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-buld 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 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_{Dn} incident upon a plane *perpendicular* to the sun's rays at the earth's surface,

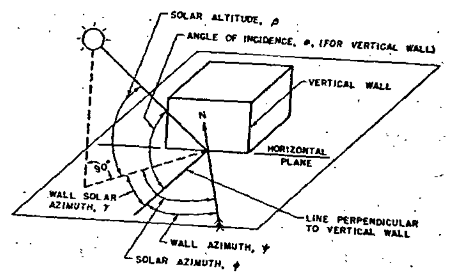

Fig. 1. Definition of Solar Angles

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 values of the order of those given for industrial atmospheres are usually associated with dry-bulb and wet-bulb temperatures near the design values of 95 F and 75 F (67 F dew-point). On the other hand, values

Table 4. Values of I_{Dn}, Direct Solar Radiation Received at Normal Incidence at the Earth's Surface, and Values of I_d, Diffuse or Sky Solar Radiation, Received by Variously Oriented Surfaces

Solar Altitude β, Degrees	Btu per (hour) (square foot)											
	For Clear Atmospheres						For Industrial Atmospheres					
	Direct[a] Normal Radiation	Diffuse or Sky Radiation[b,c]					Direct[d] Normal Radiation	Diffuse or Sky Radiation[b,c]				
AM → ↓		N	E	S	W	Horiz.		N	E	S	W	Horiz.
5	67	6	11	4	4	7	34	4	11	5	3	9
10	123	11	20	8	7	14	58	8	22	9	7	18
15	166	14	27	11	10	19	80	11	28	13	9	24
20	197	15	32	13	12	23	103	13	36	17	12	31
25	218	16	35	15	13	26	121	16	43	21	16	38
30	235	17	36	17	15	28	136	18	47	24	18	44
35	248	17	36	19	16	30	148	19	50	27	21	48
40	258	18	36	21	17	31	158	20	50	30	23	52
45	266	19	35	23	18	32	165	21	49	31	25	55
50	273	19	33	25	19	33	172	22	47	34	27	58
60	283	21	28	27	21	34	181	22	41	37	30	63
70	289	22	23	29	23	35	188	22	34	41	34	69
80	292	—	—	—	—	—	195	—	—	—	—	—
90	294	—	—	—	—	—	200	—	—	—	—	—
↑ PM →		N	W	S	E	Horiz.		N	W	S	E	Horiz.

[a] Moon's[4] proposed standard for sea level, 20 mm precipitable water vapor, 300 dust particles per cu cm, 2.8 mm Hg partial pressure of ozone.

[b] For 40 deg north latitude on about August 1.

[c] Based on observations by ASHVE Laboratory at Cleveland on cloudless days during which the observed normal incidence values closely approximated the normal incidence values tabulated.

[d] Derived from recommended design sol-air temperatures[4] for New York City for a horizontal surface with absorptivity of 1.0.