1-15. A cylindrical rod has a diameter of d = 0.6 in and a length of L = 1.2 ft. An axial load is applied to the bar. From repeated measurements, the increase is found to be normally distributed with $\delta P \sim N(1440, 15^2)$ lb. Find the distribution of the change in length of the rod if E = 9300 ksi.

Solution

$$A = \frac{\pi}{4} d^2 = \frac{\pi}{4}(0.6)^2 = 0.196 \text{ in}$$

$$E = \frac{\Delta\sigma}{\Delta\varepsilon} = \frac{\frac{\delta P}{A}}{\Delta\varepsilon}$$

$$\Rightarrow \Delta\varepsilon = \frac{\delta P}{EA}$$

$$\Delta\varepsilon = \frac{\Delta L}{L} = \frac{\delta P}{AE}$$

$$\Rightarrow \Delta L = \frac{(\delta P) L}{AE}$$

$$\mu_{\Delta L} = \frac{\mu_{\delta P} L}{AE} = \frac{(1.440)(1.2)(12)}{(0.1963)(9300)} = 0.0114 \text{ in}$$

$$\sigma_{\Delta L} = \sqrt{\left(\frac{L}{AE}\right)^2 \sigma_{\delta P}^2} = \sqrt{\left(\frac{(1.2)(12)}{(0.1963)(9300)}\right)^2 (15)^2} = 1.18 \times 10^{-4} \text{ in}$$

Then

$$\Delta L \sim N\left(0.0114, \left(1.18 \times 10^{-4}\right)^2\right) \text{ in}$$ **Ans.**