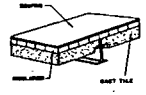
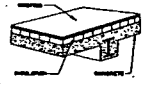
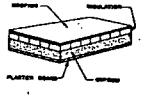
TABLE 11. SUMMER COEFFICIENTS OF HEAT TRANSMISSION U OF FLAT ROOFS COVERED WITH BUILT-UP ROOFING[a]

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 2	0.65	0.33	0.22	0.16	0.13	0.37	0.24	0.18	0.14	0.12
	Felt 4	0.59	0.31	0.21	0.16	0.13	0.36	0.23	0.17	0.13	0.12
	Roof 6	0.54	0.30	0.20	0.16	0.13	0.33	0.22	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 2½	0.34	0.23	0.17	0.13	0.12	0.25	0.18	0.14	0.12	0.097
	Roof 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 1	0.43	0.26	0.19	0.15	0.12	0.29	0.20	0.15	0.13	0.11
	Felt 1½	0.33	0.22	0.17	0.13	0.11	0.24	0.18	0.14	0.12	0.097
	Roof 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	0.13	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 have been assumed as an additional thickness of ½ 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.

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.V.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 outside surface conductance of 4.0 and an inside 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 of heat transfer in 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 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 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 trans-