43.13 $1100cfm$ **of air flows in a** $14in$ **round duct. The duct reduces to** $12in$ **after a branch takeoff of** $200cfm$**. Neglecting losses, what is the change in static pressure after the branch takeoff?**

A. $0.03in\,wg\,decrease$

B. $0.02in\,wg\,decrease$

C. $0.02in\,wg\,increase$

D. $0.03in\,wg\,increase$

Using the Reference Handbook chapter on Duct Design, use the equation for total pressure:

$$p_t = p_s + p_v$$

where p_t is total pressure, p_s is static pressure, and p_v is velocity pressure. For a small branch takeoff, the total pressure before and after the branch will remain unchanged. However, due to the reduction in area, some static pressure will be converted to velocity pressure (by design). Set the total pressure before and after the branch takeoff equal, and refer to them as a sections 1 and 2, respectively:

$$p_{t,1} = p_{t,2}$$

$$p_{s,1} + p_{v,1} = p_{s,2} + p_{v,2}$$

$$\Delta p_s = p_{s,2} - p_{s,1} = p_{v,1} - p_{v,2}$$

This is an expression for the change in static pressure which depends upon the change in velocity pressure. The velocity pressure may be expressed in two ways:

$$p_v = \rho \left(\frac{V}{1097}\right)^2 = \left(\frac{V}{4005}\right)^2$$

where V is the velocity in $\frac{ft}{min}$. Calculate the velocity before and after the branch takeoff:

$$Q = VA \rightarrow V = \frac{Q}{A}$$

$$V_1 = \frac{Q_1}{A_1} = \frac{\left(1100\frac{ft^3}{min}\right)}{\frac{\pi}{4}\left(\frac{14}{12}ft\right)^2} = 1029\frac{ft}{min}$$

$$V_2 = \frac{Q_2}{A_2} = \frac{\left(900\frac{ft^3}{min}\right)}{\frac{\pi}{4}\left(1ft\right)^2} = 1146\frac{ft}{min}$$

Substitute and solve for the change in static pressure:

$$\Delta p_s = p_{v,1} - p_{v,2} = \left(\frac{V_1}{4005}\right)^2 - \left(\frac{V_2}{4005}\right)^2$$

$$\Delta p_s = \left(\frac{1029}{4005}\right)^2 - \left(\frac{1146}{4005}\right)^2 = -.016 in\, wg$$

The negative value implies the static pressure is decreasing. As a sense check, an increase in velocity pressure would arise from a decrease in static pressure.

Answer B