Cruise Performance Demonstration

Introduction

Cruise performance testing is accomplished to define the range and endurance of an airplane in the cruise configuration. The test is performed by maintaining specific indicated airspeeds, which range from the maximum speed attainable in level flight to a speed slightly above the unaccelerated stall airspeed, at a predetermined altitude. Various engine and flight parameters are noted at each airspeed. This demonstration will be limited to one altitude although it is usual to select several altitudes between sea level and the aircraft's service ceiling for testing.

Theory

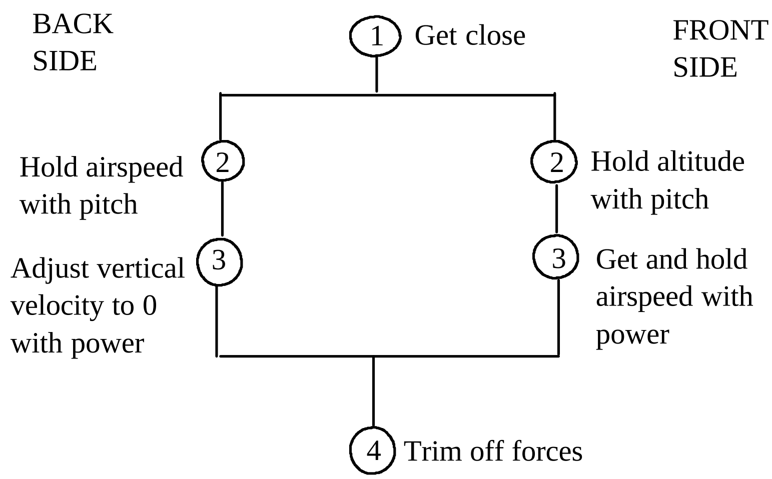
The aerodynamic characteristics of the aircraft determine the power requirements of the various flight configurations while the powerplant defines the power available. A good match of aerodynamics and powerplant in the design stage ensures an aircraft capable of performing its mission. Measurement of the power required to fly in steady level flight allows determination of the aircraft drag polar since in steady flight the power required is proportional to the drag of the aircraft. The minimum power required occurs at the velocity where the parasite drag equals one-third the induced drag. This airspeed also corresponds to the maximum endurance for the airplane. The velocity for maximum range in still air is the airspeed where the induced drag equals the parasite drag.

An increase in altitude increases the power required and the true airspeeds that correspond to maximum endurance and maximum range. An increase in weight acts similarly. Since the aircraft can be flown at many altitudes and over a range of weights, the data acquired using the power required technique to determine cruise performance must be standardized.

The flight test technique used in the United States is called the P_{iw} -V_{iw} method which essentially consists of normalizing the data to an equivalent airspeed and a constant angle of attack. P_{iw} is defined as the power required corrected to standard weight sea level conditions. Since the absolute altitude is not important, a trim shot flight test technique is effective in gathering data for the reciprocating engine cruise performance documentation especially if the aircraft is initially stabilized at the highest airspeed attainable in level flight. The rest of the test points are obtained by incrementally reducing airspeed while maintaining altitude until the unaccelerated stall speed is reached.

Trim Shots

A trim shot is basic to many flight test techniques and good trim shots are essential for accurate cruise performance data. Essentially, a trim shot is simply getting the power and pitch trim set so that the aircraft will hold a constant altitude and airspeed, hands off. For performance testing, the hands off part is of little importance. When performing a trim shot, the following procedure will yield the best results in the shortest time.



Step 1: Get close. Initially, use normal piloting techniques to get close to the desired airspeed and altitude (within ±2 MPH and 50 feet).

Step 2: **Backside** (speeds less than V_Y) - The best technique at slower speeds is to hold the airspeed constant by aggressively making small pitch changes. Do not trim.

Frontside (speeds greater than V_Y) - At high speeds, use pitch to hold altitude constant. Do not trim.

Step 3: **Backside** - While holding the airspeed constant by aggressively making small pitch changes, make infrequent power changes (every 10 to 15 seconds) until the altitude is constant (VVI = 0).

Frontside - While holding altitude constant with pitch, make infrequent power changes until the airspeed is constant.

Step 4: Once the proper pitch and power are set to maintain the desired airspeed and altitude, trim off the control forces.

If you are unsure whether you are on the front or backside, use the backside technique. It will always work. Only at very high true airspeeds will the backside technique take more time than the frontside technique. Never try to use the frontside technique at low speeds. It will yield an unstable solution.

Aircraft Limitations

Know the maximum continuous engine speed (RPM and manifold pressure) for the aircraft to be flown. Oil and cylinder head temperatures should be monitored closely at airspeeds less than 100 mph.

Mission Specifics

The technique for gathering cruise data is very simple and embodies the basis of most of the flight test techniques; the trim shot. The following steps should be used to obtain the data:

a. Level off at a pressure altitude between 5000 and 6000 feet (altimeter set to 29.92 in. Hg.) and trim at the highest power setting recommended.

b. When stable, record indicated airspeed (V_i), indicated altitude (H_i), outside air temperature (T_i), engine speed (*RPM*), and manifold pressure (*MP*). The test point should be held for at least one minute to ensure the proper power is set.

c. The trim point does not have to be accomplished hands off. The altitude should be maintained within 50 feet and the airspeed within 2 MPH over the one minute period without changing the throttle.

d. Do not reset the power or change trim while taking data.

e. When on the front side of the power curve reduce MP and retrim for the next lower airspeed while maintaining altitude. Repeat steps **b** through **d**. When on the back side of the power curve it will be necessary to increase MP in order to trim at a lower airspeed and maintain altitude.

f. Continue repeating the test technique for each desired airspeed until data has been acquired for an airspeed just above the unaccelerated stall speed of the airplane at the test altitude.

Data reduction would normally result in a plot of fuel flow versus true airspeed. For the demonstration flight the curve can be approximated by plotting *MP* versus V_i. The minimum point on the curve corresponds to the maximum endurance airspeed and a line from the origin tangent to the curve identifies the airspeed to be flown for maximum range in still air.

Cruise Performance Demonstration

Test Initial Conditions

Pressure Altitude: 5000 to 6000 feet

RPM: Max Continuous

MP: Max Allowable

Airspeed: V_{max}

Configuration: Flaps up, gear up

Tiger _______ Date ________ Taxi ______

T/O ______

Land ______

For Each Target Airspeed Record:

V_{aim}	V_i	H_i	T_i	*RPM*	*MP*
V_{max}					
-10					
-20					
-30					
-40					
-50					
-60					
-70					
-80					
-90					

Test Hazard Analysis Worksheet

Test Title:

Cruise Performance

Aircraft/System:

Subjective Probability of Occurrence

Hazard Category	high	probable	uncertain	remote	improbable
catastrophic					
critical	High		Medium		
marginal				Low	
negligible					

Hazard:
No test unique hazards identified for this demo sortie.

Cause:

Effect:

Minimizing Procedures:

Emergency Procedures:

Risk Level (after minimizing procedures taken into account):

High ____ Medium ____ Low __X__