where

Δt = temperature drop, degrees Fahrenheit.
H_d = heat loss in duct, Btu per hour.

Unless the duct passes through an unheated portion of the building, heat loss from ducts can frequently be neglected. Final decision rests on careful analysis of local conditions.

The duct distribution system is designed using velocities as recommended in Chapter 30, and grille locations as discussed in Chapter 29. In most installations it is advisable in order to permit economical heating prior to occupancy to design the return duct system of sufficient area to convey 100 per cent of the air handled by the fan. Also in mild weather certain economies of operation may be affected by designing the outside air duct of sufficient area to convey approximately the total quantity of air handled by the fan and means should be provided for the escape of this air quantity. In every case, however, the outside air duct must be of sufficient area to pass minimum ventilation air.

Air Distribution System for Cooling

The total cooling and dehumidifying load to be supplied by the central system is determined from the several components of the design load listed under *Item 3*. The entering air temperature is determined by selecting the proper relationship between the quantity of air to be handled, the heat gain in the conditioned space, and the location of the air inlets. In cooling applications it is desirable that the difference between the temperature of air currents in the space frequented by occupants and the average temperature in such space, be not greater than 2 F for air velocities of 40 linear feet per minute and over and not greater than 3 F for velocities of less than 40 linear feet per minute.

There is a fairly wide range of permissible entering air temperatures. With high velocity jets or diffusing nozzles, located at some distance from the occupied space, entering air temperatures may be as much as 30 F below room temperature. Where the air is introduced through supply inlets fairly close to the occupied zone the entering air should be within 10 to 15 F of a desired room temperature. The problem of preventing drafts in summer air conditioning is important as air, cooler than room air, tends to fall without diffusing and proper design must consider the relationship between temperature and diffusion to secure satisfactory results.

The relation between heat gain, air quantity, and air temperatures is given by Equation 1. For cooling, t_1 and t_2 are reversed. At this stage in the design, the only known quantities are H and t_1. The maximum and minimum limits for Q are the same as given for heating, and t_2 may be from 10 to 30 F below t_1, depending on room size and shape and type and location of supply grilles.

Moisture added within the conditioned space does not increase the dry-bulb temperature in the space, and therefore only the total sensible heat gain to the space is used for H in Equation 1. Any reasonable value may be assigned to t_2 and a trial calculation made. The value of Q obtained should lie within the proper limits; and if coils are to be used, the

air quantity should be investigated to determine the most economical coil size.

To absorb the moisture load, the supply air must enter the space with a lower dew-point than that desired in the conditioned space. A method for determining this dew-point reduction follows:

Total all the latent heat gains in the room and convert them to equivalent grains of moisture. Divide the total grains of moisture by the number of pounds of air delivered to the room which will give the difference in weight of moisture between the entering air and room air conditions. Subtract this amount from the grains of moisture corresponding to the dew-point temperature in the room and refer to psychrometric charts or tables to establish the required dew-point temperature of the entering air. The intersection of this new dew-point condition with the dry-bulb temperature line of the entering air at the supply inlet to the room will establish the entering wet-bulb temperature condition.

When the supply duct passes through an unconditioned space, the dry-bulb temperature rise in the duct should be estimated (see Chapter 40). This temperature rise usually ranges from 1 to 3 deg and is deducted from t_2 to establish dry-bulb temperature leaving conditioner. Ducts intended for low temperature air must frequently be insulated to prevent condensation on outer surfaces, even though heat saving is not large enough to justify the cost of covering.

It is seldom that standard equipment will produce exactly the combination of dry-bulb and dew-point temperatures indicated by preceding calculations, and it becomes necessary to revise assumptions regarding grille temperature, air quantity, refrigerant temperature, and air velocity through conditioner until the proper balance is obtained. When such alterations fail to produce desired results, reheating is indicated. Reheating methods have been previously mentioned in this chapter.

The design of a duct distribution system for cooling is accomplished in the same manner as that previously described for heating installations. For cooling spaces prior to occupancy, it is also desirable to design the return air ducts of sufficient area to convey 100 per cent of the air handled by the fan and the same recommendations with regard to the outside air duct as referred to in the heating design would be applicable for summer air conditioning.

CORRELATION OF SUMMER AND WINTER DESIGN

Frequently the quantity of air required for the central system in summer conditioning is considerably greater than the quantity required for winter conditioning. In practice, volume control should be provided using a speed regulator on the fan, or dampers, so that the air quantity may be changed for the cooling and heating cycles. Sometimes a recalculation using different entering air temperatures will permit using the same quantity of air all year round. There is no fixed rule or method for determining the most practical design for air quantity and the engineer should use discretion to a large extent in working out a balanced system.

If the system is to be used for heating only, good results will be obtained with supply grilles located in the baseboard. For cooling systems, it is better to locate them in sidewalls above heads of occupants or in the ceiling. This same location will be satisfactory for year-round systems, especially if the supply temperature in winter does not exceed 100 to 110 F. Air distribution is discussed in more detail in Chapter 29.