

This heat gain is then used as a credit against the heat loss calculations. In general, however, the design for heating disregards these gains as in most cases these values are not a continuous or uniform source of heat and the heating system must be adequate to maintain the required temperature at all times including nights, Sundays and holidays, when the space is not in normal use.

The summation of these heat losses will give the total heat to be supplied by the air entering the conditioned space and the additional heat necessary to be added to the conditioning unit to provide the prescribed entering air temperature.

Load Calculations for Cooling

The heat gain through the windows, partitions, doors, floors, skylights, ceilings or roofs of the enclosure due to the air dry-bulb temperature difference assumed to exist between the air on the opposite sides of the construction may be determined from data given in Chapter 5.

The heat gain from occupants may be calculated from data given in Chapter 3, which gives the metabolic rate for people engaged in various activities. In addition charts are included which give a separation of the sensible and latent heat losses from the body which should be itemized separately in all calculations.

The heat emission from various appliances should be calculated according to the information and data given in Chapter 8, with special consideration being given to the division of latent and sensible heat requirements of the apparatus. Complete details may also be found in Chapter 8 for determining the heat gain resulting from electric lights and motors within the enclosure.

The transfer of solar radiation through windows, walls, doors, skylights or roofs of enclosures may be determined from the charts and tables in Chapter 8.

The heat to be removed from the outside air in cooling load calculations is determined in exactly the same manner as described previously under Load Calculations for Heating. The minimum ventilation requirements should be carefully considered.

The heat gain through ducts, casings and fans between the conditioning unit and the treated space may be determined from information in Chapter 39, and such calculations demonstrate the value of insulation in applications of this type.

Air Distribution System for Heating

The total heating load to be supplied by the central system is determined from the several components of the load listed under Item 2. The quantity, air motion, and temperature of the treated air and the method of introducing it to the conditioned space should be designed so as to limit the variation in dry-bulb temperature to 3 F or less at a 5 ft level throughout that portion of the enclosure which is normally frequented by persons. It is desirable to avoid air velocities exceeding 50 linear feet per minute in the occupied zone between the floor and the 5 ft level. When architectural or other construction requirements necessitate the location of a supply or return grille below the 5 ft level in an occupied

space, special consideration should be given to the air velocities in that region to avoid uncomfortable drafts.

It is desirable to use reasonably low temperature differences between the entering air and room conditions where possible. Air temperatures from 80 to 90 F will generally be satisfactory, although where the quantity of air to be circulated is kept at a minimum and where the arrangement of air inlets permits adequate mixing with the room air before reaching the breathing zone, higher temperatures from 100 to 120 F can be used. Having selected the desired temperature of the entering air, the quantity of air is determined as follows:

$$Q = \frac{H}{60d \times 0.24 (t_y - t)} \quad (1)$$

where

- Q = volume of air to be introduced, cubic feet per minute.
- H = sensible heat loss of space to be conditioned, Btu per hour.
- d = density of air, pounds per cubic foot.
- t_y = outlet temperature at the grille, degrees Fahrenheit.
- t = design room temperature, degrees Fahrenheit.

If the air quantity calculated is excessive, it may be decreased by using a higher entering temperature. If the quantity is too small to provide adequate distribution and ventilation, it may be increased by using a lower entering temperature. Air motion has a cooling effect on the individual, and ordinarily the air quantity circulated should provide an overall air change in the conditioned space in not less than 5 min or more than 12 min. Best results are secured when the entering air temperature and method of distribution permit uniform mixture of air without excessive motion in the occupied zone.

The temperature drop between the heating element and the supply grille may be calculated according to the following formula:

$$t_d = \frac{H_d}{60 d \times 0.24 \times Q} \quad (2)$$

where

- t_d = temperature drop, in degrees Fahrenheit.
- H_d = heat loss in ducts, etc., Btu per hour.

The temperature drop t_d is added to the grille outlet temperature to determine the air temperature leaving conditioning unit heating coil. In general, duct losses will vary from 2 to 5 F and if greater than 5 F special consideration should be given to insulation.

The duct distribution system is designed using velocities as recommended in Chapter 29, and grille locations as discussed in Chapter 28. 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 should be of sufficient area to permit the minimum ventilation requirements to be met.