UNIFIED PROPULSION P4 SOLUTIONS — WAITZ 2001

a) $V_{max\ range} = \left[4\left(\frac{W}{S}\right)^2 \frac{1}{\rho^2} \frac{1}{C_{D_0}} \left(\frac{1}{\pi e AR}\right)\right]^{1/4}$

$\frac{W}{S} \approx \frac{4.8\,oz}{ft^2} = 144\,\frac{N}{m^2}$ $\quad C_{D_0} \approx 0.3$ (per Coleman) $\quad e \approx 0.96$ $\quad$ } ALL PER COLEMAN

$\rho = 1.2\,kg/m^3$ $\quad AR \approx 5.12$ $\quad W \approx 15\,oz = 4.2\,N$ }

$V_{max\ range} \approx 3.3\ m/s$

b) $V_{max\ endurance} = 3^{-1/4}\,(V_{max\ range}) = 2.5\ m/s$
(= min power)

c) ASSUME THE AIRPLANE IS BEING FLOWN AT MAX ENDURANCE CONDITIONS

$$\text{POWER REQUIRED} = D_{MIN\,POWER} \cdot V_{MIN\,POWER}$$

$D_{MIN\,POWER} = W\left[\frac{16}{3}\frac{C_{D_0}}{\pi e AR}\right]^{1/2} = 1.34\,N$

$\text{POWER REQD} = D_{min\,power}\, V_{min\,power} = 3.4\ W = 3.4\ J/s$

FLIGHT TIME = 15 min = 900 s $\quad \therefore$ ~~ENERGY~~

$\therefore$ ENERGY = TIME (POWER REQD) $* \frac{1}{\eta_0} = 30.6\ kJ$

NOTE: PROF. COLEMAN CALCULATED $E_{batt.} = 18.1\ kJ$ SO PERHAPS η_0 IS BETTER THAN 0.1 !

(600 mA-hr = 2150 A-s $\quad$ 8.4 Volts $= \frac{W}{A}$

$E = 8.4 \cdot 2150\ W \cdot s = J/s \cdot s = J = 18144$)