TABLE 4. DURATION OF HEATING SEASON

CITY	DEGREE—DAYS FOR HEATING SEASON	CITY	DEGREE—DAYS FOR HEATING SEASON	CITY	DEGREE—DAYS FOR HEATING SEASON
Atlanta	2880	Denver	5880	Pittsburgh	5327
Boston	6055	Detroit	6202	San Francisco	3450
Buffalo	6750	Jacksonville	1080	St. Louis	4583
Cincinnati	5302	Kansas City	5302	Philadelphia	4950
Cleveland	6096	Minneapolis	7953	Seattle	5156
Chicago	6007	New York	5303	Washington	4562
Dallas	2455	Oklahoma City	3827		

Observe in the equation that the calculated theoretical amount of radiation is to be used. By this is meant the actual amount of radiation that is required, as determined by accepted methods of heat loss calculations. Over-radiation will not materially affect the gas consumption while under-radiation will merely reflect itself in inability to heat in extremely cold weather. The amount of gas consumed for heating a building during any given heating season may vary decidedly from an estimate made according to the method outlined above but the variation will be in almost direct proportion to the difference between the actual degree-days for the season in question and the average degree-days as shown in Table 4.

The charts Figs. 1 and 2 graphically represent the number of cubic feet of gas per square foot of radiation for the heating season in any climate, the climate being expressed in degree-days and applicable to any heating condition in the United States.

Gas consumption will also vary according to the use to which the building is to be put. Factories and stores, usually maintained at a lower temperature than residences, will not require heat for as many hours during the season as a residence will, although the rate of heat consumption per square foot of radiation will be greater, due to the lower temperature maintained.

Observation of a large number of installations seems to indicate that the cost of heating with a warm-air furnace is about 10 per cent less than the cost of heating with steam. Estimates on warm-air heating may therefore be made exactly the same as for steam; by calculating the heat loss, reducing it to equivalent direct steam radiation by dividing the heat loss in B.t.u. per hour by 240; and calculating as above with the 10 per cent correction for increased economy introduced into the calculation.

Figs. 1 and 2 adapted from a similar chart in the House Heating Manual of the *American Gas Association*, give the two previous equations in graphical form.

CROSS-CONNECTING COAL AND GAS BOILERS

Quite frequently, when a customer already has a coal boiler in his home, it is desirable to leave the coal boiler in place, and to cross-connect the gas boiler with it. For very small gas companies or any others where there is any possible chance of a shortage or failure of gas, it would seem to be good practice to encourage cross-connecting as the

customer would realize very little for a second-hand coal boiler, and it is worth more to him as a safeguard against failure of his gas system than he would realize by selling it. It also produces a more secure feeling in the customer's mind when putting in gas-fired house-heating equipment, if he knows that he can burn coal at any time he has occasion to.

In hot water heating systems, it is necessary to valve off the return pipes on the coal boiler, which prevents circulation through the latter when the gas boiler is in use. Since the gas boiler holds comparatively little water and is almost always insulated, no valves are needed on the return pipes to the gas boiler. Hence, by opening the valves on the coal boiler, it may be operated independently or in conjunction with the gas boiler.

For steam or vapor installation, it is necessary to valve off all of the returns and flows on each boiler unless the gas boiler is set so that the water line in both boilers is at the same level, in which case it is necessary to valve off only the coal boiler to prevent the heating of the water in the coal boiler when it is not in use.

The gas boiler should be set as close to the coal boiler as practicable, and the flows and returns should cut into the flows and returns of the coal boiler as near to the latter as possible.

HEATING INDUSTRIAL BUILDINGS WITH GAS

As has been mentioned previously, great advances have been made within the past year or two toward extending the field of gas heating from the residence class of building into the class of larger buildings, such as factories and office buildings; and new apparatus has been developed with this end in view. Office and store buildings in large cities, where coal and ashes can be handled only by truck and where cleanliness is of some value, can often be heated with gas to the profit and satisfaction of the occupants. The same thing is true of institutional heating. Several large factory installations, where gas boilers are used to supply steam to indirect heaters of the unit type, are now in use. A number of smaller industrial buildings are being successfully heated with gas-fired warm-air furnaces, provided with fans for air distribution. This type of heating plant is particularly applicable to garages because the entire heating plant takes up very little space (it may even be put on the roof) requires no attention, and aids in ventilation.

INSULATION

For reasonable economy with gas heating, heat losses should be reduced in every possible way and adequate provision should be made wherever possible for cutting down losses from infiltration and transmission through walls and roofs as well as reduction of losses from mains and risers. Summarizing the advantages of building wall insulation in its relation to gas fuel it has been said that through the use of insulation it is possible even at the present rates for gas heating to cut the fuel cost down to a figure comparable to the present cost for coal operation. It is also true that a house owner can use insulation to equal advantage with