mounted together in a single unit and supported on a track on the car under-frame on pneumatic supports. Propane fuel sufficient for several days' operation is carried in three drums mounted in a rack under the car. Freon is used as the refrigerant. The unit may be used with a direct expansion air conditioning unit or it can be used with a heat exchanger with cold water cooling coils.

The capacity required in the refrigerating system depends upon a number of factors such as size and type of construction of car, thickness and kind of insulation used, amount of heat produced within the car by motors, lights, and other appliances, amount of outside air, outside air temperature and humidity, intensity of solar radiation, number of passengers, and inside temperature desired. A check of a number of cars with ice-activated systems indicates an average ice consumption, day and night, of approximately 275 lb per hour. This means an average capacity of 3.3 tons of refrigeration. It has also been observed on test that in the sunshine with an outside dry-bulb temperature of 85 to 90 F and a wet-bulb temperature of 73 to 75 F, a six-ton compressor unit operates approximately 50 per cent of the time. As the average temperature during the cooling season is below 90 F the observed performance of the six-ton compressor unit compares with the 3.3 tons average capacity determined for the ice systems. It was also observed on test that with temperatures above 90 F, high humidity, and in the sunshine, a six ton unit operates almost continuously. The sun load on a bright sunshiny day is about one ton. For average cars on sunshiny days, with high temperatures and humidity, from 65,000 to 80,000 Btu per hour will have to be removed from the interior of the car to maintain an inside effective temperature within the comfort zone. This means that a refrigerating capacity of from 5.5 to 7 tons will be required.

CALCULATION OF CAR COOLING LOAD

Due to the many variables involved the calculated heat gain will be more or less of an approximation, but if a careful study is made, results sufficiently accurate for all practical purposes may be obtained. The following example illustrates a typical cooling load calculation.

Example and Solution.

Type of car	= Arched-roof steel coach.	
Roof area	= 70.3 × 12.5	= 880 sq ft.
Floor area	= 70.3 × 9.8	= 687 sq ft.
Window area	= 38 × 2.5 × 2	= 190 sq ft.
Net side wall area	= (2 × 7.5 × 70.3) − (190)	= 865 sq ft.
End area	= 2 × 7.5 × 9.8	= 147 sq ft.

Average roof section: 1/16 in. steel sheet, 1 layer tar paper, 2 in. air space, ½ in. hairfelt, ⅛ in. rigid fiber board insulation.

Average window section: two layers of ⅛ in. glass with 1½ in. air space between.

Average floor section: 1 in. composition, 1/16 in. steel, ½ in. air space, 1 in. hairfelt, 1/16 in. steel.

Average side and end section: 3/16 in. steel, ½ in. hairfelt, 3 in. air space, ¾ in. wood.

End area is taken as total area at body and bulkheads with no allowance made for glass as car is vestibuled and glass in body ends is not subjected to direct solar radiation.

Outside dry-bulb temperature	t_o	= 95 F.
Outside wet-bulb temperature	t'_o	= 75 F.

Outside effective temperature	ET_o	= 83 F.
Outside relative humidity	rh_o	= 40 per cent.
Inside dry-bulb temperature	t	= 80 F.
Inside wet-bulb temperature	t'	= 66.5 F.
Inside effective temperature	ET	= 73.5 F.
Inside relative humidity	rh	= 50 per cent.
Density of air at t	d	= 0.07353.
Moisture per pound of dry air at t_o and t'_o	G_o	= 99 grains.
Moisture per pound of dry air at t and t'	G	= 77 grains.
Moisture per pound of dry air to be removed	M	$= \frac{G_o - G}{7000} = \frac{99 - 77}{7000} = 0.00314$ lb
Evaporator condensate temperature		= 53 F.
Latent heat of water at 53 F	L	= 1060 Btu per pound.
Specific heat of air	C_p	= 0.241.
Number of seated passengers	P_s	= 68.
Number of attendents	P_a	= 1
Heat given off by each passenger		= 400 Btu per hour.
Heat given off by attendent		= 650 Btu per hour.
Outside air introduced	Q	= 500 cfm.

Roof temperature in sun = 40 F above ambient.
Wall temperature in sun = 25 F above ambient.
Sun 15 deg from Zenith.

Solar heat = 4.75 Btu per minute per square foot. 30 per cent of heat passing through glass is reflected and reradiated, 70 per cent remaining. 80 per cent of heat at surface passes through glass. Then 4.75 × Sine 15 deg × 0.8 × 0.7 = 0.7 Btu per square foot per minute passes through glass. Evaporator motor = ½ hp. Evaporator motor efficiency = 65 per cent. The total heat gain will include the gains from leakage through roof, floor, side walls, end walls, windows, sensible and latent heats from outside air, heat from occupants, heat from evaporator fan motors and solar radiation.

Calculation of Transmission Coefficients. (See Chapter 5.)

Roof coefficient = U_r = Btu per hour per square foot per degree Fahrenheit.

Outside air film	$f_o = 6.00$	$1/f$	= 0.1660
1/16 in. steel	$k = 308$	$\frac{x}{k} = \frac{0.0625}{308}$	= 0.0002
2 in. air space	$a = 1.10$	$1/a$	= 0.9090
½ in. hairfelt	$k = 0.25$	$\frac{x}{k} = \frac{0.5}{0.25}$	= 2.0000
⅛ in. rigid fiber board insulation	$k = 0.33$	$\frac{x}{k} = \frac{0.125}{0.33}$	= 0.3800
Inside air film	$f_i = 1.65$	$1/f$	= 0.6080
Total			= 4.0632

$$U_r = \frac{1}{4.0632} = 0.246 \text{ Btu per hour per square foot per Fahrenheit.}$$

Side and end wall coefficient = U_s = Btu per hour per square foot per degree Fahrenheit.

Outside air film			= 0.1660
3/16 in. steel	$k = 308$	$\frac{x}{k} = \frac{0.1875}{308}$	= 0.0006
½ in. hairfelt	$k = 0.25$	$\frac{x}{k} = \frac{0.5}{0.25}$	= 2.0000
3 in. air space	$a = 1.10$	$1/a$	= 0.9090