TABLE 6. 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 | 5330 | 6910 | ——— | 1440 | 2180 | 15,860 |
| Bedroom B | 3490 | 4660 | ——— | 1440 | 1470 | 11,060 |
| Bedroom C | 2560 | 3540 | ——— | 970 | 1260 | 8,330 |
| Bedroom D | 2650 | 3020 | 960 | 720 | 950 | 8,300 |
| Bathroom 1 | 670 | 1510 | ——— | 500 | 630 | 3,310 |
| Bathroom 2 | 1640 | 960 | 310 | 320 | 400 | 3,630 |
| Living Room | 7260 | ——— | ——— | 1800 | 5400 | 14,460 |
| Dining Room | 3720 | ——— | ——— | 3880 | 3080 | 10,680 |
| Kitchen | 2850 | ——— | ——— | 950 | 2300 | 6,100 |
| Lavette | 3000 | ——— | ——— | 1100 | 550 | 4,650 |
| Entrance Hall | 870 | 2390 | ——— | 640 | 1600 | 5,500 |
| Garage | −1030[a] | −1270[b] | −280[c] | 3710 | 1910 | 3,040 |
| Recreation | 840 | ——— | 570 | 720 | 2890 | 5,020 |
| Design Totals | 33,850 | 21,720 | 1,560 | 18,190 | 24,620 | 99,940 |
| Operating Totals[d] | 33,850 | 21,720 | 1,560 | 18,190 | 12,310 | 87,630 |
| Percentages[e] | 38.6 | 24.8 | 1.8 | 20.7 | 14.1 | 100.0 |

[a] Wall heat loss of 2110 Btuh minus wall heat gains of 1280, 700 and 1160 Btuh. [b] Heat gains of 960,310 Btuh. [c] Heat gain. [d] Based on ½ computed infiltration. [e] Based on Operating Totals.

TABLE 7. 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 | ——— | ——— | 3880 | 3080 | 8,690 |
| 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] | −280[c] | 3710 | 1910 | 3,960 |
| Recreation | 840 | ——— | 570 | 720 | 2890 | 5,020 |
| Design Totals | 16,180 | 7,190 | 1,200 | 18,190 | 24,620 | 67,380 |
| Operating Totals[d] | 16,180 | 7,190 | 1,200 | 18,190 | 12,310 | 55,070 |
| Percentages[e] | 29.4 | 13.0 | 2.2 | 33.0 | 22.4 | 100.0 |

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

## REFERENCES


[1]—ACRMA Application Engineering Standards for Air Conditioning for Comfort, (1947). *Air Conditioning and Refrigerating Machinery Association, Inc.* pages 4 to 7.

[2]—An Analysis of Winter Temperatures for One Hundred and Twenty Cities, by Clark M. Humphreys (*Carnegie Institute of Technology Bulletin*).

[3]—Investigation of Oil-Fired Forced Air Furnace Systems in the Research Residence, by A. P. Kratz and S. Konzo (*University of Illinois Engineering Experiment Station Bulletin* No. 318).

[4]—A.S.H.V.E. RESEARCH REPORT No. 1011—Tests of Three Heating Systems in an Industrial Type of Building, by G. L. Larson, D. W. Nelson, and John James (A.S.H.V.E. TRANSACTIONS, Vol. 41, 1935, p. 185).

[5]—Methods of Moisture Control and Their Application to Building Construction, by F. B. Rowley, A. B. Algren and C. E. Lund. *University of Minnesota, Engineering Experiment Station Bulletin*, No. 17).

[6]—A.S.H.V.E. RESEARCH REPORT No. 1213—Heat Loss Through Basement Walls and Floors, by F. C. Houghten, S. I. Taimuty, Carl Gutberlet and C. J. Brown (A.S.H.V.E. TRANSACTIONS, Vol. 48, 1942, p. 369).

[7]—Measurements of Heat Losses from Slab Floor, by R. S. Dill, W. C. Robinson and H. E. Robinson (*U. S. Department of Commerce, National Bureau of Standards*, Building Materials and Structures Report BMS 103).

[8]—Heat Requirement Tables for Intermittently Heated Buildings, (*Engineering Experiment Station Bulletin*, No. 60, *A. and M. College of Texas*, College Station, Texas), contains a set of tables applicable to either intermittent heating or cooling. Further information may be found in a paper, A Method of Compiling Tables for Intermittent Heating, by Elmer G. Smith (A.S.H.V.E. JOURNAL SECTION, *Heating, Piping and Air Conditioning*, June, 1942, p. 386).


# Chapter 15

# COOLING LOAD

***Cooling Load Calculations; Design Conditions; Instantaneous Heat Load; Solar and Sky Radiation, and Heat Transmission Losses; Principles of Periodic Heat Flow; Glass Areas and Design Tables; Load from Interior Partitions; Ceiling and Floors; Load from Outside Air, Ventilation or Infiltration; Heat Sources Within Space; Moisture Heat Load; Regional Air Quantity; Example Cooling Load Calculation***

THE variables affecting cooling-load calculations are numerous, often difficult to define precisely, and always intricately inter-related. 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 particularly influential 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 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 are useful 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. (6) Miscellaneous heat sources.

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