TABLE 1. SUMMARY OF DATA APPLIED TO WARM AIR RESEARCH RESIDENCE

Rooms	From Chapter 7 Estimating Heat Losses Btu Heat Losses H	Leader Area Sq In.	Stack Area Sq In. $0.7 \times LA$	Leader Diameter Inches	Stack Size Net	Register Size Gross
First Floor		$= 0.009H$				
Living	17250	155	---	14	----------	14 × 16
Dining	6810	61	---	9	----------	8 × 12
Breakfast	2300	21	---	8	----------	8 × 10
Kitchen	9210	83	---	11 or 12	----------	12 × 14
Sun	25710	230	---	Two 12	----------	Two 12 × 14
Hall and stair	12570	113	---	12	----------	12 × 14
Second Floor		$= 0.006H$				
Owner's	15030	90	63	11 or 12	5 × 12	12 × 14
S. W. Bed	9800	59	41	9	3½ × 12	8 × 12
Bath	2450	15	10	8	3 × 10	8 × 10
N. Bed	14800	89	62	11 or 12	5 × 12	12 × 14
Third Floor		$= 0.005H$				
E. Bed	8220	41	29	8	3 × 10	8 × 10
W. Bed	8220	41	29	8	3 × 10	8 × 10

BOOSTER FANS

Booster fans often may be arranged to operate when gas or oil burners are running and to stop automatically when the burners shut down. The booster equipment is most effective in increasing output at low operating temperatures. According to tests, efficiencies may be advanced from 60 per cent for gravity to 70 per cent with boosters at low operating temperatures, but at high operating temperatures gravity and booster efficiencies are almost identical[9].

[9]University of Illinois, *Engineering Experiment Station Bulletin* No. 141, p. 79, and No. 246.

PROBLEMS IN PRACTICE

1 ● What may prohibit the use of a gravity warm air system in a large house having several exposed wings?

In a gravity warm air system, excessive vertical distances above the furnace cause little trouble in the design of the wall stacks, but excessive horizontal distances from the furnace should be carefully considered in the design of the leaders. To work effectively, a gravity warm air system should be balanced and leaders over 12 ft in length should be avoided if possible. Long leaders, if used, must be of ample size, well pitched, and well insulated. Large houses having exposed wings may require leaders much longer than 12 ft; infiltration may create severe back-drafts in the exposed wings; and the basement ceiling height may not be sufficient to allow the leaders to have a pitch of more than one inch per foot. These conditions may make the exposed wings very difficult to heat with a gravity system because of its low air head differentials.

2 ● A first story dining room has a calculated heat loss of 12,000 Btu per hour.
a. What size leader pipe should be used for 175 F register air temperature?
b. What size register?

a. Leader area $= \frac{12{,}000}{111} = 108.1$ sq in. Use leader with diameter of 12 in.

b. Register gross area $= \frac{108}{0.7} = 154$ sq in. Use 12 in. by 14 in. register.

3 ● A third-story bedroom has a calculated heat loss of 12,000 Btu per hour.
a. What size leader pipe should be used for a 175 F register air temperature?
b. What size stack?
c. What size register?

a. Leader area $= \frac{12{,}000}{200} = 60$ sq in. Use leader with diameter of 9 in.

b. Stack area $= 0.7 \times 60 = 42$ sq in. Use stack 3½ in. by 12 in.

c. Register gross area $= \frac{60}{0.7} = 85.7$ sq in. Use register 8 in. by 12 in.

4 ● The calculated heat loss of a house is 130,000 Btu per hour. Find the grate area required for the furnace under the following conditions:

Heating value of coal = 12,790 Btu per pound.
Furnace efficiency = 55 per cent.
Combustion rate = 7.5 lb per sq ft per hr.
Ratio of heating surface to grate area of furnace = 20 to 1.
Register temperature = 175 F.
Loss between furnace and registers = 25 per cent.

See Equations 9 and 10.
Grate area $= 0.004205 \times 130{,}000 = 547$ sq in.
Grate diameter = 26.3 in.
Use grate with diameter of 26 in.

5 ● If in Question 4 the conditions were the same except that the ratio of heating surface to grate area of furnace was 24 to 1, what size grate would be required for the furnace?

Grate area $= \frac{0.004205 \times 130{,}000}{1 + 0.02\ (24\text{-}20)} = \frac{547}{1.08} = 506$ sq in.

Grate diameter = 25.4 in.
Select grate with diameter of 25 in.

6 ● Name the items involved in the design of a furnace heating system.

a. Heat loss from each room, Btu.
b. Area and dimensions of warm-air pipes in basement, inches.
c. Area and dimensions of vertical pipes, inches.
d. Free and gross area and dimensions of warm-air registers, inches.
e. Area and dimensions of recirculating or outside air ducts, inches.
f. Free and gross area and dimensions of recirculating registers, inches.
g. Size of furnace necessary to supply the warm air to overcome the heat loss.
h. Area and dimension of chimney and smoke pipe, inches.

7 ● Discuss the design features of recirculating ducts.

a. Their area should be equal to or greater than that of the supply ducts.
b. They should be streamlined, and have a minimum number of turns.
c. All runs should be as short as possible.
d. Account should be taken of all cold walls and window areas in determining sizes and positions of return air inlets.