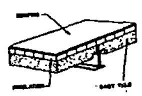
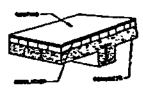
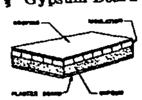
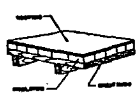
TABLE 11. SUMMER COEFFICIENTS OF HEAT TRANSMISSION U OF FLAT ROOFS COVERED WITH BUILT-UP ROOFING[a]

Btu per (hour) (square foot) (F deg difference between the air on the two sides)

Type of Roof Deck (Ceiling not shown)	Thickness of Roof Deck (Inches)		Insulation on Top of Deck (Covered With Built-Up Roofing): No Ceiling—Underside of Roof Exposed					Furred Ceiling with Air Space, Metal Lath and Plaster				
			No Insulation	Insulating Board[d] Thickness, In. ½	1	1½	2	No Insulation	Insulating Board[d] Thickness, In. ½	1	1½	2
Flat Metal Roof Deck 	4 Ply Felt Roof		0.73	0.35	0.23	0.17	0.13	0.40	0.25	0.18	0.14	0.12
	Ditto + ½ in. Slag		0.54	0.30	0.20	0.16	0.13	0.34	0.22	0.16	0.13	0.11
Precast Cement Tile 	4 Ply Felt Roof	1⅝	0.67	0.33	0.22	0.17	0.13	0.38	0.24	0.18	0.14	0.12
	Ditto + ½ in. Slag	1⅝	0.50	0.28	0.20	0.15	0.12	0.32	0.21	0.17	0.13	0.11
Concrete 	4 Ply Felt Roof	2	0.65	0.33	0.22	0.16	0.13	0.37	0.24	0.18	0.14	0.12
		4	0.59	0.31	0.21	0.16	0.13	0.36	0.23	0.17	0.13	0.12
		6	0.54	0.30	0.20	0.16	0.13	0.33	0.22	0.17	0.13	0.11
	Ditto + ½ in. Slag	2	0.49	0.28	0.20	0.15	0.12	0.31	0.21	0.16	0.13	0.11
		4	0.46	0.27	0.19	0.15	0.12	0.30	0.21	0.16	0.13	0.11
		6	0.42	0.26	0.19	0.14	0.12	0.29	0.20	0.16	0.13	0.10
Gypsum and Wood Fiber[b] on ½" Gypsum Board 	4 Ply Felt Roof	2½	0.34	0.23	0.17	0.13	0.12	0.25	0.18	0.14	0.12	0.097
		3½	0.28	0.20	0.15	0.12	0.11	0.21	0.16	0.13	0.11	0.094
	Ditto + ½ in. Slag	2½	0.29	0.20	0.16	0.13	0.11	0.22	0.16	0.13	0.11	0.093
		3½	0.25	0.18	0.14	0.12	0.10	0.19	0.15	0.13	0.10	0.090
Wood[c] 	4 Ply Felt Roof	1	0.43	0.26	0.19	0.15	0.12	0.29	0.20	0.15	0.13	0.11
		1½	0.33	0.22	0.17	0.13	0.11	0.24	0.18	0.14	0.12	0.097
		2	0.29	0.20	0.16	0.13	0.11	0.22	0.16	0.13	0.11	0.094
		3	0.22	0.16	0.13	0.11	0.09	0.17	0.13	0.12	0.10	0.085
	Ditto + ½ in. Slag	1	0.35	0.23	0.17	0.14	0.11	0.25	0.18	0.14	0.12	0.10
		1½	0.29	0.20	0.15	0.12	0.10	0.21	0.17	0.13	0.11	0.093
		2	0.26	0.19	0.14	0.12	0.10	0.20	0.15	0.13	0.10	0.090
		3	0.20	0.15	0.12	0.10	0.09	0.16	0.13	0.11	0.09	0.081

[a] The summer coefficients are considered temporary, and have been calculated with an outdoor wind velocity of 8 mph. For summer an inside surface conductance of 1.2 has been used instead of the regular 1.65 value. In all of these roofs a 4 ply felt roof has been assumed ⅜ in. thick, thermal conductivity = 1.33. Pitch and slag have been assumed as an additional thickness of ½ in. which has been assigned thermal conductivity = 1.0. In both cases thermal conductivity refers to one *inch* thickness.

[b] 87½ percent gypsum, 12½ percent wood fiber. Thickness indicated includes ½ in. gypsum board. This is a poured roof.

[c] Nominal thickness of wood is specified, but actual thickness was used in calculations.

[d] If corkboard insulation is used, the coefficient U may be decreased 10 percent.

A method of determining *heat flow rates*, when structure is not given in Tables 9 or 10, is illustrated in *Example 7*.

Example 7: A 4 in. stone concrete roof covered with an average depth of 4 in. cinder concrete (k = 4.9) on which is placed a ⅜ in. thick felt roof with ½ in. pitch and slag surface, is exposed to the sun. The location is the central part of the United States. Design temperatures are: outdoor 95 F; daily range 20 deg; indoor temperature 80 F. Find the heat flow rate at 2:00 p.m. for a day in July.

Solution: For the purpose of selecting the *equivalent temperature differential*, this construction is assumed to be equal approximately to an uninsulated 6 in. concrete roof, for which the equivalent temperature is found to be 38 deg in the 2:00 p.m. column of Table 9. Calculate the overall heat transmission coefficient U (see Equation 3 of Chapter 9) of the roof as follows:

$$U = \frac{1}{\frac{1}{1.2} + \frac{4}{12} + \frac{4}{4.9} + \frac{0.375}{1.33} + \frac{0.50}{1.00} + \frac{1}{4.0}} = 0.33.$$

The heat flow rate is then 38 × 0.33 equals 12.5 Btu per (hr) (sq ft).

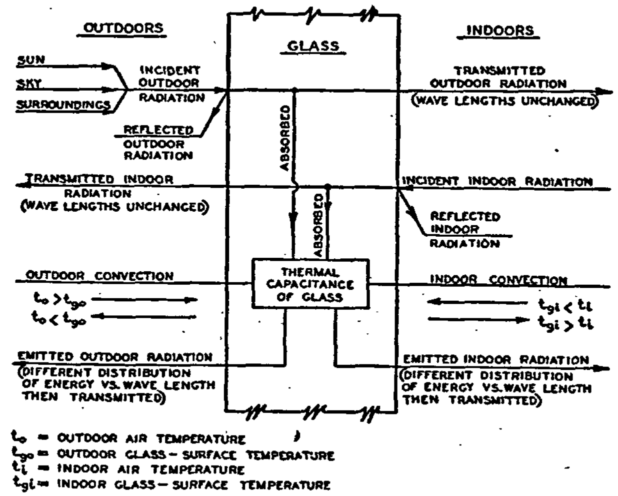


FIG. 2. INSTANTANEOUS HEAT-BALANCE CONDITIONS ON A GLASS SECTION

TABLES FOR CALCULATING SOLAR HEAT GAIN THROUGH GLASS AREAS

Basic Principles

In order to set forth the principles involved in calculating heat flow through glass areas, the general instantaneous heat-balance relation will be presented. It will be shown schematically in Fig. 2. The net heat gain for the indoor space is the result of several contributing phenomena. Some observations concerning the behavior of glass with respect to radiant energy will lead to a better understanding of the heat-balance relation. To various degrees glass transmits radiation having wave lengths between 0.29 and 4.75 microns. Of the portion not transmitted, part is absorbed, and the remainder is reflected. Outside these limits glass is opaque, absorbing approximately 94 percent and reflecting 6 percent. Only a negligible amount of radiant energy from a surface at 450 F has a wave length shorter than 4.75 microns. It is therefore convenient to treat all forms of solar radiant energy separately from radiant energy from other