When low pressure steam is used with unit heaters and ventilating units, it is important that proper means be provided for the removal of the heavy condensation. Such units should not be applied to low pressure gravity return systems except where the difference in heater level and boiler water line is large enough to compensate for the pressure loss through the convector at its highest condensation rate. The use of vacuum or return pumps and receivers is advisable with jobs of any considerable size, as the best method of taking care of the condensate and at the same time providing for proper venting of the units directly into a vacuum return line system, or into an open vented return system, the latter having some advantage in preventing the formation of any vacuum in the unit itself, which sometimes tends to hold up condensate and causes freezing.

ESTIMATING HEAT LOSSES

The heat losses of a building to be equipped with unit heaters are determined in the same manner as for any other heating system, excepting so far as the unit heaters may prevent air stratification and thus reduce the temperature difference between the ceiling and floor. (See Chapter 7.)

Unit heaters may be arranged to recirculate the air or to supply warmed air from the outside for ventilation or to make up air exhausted.

If all or a part of the air is to be taken in from out-of-doors, the heat necessary to warm this air from the outside temperature to the inside temperature must be added to the transmission or other losses. Units of the number and size needed to furnish the total heat required are then selected from the manufacturers' rating tables, using these ratings at the steam pressure to be used and at the temperature at which the air will enter the convector.

AIR TEMPERATURES [3]

For recirculating heaters with intakes at the floor level, the temperature to be maintained in the room should be considered as the temperature of the air entering the heater. Where outside air is introduced, the temperature of the mixture must be calculated and used as the entering air temperature to the heater. Where suspended heaters are used without any intake boxes extending down to the floor level, a higher entering air temperature should be used than that at which the room is to be maintained.

With suspended unit heaters taking air at some distance above the floor, the temperature variation from floor to ceiling may reach as much as 1 deg for each foot of elevation during the periods when the maximum capacity of the heaters is required. Thus this allowance should be made in calculating the capacity of suspended heaters. High velocity discharge units (blower type) will maintain slightly lower temperature differences than will low velocity units (propeller type). Unit heaters taking in recirculated air at the floor level should maintain temperature differentials

[3]Temperature Gradient Observations in a Large Heated Space, by G. L. Larson, D. W. Nelson, and O. C. Cromer (A.S.H.V.E. Transactions, Vol. 39, 1933).

Tests of Three Heating Systems in an Industrial Type of Building, by G. L. Larson, D. W. Nelson, and John James (A.S.H.V.E. Journal Section, *Heating, Piping and Air Conditioning*, November, 1934).

of less than 0.5 deg per foot of elevation when the maximum capacity of the heaters is required. This temperature difference per foot of elevation is less than the corresponding variations for spaces heated by direct radiation.

Unit heaters save fuel because of their ability to circulate air at a lower average temperature than the air circulated by direct radiators; however, the unit heaters must circulate more air in any given time than is needed with direct radiators. This requires the selection of heaters having a liberal air capacity for the required heat output, which in turn means a relatively low final temperature. Extremely low final temperatures can be had only at the expense of larger heaters and increased power, so that an economic limit is imposed. In general, for heating purposes it is advisable to use a delivery temperature not more than 70 F above the average room temperature desired, and considerably less where possible. Since the delivery temperature increases with increase in steam pressure with high pressure steam, units should be selected that have a minimum heating surface in order to provide outlet air not in excess of 70 F above average room temperature.

OUTPUT OF HEATERS

It is standard practice to rate unit heaters in Btu per hour at a given temperature of air entering the heater and at a given steam pressure maintained in the coil. Steam at 2 lb pressure and air entering at 60 F are used as the standard basis of rating[4]. The capacity of a heater increases as the steam pressure increases, and decreases as the entering air temperature increases. The heat capacity for any condition of steam pressure and entering air temperature may be calculated approximately from any given rating by the use of factors in Tables 1 and 2. Table 1 is for blow-through and Table 2 is for draw-through unit heaters. These tables are accurate within 5 per cent.

Unit heaters are customarily rated as free delivery type units. If outside air intakes, filters, or ducts on the discharge side are used with the heater, proper consideration should be given to the reduction in air and heat capacity that will result because of this added resistance.

The percentage of this reduction in capacity will depend upon the characteristics of the heater and on the type, design, and speed of the fans employed, so that no specific percentage of reduction can be assigned for all heaters for a given added resistance. In general, however, disc or propeller fan units will have a larger reduction in capacity than housed fan units for a given added resistance, and a given heater will have a larger reduction in capacity as the fan speed is lowered. When confronted with this problem the ratings under the conditions expected should be secured from the manufacturer.

When steam supplied to the heaters contains superheat, the capacity of the heater will be but slightly less than with saturated steam at the same pressure. Recent tests indicate that the reduction of capacity

[4]A.S.H.V.E. Standard Code for Testing and Rating Steam Unit Heaters (A.S.H.V.E. Transactions, Vol. 36, 1930).