8.29 We are asked to determine the tensile load necessary to elongate a 635 mm long low carbon-nickel alloy specimen 6.44 mm after 5,000 h at 538°C. It is first necessary to calculate the steady state creep rate so that we may utilize Figure 8.31 in order to determine the tensile stress. The steady state elongation, Δl_s, is just the difference between the total elongation and the sum of the instantaneous and primary creep elongations; that is,

$$\Delta l_s = 6.44 \text{ mm} - 1.8 \text{ mm} = 4.64 \text{ mm} \quad (0.18 \text{ in.})$$

Now the steady state creep rate, $\dot{\varepsilon}_s$ is just

$$\dot{\varepsilon}_s = \frac{\Delta \varepsilon}{\Delta t} = \frac{\frac{\Delta l_s}{l_0}}{\Delta t} = \frac{\frac{4.64 \text{ mm}}{635 \text{ mm}}}{5{,}000 \text{ h}}$$

$$= 1.46 \times 10^{-6} \text{ h}^{-1}$$

Employing the 538°C line in Figure 8.31, a steady state creep rate of 1.46×10^{-6} h^{-1} corresponds to a stress σ of about 40 MPa (5,800 psi) [since log (1.46×10^{-6}) = -5.836]. From this we may compute the tensile load using Equation 6.1 as

$$F = \sigma A_0 = \sigma \pi \left(\frac{d_0}{2}\right)^2$$

$$= \left(40 \times 10^6 \text{ N/m}^2\right)(\pi)\left(\frac{19.0 \times 10^{-3} \text{ m}}{2}\right)^2 = 11{,}300 \text{ N} \quad (2560 \text{ lb}_\text{f})$$