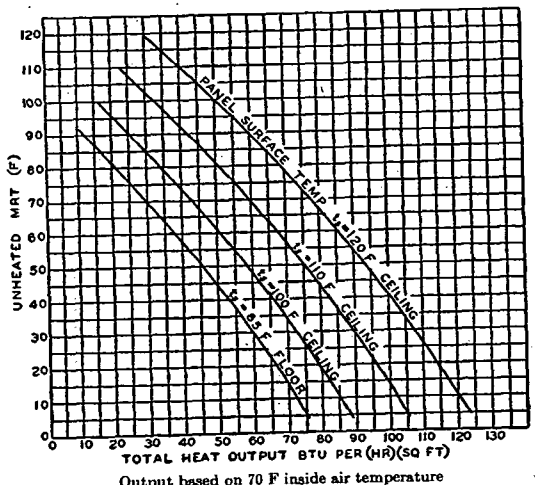
Peterson, and gives values which may be used for convection outputs from floor panels.

More experimental data are required on convection outputs of ceiling panels. The warming of the air by a ceiling panel does not in itself create convection currents. Instead, it is the action of cooling along the outside wall or walls which causes the air movement. In lieu of actual test data which would take this factor into account, it is recommended that the values obtained from Curve B in Fig. 10, based on the Nusselt and Henky equation

$$q_c = 0.22\ (t_s - t_a)^{1.25} \qquad (6)$$

be used for determining convection outputs from ceiling panels for various surface temperatures.



Output based on 70 F inside air temperature

FIG. 11. TOTAL PANEL OUTPUT RADIATION PLUS CONVECTION

Combined Heat Transfer

The *sum* of the *radiant* heat transfer from Fig. 9 and the *convective* transfer from curve A or B of Fig. 10, gives the combined useful heat transfer to the room for any combination of panel surface temperature, room air temperature, unheated mean radiant temperature (UMRT), and panel location.

Example 1: Find the combined total useful heat transfer from a square foot of floor panel having a surface temperature of 85 F, when the average room air temperature is 70 F and the mean radiant temperature UMRT of the unheated room surfaces is 60 F.

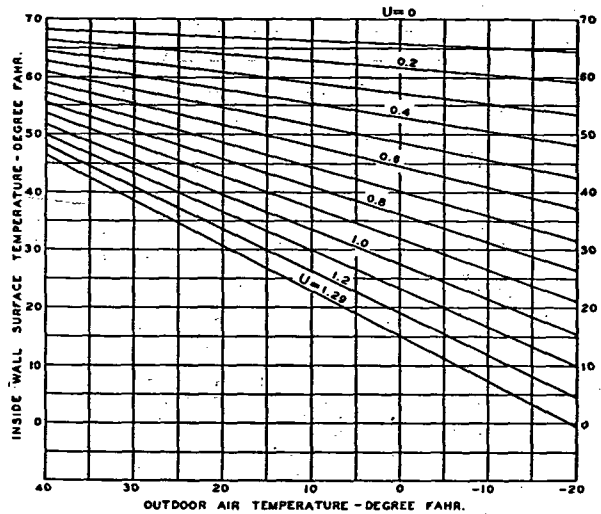
Solution:	Btu/(hr)(sq ft)
Radiation (Fig. 9 for UMRT of 60 F and t_s of 85 F)	21.4
Convection (Fig. 10, Curve A for a temperature difference of 15 deg F)	16.9
Total useful heat transfer	38.3

Example 2: Find the combined total useful heat transfer from a square foot of ceiling panel having a surface temperature of 100 F, when the average room air temperature is 70 F and the mean radiant temperature UMRT of the unheated room surfaces is 60 F.

Solution:

	Btu/(hr)(sq ft)
Radiation (Fig. 9 for UMRT of 60 F and t_s of 100 F)	35.3
Convection (Fig. 10, Curve B for a Δt of 30 F)	15.5
Total useful heat transfer	50.8

Since the greater number of panel installations are designed for an average room air temperature of 70 F, it is possible to present in chart form



Inside air temperature = 70 F

FIG. 12. RELATION OF OVERALL COEFFICIENT OF HEAT TRANSFER TO INSIDE SURFACE TEMPERATURE

(see Fig. 11) the relationship between panel output (radiation plus convection) and the unheated mean radiant temperature for various surface temperatures and panel positions based on 70 F inside air temperature. From Fig. 11 the panel output for *Examples* 1 and 2 can be read directly, 38.3 and 50.8 Btu, respectively. Similarly, combined transfer rates for floor or ceiling panels operating under other conditions may be determined from Fig. 11, or from Figs. 9 and 10.

Before Figs. 9 and 11 can be used, the unheated mean radiant temperature UMRT of the room surface must be known. For the purpose of this work, the UMRT may be defined as the average temperature of the unheated surfaces of the space, weighted according to the areas of the surfaces.

The surface temperature of the inside walls may be assumed to be the same as the inside air temperature. The surface temperatures of outside walls or exposed ceilings, for any combination of outside design temperature and transmission coefficient, may be obtained from Fig. 12. If the