UNIFIED PROPULSION P5 SOLUTIONS — WAITZ

$$P_{AVAIL} - P_{REQ} = \Delta P.E. + \Delta K.E.$$

$$TV - DV = W\frac{dh}{dt} + \frac{d}{dt}\left(\frac{1}{2}\frac{W}{g}V^2\right)$$

CASE i) STEADY, NO CLIMB $T = D$ $L = nW = 5W$

$$\frac{T}{W} = \frac{D}{W} \qquad D = \frac{1}{2}\rho V^2 S k C_L^2 + \frac{1}{2}\rho V^2 S C_{D_0}$$

$$\frac{T}{W} = \frac{1}{2}\rho V^2\left(\frac{1}{W/S}\right)k\frac{L^2}{\left(\frac{1}{2}\rho V^2 S\right)^2} + \frac{1}{2}\rho V^2\left(\frac{1}{W/S}\right)C_{D_0}$$

$$\frac{T}{W} = \cancel{\frac{1}{2}\rho V^2}\left(\cancel{\frac{1}{W/S}}\right)k\frac{n^2W^2}{\left(\frac{1}{2}\rho V^2\right)^2 S^2} + \frac{1}{2}\rho V^2\left(\frac{1}{W/S}\right)C_{D_0}$$

$$\frac{T}{W} = \frac{kn^2}{\frac{1}{2}\rho V^2}\left(\frac{W}{S}\right) + \frac{C_{D_0}}{\left(\frac{W}{S}\right)}\frac{1}{2}\rho V^2$$

$$= 1.53 \qquad + 0.034$$

$V = 0.9(295) = 265.5\ m/s$
$\rho = 0.34\ kg/m^3$
$k = 0.21$
$C_{D_0} = 0.01$
$W/S = 3500$

$$\boxed{\frac{T}{W} = 1.56}$$

CASE ii) $TV - DV = \frac{d}{dt}\left(\frac{1}{2}\frac{W}{g}V^2\right) = \frac{1}{2}\frac{W}{g}2V\frac{dV}{dt}$

$$\frac{T}{W} = \frac{D}{W} + \frac{1}{g}\frac{dV}{dt}$$

$$\frac{T}{W} = \underbrace{\frac{kn^2}{\frac{1}{2}\rho V^2}\left(\frac{W}{S}\right) + \frac{C_{D_0}}{\left(\frac{W}{S}\right)}\frac{1}{2}\rho V^2}_{\text{from above (now } n=1)} + \frac{1}{g}\frac{(V_{final} - V_{initial})}{\Delta t}$$