TABLE 13. SUMMER DESIGN SOL-AIR TEMPERATURES USED FOR TABLES 14 AND 15

MEAN SUN TIME	SOL-AIR TEMPERATURE t_e, FAHRENHEIT DEGREES								
	Any Surface[b]	Horiz.	North	East		South		West	
Ratio[a]: $\frac{b}{f_o}$	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] b = surface absorptivity, dimensionless: roof = 0.9; dark walls = 0.9, and light walls = 0.5. f_o = unit convective conductance = 4.0 Btu per (hr) (F deg).

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

The design sol-air temperature at a time earlier than 9:30 p.m. by the time lag (at 4:00 p.m.) for a west wall in New York, N. Y., is, from Table 10,

$$t'_e = 94 + \frac{0.175}{0.25}(145 - 94) = 129.7 \text{ F}$$

From Equation 6, the instantaneous design rate of heat gain is

$$\frac{q}{A} = 0.41\,[(93 - 80) + 0.44\,(129.7 - 93)]$$

= 11.9 Btu per hour for each square foot of sunlit surface.

From Table 12, the time lag is 5.5 hr. From Table 10, the time of maximum rate of heat entry for a west wall is 4:00 p.m. The time of maximum instantaneous rate of heat gain by the enclosure, as far as the west wall is concerned, is then 4:00 p.m. plus 5.5 hr or 9:30 p.m. (This is *sun time*.) The computed rate is therefore the maximum.

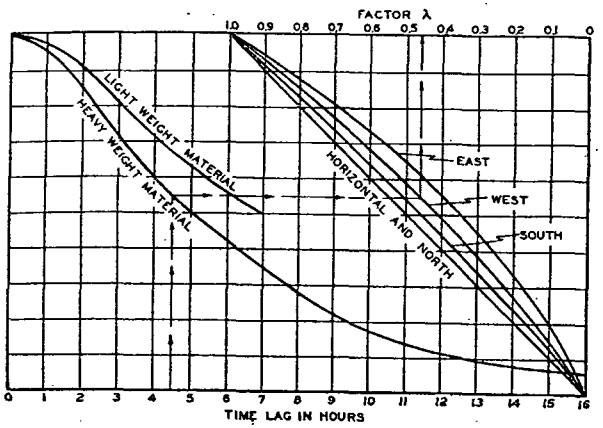

FIG. 4. APPROXIMATE VALUE OF THE AMPLITUDE DECREMENT FACTOR λ FOR USE IN EQUATION 6

Composite Walls or Roofs, Constant Indoor Temperature

A composite wall or roof is made up of two or more layers of different materials. Since the analytical solution for this type of construction has not been reduced to simple and practical terms, it is necessary at present to utilize approximate procedures. In accord with the results of comparative calculations, the following procedures are suggested.[7]

To find the time lag for a composite construction:

a. Find the time lag for each layer from Table 12.

b. Add the individual time lags, recognizing that this sum will always be *less* than the true time lag for the actual composite wall.

c. To the sum from (b), *add* an *arbitrary* additional lag of ½ to 1 hr to obtain the estimated lag for the actual construction. For two-layer and light construction walls, the ½-hr value will be suitable while, for walls of three or more layers, or very heavy construction, the 1-hr value is preferred. For intermediate conditions, individual judgment is the only guide. (Computed time lags should not be considered to be accurate closer than to about the nearest hour by this method.)

To find the amplitude decrement factor, λ, for composite construction:

Having determined the time lag and the orientation, use Fig. 4. (Note also that the factor λ for a composite construction should never exceed the *product* of the factors for the individual layers.)

One valuable result of the analytical studies made to date on composite walls has been the demonstration of the effect of the *order* of the materials. Other factors remaining the same, the use of the material of lower density on the weather side will increase the time lag and decrease the instantaneous maximum rate of heat gain.

Two examples are given to show how to estimate, roughly, the instantaneous rate of heat gain through sunlit composite walls or roofs.

Example 4. Estimate the maximum instantaneous design rate of heat gain from a horizontal roof in New York, N. Y., that is made up of black built-up roofing on the