Table 1. Conductances (C) for Surfaces and Air Spaces

All conductance values expressed in Btu per hour per square foot per degree Fahrenheit temperature difference.

Section A. Surface Conductances for Still Air[a]

Position of Surface	Direction of Heat Flow	Surface Emissivity e = 0.83	Surface Emissivity e = 0.05
Horizontal	Upward	1.95	1.16
Horizontal	Downward	1.21	0.44
Vertical		1.52*	0.74

Section B. Conductance of Vertical Spaces at Various Mean Temperatures[b]

Mean Temp Deg Fahr	Conductances of Air Spaces for Various Widths in Inches: 0.128	0.250	0.364	0.493	0.713	1.00	1.500
20	2.300	1.370	1.180	1.100	1.040	1.030	1.022
30	2.385	1.425	1.234	1.148	1.080	1.070	1.065
40	2.470	1.480	1.288	1.193	1.125	1.112	1.105
50	2.560	1.535	1.340	1.242	1.168	1.152	1.149
60	2.650	1.590	1.390	1.295	1.210	1.195	1.188
70	2.730	1.648	1.440	1.340	1.250	1.240	1.228
80	2.819	1.702	1.492	1.390	1.295	1.280	1.270
90	2.908	1.757	1.547	1.433	1.340	1.320	1.310
100	2.990	1.813	1.600	1.486	1.380	1.362	1.350
110	3.078	1.870	1.650	1.534	1.425	1.402	1.392
120	3.167	1.928	1.700	1.580	1.467	1.445	1.435
130	3.250	1.980	1.750	1.630	1.510	1.485	1.475
140	3.340	2.035	1.800	1.680	1.550	1.530	1.519
150	3.425	2.090	1.852	1.728	1.592	1.569	1.559

Section C. Conductances and Resistances of Air Spaces Faced on One Surface with Reflective Insulation[c]

Location and Position of Air Space	Direction of Heat Flow	Temp[d] Diff Deg Fahr		Conductance[e] (C)			Resistance[e] $\left(\frac{1}{C}\right)$		
		Winter	Summer	No. of Air Spaces 1	2	3	No. of Air Spaces 1	2	3
Rafter Space (8 in.)									
Horizontal	Down	45			0.10	0.07		10.00	14.29
Horizontal	Up	45			0.27	0.17		3.70	5.88
Horizontal	Down		25		0.09	0.06		11.11	16.67
Horizontal	Up		25		0.24	0.16		4.17	6.25
30 deg slope	Down	45			0.15	0.10		6.67	10.00
30 deg slope	Up	45			0.25	0.17		4.00	5.88
30 deg slope	Down		25		0.13	0.09		7.69	11.11
30 deg slope	Up		25		0.23	0.14		4.35	7.14
Stud Space (3⅝ in.)									
Vertical[f]		30		0.34			2.94		
Vertical		40			0.23	0.13		4.35	7.69
Vertical[f]			15	0.32			3.13		
Vertical			20		0.18	0.11		5.56	9.09
Vertical[g]		30		0.46			2.17		

[a]Radiation and Convection from Surfaces in Various Positions, by G. B. Wilkes and C. M. F. Peterson (A.S.H.V.E. Transactions, Vol. 44, 1938, p. 513).

[b]A.S.H.V.E. Research Report No. 825—Thermal Resistance of Air Spaces, by F. B. Rowley and A. B. Algren (A.S.H.V.E. Transactions, Vol 35, 1929, p. 165).

[c]Thermal Test Coefficients of Aluminum Insulation for Buildings, by G. B. Wilkes, F. G. Hechler and E. R. Queer (A.S.H.V.E. Transactions, Vol. 46, 1940).

[d]Temperature difference is based on total space between plaster base and sheathing, flooring or roofing.

[e]These air space conductance and resistance values are based on one reflective surface (aluminum) having an emissivity of 0.05 facing each space and are based on total space between plaster base and sheathing, flooring or roofing. The rafter and stud spaces are divided into equal spaces.

[f]Stud space is lined on plaster base side with loose paper with aluminum on surface facing air space. The resistance of the small air space between the plaster base and paper was 0.43.

[g]Radiation and Convection Across Air Spaces in Frame Construction, by G. B. Wilkes and C. M. F. Peterson (A.S.H.V.E. Transactions, Vol. 43, 1937, p. 351).

*The recommended surface conductance for calculating heat losses for still air for non-reflective surfaces is 1.65 Btu. For a 15 mph wind velocity, the recommended value is 6.0 Btu. These coefficients were derived from Fig. 1 which was based on tests conducted at the University of Minnesota, and apply to vertical surfaces.

in the emissivity coefficient due to surface coatings or chemical action[6] should be investigated as to the permanence of the reflective surface for the conditions under which this material will be used. In making installations of this material the partitions between air spaces should be tight, particularly at the top and bottom so that air cannot circulate between adjacent spaces.

When reflective insulating materials are installed with multiple air spaces, the position (vertical, horizontal or inclined) of the material in the structure must be taken into consideration. For example, the resistance to heat flow upward is about one-third that of downward flow in a horizontal position in the same construction, as will be apparent from Table 1, **Section C.** However, the difference between upward heat flow through single horizontal or sloping air spaces and through single vertical air spaces is comparatively small for the same temperature difference. Consequently the same conductance value (0.46) may be used for computing coefficients involving upward heat flow through horizontal and sloping air spaces bounded on one side by aluminum foil applied to plasterboard, as for similar vertical air spaces.

As already stated, a conductance value of 1.10 was similarly used in all cases for calculating the coefficients of construction involving vertical, horizontal and sloping air spaces bounded on both sides by ordinary building materials.

PRACTICAL COEFFICIENTS

For practical purposes it is necessary to have average coefficients that may be applied to various materials and types of construction without the necessity of making tests on the individual material or combination of materials. In Table 2 coefficients are given for a group of materials which have been selected from various sources. Wherever possible the properties of material and conditions of tests are given. However, in selecting and applying these values to any construction a reasonable amount of caution is necessary; variations will be found in the coefficients for the same materials, which may be partly due to different test methods used, but which are largely due to variations in materials. It is recommended that future determinations of thermal conductivity be made in accordance with the code, Standard Method of Test for Thermal Conductivity of Materials by Means of the Guarded Hot Plate[7]. The coefficients which have been used for the calculation of over-all coefficients are given in Table 3.

It should be recognized that in these tables of calculated coefficients space limitations will not permit the inclusion of all the combinations of materials that are used in building construction and the varied applications of insulating materials to these constructions. Typical examples are given of combinations frequently used, but any special construction not given in Tables 4 to 16 can generally be computed by using the conductivity values given in Table 3 and the fundamental heat transfer formulas. For example, the tabulation of all of the values for multiple layers of insulating materials would present extensive and detailed problems of calculations for the varied application combinations, but the engineer having the fundamental conductivity values can quickly obtain the proper coefficients.

[6]Thermal Test Coefficients of Aluminum Insulation for Buildings, by G. B. Wilkes, F. G. Hechler and E. R. Queer (A.S.H.V.E. Transactions, Vol. 46, 1940, p. 109).

[7]Sponsored by A.S.H.V.E., *A.S.T.M.*, *A.S.R.E.* and *N.R.C.* and approved as a Tentative Code by A.S.H.V.E. and *A.S.T.M.* in 1942 (*A.S.T.M.* Designation of Code is C177-42T).