Table 10 .... Summary of Heat Losses of Uninsulated Residence (*Btu Per Hour*)

Room or Space	Walls	Ceiling and Roof	Floor	Glass and Door	Infil-tration	Totals
Bedroom A	5520	7410	...	1440	2180	16,550
Bedroom B	3620	5000	...	1440	1470	11,530
Bedroom C	2650	3800	...	970	1260	8,680
Bedroom D	2740	3240	960	720	950	8,610
Bathroom 1	690	1620	...	500	630	3,440
Bathroom 2	1640	1060	320	320	400	3,740
Living Room	7480	...	...	1800	5400	14,680
Dining Room	3850	...	...	3100	3080	10,030
Kitchen	2920	...	...	950	2300	6,170
Lavette	3060	...	...	1100	550	4,710
Entrance Hall	900	2560	...	640	1600	5,700
Garage	−960[a]	−1280[b]	1060	3710	1910	4,440
Recreation	840	...	570	720	2890	5,020
Design Totals	34,950	23,410	2,910	17,410	24,620	103,300
Operating Totals[c]	34,950	23,410	2,910	17,410	12,310	90,990
Percentages[d]	38.4	25.8	3.2	19.1	13.5	100.0

[a] Wall heat loss of 2180 Btuh minus wall heat gains of 1280, 700, and 1160 Btuh. [b] Heat gains of 960 and 320 Btuh. [c] Based on ½ computed infiltration. [d] Based on operating totals.

Table 11 .... Summary of Heat Losses of Insulated Residence (*Btu Per Hour*)

Room or Space	Walls	Ceiling and Roof	Floor	Glass and Door	Infil-tration	Totals
Bedroom A	2480	2460	...	1440	2180	8,560
Bedroom B	1620	1660	...	1440	1470	6,190
Bedroom C	1190	1260	...	970	1260	4,680
Bedroom D	1230	1080	690	720	950	4,670
Bathroom 1	310	540	...	500	630	1,980
Bathroom 2	760	250	220	320	400	1,950
Living Room	3370	...	...	1800	5400	10,570
Dining Room	1730	...	...	3100	3080	7,910
Kitchen	1320	...	...	950	2300	4,570
Lavette	1390	...	...	1100	550	3,040
Entrance Hall	410	850	...	640	1600	3,500
Garage	−470[a]	−910[b]	1060	3710	1910	5,300
Recreation	840	...	570	720	2890	5,020
Design Totals	16,180	7,190	2,540	17,410	24,620	67,940
Operating Totals[c]	16,180	7,190	2,540	17,410	12,310	55,630
Percentages[d]	29.1.	12.9	4.6	31.3	22.1	100.0

[a] Wall heat loss of 980 Btuh minus wall heat gains of 590, 320, and 540 Btuh. [b] Heat gains 690 and 220 Btuh. [c] Based on ½ computed infiltration. [d] Based on operating totals.

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CHAPTER 13

COOLING LOAD

Cooling Load Calculations; Design Conditions; Instantaneous Heat Load; Solar Radiation; Periodic Heat Flow; Tables for Calculating Solar Heat Gain Through Walls, Roofs, and Glass; Instantaneous Heat Gain vs. Cooling Loads; Load from Interior Partitions, Ceiling, and Floors; Load from Outdoor Air, Ventilation and Infiltration; Effect of Outdoor Air on Load; Heat Sources Within Conditioned Space; Moisture Transfer Heat Load; Miscellaneous Heat Loads; Apparatus Dew Point and Required Air Quantity Through Conditioning Equipment; Minimum Entering Air Temperature; Example Cooling Load Calculation

THE variables affecting cooling load calculations are numerous, often difficult to define precisely, and always intricately interrelated. Most of the components of the cooling load vary in magnitude over a wide range during a 24-hour period, and as the cyclic changes in load components are not usually in phase with each other, careful analysis is required to establish the resultant maximum cooling load for a building or zone. A zoned system must often handle peak loads in different zones at different hours.

Economic considerations must be of particular influence in the selection of equipment for cooling season operation in comfort air conditioning, and this fact, coupled with present inadequacies in available data and knowledge of the air-conditioning art, places a premium on the experienced judgment essential to successful design or practice. Variations in the weather, building occupancy, and other factors affecting load, necessitate carefully coordinated controls to regulate simultaneously the components and the equipment in order to maintain the desired room conditions.

The calculation procedures presented in this chapter deal with the various instantaneous rates of heat gain, both sensible and latent, in a conditioned space. There may be an appreciable difference between the *net instantaneous rate of heat gain* and the *total cooling load* at any instant. This difference is caused by the storage and subsequent release of heat by the structure and its contents. This thermal-storage effect may be quite important in determining an economical cooling equipment capacity. The lack of any adequate means of treating this storage quantitatively in its entirety for a complete structure, must be recognized in judging the procedures and data presented for calculating individual components of the net rate of instantaneous heat gain.

Solar heating calculations involve the same principles as cooling load calculations. Many of the data on solar radiation given in this chapter can be used in calculations for solar heating.

COOLING LOAD CALCULATIONS

Summer cooling load calculations, whether for industrial or comfort applications, require consideration of the following factors:

A. Design Conditions: (1) indoor conditions; (2) outdoor conditions; (3) ventilation rate.

B. Instantaneous Heat Load, Sensible and Latent: (1) load from solar radiation, 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 materials; and (6) miscellaneous heat sources.

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 continue 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 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 deg.

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 tem-