change in U. It should be noted that the over-all coefficient should be multiplied by the ceiling and not the roof area.

If the unheated attic space between the roof and ceiling has no dormers, windows or vertical wall spaces the combined coefficient may be used for determining the heat loss through the roof construction, attic and top floor ceiling. If the unheated attic contains windows and vertical wall spaces these must be taken into consideration in calculating the roof area and also its coefficient U_r. In this case an approximate value of U_r may be obtained as the summation of the coefficient of each individual section such as the roof, vertical walls or windows times its percentage of total area. This coefficient may then be used with reasonable accuracy in Equation 6. If there are large vertical wall areas, the most accurate procedure is to estimate the attic temperature by means of Equation 1 Chapter 6 and to calculate the heat loss by using the ceiling coefficient only, and the attic temperature instead of the outside temperature.

Effect of Attic Ventilation on Ceiling Heat Loss

Neither the combined coefficient equation in this chapter nor the attic temperature equation (Chapter 6) makes allowance for attic ventilation. The effect of winter attic ventilation is to reduce the attic temperature, thereby increasing the ceiling heat loss. Obviously, if the amount of ventilation were such that the attic temperature would be substantially at outside temperature, then the roof should be neglected and only the top floor ceiling coefficient used. On the other hand, according to recently conducted tests[5], ordinary venting to preclude attic condensation has only a minor effect on the attic temperature, in which case the full value of the roof may be taken into consideration without appreciable error.

Basements and Unheated Rooms

The heat loss through floors into basements and into unheated rooms kept closed may be computed by assuming a temperature for these rooms of 32 F. The coefficients of transmission for concrete floors on ground (Table 10) are based on the assumption that the heat-resisting value of the floor extends downward and stops at the under side of the concrete. It is probable, however, that the dirt underneath has some heat-resistance value extending to a considerable depth, which would result in substantially lower heat transmission coefficients than given in Table 10. This problem is now the subject of research. Additional information on the inside and outside temperatures to be used in heat loss calculations is given in Chapter 6.

CONDENSATION IN BUILDINGS

The water vapor or moisture mixed with the air in buildings will be transmitted through many types of building construction if there is a difference in the vapor pressures on the two sides of the structure. Such water vapor will also condense whenever it comes in contact with surfaces

[5]Methods of Moisture Control and Their Application to Building Construction, by F. B. Rowley, A. B. Algren and C. E. Lund. (University of Minnesota *Engineering Experiment Station Bulletin* No. 17).

or objects at or below the dew-point temperature. Thus two types of condensation problems are encountered in building practice, namely (1) *Surface condensation* or condensation on the interior building surfaces including the walls, ceiling (or roof) and glass, and (2) *Interstitial condensation* or the transmittance of the vapor through the building materials and condensation of the moisture on surfaces or voids within the materials of construction.

Condensation within the construction as well as condensation on the interior surfaces does not necessarily occur in all buildings but only in isolated cases when conditions conducive to such condensation exist. The probability of condensation increases with the relative humidity or vapor pressure and with the temperature difference and, in the case of inter-

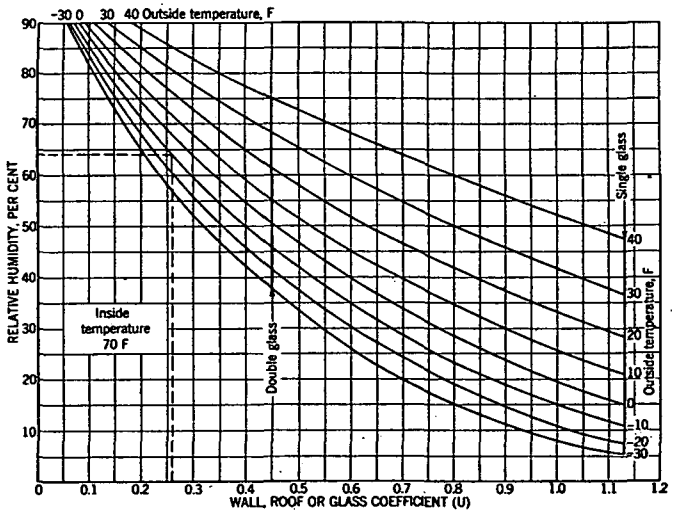

FIG. 2. PERMISSIBLE RELATIVE HUMIDITIES FOR VARIOUS TRANSMISSION COEFFICIENTS

stitial condensation, decreases with the vapor resistance on the warm side of the wall.

Condensation on interior building surfaces[6] (surface condensation) may be eliminated by either reducing the relative humidity or by maintaining the interior surfaces at or above the dew-point temperature. Permissible relative humidities for various wall, roof or glass coefficients and temperature differences may be determined from Fig. 2. The permissible relative humidity for any specific type of construction may be determined by first ascertaining the coefficient of transmission (U) of the construction and then locating this coefficient on the horizontal scale of Fig. 2. A vertical line drawn to the proper outside temperature curve and then to the left hand scale will indicate the permissible relative humidity for the conditions involved. The dotted line shown in Fig. 2 indicates the per-

[6]Permissible Relative Humidities in Humidified Buildings, by Paul D. Close (A.S.H.V.E. JOURNAL SECTION, *Heating, Piping and Air Conditioning*, December, 1939, p. 766).