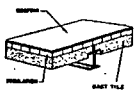
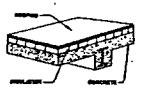
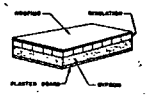
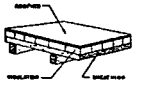
TABLE 14. SUMMER COEFFICIENTS OF HEAT TRANSMISSION U OF FLAT ROOFS COVERED WITH BUILT-UP ROOFING[a]

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.				No Insulation	Insulating Board[d] Thickness, In.			
			½	1	1½	2		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 1½	0.67	0.33	0.22	0.17	0.13	0.38	0.24	0.18	0.14	0.12
	Ditto + ½ in. Slag 1½	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	0.13
	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	0.23	0.17	0.13	0.11
	Ditto 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
	+ ½ in. Slag 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 2½	0.29	0.20	0.16	0.13	0.11	0.22	0.16	0.13	0.11	0.093
	+ ½ in. Slag 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 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
	+ ½ in. Slag 2	0.26	0.19	0.14	0.12	0.10	0.20	0.15	0.12	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 ¾ in. thick, thermal conductivity = 1.33. Pitch and slag have been assumed as an additional thickness of ¼ 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.

sky which is not included in the Mackey and Wright method. The *temperature differentials* for roofs were based on an inside surface conductance of 1.65 because the charts prepared by Mackey and Wright[11] 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 of heat transfer in summer.

The roof coefficients of transmission for summer shown in Table 14 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 factor of downward heat flow from a horizontal surface is appreciably less than the winter conductance, which applies when heat is flowing upward.

Since there is little difference in *wall transmission coefficients* for summer, based on 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 10* to *12*.

1. The total sensible heat flow is obtained by multiplying the overall heat transmission coefficient, U, and the equivalent temperature differential indicated in Tables 12 and 13.

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 12 and 13.

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

Examples of Use of Equivalent Temperature Tables

Example 10. Given: A roof is constructed of 6 in. of stone concrete with 2 in. of insulating board and tar felt roofing ¾ in. thick, and is exposed to the sun. The location is the central part of the United States. Find the rate of heat flow into building at 2:00 p.m. during July for an outdoor design temperature 95 F, and an inside temperature 80 F.

Solution: From Table 12 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 14 and is found to be 0.13. The heat flow rate equals $34 \times 0.13 = 4.42$ Btu per (hr) (sq ft).

Example 11: For the conditions of Example 10, 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 deg, *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 12 as follows:

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