

HEATING VENTILATING AIR CONDITIONING GUIDE 1940

sion systems are, also, equipped with A. C. motors for operation from auxiliary circuits. As these equipments can only be operated when connected to the auxiliary circuit or while the train is running above the cut in speed of the drive, many cars are equipped with an auxiliary hold-over system by which reserve cooling is available. Due to the characteristics of the direct drive, the air conditioning system operates at reduced capacity when the car is moving at speeds below 42 mph.

TABLE 2. LOCOMOTIVE POWER DEMANDS FOR DIFFERENT AIR CONDITIONING SYSTEMS

SYSTEM	DRAWBAR HORSEPOWER PER CAR REQUIRED AT TRAIN SPEEDS			
	30 MPH	50 MPH	70 MPH	90 MPH

For Continuous Operation

Electro Mechanical.....	20.9	22.2	25.4	31.6
Direct Mechanical.....	16.8	19.5	29.5	42.6
Internal Combustion Engine Mechanical.....	3.4	4.6	7.0	11.9
Steam Ejector ^a	7.6	9.3	12.5	19.0
Ice-Activated.....	3.2	4.5	6.8	11.6

For Non-Operation

Electro Mechanical.....	5.0	6.4	9.0	14.4
Direct Mechanical.....	5.2	6.3	8.7	13.5
Internal Combustion Engine Mechanical.....	2.2	3.5	5.8	10.6
Steam Ejector.....	3.7	5.4	8.4	14.8
Ice-Activated.....	1.9	3.2	5.5	10.2

For Average Condition of 56 Per Cent Continuous Operation and 44 Per Cent Non-Operation

Electro Mechanical.....	13.9	15.2	18.2	24.0
Direct Mechanical.....	11.7	13.7	20.3	29.6
Internal Combustion Engine Mechanical.....	2.8	4.1	6.5	11.4
Steam Ejector ^a	5.9	7.6	10.7	17.5
Ice-Activated.....	2.6	3.9	6.2	11.0

^aIn addition, steam is required from the locomotive to the extent of 230 lb per hour during the time the equipment is in operation.

COST OF RAILWAY AIR CONDITIONING

The cost of railway air conditioning is usually expressed in terms of 1000 car-miles. The actual costs for the different systems, however, are dependent upon a number of variables. Based upon a survey of the most prominent railroads in air conditioning, and upon extensive tests, the values given in Table 3 are indicative of the present costs of air conditioning to the railroads.

Gross Installation Cost

The gross installation cost, from which the fixed charges are derived, may be amortized on this basis:

CHAPTER 33. RAILWAY AIR CONDITIONING

TABLE 3. AIR CONDITIONING COSTS FOR RAILWAY AIR CONDITIONING

SYSTEM	GROSS INSTALLATION COST	COSTS PER 1000 CAR-MILES ^a			
		Fixed Charges	Maintenance Cost	Operation Cost	Total
Electro Mechanical.....	\$6,484.00	\$ 8.65	\$3.33	\$0.99	\$12.97
Direct Mechanical.....	8,515.00	11.35	2.33	0.93	14.61
Internal Combustion Engine Mechanical.....	5,750.00	7.67	3.30	1.99	12.96
Steam Ejector.....	8,475.00	11.30	2.15	1.02	14.47
Ice-Activated.....	3,982.00	5.31	0.97	5.29	11.57

^aFor an average cooling season of 5 months, an average train speed of 50 mph and an average car mileage of 150,000 miles per year.

1. Depreciation, at the rate of 12.5 per cent.
2. Interest, at the rate of 6 per cent.
3. Taxes and insurance, at the rate of 1.5 per cent.

The fixed charges per 1000 car-miles for any type of system are:

$$FC = \frac{1000}{m} (0.20A) \quad (1)$$

where

FC = fixed charges, dollars per 1000 car-miles.

A = gross installation cost, dollars.

m = total number of car-miles traveled in one year.

Maintenance Cost

The average maintenance cost is based upon the experience of the railroads in maintaining several hundred air conditioning units. The maintenance cost per 1000 car-miles is:

$$MC = \frac{1000B}{m} \quad (2)$$

where

MC = maintenance cost, dollars per 1000 car-miles.

B = total annual maintenance cost, dollars.

m = total number of car-miles traveled in one year.

Operation Cost

The cost of operation is influenced by:

1. Speed of train operation.
2. Average drawbar horsepower required to operate air conditioning system.
3. Length of the cooling season.
4. Cost of power produced by the locomotive at \$0.00493 per horsepower-hour.
5. Proportion of time the cooling equipment is operated during the cooling season considered as 56 per cent.
6. Cost of additional necessities as: a. Ice in bunker, at \$4.42 per ton, b. Propane on the car, at \$0.039 per pound, c. Steam at \$0.021 per 100 pound.

The operation cost in dollars per 1000 car-miles is:

$$OC = \frac{1000K}{12S} (D \times E + 0.56 F \times G) + \frac{1000(12 - K)}{12S} (H \times E) \quad (3)$$