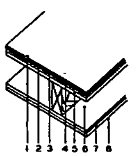
Table 11 . . . . Coefficients of Transmission (U) of Frame Construction Ceilings and Floors[a]

Coefficients are expressed in Btu per (hour) (square foot) (Fahrenheit degree difference between the air on the two sides) and are based on still air (no wind) conditions on both sides

Example—Floor K 5



Resistances used are given below in this table or in Table 3 or 4

Heated room above unheated space

Construction (Heat flow down)	Resistance (R)
1. Top surface (still air)	0.92
2. Linoleum or tile (av. R)	0.05
3. Felt	0.06
4. Plywood (5/8 in.)	0.78
5. Wood subfloor (25/32 in.)	0.98
6. Air space[b] (7 1/2 in.)	1.25
7. Metal lath and 3/4 in. plas. (lt. wt. agg.)	0.47
8. Bottom surface (still air)	0.92
Total resistance	5.43
$U = 1/R = 1/5.43 =$	0.18

See value 0.18 in boldface type in table below.

Example of Substitution

Resistances used are given below in this table or in Table 3 or 4

Assume heated room is below unheated space so heat flow is up

Total resistance		5.43
Deduct 1. Top surface (heat flow down)	0.92	
6. Air space (heat flow down)	1.25	
8. Bottom surface (heat flow down)	0.92	3.09
Difference		2.34
Add 1. Top surface (heat flow up)	0.61	
6. Air space (heat flow up)	0.85	
8. Bottom surface (heat flow up)	0.61	2.07
Total resistance		4.41
$U = 1/R = 1/4.41 =$		0.23

To Adjust U Values for Construction with Added Insulation between Framing Members, See Table 16

Direction of Heat →		Heat Flow Upward (Winter Conditions)						Heat Flow Downward (Summer Conditions)						
		Type of Floor												
				Wood subfloor (25/32 in.), felt, and—						Wood subfloor (25/32 in.) felt, and—				
Type of Ceiling		None	Wood subfloor (25/32 in.)	Cement (1 1/2 in.) and ceramic tile (1/2 in.)	Hardwood floor (3/4 in.)	Plywood (5/8 in.) and floor tile or linoleum (1/8 in.)	Insul. bd. (5/8 in.) and hard bd. (1/4 in.) and floor tile or linoleum (1/8 in.)	None	Wood subfloor (25/32 in.)	Cement (1 1/2 in.) and ceramic tile (1/2 in.)	Hardwood floor (3/4 in.)	Plywood (5/8 in.) and floor tile[c] or linoleum (1/8 in.)	Insul. bd. (5/8 in.) and hard bd. (1/4 in.) and floor tile or linoleum (1/8 in.)	Number
Resistance →		—	0.98	1.38	1.72	1.87	2.26	—	0.98	1.38	1.72	1.87	2.26	
Material	R	U	U	U	U	U	U	U	U	U	U	U	U	
		A	B	C	D	E	F	G	H	I	J	K	L	
None	—	—	0.45	0.38	0.34	0.31	0.28	—	0.35	0.31	0.28	0.26	0.24	1
Gypsum bd. (3/8 in.)	0.32	0.65	0.30	0.27	0.24	0.23	0.21	0.46	0.23	0.21	0.20	0.18	0.17	2
Gypsum lath (3/8 in.) and 1/2 in. plas. (lt. wt. agg.)	0.64	0.54	0.27	0.24	0.23	0.21	0.20	0.40	0.21	0.20	0.18	0.17	0.16	3
Gypsum lath (3/8 in.) and 1/2 in. plas. (sand agg.)	0.41	0.61	0.29	0.26	0.24	0.22	0.21	0.44	0.22	0.21	0.19	0.18	0.17	4
Metal lath and 3/4 in. plas. (lt. wt. agg.)	0.47	0.59	0.28	0.26	0.23	0.22	0.20	0.43	0.22	0.20	0.19	**0.18**	0.17	5
Metal lath and 3/4 in. plas. (sand agg.)	0.13	0.74	0.31	0.28	0.26	0.24	0.22	0.51	0.24	0.22	0.20	0.19	0.18	6
Insul. bd. (1/2 in.)	1.43	0.38	0.22	0.20	0.19	0.18	0.17	0.31	0.18	0.17	0.16	0.15	0.15	7
Insul. bd. lath (1/2 in.) and 1/2 in. plas. (sand agg.)	1.52	0.36	0.22	0.20	0.19	0.18	0.17	0.30	0.18	0.17	0.16	0.15	0.14	8
Acoustical tile														
(1/2 in.) on gypsum bd. (3/8 in.)	1.51[d]	0.37	0.22	0.20	0.19	0.18	0.17	0.30	0.18	0.17	0.16	0.15	0.14	9
(1/2 in.) on furring	1.19	0.41	0.24	0.22	0.20	0.19	0.18	0.33	0.19	0.18	0.17	0.16	0.15	10
(3/4 in.) on gypsum bd. (3/8 in.)	2.10[d]	0.30	0.19	0.18	0.17	0.16	0.15	0.25	0.16	0.15	0.15	0.14	0.13	11
(3/4 in.) on furring	1.78	0.33	0.21	0.19	0.18	0.17	0.16	0.28	0.17	0.16	0.15	0.15	0.14	12
Wood lath and 1/2 in. plas. (sand agg.)	0.40	0.62	0.29	0.26	0.24	0.22	0.21	0.45	0.22	0.21	0.19	0.18	0.17	13

[a] See text section Calculating Overall Coefficients for basis of calculations.
[b] To adjust U values for the effect of added insulation between framing members, see Table 16.
[c] Includes asphalt, rubber, and plastic tile (1/8 in.), ceramic tile, or terrazzo (1 in.).
[d] Includes thermal resistance of 3/8 in. gypsum wall board.

per, 25/32-in. wood sheathing, studs, gypsum lath, and sand aggregate plaster, with 2-in. fibrous insulation between studs.

Solution: According to the example calculation in Table 5 a wall of this construction with no insulation between studs has a coefficient U of 0.24. Referring to Table 16, Part A, it will be found that a wall of this value with 2-in. fibrous insulation between the studs has a coefficient U of 0.087.

Attention is called to the necessity of applying the insulating material in accordance with the manufacturer's specification. The engineer must evaluate carefully the economic considerations involved in the selection of an insulating material as adapted to various building constructions. Lack of proper evaluation, or improper installation may lead to unsatisfactory results. Special attention must be given to vapor barriers as outlined in Chapter 10. Moisture from condensation or other sources materially reduces the heat-flow resistance of insulation.

INSULATED CONSTRUCTIONS—HOW TO USE TABLE 16

In Tables 5 through 15, U values are given for many common types of building wall, floor, and ceiling constructions. For such of these constructions as contain an air space, the tabulated U value is based on the assumption that the air space is empty, and that its surfaces are of ordinary building materials of low thermal reflectivity, such as wood, masonry, plaster, or paper. Considerable benefit in reducing the heat transmission coefficient of a construction can be effected by the application of thermal insulating materials in the air space.

Table 16 provides a means of determining, without calculation, the U value of the between-framing area of such constructions with the added insulation installed in the air space. Column 1 of Table 16 refers to the U values of uninsulated constructions as taken from Tables 5 through 15. Columns 2 to 14 of the table give corresponding coefficients U_i for the constructions with various insulating applications in the between-framing air space, as indicated by the column headings. Table 16 is in 5 parts, (A, B, C, D, and E) corresponding to the type of building element and the direction of heat flow. Each part is based on temperature conditions considered generally appropriate for the case.

Any and all U values are based on a series of assumptions as to nominal characteristics. Common variations in conditions, materials, workmanship, etc., can introduce much greater variations in U values than the variations resulting from the assumed mean temperatures and temperature differences described. From this it is also clear that the use of more than two significant figures in stating a U value is assuming more precision than can possibly exist. Three significant figures are used in Table 16 merely as a means of reducing cumulative errors when the table is used several times to obtain a single result. It should ont be assumed that the figures are accurate, overall, to three significant figures. Also, a result taken from Table 16 should always be rounded off to two significant figures.

To use Table 16:

1. Find in Column 1 of the appropriate table the value for U obtained from Tables 5 through 15 for the construction without added insulation.

2. If there is a column which exactly corresponds to the condition for which you desire the U value, read the answer in this column, opposite the Column 1 value. Interpolate if necessary.

3. If there is no column which fully corresponds to the condition for which you desire the U value, then obtain the answer *by means of two or more steps—each time using the value obtained in one step* to reenter the same table through Column 1. In this way U values may be obtained for combinations of insulation in the framing space.

For combinations of fibrous insulations and air spaces, take account of the fibrous component first and the air space second as illustrated in Example 6. This is necessary to assure the approximately correct temperature difference across the air space.

Examples of the Use of Table 16

Example 3: Find the coefficient of transmission U_i of the frame wall shown as an example at the top of Table 5 when (*a*) a 2-inch blanket fibrous insulation is added between the studs and in contact with the gypsum lath and when (*b*) aluminum-foil-backed gypsum lath is added.

Solution: According to Table 5, the U value for this construction with no insulation in the air space is 0.24. Referring to Table 16, Part A, for walls, it is found that corresponding to the value 0.24 in Column 1, the coefficient for conditions (*a*) and (*b*) are:

(*a*) In Column 4, find $U_i = 0.087$. Use 0.09.

(*b*) From Table 3, Section C, the effective emissivity E of aluminum foil is 0.05.

In Column 8 find $U_i = 0.173$. Use 0.17.

Example 4: Consider the floor-ceiling construction shown in the example at the top of Table 11, insulated with a sheet of aluminum foil, or paper faced on both sides with foil, (effective emissivity E of air space = 0.05) placed between the joists and dividing the air space into two equal spaces. From Table 11, the U value for the uninsulated construction is 0.18 for heat flow down for summer, and 0.22 for heat flow up for winter. Determine the coefficient U_i for:

(*a*) Heat flowing downward from uncooled room above to cooled space below (a summer condition) and,

(*b*) Heat flowing upward from heated room below to unheated space above (a winter condition).

Solution:

(*a*) Use Table 16, Part D, and corresponding to $U = 0.18$ in Column 1 find, in Column 11, $U_i = 0.049$. Use 0.05.

(*b*) Use Table 16, Part C, and corresponding to $U = 0.22$ in Column 1 find, in Column 11, $U_i = 0.12$.

Special Uses of Table 16

Values of U_i for insulating applications or combinations other than those indicated by the headings of Columns 2 to 14 of Table 16 can be ascertained if the table is used appropriately. For instance, going horizontally in the table from Column 2 to Column 3 is equivalent to adding 1/2 in. of fibrous insulation to the construction. Similarly, going from Column 2 to Column 4 adds 1 1/2 in. of fibrous insulation to the construction. In the same way, going horizontally from Column 8 to Column 11 is equivalent to adding to a construction the insulating value of one additional highly reflective (E = 0.05) air space, and going from Column 6 to Column 12 in effect adds two non-reflective (E = 0.82) air spaces to the construction, etc.

Examples 5 and 6 show the combinational use of Table 16

Example 5: Determine the coefficient U_i for the wall of *Example 3*, with 1 1/2 in. of fibrous insulation added on one side of the air space.

Solution: U_i can be determined in several ways, by using Table 16, Part A, for example;

(*a*) By going from Column 1 to Column 2 three times, for a total of 1 1/2 inches of insulation, as follows; enter Column 1 at 0.24 and find $U_i = 0.166$ in Column 2; enter Column 1 at 0.166 and find $U_i = 0.126$ in Column 2; enter Column 1 at 0.126 and find $U_i = 0.102$ in Column 2. Therefore, for a total of 1 1/2 in. of insulation, use 0.10.

(*b*) More simply, by going from 0.24 in Column 2 to 0.103 in Column 4. Use 0.10.

Example 6: Considering again the wall of *Example 3*, assume that one-inch blanket insulation is to be installed in mid-space,

(Continued on p. 113.)