APPENDIX

ANALYSIS OF PARAGLIDER AERODYNAMICS

Performance

Wind-tunnel data (ref. 2) from a wing geometrically similar to the wings of the test vehicles and the estimated drag of the fuselage were used to determine the lift-drag characteristics and steady-state flight conditions of the vehicles.

The fuselage drag of vehicle A was estimated by considering the drag of each of the following components, assuming no interference effects: pilot, 30 feet of 1 1/2-inch-diameter tubing perpendicular to the airstream (supercritical Reynolds number), wheels, and instrument panel (ref. 4). The summation of the drag of these components yields a total drag coefficient of the fuselage of 0.06, based on the wing area. This fuselage drag was summed with the wing data to obtain the lift-drag-ratio and steady-state flight data presented in figures 9 and 10.

The lift-drag characteristics of vehicle B were estimated in a similar manner, with a more conservative estimate of the drag of the structure than was used for vehicle A. The flight data from vehicle A were also used in the analysis, inasmuch as the wing used on vehicle A was geometrically similar to the wing of vehicle B. These data were conservative, since the shape of the wing membrane on vehicle A resulted in a higher drag for the wing. The summation of the drag of the components of the fuselage yields a total drag coefficient of the fuselage of 0.123, based on the wing area. This fuselage drag summed with the wing drag yields the lift-drag characteristics and steady-state flight conditions of vehicle B presented in figures 11 and 12.

Gust Effects

Vehicles with low wing loadings are particularly susceptible to gusts. To determine the effect of gusts on the test vehicles, the initial normal acceleration resulting from a 5-knot gust was calculated. The analysis of this condition is based on the following assumptions: gust acts as a pure step in horizontal velocity, only initial accelerations are considered, and the lift coefficient is constant. Considering these assumptions, the initial normal accelerations from a 5-knot gust were calculated from the equation

$$a_n = \frac{\Delta L}{W} = \frac{C_L}{2W}\rho S\left[\left(\frac{V_0}{0.594} + \frac{\Delta V}{0.594}\right)^2 - \left(\frac{V_0}{0.594}\right)^2\right] \tag{1}$$

and are presented in figure 14 as a function of C_L. This acceleration disturbed the vehicle from the flight path and was critical during the flare maneuver since the vehicle did not have adequate lift-drag ratio to recover.