

$$\dot{Q}_{infiltration} = 4.5 (1200) (28.4) = 153,360 \frac{Btu}{hr}$$

Determine the total cooling load including the internal heat load as well as the infiltration. Align units to  $\frac{Btu}{hr}$ , then convert to refrigeration tons:

$$\dot{Q}_{total} = \dot{Q}_{infiltration} + \dot{Q}_{internal}$$

$$\dot{Q}_{total} = 153,360 \frac{Btu}{hr} + (50KW) \left( 3412 \frac{Btu}{hr \cdot KW} \right) = 323,960 \frac{Btu}{hr}$$

$$\dot{Q}_{total} = 323,960 \frac{Btu}{hr} \left( \frac{1ton}{12000 \frac{Btu}{hr}} \right) = 27tons$$

**Answer D**

**44.5** A pumping system delivers water to a factory through a standard weight steel piping supply line (surface roughness  $C = 120$ ) with 3 outlets delivering 100gpm to each outlet. The main pipe initially has a 5in nominal diameter, reducing to 4in and 3in after each branch outlet. The first outlet is located 50ft from the pumping station; the second outlet is 100ft downstream of the first, and the third outlet is 100ft downstream of the second. What is the pressure loss for the system? Ignore minor losses.

- A. 7ft
- B. 10ft
- C. 14ft
- D. 20ft

The pressure loss is based on the flow rate, diameter, surface roughness, and the length of the pipe. Break the problem into 3 sections and use the [Steel Pipe Friction Tables](#) to look up the head loss per 100 ft for each section. The surface roughness may be considered at the end.

For the 5 inch section:

$$D = 5in$$

$$L = 50ft$$

$$Q = 300gpm$$

$$h_{d.loss} = 3ft/100ft$$

$$h_f = (50ft) \left( \frac{3ft}{100ft} \right)$$

For the 4 inch section, the flow is reduced by 100gpm after the first branch:

$$D = 4in$$

$$L = 100ft$$

$$Q = 200gpm$$

$$h_{d.loss} = 4.3ft/100ft$$

$$h_f = (100ft) \left( \frac{4.3ft}{100ft} \right)$$

For the 3 inch section, the flow is reduced again by 100gpm after the second branch:

$$D = 3in$$

$$L = 100ft$$

$$Q = 100gpm$$

$$h_{d.loss} = 4.5ft/100ft$$

$$h_f = (100ft) \left( \frac{4.5ft}{100ft} \right)$$

Look up **Surface Roughness Factors** in the Reference Handbook under the Steel Pipe Friction Tables and refer to the **correction factors**. For a **surface roughness** of  $C = 120$ , it is necessary to multiply the total head loss by .71. Take the sum of the losses from the 3 sections and apply the correction factor to determine the total pressure loss for the system:

$$h_f = (.71) \left[ (50ft) \left( \frac{3ft}{100ft} \right) + (100ft) \left( \frac{4.3ft}{100ft} \right) + (100ft) \left( \frac{4.5ft}{100ft} \right) \right] = 7.3$$

**Answer A**