

heat emission varies as the height of the coil. The heat emission of each pipe in *ceiling* coils, placed horizontally, is about 126 Btu, 156 Btu, and 175 Btu per linear foot of pipe, respectively, for 1-in., 1½-in., and 1¾-in. coils.

When vertical pipes leading through small rooms are left uninsulated for the purpose of supplying heat, the overall coefficient of heat transfer may be safely estimated at 2.5 Btu per (hr) (sq ft) (F deg temperature difference between the heating medium and the average air).

### RATINGS

A standard method of testing radiators was adopted by the A.S.H.A.E. in 1927.<sup>3</sup> This Code provides for a standard test room, the temperature of which is to be maintained at 70 F, measured in the center of the room at an elevation of 5 ft above the floor. The steam temperature in the radiator is to be 215 F, which corresponds to 15.6 lb per sq in. absolute. The weight of condensate per hour, under these standard conditions, multiplied by the difference in the enthalpy of the steam entering the radiator and that of the condensate leaving the radiator, gives the radiator output

TABLE 5. HEAT EMISSION OF PIPE COILS PLACED VERTICALLY ON A WALL (PIPES HORIZONTAL) CONTAINING STEAM AT 215 F AND SURROUNDED WITH AIR AT 70 F

| Btu per linear foot of coil per hour (not linear feet of pipe) |       |        |        |
|----------------------------------------------------------------|-------|--------|--------|
| SIZE OF PIPE                                                   | 1 IN. | 1½ IN. | 1¾ IN. |
| Single row.....                                                | 132   | 162    | 185    |
| Two.....                                                       | 252   | 312    | 348    |
| Four.....                                                      | 440   | 545    | 616    |
| Six.....                                                       | 567   | 702    | 793    |
| Eight.....                                                     | 651   | 796    | 907    |
| Ten.....                                                       | 732   | 907    | 1020   |
| Twelve.....                                                    | 812   | 1005   | 1135   |

in Btu per hour. This output divided by 240 gives the steam rating of the radiator in equivalent square feet, EDR.

The method of testing and rating both ferrous and non-ferrous convectors, which is now generally accepted, is given in Commercial Standard CS140-47, Testing and Rating Convectors,<sup>4</sup> which has been developed co-operatively by the Convector Manufacturers Association, the Institute of Boiler and Radiator Manufacturers, other members of the trade, and the National Bureau of Standards.

The rating of a top outlet convector is established at a value not in excess of the *condensation capacity* (which is the heat extracted from the steam or water in the convector, under standard test conditions). The rating of a front-outlet or inclined-outlet convector includes the *condensation capacity* plus an allowance for heating effect<sup>5, 6</sup> in the occupied zone, based on convector enclosure height from bottom of the enclosure to top of the outlet. The heating-effect allowance for a front-outlet convector varies from 0 percent for a 36-in. outlet height to 15 percent for an outlet height of 18 in. or less.

For an inclined-outlet convector the heating effect allowance is obtained by multiplying the allowance for a front-outlet convector by a factor (angle of outlet to horizontal ÷ 90).

A Testing and Rating Code for Baseboard Type of Radiation was first adopted by the Institute of Boiler and Radiator Manufacturers in 1950. A

revised second edition<sup>7</sup> of the code was published in 1952. The second edition contains test procedures for determining both steam and water capacities. The ratings are expressed in Btu per hour per linear foot, and may also be expressed in square feet of steam radiation per linear foot. Both steam and water ratings include an effective heat allowance of 15 percent of the heat capacity determined by test.

Manufacturers who wish to publish baseboard radiation ratings as  $I=B=R$  ratings may submit test data to the  $I=B=R$  Baseboard Rating Committee and receive approval of test procedure and ratings. The following catalog information must be given for  $I=B=R$  Steam Ratings: (1) name or other type of designation, (2)  $I=B=R$  emblem, (3) rating in Btu per linear ft, (4) percentage added to capacity in determining rating, (5) a statement that ratings are based on active length, (6) the difference between active and total length, and (7) if a finned tube element is used, a statement of the fin size, thickness and spacing.

The following additional information must be given for  $I=B=R$  water ratings: (1) the water temperatures and flow rates for which ratings have been approved, and (2) pressure loss through the unit.

TABLE 6. FACTORS TO CONVERT  $I=B=R$  FINNED-TUBE STEAM RATINGS TO HOT WATER RATINGS AT TEMPERATURES INDICATED

| AVERAGE RADIATOR TEMPERATURE | FACTOR | AVERAGE RADIATOR TEMPERATURE | FACTOR | AVERAGE RADIATOR TEMPERATURE | FACTOR |
|------------------------------|--------|------------------------------|--------|------------------------------|--------|
| 150                          | 0.45   | 175                          | 0.65   | 200                          | 0.86   |
| 155                          | 0.49   | 180                          | 0.69   | 205                          | 0.91   |
| 160                          | 0.53   | 185                          | 0.73   | 210                          | 0.95   |
| 165                          | 0.57   | 190                          | 0.78   | 215                          | 1.00   |
| 170                          | 0.61   | 195                          | 0.82   | 220                          | 1.05   |

A Testing and Rating Code for Finned-Tube Type of Radiation<sup>8</sup> was adopted by The Institute of Boiler and Radiator Manufacturers in 1951, and the code was amended in 1954. This code contains a test procedure for determining steam ratings. The code contains a table of effective heat allowances which may be added to the condensate output (corrected to standard conditions) in establishing the rating. These allowances vary from zero for an installed height of 36 in. or more to a maximum of 15 percent for an installed height of 18 in. or less. Water ratings are determined by applying the factors in Table 6 to approved  $I=B=R$  steam ratings.

Manufacturers who wish to publish finned-tube radiation ratings as  $I=B=R$  ratings must submit test data to the  $I=B=R$  Finned-Tube Rating Committee and receive approval of test procedure and rating. In their catalogs they must show information similar to that required when publishing ratings for baseboard radiation.

### Heating Effect

The acceptance of heating effect allowance by the industry is the result of observation such as the following:<sup>6</sup>

1. The heating effect of a radiator cannot be judged solely by the amount of steam condensed within the radiator.
2. Smaller floor-to-ceiling temperature differentials can be maintained with long, low, thin, direct radiators, than can be maintained with high, direct radiators.
3. The larger portion of the floor-to-ceiling temperature differential in a room of average ceiling height heated with direct radiators occurs between the floor and the breathing level.
4. The comfort level (approximately 2 ft-6 in. above floor) is below the breathing