

surface. When recirculation is employed, the air velocities through the heater may become excessive on account of the fact that a smaller heater capacity is required for the same quantity of air.

The following general procedure is recommended for the design of fan-furnace systems:

1. Calculate heat loss of each room in building: (See Chapter 5).

Example: Assume schoolroom with cubic content 6,550.
Heat loss = 45,269 Btu.

2. Determine volume of air per minute, based on number of occupants and number of air changes:

Example: Assuming 33 occupants; 30 cu ft per minute per occupant.
 $33 \times 30 = 990$ cu ft per minute.

$\frac{6,550}{990}$ contents = $6\frac{1}{2}$ min. per air change or approximately 9 changes per hour.

3. Figure diffusion temperature of air for each room¹:

Example: Diffusion Temperature = $\frac{56 \times H}{60 \times Q_r} = \frac{56 \times 45,269}{60 \times 990} = 42.3$ F.

4. Determine required register temperature:

Register temperature equals room temperature plus diffusion temperature:

Example: Assume 70 F room temp.
42.3 F plus 70 F = 112.3 F.

5. Determine final temperature of air leaving heater:

Final temperature equals register temperature plus allowance for loss in ducts:

Example: 112.3 F register + 10 F.
Loss in ducts = 122.3 F.

6. Determine temperature rise through heater:

Temperature rise equals final temperature minus initial temperature. Where part outside air and part recirculated air is used, initial temperature approximately equals $p_o t_o + p_r t_r$:

p_o = percentage outside air.
 t_o = temperature of outside air.
 p_r = percentage recirculated air.
 t_r = temperature recirculated air.

Example: Temperature rise 122.3 F - 0 F = 122.3 F with all outside air.
or

¹The diffusion temperature may be defined as the number of degrees the volume of air as determined under Item 2 must be in excess of the room temperature, in order to offset the heat loss by cooling over that range. In other words it is the number of degrees representing the difference between the necessary supply register temperature and the room temperature for the conditions under which the heat losses are calculated in Item 1. It is readily calculated by using the following formula:

Diffusion temperature = $\frac{56 H}{60 Q_r}$ where H is the heat loss in Btu per hour.
 Q_r is the volume of air in cubic feet per minute measured at 70 F for the room in question.

Assume 50 per cent outside air 0 F.
50 per cent recirculation 60 F.

$p_o t_o + p_r t_r = 50 \times 0 + 0.50 \times 60 = 30$ F initial temperature.

Temperature rise through heater = 122.3 F - 30 F = 92.3 F.

7. Calculate required free area through heaters²:

Select velocity through heaters suitable to problem.

Free area = $\frac{\text{Total cubic feet per minute}}{\text{Velocity in feet per minute}}$

Example.—Assume total cubic feet per minute of all rooms = 21,000.
Assume 900 ft per minute through heater. (See Table 1.)

$\frac{21,000}{900} = 23.3$ sq ft free area.

TABLE 1. AIR VELOCITIES AND REGISTER TEMPERATURES FOR FAN-FURNACE SYSTEMS

TYPE OF BUILDING	VELOCITIES IN FEET PER MINUTE							REGISTER TEMPERATURE
	Thru Free Area of Heaters	In Horizontal Supply Ducts	In Supply Risers	Into Room	In Vent Outlets	In Vent Risers	In Horizontal Vent Ducts and Recirculating Ducts	
Schools	800 to 1000	800 to 1000	500 to 600	300 to 400	300 to 400	500 to 600	600 to 800	90° to 120°
Churches	800 to 1000	700 to 900	400 to 600	300 to 500	300 to 500	400 to 600	500 to 700	80° to 120°
Auditoriums and Convention Halls	800 to 1000	800 to 1000	500 to 600	300 to 500	300 to 500	500 to 600	600 to 800	80° to 120°
Garages and Industrial Buildings	1000 to 1400	1000 to 1400	600 to 1000	400 to 1000	400 to 600	600 to 1000	800 to 1200	80° to 140°

8. Select size and number of heaters:

- a. Take temperature rise from item 6;
- b. Take free area from item 7, or manufacturers' tables;
- c. Assume maximum allowable combustion rate for fuel to be burned and stack available;
- d. Note resistance of heaters for air volume;
- e. Select suitable heaters from ratings.

9. Design duct system:

Ducts may be designed according to standard practice. (See Chapter 31).

²Some heaters are rated on the basis of the volume of air that may be warmed over any given temperature range for all heater sizes and list the static resistance in each instance. In this case the free area need not be calculated, but the combustion rate should be investigated.