7.40 A model of a submarine, 1:15 scale, is to be tested at 180 ft/s in a wind tunnel with standard sea-level air, while the prototype will be operated in seawater. Determine the speed of the prototype to ensure Reynolds number similarity.

Let \( l_m \) and \( l_p \) denote model and prototype, respectively. Thus, \( R_{en} = R_{ep} \), so

\[
\frac{V_m l_m}{V_m} = \frac{V_p l_p}{V_p}, \quad \text{where } l_m = \frac{1}{15} l_p
\]

Hence,

\[
V_m = \left( \frac{V_p}{V_p} \right)^{\frac{l_p}{l_m}} V_p = 15 \left( \frac{V_m}{V_p} \right) V_p
\]

Also,

\[
V_m = 1.57 \times 10^{-4} \frac{ft^2}{s} \quad \text{and} \quad V_p = 1.26 \times 10^{-5} \frac{ft^2}{s} \quad \text{so that}
\]

\[
V_m = 15 \left( \frac{1.57 \times 10^{-4} \frac{ft^2}{s}}{1.26 \times 10^{-5} \frac{ft^2}{s}} \right) V_p = 187 V_p
\]

Thus,

\[
V_p = \frac{V_m}{187} = \frac{180 \frac{ft}{s}}{187} = 0.963 \frac{ft}{s}
\]