The total heat gain resulting from outside air introduced may be determined by Equation 3:

$$H = \frac{Q}{v}(h_o - h_i) \tag{3}$$

where

H = heat to be removed from outside air entering the building above inside conditions, Btu per hour.

Q = volume of outside air entering building, cubic feet per hour.

v = cubic feet of outside air per pound of dry air.

h_o = enthalpy of outside air, Btu per pound of dry air.

h_i = enthalpy of inside air, Btu per pound of dry air.

The moisture gain resulting from outside air and infiltration may be determined by Equation 4:

$$Q_w = \frac{Q}{v}(W_o - W_i) \tag{4}$$

where

Q_w = weight of water to be removed from outside air above inside conditions, pounds per hour.

W_o = humidity ratio of outside air, pounds water per pound dry air.

W_i = humidity ratio of inside air, pounds water per pound dry air.

Heat Emission of Appliances

Heat generating appliances which give off either sensible heat or both sensible and latent heat in an air conditioned enclosure may be divided into three general classes of equipment or devices: (1) electrical appliances, (2) gas appliances, and (3) steam heating appliances.

In the first group may be found such devices as lights[10], fans, motors, toasters, waffle irons, etc. The heat load caused by such devices may normally be obtained by multiplying the nameplate rating in watts by an appropriate load factor and by 3.4 (Btu per watt hour). In some cases it may also be possible to remove some of the heat of such appliances as lights and motors with exhaust air without involving it in the room load.

Electric motors are usually rated in units of horsepower *output*. To determine the corresponding input, which is the rate at which heat is added to the conditioned space by full-load operation of such motors, some idea of motor efficiency is necessary. The aggregate input in horsepower should then be multiplied by 2546 (Btu per horsepower hour).

Motor efficiencies can be assumed about as follows: Motor efficiencies vary from 50 to 60 per cent at the ⅛ hp level to 80 per cent at 1 hp and 88 per cent at 10 hp and above. Where the motor is outside of the conditioned space the heat equivalent of the motor output only is used, but where the motor is inside of the space the heat equivalent of the output divided by the efficiency is used.

In the second group belong such appliances as coffee urns, gas ranges, steam tables, broilers, hot plates, etc. For heat generating capacities of such appliances refer to Table 13.

Judgment must be used in the application of data given in Table 13. Consideration must be given to the heat contributed by appliances which are in use at the time of peak load. The quantity of heat will depend upon whether products of combustion are vented to a flue, whether they escape into the space to be conditioned, or whether appliances are hooded allowing part of the heat to escape through a stack. There are no generally accepted data available on the effects of venting and shielding heating appliances but it is believed that, when they are properly hooded with a positive fan exhaust system through the hood, 50 per cent of the heat will be carried away and 50 per cent dissipated in the space to be conditioned. The same effectiveness of the hood should be figured for both latent and sensible heat.

TABLE 14. PERMEABILITY OF VARIOUS MATERIALS TO WATER VAPOR

MATERIAL	PERMEABILITY GRAINS PER (SQ FT) (HR) (INCH HG)
	Group 1[a]
Plaster base and plaster, ¾ in	14.7
Fir sheathing, ¾ in	2.9
Waterproof paper[c]	49.1
Pine lap siding	4.9
Paint film	3.4
Sugar cane fiberboard, ¾ in	12.5
Brick masonry, 4 in	1.1
	Group 2[b]
Foil-surfaced reflective insulation, double-faced	0.08 to 0.13
Roll roofing—smooth, 40 to 65 lb/roll 108 sq ft	0.13 to 0.17
Duplex or laminated papers, 30-30-30	1.37 to 2.58
Plaster, wood lath	11.00
Plaster, 3 coats of lead and oil	3.68 to 3.84
Plaster, 2 coats of Aluminum paint	1.15
Plaster, fiberboard or gypsum lath	19.73 to 20.57
Plywood, ½ in., 5-ply Douglas fir	2.67 to 2.74
Insulating lath and sheathing, board type	25.68 to 34.27
Insulating sheathing, surface-coated	3.03 to 4.36
Insulating cork blocks, 1 in	6.19
Mineral wool, unprotected, 4 in	29.07

[a]Calculating Vapor and Heat Transfer Through Walls, by L. G. Miller, (*Heating and Ventilating* 35, No. 11, 56 November, 1938).

[b]How to Overcome Condensation in Building Walls and Attics, by L. V. Teesdale (*Heating and Ventilating*, Vol. 36, No. 4, April, 1939).

[c]Light weight slaters felt used to keep rain from drifting through. Not used as a vapor barrier.

Moisture Through Walls

In some applications walls of the conditioned space may be in contact with other spaces which have in them a higher water vapor pressure than that in the conditioned space. It is known that water vapor will flow through the building materials in proportion to the vapor pressure difference on the two sides of the material. The total amount of water vapor transmitted is dependent on the permeability which is usually expressed in grains of moisture per (square foot) (hour) (inch of mercury vapor pressure difference). The values for permeability in Table 14 are quoted from a publication of the *National Bureau of Standards*[11]. The water vapor entering the conditioned space must be added to the latent cooling load.

Vapor barriers, to be effective in reducing entrance of moisture, must seal completely the walls, ceilings, and floors that are exposed to space