6.4 Velocity change during take-off transition

$$\dot{V} = \frac{g}{W}\left[T - D - W\gamma\right]$$

$$\dot{h} = V\gamma$$

$$\frac{dV}{dh} = \frac{g}{W}\,\frac{T-D-W\gamma}{V\gamma} \qquad \gamma = \frac{\sqrt{2g(n-1)h}}{V}$$

$$\frac{dV}{dh} = \left[\frac{g}{W}\frac{T-D}{\sqrt{2g(n-1)}} - \frac{g}{V}\sqrt{h}\right]\frac{1}{\sqrt{h}}$$

$$a = \frac{g}{W}\frac{T-D}{\sqrt{2g(n-1)}} \qquad b = \frac{g}{V}$$

$$\frac{dV}{dh} = \frac{a - b\sqrt{h}}{\sqrt{h}} \qquad dV = \frac{a-b\sqrt{h}}{\sqrt{h}}\,dh$$

$$dV = \left(a - b\sqrt{h}\right)2d\sqrt{h} \qquad V = 2\frac{\left(a-b\sqrt{h}\right)^2}{2(-b)} + Const$$

$$h_0 = 0, \quad V_0 = V_{LO} \qquad h_f = 35 \text{ ft} \qquad Const = V_{LO} + \frac{a^2}{b}$$

$$V = V_{LO} + 2a\sqrt{h} - bh \qquad V_f = V_{LO} + 2a\sqrt{h_f} - b\,h_f$$

$$a = \frac{32.2}{13{,}000}\;\frac{5{,}750 - \frac{1}{2}(.06215)(.002377)\,232\,(216)^2}{\sqrt{2(32.2)(1.2-1)}}$$

$$= \frac{32.2}{13{,}000}\;\frac{5{,}750 - 799.5}{3.589} = 3.417$$

$$b = \frac{32.2}{216} = .1491$$

$$V_f = 216 + 2(3.417)\sqrt{35} - .1491(35) = 251.2$$

$$\frac{V_f - V_0}{V_0} = \frac{251.2 - 216}{216} = 16.30\,\% \text{ increase}$$