Table 17 . . . . Effective Resistance of Ventilated Attics[a]—(Summer Condition)[11]

PART A. NON-REFLECTIVE SURFACES

Ventilation Air temp., F	Sol-air[d] temp., F	No Ventilation		Natural Ventilation		Power Ventilation[e]					
		Ventilation rate, cfm/sq ft									
		0		0.1[b]		0.5		1.0		1.5	
		1/U Ceiling resistance, ru[c]									
		10	20	10	20	10	20	10	20	10	20
80	120	1.9	1.9	2.8	3.4	6.3	9.3	9.6	16	11	20
	140	1.9	1.9	2.8	3.5	6.5	10	9.8	17	12	21
	160	1.9	1.9	2.8	3.6	6.7	11	10	18	13	22
90	120	1.9	1.9	2.5	2.8	4.6	6.7	6.1	10	6.9	13
	140	1.9	1.9	2.6	3.1	5.2	7.9	7.6	12	8.6	15
	160	1.9	1.9	2.7	3.4	5.8	9.0	8.5	14	10	17
100	120	1.9	1.9	2.2	2.3	3.3	4.4	4.0	6.0	4.1	6.9
	140	1.9	1.9	2.4	2.7	4.2	6.1	5.8	8.7	6.5	10
	160	1.9	1.9	2.6	3.2	5.0	7.6	7.2	11	8.3	13
PART B. REFLECTIVE SURFACES[f]											
80	120	6.5	6.5	8.1	8.8	13	17	17	25	19	30
	140	6.5	6.5	8.2	9.0	14	18	18	26	20	31
	160	6.5	6.5	8.3	9.2	15	18	19	27	21	32
90	120	6.5	6.5	7.5	8.0	10	13	12	17	13	19
	140	6.5	6.5	7.7	8.3	12	15	14	20	16	22
	160	6.5	6.5	7.9	8.6	13	16	16	22	18	25
100	120	6.5	6.5	7.0	7.4	8.0	10	8.5	12	8.8	12
	140	6.5	6.5	7.3	7.8	10	12	11	15	12	16
	160	6.5	6.5	7.6	8.2	11	14	13	18	15	20

[a] The term *effective resistance* is used when there is attic ventilation. A value for no ventilation is also included. The effective resistance of the attic may be added to the resistance (1/U) of the ceiling (Table 16, Part D) to obtain the effective resistance of the combination based on sol-air (Chapter 13) and room temperature. These values apply to wood frame construction with a roof deck and roofing having a conductance of 1.0 Btu/(sq ft) (hr) (F deg).

[b] When attic ventilation meets the requirements of Table 3 in Chapter 10, 0.1 cfm/sq ft may be assumed as the natural summer ventilation rate for design purposes.

[c] *Resistance Unit*, abbreviated ru is one (hr) (sq ft) (F deg) per Btu. Determine ceiling resistance from Tables 11 and 16, and correct for framing by Figure 7. *Do not* add the effect of a reflective surface facing the attic to the ceiling resistance from Table 16, Part D, as it is accounted for in Table 17, Part B.

[d] Roof surface temperature rather than sol-air temperature (see Chapter 13) may be used if 0.25 is subtracted from the attic resistance shown.

[e] Based on air discharging outward from attic.

[f] Surfaces with effective emissivity E of 0.05 between ceiling joists facing the attic space.

by the roof area. Values of U_r and U_{ce} should be calculated using a value of 2.5 (the reciprocal of one-half the air space resistance, 0.80) rather than the conductances of surfaces facing the attic, since the attic is assumed to be equivalent to an air space.

If the attic contains windows, dormers, and vertical wall spaces, and if their area is small compared to that of the roof, they may be considered part of the roof area. For accuracy, the sum of the coefficients of each individual section, multiplied by its percentage of the total area, should be used as U_r. Where attic wall areas are large or where louvers or vents are used, it is preferable to estimate the attic temperature as illustrated in Chapter 12, and calculate the heat loss through the ceiling by multiplying the value of U_{ce} for the ceiling by the difference in temperature above and below the ceiling.

BASEMENT FLOOR, BASEMENT WALL, AND CONCRETE SLAB FLOOR COEFFICIENTS

The heat transfer through basement walls and floors to the ground is dependent on the temperature difference between the air within and that of the ground, on the material constituting the wall or floor, and on the conductivity of the surrounding earth. The conductivity of the earth will vary with local conditions, and is usually unknown. Tests[12] at the ASHAE Research Laboratory indicate a heat flow of approximately 2.0 Btu per (hr) (sq ft) through an uninsulated concrete basement floor, with a temperature difference of 20 deg between ground temperature and the air temperature 6 in. above the floor (see Table 18).

For basement walls below grade only, the temperature difference for winter design conditions will be greater than for the floor. The test results indicate a unit area heat loss, at mid-height of the basement wall portion below grade approximately twice that of the same floor area.

For concrete slab floors laid in contact with the ground at grade level, tests[13] indicate that for *small floor areas* (equal to

Table 18 . . . . Coefficients of Transmission (U) of Concrete Basement Floors on Ground with Various Types of Finish Flooring

U = 0.10[a] Btu per (hr) (sq ft) (Fahrenheit degree temperature difference between the ground and the air over the floor).

[a] Since authentic data are not available, this coefficient is sometimes used for concrete floors on ground. For more recent procedures[13] refer to *National Bureau of Standards Report BMS-103.*

that of a house 25 feet square) the heat loss may be calculated as proportional to the length of exposed edge rather than total area. This amounts to 0.81 Btu per (hr) (linear foot of exposed edge) (Fahrenheit degree difference between the indoor air temperature and the average outdoor air temperature). It should be noted that this may be appreciably reduced by insulating under the ground slab, and also along the edges between the floor and the abutting walls. See also sections on Basement Temperatures and Heat Loss, and on Floor Heat Loss in Basementless Houses, in Chapter 12. In most calculations if the perimeter loss is calculated accurately, no other floor loss need be considered.

GLASS AND DOOR COEFFICIENTS

The U values for glass sheets and hollow glass block, given in Sections A, B, and C of Table 19, have been computed by methods and data given in an ASHVE Research Paper.[5] It is assumed that the surface conductance for convection loss to the air is 4.0 Btu per (hr) (sq ft) (F deg). It is also assumed that the glass loses heat by radiation to the ground and to the clear sky, which together have an effective radiating temperature *below* the air temperature. It is therefore necessary to determine, by trial and error, the temperature of the outdoor glass surface such that the sum of the radiation and convection losses equals the heat conducted through the glass section, and equals the heat delivered to the glass from the heated space. This heat flow, divided by the *air-to-air* temperature difference, results in a U value that is used in the usual manner. The equivalent surface conductance for radiation and convection combined, based on *air-to-surface* temperature difference, therefore varies from about 5.5 for single glass to about 6.6 for double glass for exactly the same environmental design conditions. Curtains, draperies, Venetian blinds, etc., will result in lower glass surface temperatures than when the windows are not covered.

It is assumed that the room air temperature equals the average temperature of the room surfaces *seen* by the glass. Special consideration should be given to those cases where the glass *sees* interior surfaces at temperatures differing greatly from the room air temperature, i.e., such cases as in sun rooms, greenhouses, and some panel heated rooms, or where there is an unusual amount of air motion in the vicinity of the glass. Although based on zero outdoor air, the values change only slightly with different design temperatures, being about 5 percent greater for a 30 F outdoor design temperature.

In computing the Table 19 values, consideration of the dependence of the indoor surface conductances upon temperature and direction of heat flow leads to surface conductances averaging about 1.50 for block and vertical glass, and about 1.80 for horizontal glass, as compared to the value of 1.46 used in computing U values given in other tables in this chapter. *These values should therefore be used in estimating the temperature at which condensation on glass surfaces will occur.*

The application factors given in Section D of Table 19 are based upon hot box tests summarized in a research bulletin,[14] and are approximate only. In practice, some variation in heat flow through windows having the same ratio of glass to sash area, may be expected because of difference in construction details and in air-space edge effects. The high conductance of aluminum and steel sash must be taken into consideration where excessive amounts of metal sash and frames are involved. This is particularly important when they are in close proximity to radiation heat sources and are consequently subjected to high differential temperatures.

Table 19 . . . . Coefficients of Transmission (U) of Windows, Skylights and Glass Block Walls

Coefficients are expressed in Btu per (hour) (square foot) (Fahrenheit degree difference in temperature between the air on the two sides). Those for outdoor exposures are based upon the following outdoor conditions: 0 F air temperature, clear skies, no solar radiation, and 15 mph outdoor wind velocity

SECTION A—VERTICAL GLASS SHEETS

Number of Sheets	One	Two			Three		
Air space, inches	None	¼	½	1[a]	¼	½	1[a]
Outdoor exposure	1.13	0.61	0.55	0.53	0.41	0.36	0.34
Indoor exposure	0.75	0.50	0.46	0.45	0.38	0.33	0.32

SECTION B—HORIZONTAL GLASS SHEETS

	Heat Flow Up				Heat Flow Down			
Number of Sheets	One	Two			One	Two		
Air space, inches	None	¼	½	1[a]	None	¼	½	1[a]
Outdoor exposure	1.40	0.70	0.66	0.63	[b]	[c]	—	—
Indoor exposure	0.96	0.59	0.56	0.56	0.60	0.43	0.39	0.38

SECTION C—WALLS OF HOLLOW GLASS BLOCK

Description	Outdoor Exposure	Indoor Partition
5¾ x 5¾ x 3⅞ in. thick	0.60	0.46
7¾ x 7¾ x 3⅞ in. thick	0.56	0.44
11¾ x 11¾ x 3⅞ in. thick	0.52[d]	0.40
7¾ x 7¾ x 3⅞ in. thick with glass fiber dividing the cavity	0.48	0.38
11¾ x 11¾ x 3⅞ in. thick with glass fiber dividing the cavity	0.44	0.36

SECTION D—APPROXIMATE APPLICATION FACTORS FOR WINDOWS—MULTIPLY FLAT GLASS U VALUES BY THESE FACTORS

Window Description	Single Glass		Double Glass[e]		Windows with Storm Sash[f]	
	Percent Glass[g]	Factor	Percent Glass[g]	Factor	Percent Glass[g]	Factor
Sheets	100	1.00	100	1.00		
Wood sash	80	0.90	80	0.95	80	0.90
Wood sash	60	0.80	60	0.85	60	0.80
Steel sash	80	1.00	80	1.20	80	1.00[h]
Aluminum	80	1.10	80	1.30	80	1.10

[a] For 1 in. or greater.

[b] See Chapter 13, Tables 14 and 15, for summer load.

[c] See Chapter 13, Tables 14, 15, and 16, for summer load.

[d] From unpublished data recommended by ASHAE Tech. Adv. Comm. on Heat Flow Through Fenestration.

[e] Unit type double glazing (two lights or panes in same opening).

[f] Use with U values for two sheets with 1 in. air space.

[g] Based on area of exposed portion of sash; does not include frame or portions of sash concealed by frame.

[h] For metal storm sash or metal sash with attached storm pane.