5.58

5.58 Water is sprayed radially outward over 180° as indicated in Fig. P5.58. The jet sheet is in the horizontal plane. If the jet velocity at the nozzle exit is 20 ft/s, determine the direction and magnitude of the resultant horizontal anchoring force required to hold the nozzle in place.

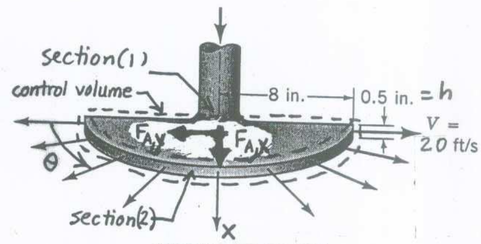

FIGURE P5.58

The control volume includes the nozzle and water between sections (1) and (2) as indicated in the sketch above. Application of the y direction component of the linear momentum equation yields

$$\int_{cs} v \rho \vec{V} \cdot \hat{n} \, dA = -F_{A,y}$$

or

$$F_{A,y} = -\rho \int_0^{\pi} (-V_2 \cos\theta)(V_2)\, h R \, d\theta = \rho h R V_2^2 (\sin\pi - \sin 0)$$

and

$$F_{A,y} = \underline{\underline{0}}$$

Application of the x direction component of the linear momentum equation leads to

$$\int_{cs} u \rho \vec{V} \cdot \hat{n} \, dA = F_{A,x}$$

or

$$F_{A,x} = \rho \int_0^{\pi} (V_2 \sin\theta)(V_2)\, h R \, d\theta = \rho h R V_2^2 (\cos 0 - \cos\pi)$$

and

$$F_{A,x} = \left(1.94 \frac{\text{slugs}}{\text{ft}^3}\right) \frac{(0.5 \text{ in.})\,(8 \text{ in.})\,\left(20 \frac{\text{ft}}{\text{s}}\right)^2 (2)}{\left(12 \frac{\text{in.}}{\text{ft}}\right)\left(12 \frac{\text{in.}}{\text{ft}}\right)} \left(1 \frac{\text{lb}}{\text{slug} \cdot \frac{\text{ft}}{\text{s}^2}}\right)$$

$$F_{A,x} = \underline{\underline{43 \text{ lb}}}$$