at 2:00 p.m. during July for an outdoor design temperature 95 F, and an inside temperature 80 F.

Solution: From Table 14 in 2 p.m. column for 6 in. concrete plus 2 in. insulation, find the total equivalent temperature differential 34 deg. The overall heat transmission coefficient for summer is taken from Table 16 and is found to be 0.13. The heat flow rate equals 34 × 0.13 = 4.42 Btu per (hr) (sq ft).

Example 7: For the conditions of Example 6, find the rate of heat flow into building at 2:00 p.m. during July for design temperatures of 105 F (outdoor) and 78 F (indoor). Daily range of temperature 30 degrees, i.e., outdoor temperature minimum of 75 F which occurs at 4:00 or 5:00 a.m.; this being 30 deg less than the maximum.

Solution: Make correction in equivalent temperature differential in accordance with Note 5 in Table 14 as follows:

The correction for 27 deg design temperature difference is (27 − 15) = + 12.

The correction for 30 deg daily range is $\left(-\dfrac{30-20}{2}\right) = -5.$

Net total correction is + 12 − 5 = + 7.

The heat flow rate at 2:00 p.m. therefore is (34 + 7) × 0.13 = 5.32 Btu per (hr) (sq ft).

A method of determining *heat flow rates*, when structure is not given in Tables 14 or 15 is illustrated in *Example 8*.

Example 8: 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 14. Calculate the overall heat transmission coefficient U of the roof as follows:

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

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

GLASS AREAS—DESIGN TABLES

In order to clearly set forth the principles involved in calculating heat transfer through glass areas, the general instantaneous heat-balance relation will be presented. Fig. 5 shows this schematically. The net heat gain for the indoor space is the result of several contributing phenomena.

In discussing the heat gain through glass, there are three dimensionless quantities which require definition:

a = absorptivity of glass, or fraction of incident radiation intensity which is absorbed within the glass itself.

τ = transmissivity of glass, or fraction of incident radiation intensity which is transmitted through the glass.

r = reflectivity of glass, or fraction of incident radiation intensity which is reflected at the surface.

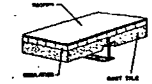
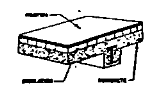
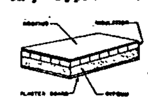
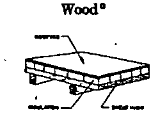
It is necessary that

$$a + \tau + r = 1 \tag{9}$$

These quantities vary with wave length and angle of incidence, primarily; and they are determined by the properties and thickness of the glass material concerned. Data are obtainable from glass manufacturers for their various products. The dependence of these quantities upon wave

TABLE 16. 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: No Insulation	No Ceiling: Insulating Board[d] Thickness, In. ½	1	1½	2	Furred Ceiling with Air Space, Metal Lath and Plaster: No Insulation	Furred Ceiling: 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		0.64	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	0.60	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 has been assumed as an additional thickness of ½ in. and has been assigned thermal conductivity = 1.0. In both cases thermal conductivity refers to one *inch* thickness.

[b] 87½ per cent gypsum; 12½ per cent 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 per cent.

length has important practical consequences; for example, common window glass transmits a large portion of incident *solar* radiation, whereas it transmits outward only a very small portion of the indoor radiation