tion of heat to the enclosure by any one or all of the mechanisms of conduction, convection, and radiation. A gain of *latent heat* is considered to occur when there is an addition of water vapor to the air of the enclosure. For example, when the humidity in an enclosure is increased by water vapor emitted by human occupants, or by water vapor resulting from a process such as cooking, the heat required to vaporize the water does *not* come from the air. Maintenance of a constant humidity ratio in a sealed enclosure requires the condensation of water vapor in the cooling apparatus at a rate equal to its rate of addition within the enclosure. The rate of heat removal from this condensing vapor would be substantially equal to the product of the rate of condensation and the latent heat of condensation; this product, expressed in Btu per hour, would be called a *latent heat* load.

As a further example, the infiltration of outdoor air with a high dry-bulb temperature and a high humidity ratio, and the corresponding escape of room air at a lower dry-bulb temperature and a lower humidity ratio, would increase both the *sensible heat* load and the *latent heat* load.

SOLAR RADIATION

Magnitude of Solar Radiation

If a plane surface were set perpendicular to the sun's rays (*i.e.*, for *normal incidence*) outside the earth's atmosphere, it would receive solar radiation of about 420 Btu per (hr) (sq ft). A similarly oriented surface, at the surface of the earth, would receive considerably less solar energy because a large part of the radiation is scattered in passing through the air, moisture, smoke, and dust which comprise the earth's atmosphere, and also, because some of the atmospheric constituents, notably water vapor, ozone, and carbon dioxide, absorb solar radiation. The intensity of solar radiation varies with wave length, reaching a peak at about 0.5 microns (a micron equals 1/1000 of a millimeter) and, for practical purposes, is confined to the radiation spectrum between 0.3 and 2.3 microns. The effects of scattering and absorption vary with the wave length, but to make an exact analysis of these phenomena is impracticable in air-conditioning estimates. The important principle to remember is that the total radiation I_t, received by a surface at the earth, is the sum of I_D and I_d, where

$I_D = K\,I_{Dn}$ = the *direct* or *beamed* solar radiation, Btu per (hour) (square foot of receiving surface).

I_{Dn} = the direct solar radiation on a plane normal to the sun's rays, Btu per (hour) (square foot of receiving surface).

I_d = the *sky* or *diffuse* solar radiation, Btu per (hour) (square foot of receiving surface). This comes principally from the atmosphere itself as a consequence of scattering. Vertical surfaces also receive solar radiation by reflection of direct and diffuse radiation from the ground and other objects. Such radiation is usually diffuse. The diffuse radiation strikes at *all* angles.

I_t = total incident solar radiation, Btu per (hour) (square foot of receiving surface).

K = cosine of the angle of incidence, θ. For a vertical surface, θ is defined in Fig. 1.

Standardized, practical-purpose values of the *direct* solar radiation I_D, incident upon a plane *perpendicular* to the sun's rays at the earth's surface,

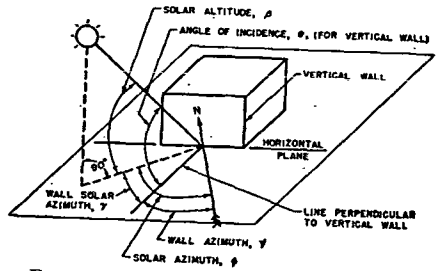

FIG. 1. DEFINITION OF SOLAR ANGLES

have been proposed by Moon.[4] Table 4 gives these values. They are representative of a *clear* summer day at sea-level elevation, and are nearly identical with values derived from suggested design sol-air temperatures for Lincoln, Nebraska.[5] Values typical of a humid industrial area derived from sol-air data for New York City[6] are also given in Table 4. Day-to-day changes in the amount of dust and water vapor in the atmosphere cause large differences in solar intensity values observed on cloudless days at a given locality. For example, it has been observed in Cleveland that

TABLE 3. OUTDOOR AIR REQUIREMENTS

Application	Smoking	Cfm per Person[b]		Cfm per Sq[b] Ft of Floor
		Recommended	Minimum[c]	Minimum[c]
Apartment Average	Some	20	10	....
DeLuxe	Some	20	10	....
Banking Space	Occasional	10	7½	....
Barber Shops	Considerable	15	10	....
Beauty Parlors	Occasional	10	7½	....
Brokers' Board Rooms	Very Heavy	50	20	....
Cocktail Bars		40	25	....
Corridors (Supply or Exhaust)		....	....	0.25
Department Stores	None	7½	5	0.05
Directors' Rooms	Extreme	50	30	....
Drug Stores[e]	Considerable	10	7½	....
Factories[d, f]	None	10	7½	0.10
Five and Ten Cent Stores	None	7½	5	....
Funeral Parlors	None	10	7½	....
Garages[d]		....	....	1.0
Hospitals Operating Rooms[f, g]	None	....	....	2.0
Private Rooms	None	30	25	0.33
Wards	None	20	10	....
Hotel Rooms	Heavy	30	25	0.33
Kitchens Restaurant		....	....	4.0
Residence		....	....	2.0
Laboratories[e]	Some	20	15	....
Meeting Rooms	Very Heavy	50	30	1.25
Offices General	Some	15	10	....
Private	None	25	15	0.25
Private	Considerable	30	25	0.25
Restaurant Cafeteria[e]	Considerable	12	10	....
Dining Room[e]	Considerable	15	12	....
School Rooms[d]	None	....	....	....
Shop, Retail	None	10	7½	....
Theater[d]	None	7½	5	....
Theater	Some	15	10	....
Toilets[d] (Exhaust)		....	....	2.0

[a] Taken from present-day practice. [b] This is contaminant-free air. [c] When minimum is used, take the larger of the two. [d] See local codes which may govern. [e] May be governed by exhaust. [f] May be governed by special sources of contamination or local codes. [g] All outside air recommended to overcome explosion hazard of anesthetics. See *National Board of Fire Underwriters'* pamphlet No. 56.