sky radiation and from outdoor-indoor temperature differential for glass areas and exterior, walls and roofs, modified by periodic heat flow or lag factors depending on the type of structure; (2) load due to heat gain through interior partitions, ceilings and floors; (3) load due to ventilation, either natural or mechanical; (4) load due to heat sources within the conditioned space such as people, lights, power equipment, and appliances; (5) load due to moisture transfer through permeable building

C. *Determination of Air Quantity and Apparatus Dew Point.*

These factors will be discussed in turn. The material presented leads to an illustrative procedure for a cooling-load calculation, and a numerical example is given to demonstrate the calculations involved.

DESIGN CONDITIONS

Indoor Conditions

Indoor air conditions for human health and comfort have been and contnue to be the subject of much discussion and research.

The effective temperature index, explained in Chapter 6 is probably the best available source of design criteria for comfort air conditioning systems for buildings or enclosures in which the air and inside surface

TABLE 1. DESIGN ROOM CONDITIONS USUALLY SPECIFIED FOR SUMMER AVERAGE PEAK LOAD IN COMFORT AIR CONDITIONING[a]

TYPE OF INSTALLATION	DRY-BULB TEMP	WET-BULB TEMP[b]	RELATIVE HUMIDITY PER CENT	GRAINS PER LB[b]	EFFECTIVE TEMP[c]
1. Ample Capacity	78	65	50	72.7	72.2
2. Practical Application	80	67	51	78.5	74.0
3. Occupancy—15 to 40 min	82	68	49	80.0	75.3

[a] Values in Table 1 are for *peak load* conditions. It is general practice to operate a system at approximately 75 F and 50 percent relative humidity at other than peak load.

[b] Psychrometric data for standard barometric pressure.

[c] Fig. 10, Chapter 6, air movement 15 to 25 fpm.

temperatures remain substantially equal; a condition that can safely be assumed for most ordinary comfort air conditioning installations. Other sources of design specifications are to be found in the requirements of codes and ordinances, and in the varied long-term experiences of manufacturers, contractors, and engineering specialists.

Past experience, cumulative over many years, indicates that indoor design conditions for which summer air-conditioning equipment is selected, should not exceed a temperature of 80 F or a relative humidity of 50 percent for the average job in the United States. If these conditions are exceeded, complaints of discomfort may be expected, especially with continuous occupancy. For very brief occupancy only, a slightly higher peak-load design temperature may be employed. In regard to the lower limit of humidity, complaints are not encountered for store installations operated down to 35 percent relative humidity or, for office jobs, somewhat lower. These observations apply to normal commercial practice in this country only; for extremes, such as tropical or very hot regions, it is regarded as more practicable to design for a peak-load outdoor-indoor temperature difference of about 15 to 20 F.

Table 1 offers typical design conditions for average requirements encountered. The values in line 1 would also apply in general for localities having a summer outdoor design temperature of 90 F or less; and the *15 to 40 min* occupancy values, or even somewhat higher dry-bulb temperatures, would indicate acceptable conditions for very hot localities. Table 1 *is to be used with good judgment*, for there is no universal rule which may be applied to indoor design conditions.

Guarantees of conditions to be maintained for summer operation are based upon a definite set of load conditions. At other than the guarantee load, the conditions produced by a system are determined by the balance of imposed load and equipment capacity, and by the method adopted for regulating the system operation. Complete specifications of indoor design conditions would include part-load and overload operation, particularly from the viewpoint of economy.

In the field of *industrial air conditioning*, indoor design conditions are established by the requirements of goods and processes, in addition to the comfort and efficiency of the workers. Many typical indoor design conditions for products in industrial air conditioning are given in Chapter 46.

The load calculations for either comfort or industrial air conditioning are usually made in accordance with a guarantee. In comfort applications, for example, this is frequently 80 F and 51 percent relative humidity or 78 F and 50 percent relative humidity. The system is normally operated at 75 or 76 F and approximately 50 percent relative humidity at all times as long as the equipment has capacity to maintain these conditions. During very hot weather, the room temperature will rise above the control point and the equipment will operate continuously. Normally, industrial jobs are operated at design conditions at all times if the optimum conditions are selected for the benefit of the product.

The indoor design conditions suggested have had reference to conditions to be maintained at the level of occupancy. For extremely high ceilings in public or industrial buildings, only the zone from 10 to 15 ft above the floor may be cooled to the full extent. The air temperature at the ceiling would be much higher, and this should be kept in mind when calculating the convective portion of the roof heat gain. A reduction of outdoor-to-indoor air temperature differential may be assumed in such instances; radiation from the inner roof surface is not diminished.

Outdoor Conditions

Summer climatic conditions and suggested design wet-bulb and dry-bulb temperatures are given in Table 2 for various locations in the United States. The highest temperature ever recorded is for the period of record shown. In some cases it should be noted that this period of record is comparatively short, and higher temperatures may be expected. In making comparisons for other localities than those shown in Table 2, due consideration must be given to elevation.

Column 6 of Table 2 indicates the design dry-bulb temperature suggested by the A.S.H.A.E. Technical Advisory Committee on Weather Design Conditions. This temperature is the maximum hourly outdoor temperature which has been equalled or exceeded 2½ percent of the total hours of June, July, August and September for the period of record, in this case the 5-year period 1935–1939, and should not be confused with the period of record given in Column 4 which applies only to highest temperature ever recorded. Since all of these data (Column 4) are based on airport records, they are not necessarily applicable to cities.

The data given in Columns 7 and 8 were obtained from local A.S.H.A.E. Chapter Secretaries, and represent the design temperatures in local use. Where such information was not available, it was taken from a publication of the A.R.I.[1] and from various other sources.