These equations 1, 2 and 3 are fundamental and are used for determining values for f_i, f_o and k for actual wall materials by test. They cannot be used for computing heat losses in an actual building, since the surface temperatures t_1 and t_2 are seldom known, although these surface temperatures can be determined in a test by means of thermocouples. Hence, for actual conditions where the only temperatures known are the inside and outside air temperatures t and t_o, it is necessary to use the transmission coefficient U = Btu transmitted per hour per square foot of wall surface per degree difference between the inside and outside air temperatures. Values of U for many common types of construction are given in Tables 9 to 33, inclusive. The heat H transmitted per hour from air inside to air outside is then computed as follows:

$$H = U\,(t - t_o)\,S \tag{4}$$

Table 1. Surface Coefficients (f_i) for Various Building Materials under Still Air (No Wind) Conditions

The values in the Table are in Btu per square foot of wall surface per hour per 1 deg F difference between the mean air temperature in the room and the inside surface temperature of the wall.

Building Material	Surface Coefficient f_i (Still Air)	
	Harding and Willard	Wood
Asbestos (sheet)	1.40	.....
Brickwork (ordinary)	1.40	.....
Cement Plaster (finished)	0.93	.....
Concrete	1.30	.....
Corkboard	1.25	1.20
Glass (window)	1.50	1.90[a]
Magnesia (blocks)	1.45	.....
Wood (finished surface)	1.40	.....
Building paper	.....	1.40
Average of all values	1.34	.....

[a]Average of both sides of glass 0.12 in. thick and for 70 F total temperature difference from air to air with moving air on one side. Probable value for still air on both sides 1.60.

and since $H = H_1 = H_2 = H_c$, the right-hand members of equations 1, 2, 3 and 4 are all equal.

The coefficient U may be computed for any wall provided values for f_i, f_o and k are known. By proper substitution in the four equations, the unknown temperatures t_1 and t_2 can be eliminated and the value of the transmission coefficient for a simple wall x inches thick is:

$$U = \frac{1}{\frac{1}{f_i} + \frac{1}{f_o} + \frac{x}{k}} \tag{5}$$

and for a compound wall of several materials having thicknesses in inches of x_1, x_2, x_3, etc., the coefficient is:

$$U = \frac{1}{\frac{1}{f_i} + \frac{1}{f_o} + \frac{x_1}{k_1} + \frac{x_2}{k_2} + \frac{x_3}{k_3} + etc.} \tag{6}$$

As in the case of the simple wall, f_i and f_o, are always the inside and outside surface coefficients for the two materials in contact with air. If the air is still (no wind), then for the same material f_i and f_o are the same, and $f_i = f_o$; but, if the outside air is in motion, then f_o is always greater than f_i and will increase as the wind velocity increases. Values for f_i in still air, as determined by various investigators, are given in Table 1.

Values for k and C, the conductivity and conductance of building materials and insulations, are given in Tables 4, 5, 6, 7 and 8, and are taken from the published values of various investigators. It should be noted that values of k and C as well as U are dependent on the temperature range, and it is therefore desirable that the investigator determine heat-transmission values under conditions approximating those existing under actual conditions.

Table 2. Factors to be Used in Determining Values of Outside Surface Coefficients (f_o) under Moving Air Conditions

In each case, the moving air factor is based on still air coefficient f_i for *same* material. For conditions where wind velocity is not known use the factor (3) or take f_o as 3 f_i for same material.

Wind Velocity in Miles per Hour	Brickwork	Multipliers of f_i[a] Wood	Average
5	2.38	2.19	2.28
10	3.20	2.71	2.96
15	3.76	2.95	3.36[b]
20	4.22	3.02	3.62
Additional Values—Smooth Surface			
10	.....	2.20	.....
20	.....	2.60	.....
Above 20	.....	3.00	.....

[a]Taken from Engineering Experiment Station Bulletin No. 102, of the University of Illinois. Additional values from Engineering Experiment Station, Pennsylvania State College, reported by Professor Wood. Tests at Pennsylvania State College indicate character of surface, rough or smooth, more important than material of surface.

[b]This is usually taken as 3 even.

In the case of air-space construction, an air-space coefficient for each air space must be inserted in either equation 5 or 6. Thus for a simple wall with one air space,

$$U = \frac{1}{\frac{1}{f_i} + \frac{1}{f_o} + \frac{1}{a} + \frac{x}{k}} \tag{7}$$

and for a simple wall of several air spaces having conductances of a_1, a_2, a_3, etc., the coefficient is:

$$U = \frac{1}{\frac{1}{f_i} + \frac{1}{f_o} + \frac{x}{k} + \frac{1}{a_1} + \frac{1}{a_2} + \frac{1}{a_3} + etc.} \tag{8}$$

With certain special forms of materials which have irregular air spaces (such as hollow tile) or are otherwise non-homogeneous, it is necessary