr (338.24 K.Cal/Hr)
Window	: 5.466 x 5.34 x 95.55 x 3.97	=	11071.34 BTU/Hr. (2788.75 K.Cal/Hr)
Total	: 557.92 + 1342.81 + 11071.34	=	12972.069 BTU/HR ...(II)

3 Heat gain due to passengers (BTU/Hr.)

S.H. = 205 x No. of passengers.

L.H. = 195 x No. of passengers.

S.H + L.H = 400 X No. of passengers.
= 400 x 46 = 18400 BTU/Hr. ...(III
= (4634.76 K.Cal/Hr)

4. Heat gain due to ventilation (BTU/Hr.) =

S.H. = 1.08 x Q x TD x 9/5
= 1.08 x 568.33 x 20 x 9/5
= 22096.67 BTU/Hr.
= (5565.91 K.Cal./Hr)

L.H. = 0.68 x Q x Gd
= 0.68 x 568.33 x 26
= 10048.07
= (2531 K.Cal./Hr)

Total = 22096.67 + 10048.07
= 32144.7 BTU/Hr ... (IV
= (8096.91 K.Cal./Hr)

5. Heat gain due to elect, appliances

= Wattagex3.4 BTU/Hr. or,
H.P. x 3600 BTU/Hr.

Flouroscent Light 20W = (20 x 1.2) W.
= 1.2 x 20 x 3.40 x 30
= 2448 BTU/Hr.
= (616.62 K.Cal./Hr)

Incandescent lamps = 15 x 16 x 3.40
= 816 BTU/Hr.
= (205.54 K.Cal/Hr)

Fan = 29W x 8 x 3.4
= 788.8 BTU/Hr.
= (198.69 K.Cal./Hr)

Blower fan = 0.65HP x 2 x 2545
= 3308.5 BTU/Hr
= 833.37 K.Cal./Hr

Total = 2448 + 816 + 788.8 + 3308.5

= 7361.3 BTU/Hr.
= 1854.22 K.Cal / Hr ...(V)

Total of I + II + III + IV + V = 80741 023 BTU/Hr (20337.78 K.Cal/Hr)

Heat gain due to infiltration @ 10% = 8074.1 BTU/Hr.
= (2033.78 K.Cal./Hr)

Gross Total Heat gain = 81003 07 - 8100.3
= 88815 BTU/Hr.
= 22371.56 K.Cal./Hr

$$\text{Refrigeration capacity (TR)} = \frac{88815}{12000} = 7.4 \text{ TR}$$

$$= \frac{22371.56}{3024} = 7.4 \text{ TR}$$