TABLE 8. SUMMER DESIGN SOL-AIR TEMPERATURES USED FOR TABLES 9 AND 10

MEAN SUN TIME	SOL-AIR TEMPERATURE t_o FAHRENHEIT DEGREES								
	Any Surface[b]	Horiz.	North	East		South		West	
Ratio[a]: $\frac{\alpha}{f_{co}}$	0	0.225	0	0.225	0.125	0.225	0.125	0.225	0.125
12 Midnight	77	77	77	77	77	77	77	77	77
1 AM	76	76	76	76	76	76	76	76	76
2	76	76	76	76	76	76	76	76	76
3	75	75	75	75	75	75	75	75	75
4	74	74	74	74	74	74	74	74	74
5	74	74	74	75	80	74	74	74	74
6	74	76	74	110	93	74	74	74	74
7	75	91	75	123	100	75	75	75	75
8	77	106	77	126	103	82	78	77	77
9	80	119	80	125	104	93	86	80	80
10	83	129	83	117	100	102	93	83	83
11	87	137	87	108	96	110	99	89	87
12 Noon	90	142	90	92	92	114	104	96	92
1 PM	93	144	93	93	93	115	105	110	102
2	94	140	94	95	94	111	104	124	111
3	95	132	95	95	95	104	100	135	119
4	94	120	94	94	94	99	96	141	120
5	93	107	93	93	93	95	94	139	118
6	91	96	91	91	91	91	91	125	111
7	87	90	87	87	87	88	87	103	94
8	85	85	85	85	85	85	85	85	85
9	83	83	83	83	83	83	83	83	83
10	81	81	81	81	81	81	81	81	81
11	79	79	79	79	79	79	79	79	79
24 Hr Avg t_m	83.1	100.5	83.1	93.0	88.4	89.0	86.2	93.0	88.4

[a] α = surface absorptivity, dimensionless: roof = 0.9; dark walls = 0.9, and light walls = 0.5. f_{co} = unit convective conductance = 4.0 Btu per (hr) (F deg).

[b] values in this column are magnitudes of t_o, the outdoor air temperature.

of walls and roofs which appear in the literature.[11, 12] Both analytical and experimental studies have been made on the problem[10] of heat flow through walls and roofs. Those concerned with a further study of the details of cooling-load estimates in particular relation to periodic heat flow will find much of value and interest in the reports of experimental studies of these problems.[10, 11, 12, 13, 14, 15] The reader may also refer to the Cooling Load chapter of THE GUIDE 1952 for the theory of heat flow through walls and roofs.

PRACTICAL TABLES FOR CALCULATING SOLAR HEAT GAIN THROUGH WALLS AND ROOFS

The analytical[10] method reported by Mackey and Wright was used by Stewart[16] to obtain temperature differentials based on Table 8 and shown in Tables 9 and 10. These analytical procedures, as well as those using Tables 9 and 10, presented here, yield generally higher rates of heat gain

than reported for Pittsburgh in early A.S.H.A.E. experimental studies. Current authoritative opinion indicates a preference for analytical calculations. Thermal and physical properties of materials used in these tables are given in a paper.[16] The rate of heat flow is obtained by multiplying the overall heat transmission coefficient of the structure by the equivalent temperature differential obtained from the tables.

Tables 9 and 10 were developed by using an outdoor surface conductance of 4.0 and an indoor film conductance of 1.65 Btu (hr) (sq ft) (F deg). A reduction was made in the temperature differentials for roofs amounting to some 20 percent of solar radiation as explained by Stewart.[16] This was to compensate for several factors, one of which is the radiant heat lost to the sky which is not included in the Mackey and Wright method. Recent experimental work by Parmelee[17] and previous work by Brunt[18] gives data showing the magnitude of this radiant heat loss from a roof or wall to the sky. Temperature differentials for roofs probably would be reduced below those shown in Table 9 whenever the radiant heat lost to the sky is included in calculation of sol-air temperature. The *temperature differentials* for roofs were based on an inside surface conductance of 1.65 because the charts prepared by Mackey and Wright[10] used this value, and it was not considered practicable to repeat their work using a different film coefficient. An examination of the values given in their paper indicates that the *temperature differential* would be changed very little even if a value 1.20 were used instead of 1.65. But to obtain the heat flow rates through roofs, more accurate values will be obtained if the *overall heat transmission coefficient is calculated using* 1.2 as the inside film conductance for summer.

The roof coefficients of transmission for summer shown in Table 11 are based on surface conductances f_{cro} of 4.0 for an outside roof surface and 1.20 for an inside ceiling surface. The outside conductance 4.0 is used for summer because it corresponds to a wind velocity of approximately 7.5 mph averaged for rough and smooth surfaces, and is more representative of summer wind velocities. Also, the lower wind velocity should be used in order to be on the safe side in determining the sol-air temperature. The inside conductance 1.20 is used because the convective portion of the film conductance for downward heat flow from a horizontal surface is appreciably less than the winter conductance for heat flowing upward.

Since there is little difference in *wall transmission coefficients* for summer, based on the conductances of 4.0 and 1.65, and the winter coefficients, based on 6.0 and 1.65, it is recommended that the overall coefficient U, *for walls*, be taken directly from the tables in Chapter 9 in which they are based on an outside film conductance of 6.0, corresponding to a 15 mph wind velocity.

Advantages of Equivalent Temperature Differential Method

The advantages of the *equivalent* temperature differential method of determining the total heat transmission are given in following paragraphs, and are apparent from *Examples 5* to *7*.

1. The total sensible heat flow is obtained by multiplying the overall heat transmission coefficient, U, and the equivalent temperature differential indicated in Tables 9 and 10.

2. The temperature differentials listed for a few representative types of construction may be used on all classes of walls and roofs, even though the overall heat transmission coefficient is different, provided the structure has thermal and physical properties similar to one of those listed in Tables 9 and 10.

3. Adjustments can be made, according to instructions given in the footnotes, for room and outdoor conditions different from those on which the tables are based.