TABLE 9. TOTAL EQUIVALENT TEMPERATURE DIFFERENTIALS FOR CALCULATING HEAT GAIN THROUGH SUNLIT AND SHADED ROOFS

Description of Roof Construction[a]	Sun Time A.M. 8	10	12	P.M. 2	4	6	8	10	12
Light Construction Roofs—Exposed to Sun									
1″ Wood[b] or 1″ Wood[b] + 1″ or 2″ Insulation	12	38	54	62	50	26	10	4	0
Medium Construction Roofs—Exposed to Sun									
2″ Concrete or 2″ Concrete + 1″ or 2″ Insulation or 2″ Wood[b]	6	30	48	58	50	32	14	6	2
2″ Gypsum or 2″ Gypsum + 1″ Insulation; 1″ Wood[b] or 2″ Wood[b] or 2″ Concrete or 2″ Gypsum + 4″ Rock Wool in Furred Ceiling	0	20	40	52	54	42	20	10	6
4″ Concrete or 4″ Concrete with 2″ Insulation	0	20	38	50	52	40	22	12	6
Heavy Construction Roofs—Exposed to Sun									
6″ Concrete	4	6	24	38	46	44	32	18	12
6″ Concrete + 2″ Insulation	6	6	20	34	42	44	34	20	14
Roofs Covered with Water—Exposed to Sun									
Light Construction Roof with 1″ Water	0	4	16	22	18	14	10	2	0
Heavy Construction Roof with 1″ Water	−2	−2	−4	10	14	16	14	10	6
Any Roof with 6″ Water	−2	0	0	6	10	10	8	4	0
Roofs with Roof Sprays—Exposed to Sun									
Light Construction	0	4	12	18	16	14	10	2	0
Heavy Construction	−2	−2	2	8	12	14	12	10	6
Roofs in Shade									
Light Construction	−4	0	6	12	14	12	8	2	0
Medium Construction	−4	−2	2	8	12	12	10	6	2
Heavy Construction	−2	−2	0	4	8	10	10	8	4

[a] Includes 3/8 in. felt roofing with or without slag. May also be used for shingle roof. [b] Nominal thickness of the wood.

NOTES FOR TABLE 9

Explanation: {Total heat transmission from solar radiation and temperature difference between outside and room air. Btu per (hr) (sq ft) of roof area} = {Equivalent temperature differential from above table} × {Heat transmission coefficient for summer Btu per (hr) (sq ft) (F deg)}

1. *Source.* Calculated by Mackey and Wright method (see reference list) and adjusted after studying ASHVE original test data. Estimated for July in 40 deg north latitude. (For sol-air temperatures used in calculations see Table 8.) For typical design day where the maximum outdoor temperature is 95 F and minimum temperature at night is approximately 75 F (daily range of temperature, 20 F) mean 24 hr temperature 84 F for a room temperature of 80 F. All roofs have been assumed a dark color which absorbs 90 percent of solar radiation, and reflects only 10 percent.

2. *Application.* These values may be used for all normal air conditioning estimates; usually without correction, in latitude 0 deg to 50 deg north or south when the load is calculated for the hottest weather. Note 5 explains how to adjust the temperature differential for other room and outdoor temperatures.

3. *Peaked Roofs.* If the roof is peaked and the heat gain is primarily due to solar radiation, use for the area of the roof, the area projected on a horizontal plane.

4. *Attics.* If the ceiling is insulated and if a fan is used in the attic for positive ventilation, the total temperature differential for a roof exposed to the sun may be decreased 25 percent.

5. *Corrections. For temperature difference when outdoor maximum design temperature minus room is different from 15 deg.* If the outdoor design temperature minus room temperature is different from the base of 15 deg, correct as follows: When the difference is greater (or less) than 15 deg add the excess to (or subtract the deficiency from) the above differentials.

For outdoor daily range of temperature other than 20 deg. If the daily range of temperature is less than 20 deg, add 1 deg for every 2 deg lower daily range; if the daily range is greater than 20 deg, substract 1 deg for every 2 deg higher daily range. For example, the daily range in Miami, Florida is 12 deg or 8 deg less than 20 deg, therefore, the correction is + 4 deg at all hours of the day.

Light Colors. Credit should not be taken for light colored roofs except where the permanence of the light color is established by experience, as in rural areas or where there is little smoke. When the exterior surface of roof exposed to the sun is a light color, such as white or aluminum (which absorb approximately 50 percent and reflect 50 percent of the solar radiation) add to the temperature differential for roof in shade 55 percent of the difference between the roof in sun and roof in shade. When the roof exposed to the sun is a medium color such as light grey, blue or green, or bright red, add 80 percent of this difference.

For solar transmission in latitudes other than 40 deg north, and in other months. The table values of temperature differentials will be approximately correct for a roof in the following months:

North Latitude: Latitude (deg)	Months	South Latitude: Latitude (deg)	Months
0	All Months	0	All Months
10	All Months	10	All Months
20	All Months except Nov, Dec, Jan	20	All Months except May, June, July
30	Mar, Apr, May, June, July, Aug, Sept	30	Sept, Oct, Nov, Dec, Jan, Feb, Mar
40	April, May, June, July, Aug	40	Oct, Nov, Dec, Jan, Feb
50	May, June, July	50	Nov, Dec, Jan

For other months, the total temperature differential (t_x) may be approximated by the use of the following formula:

$$t_x = t_s + \frac{I_x}{I_y}(t_v - t_s)$$

where t_s = temperature differential for the same roof in shade for desired time of day; obtained from Table 9.

I_y = maximum solar transmission through glass, Btu per (hr) (sq ft) for flat skylight in July, 40 deg north latitude (*Note:* this is maximum value irrespective of time).

I_x = same as I_y except use the maximum value for flat skylight, for month, and latitude desired for t_x.

t_v = temperature differential for particular roof exposed to sun for the desired time of day from Table 9.

(Note that this makes adjustment only for solar radiation and that there may be additional correction for outdoor temperature.)

air temperature t_e is the temperature of the outdoor air, which, in the absence of all radiation exchanges, would give the same rate of heat entry into the surface as would exist with the actual combination of incident solar radiation, radiant energy exchange with the sky and other outdoor surroundings, and convective heat exchange with the outdoor air.

The sol-air temperature data[5, 6, 10] as developed by Mackey and Wright for an industrial atmosphere were used as a basis for preparing Table 8 showing summer design sol-air temperatures. Sol-air temperatures may also be estimated from experimental observation of surface temperatures 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