emissivities and is practically independent of depth. The convection and conduction transfer is controlled by depth and shape of the air space, the roughness of the boundary surfaces, the mean temperature and the direction of heat flow. For air spaces usually employed in building construction, the radiation and convection factors vary independently of each other.

Table 1, **Section B** gives experimentally-determined conductances of vertical air spaces bounded by such materials as paper, wood, plaster, etc., having emissivity coefficients of 0.8 or higher, and having extended parallel surfaces perpendicular to the direction of heat flow. The conductances decrease as the depth is increased but change only slightly

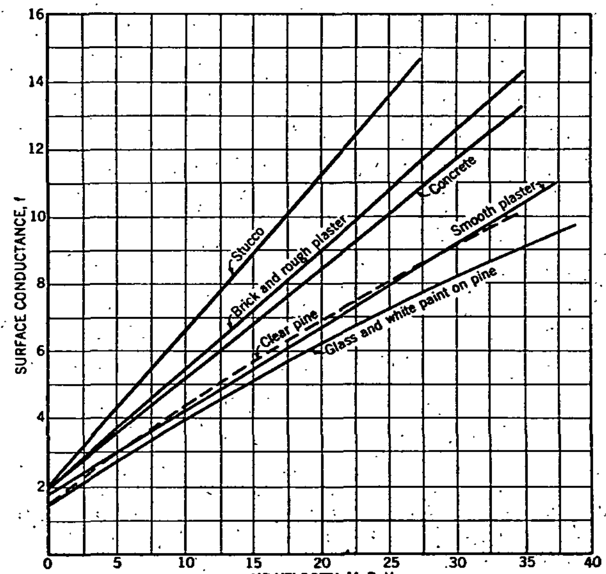

Fig. 3. Curves Showing Relation Between Surface Conductances for Different Surfaces at 20 F Mean Temperature.

for spaces greater than ¾ in. Air space tests reported by Wilkes and Peterson gave conductance values for air spaces of 3⅝ in. depth having boundary surfaces with emissivity values of 0.83 as follows [5].

Vertical	1.17
Horizontal (heat flow upward)	1.32
Horizontal (heat flow downward)	0.94

Since, in buildings, the same constructions may be used for conditions where the direction of heat flow may be in one direction or its opposite, and since much of the construction involves vertical air spaces, an average value of 1.10 Btu per (hour) (square foot) (Fahrenheit degree temperature difference) was chosen for use in calculating the over-all coefficients in Tables 5 to 18 wherever air spaces ¾ in. or more in depth were involved.

If one or both boundary surfaces of an air space are faced with metals which have low emissivity surfaces, the radiant heat transfer will be greatly reduced in comparison with that occurring from surfaces of ordinary building materials. Table 1, **Section C** gives conductances and resistances of air spaces *bounded by one reflective surface* with an emissivity of 0.05. These values include heat transferred both by radiation and convection, but the radiation component is relatively small for the test conditions.

When reflective materials are installed with single or multiple air spaces, the position (vertical, horizontal or inclined) of the material and the direction of heat flow must be taken into consideration. For example, the resistance to *upward* heat flow is about one-third the resistance to *downward* heat flow in a horizontal position (Table 1, **Section C**). The difference between the conductance through vertical air spaces and that through horizontal and sloping air spaces with upward heat flow is considerably less. For upward heat flow it is recommended that a value of 0.46 be used for the conductance of horizontal or sloping air spaces bounded on one side by reflective materials having an emissivity of approximately 0.05. The same conductance value is also recommended for similar vertical air spaces.

When considering heat transfer to and from reflective surfaces in building construction, the emissivity should be known. This can be determined directly for the long wave length radiation corresponding to average room and wall temperatures. The possibility of change in emissivity with time of exposure due to surface coatings, chemical action, deposition of dust, etc. must be considered in selecting a material for use [6].

PRACTICAL COEFFICIENTS AND THEIR USE

For practical purposes it is necessary to have average coefficients that may be applied to various materials and types of construction without the necessity of making actual tests. In Table 2 coefficients are given for a group of materials which have been selected from tests by various authorities. Since there is some variation in the resulting values due to variations in materials and in test conditions, average values for the usual conditions encountered in building practice have been selected and listed in Table 4. These coefficients were used in the calculation of over-all coefficients given in Tables 5 to 18. These tables constitute typical examples of combinations frequently used, but any special constructions not given can be computed by the use of the conductivity values in Table 4 and the fundamental heat transfer formulae.

Caution

The user should realize that the average conductivity and conductance values given in Tables 2 or 4 do not necessarily apply to all products of the same general description. In using these values judgment should be exercised with regard to the extent to which the product (either as received or as applied) will comply with the tabulated values. Exact conductivities or conductances for specific materials should be obtained from the manufacturer.

Insulating Materials

In order to determine the benefit derived from the addition of insulating materials to a given construction, the over-all coefficient of heat