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Assumptions

1. Fixed Engine Weight $W_{eng-tot} \leftarrow 6$ lbf $P_{shaft-maxMSL} \leftarrow 2.189$ kW. Also assuming that engine performance is affected by altitude and RPM. This BSFC model is technically fit for a single propellor. We are assuming that the the variance in BSFC curves in the family of propellers is small.
2. Fixed range to station $R \leftarrow 200$ nmi
3. Fixed payload $W_{pay} \leftarrow 10$ lbf $Vol_{pay} \leftarrow 0.5$ ft^3
4. Fixed altitude at cruise $h_{cruise} \leftarrow 5000$ ft
5. Fixed altitude at station $h_{station} \leftarrow 1.5 \times 10^4$ ft
6. Fixed avonics $Vol_{avionics} \leftarrow 0.125$ ft^3 $W_{avionics} \leftarrow 8$ lbf
7. Fixed climb rate $h_{dot} \leftarrow 125$ $\frac{\text{ft}}{\text{min}}$
8. Fixed time to get on station $t_{cruise} \leq 1$ day
9. Constant wind speed during loiter $V_{wind} \leftarrow 25$ m/s
10. Fuselage fineness ratio $fr \leftarrow 3.5$

Performance Curves

The following curves are performance curves. They assume that the weight of the aircraft is fixed. All of the above assumptions hold.

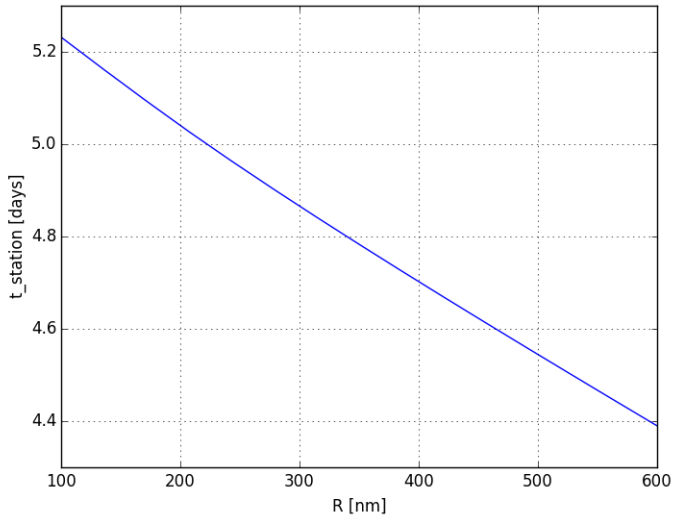

Figure 1: Time on station vs R. Assumes fixed weight of $MTOW = 87$ [lbf].

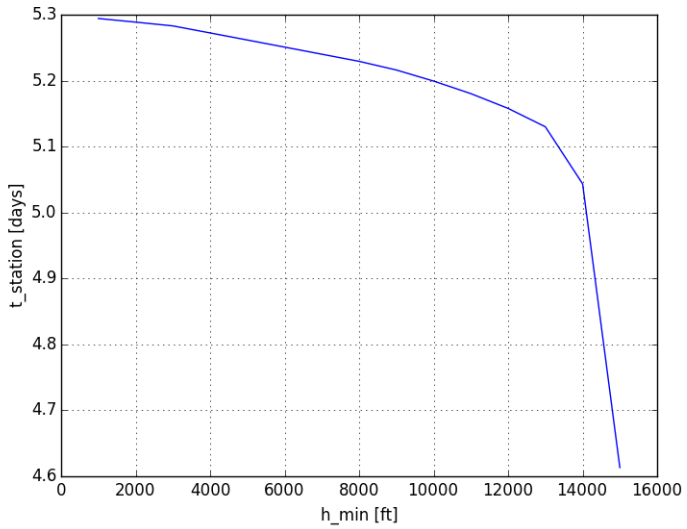

Figure 2: Time on station vs cruise altitude. Assumes fixed weight of $MTOW = 87$ [lbf].

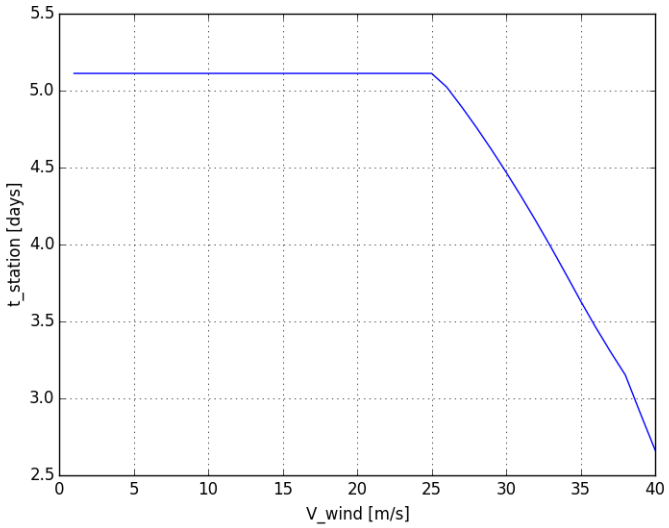

Figure 3: Time on station vs wind velocity. Assumes fixed weight of $MTOW = 87$ [lbf].

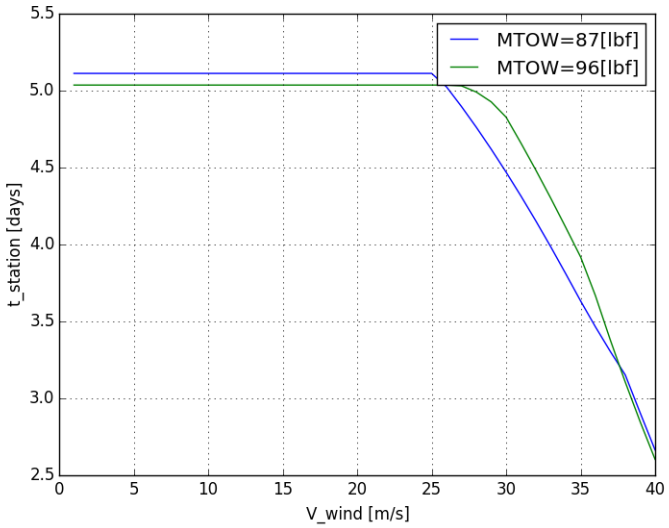

Figure 4: Time on station vs wind velocity.

Solution

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Cost
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 83.13 [lbf]
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AR	27.87		Aspect ratio
A_{capcent}	9.979e-05	[m**2]	Cap area at center
C_{D-fuse}	0.003734		fueslage drag
C_{f-fuse}	0.006756		Fuselage skin friction coefficient
F	1633	[N]	Load on wings
LoverA	5.225	[lbf/ft**2]	Wing loading
MTOW	83.13	[lbf]	max take off weight
M_cent	1310	[N*m]	Center bending moment
P_{cap}	4.74e+04	[N]	Cap load
S	15.91	[ft**2]	wing area
S_{fuse}	7.994	[ft**2]	Fuselage surface area
Vol_{cap}	0.0002135	[m**3]	Cap volume
Vol_{fuel}	0.02653	[m**3]	Fuel Volume
Vol_{fuse}	0.04423	[m**3]	fuselage volume
W_{cent}	73.41	[lbf]	Center aircraft weight
W_{fuel-tot}	42.13	[lbf]	total fuel weight
W_{fuse}	4.284	[lbf]	fuselage weight
W_{wing}	7.514	[lbf]	Total wing structural weight
W_{zfw}	41	[lbf]	Zero fuel weight
\delta_{tip}	4.211	[ft]	Tip deflection
\rho_{sl}	1.225	[kg/m**3]	density at sea level
b	21.06	[ft]	Span
c	0.7556	[ft]	Wing chord
h_{spar}	0.02764	[m]	Spar height
l_{cent}	2.675	[ft]	center fuselage length
l_{fuse}	3.316	[ft]	fuselage length
m_{cap}	0.3757	[kg]	Cap mass
m_{fuse}	0.7427	[kg]	fuselage mass
m_{skin}	2.956	[kg]	Skin mass
w_{cap}	5.524	[in]	Spar cap width
w_{cent}	0.7642	[ft]	center fuselage width
\vec{BSFC}	[0.507	0.681	0.507	0.649 ...]	[lb/hp/hr]	brake specific fu
\vec{C_D}	[0.0304	0.0131	0.0299	0.0274 ...]		Drag coefficient
\vec{C_L}	[1.08	0.498	1.06	0.991 ...]		Lift coefficient
\vec{L_factor}	[0.188	0.189	0.518	0.518 ...]		Max shaft power loss fa
\vec{P_{shaft-max}}	[2.38	2.37	1.41	1.41 ...]	[hp]	Max shaft power at
\vec{P_{shaft}}	[2.38	0.66	1.41	0.448 ...]	[hp]	Shaft power
\vec{RPM}	[8.44e+03	5.82e+03	8.44e+03	6.1e+03 ...]	[rpm]	Engine operating RP
\vec{Re_{fuse}}	[1.49e+06	2.18e+06	1.24e+06	1.24e+06 ...]		fuselage Reynolds numbe
\vec{Re}	[3.38e+05	4.97e+05	2.83e+05	2.83e+05 ...]		Reynolds number
\vec{T}	[9.54	2.16	4.74	2.1 ...]	[lbf]	Thrust
\vec{V}	[20.9	30.7	25	25 ...]	[m/s]	cruise speed
\vec{W_{end}}	[82.8	81.4	80.6	71.6 ...]	[lbf]	segment-end weight
\vec{W_{fuel}}	[0.288	1.4	0.83	9.06 ...]	[lbf]	segment-fuel weight
\vec{\eta_{prop}}	[0.5	0.6	0.5	0.7 ...]		propulsive efficiency
\vec{\rho}	[1.05	1.05	0.738	0.738 ...]	[kg/m**3]	air density
\vec{c_{dp}}	[0.0117	0.00622	0.012	0.0112 ...]		wing profile drag coeff

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      \vec{h_{dot}} : [ 357     148      ]      [ft/min]    Climb rate
           \vec{h} : [ 5e+03     5e+03     1.5e+04   1.5e+04  ... ]  [ft]      altitude
           \vec{t} : [ 0.00973   0.126     0.047     1.2      ... ]  [day]     time per flight seg
      \vec{z_{bre}} : [ 0.0034    0.0167    0.01      0.117    ... ]        breguet coefficient

Constants
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        BSFC_{min} : 0.32         [kg/hr/kWMinimum BSFC
         C_{L-max} : 1.5                  Maximum lift coefficient
           E_{cap} : 2e+07        [pound_force_per_square_inch] Youngs modulus of CF cap
       FuelOilFrac : 0.98                 Fuel-oil fraction
          K_{fuse} : 1.1                  Fuselage form factor
           N_{Max} : 5                    Load factor
  P_{shaft-maxMSL} : 2.93         [hp]     Max shaft power at MSL
                 R : 200          [nmi]    range to station
         RPM_{max} : 9000         [rpm]    Maximum RPM
        R_{cruise} : 180          [nmi]    range to station during climb
          Re_{ref} : 3e+05                 Reference Re for cdp
          V_{wind} : 25           [m/s]    wind speed
    Vol_{avionics} : 0.125        [ft**3]  Avionics volume
         Vol_{pay} : 0.5          [ft**3]  Payload volume
       W_{avionics} : 8            [lbf]    Avionics weight
       W_{eng-tot} : 6            [lbf]    Installed engine weight
           W_{pay} : 10           [lbf]    Payload weight
          W_{skid} : 3            [lbf]    skid weight
  \delta_{tip-max} : 0.2                   max tip deflection ratio
 \eta_{prop-climb} : 0.5                   propulsive efficiency in climb
\eta_{prop-cruise} : 0.6                   propulsive efficiency in cruise
\eta_{prop-loiter} : 0.7                   propulsive efficiency in loiter
              \mu : 1.5e-05      [N*s/m**2]Dynamic viscosity
        \rho_{cap} : 1.76         [g/cm**3] Density of CF cap
       \rho_{fuel} : 6.01         [lbf/liquid_gallon]     density of 100LL
       \rho_{skin} : 0.1          [g/cm**2] Wing Skin Density
      \sigma_{cap} : 4.75e+08     [Pa]      Cap stress
             \tau : 0.12                   Airfoil thickness ratio
                e : 0.9                    Spanwise efficiency
               fr : 3.5                    fineness ratio fuselage
                g : 9.81         [m/s**2]  Gravitational acceleration
           h_{min} : 5000         [ft]      minimum cruise altitude
       h_{station} : 1.5e+04      [ft]      minimum altitude at station
        k-{2-fuse} : 5.938                 fuselage form factor 2
        k_{1-fuse} : 2.858                 fuselage form factor 1
           m_{rib} : 1.2          [kg]      rib mass
          m_{tail} : 1            [kg]      tail mass
           t_{cap} : 0.028        [in]      Spar cap thickness
t_{cruise} : 1            [day]     time to station
       t_{station} : 6            [day]     time on station
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