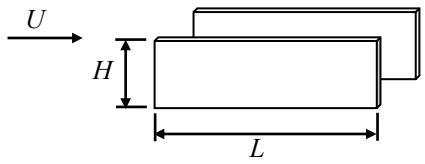
The U.S. Navy has built the *Sea Shadow*, which is a *small waterplane area twin-hull* (SWATH) ship with a reduced radar profile. This catamaran is 160 ft long and its twin hulls have a draft of 14 ft. Assume that ocean turbulence triggers a fully turbulent boundary layer on the sides of each hull. Treat these as flat plate boundary layers and calculate the drag on the ship and power required to overcome this drag for speeds ranging from 5 to 13 knots.

SOLUTION:
Model the twin hulls as two flat plates with turbulent boundary layers as shown in the figure below.



Assuming turbulent boundary layer over the full length of the hull, the drag force on one side of a hull is,

$$C_D \equiv \frac{D}{\frac{1}{2}\rho U^2 LH} = \frac{0.0742}{\mathrm{Re}_L^{1/5}}, \tag{1}$$

$$D_{\substack{\text{one side}\\ \text{of hull}}} = \frac{0.0742}{\mathrm{Re}_L^{1/5}}\left(\tfrac{1}{2}\rho U^2 LH\right) \text{ where } \mathrm{Re}_L = \frac{UL}{\nu}. \tag{2}$$

The total drag acting on the ship will be four times the drag in Eq. (2) since there are two hulls, each with two sides,

$$D_{\text{total}} = 4D_{\substack{\text{one side}\\ \text{of hull}}}. \tag{3}$$

Using the given numbers,

$\rho_{\text{seawater}} = 1025 \text{ kg/m}^3 = 63.99 \text{ lb}_\text{m}/\text{ft}^3$,
$U = 5$ to 13 kn = 8.44 ft/s to 21.94 ft/s (1 kt = 1.15 mph = 1.688 ft/s),
$L = 160$ ft,
$H = 14$ ft,
$\mu_{\text{seawater}} = 1.08*10^{-3}$ Pa.s,
□□□ ν□□□□□□□□□ μ□ρ □ $1.05*10^{-6}$ m^2/s = $1.13*10^{-5}$ ft^2/s,
□□□□$\mathrm{Re}_L = 1.19*10^8 - 3.10*10^8$ (clearly in the turbulent regime),
=> $D_{\text{one side of hull}} = 285 - 1590$ lb$_\text{f}$ (1 lb$_\text{f}$ = 32.2 lb$_\text{m}$.ft/s^2),
=> $\boxed{D_{\text{total}} = 1140 - 6370 \text{ lb}_\text{f}}$.

The power to overcome this total drag is,

$P = D_{\text{total}} U$,
=> $\boxed{P = 17.5 - 254 \text{ hp}}$ (1 hp = 550 lb$_\text{f}$.ft/s)

Note that the hulls for the *Sea Shadow* are more complex than the flat plates described in this simple problem. The actual hulls have cylindrical elements, which are tapered at the ends, as shown in the figure to the side.