33.17 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 5 inch nominal diameter, reducing to 4 inch and 3 inch after each branch outlet. The first outlet is located 50 feet from the pumping station; the second outlet is 100 ft downstream of the first, and the third outlet is 100 feet 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 $100ft$ 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 0.71. Take the sum of the losses from the 3 sections and apply the correction factor to determine the total pressure loss for the system:

$$h_f = (0.71)\left[(50ft)\left(\frac{3ft}{100ft}\right) + (100ft)\left(\frac{4.3ft}{100ft}\right) + (100ft)\left(\frac{4.5ft}{100ft}\right)\right] = 7.3ft$$

Answer A