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ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: AERIAL APPLICATOR AERODYNAMICS REVIEW OF "REGION OF REVERSED COMMAND"

1. PURPOSE. This Advisory Circular has been prepared for the purpose of increasing pilot awareness of the aerodynamic limitations pertinent to aerial applicator operations.

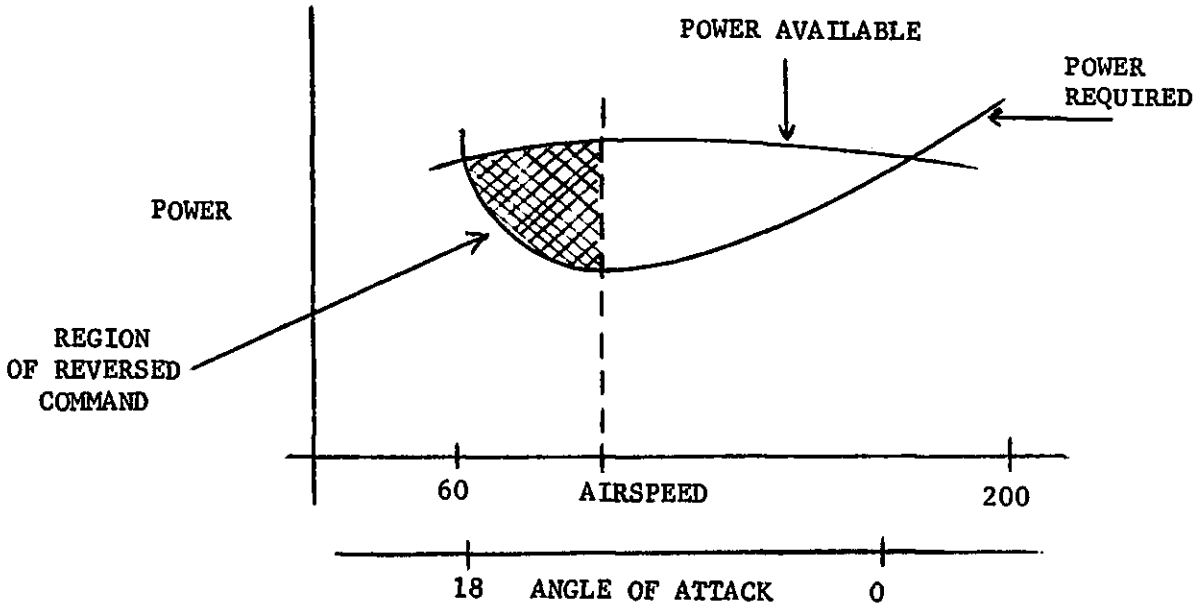
2. BACKGROUND. A comment quite often made in reference to the sequence of events preceding an airplane accident is "--I had full power on but the plane just would not climb." Discussion of one of the possible contributing factors follows.

3. DISCUSSION.

   a. All pilots have come face to face with the situation commonly referred to as operating on the "back side of the power curve." This is also referred to as the "region of reversed command." Flight at minimum controllable airspeed is an excellent example of operation in this flight regime. Stated simply, the "region of reversed command" is one in which a reduction in airspeed brings about a need for increased power if altitude is to be maintained. There is no intent to imply that operation within this region is undesireable. However, such operation should be conducted only with full awareness of the potential problems associated with low altitude, slow airspeed flight.

   b. On the chart showing power available (PA) and power required (PR) curves, the "region of reversed command" or "back side of the power curve" is the shaded area at the left of the vertical line through the low point on the power required curve.

Initiated by: FS-444



* NOTE: AIRSPEED AND ANGLE OF ATTACK VALUES SHOWN ARE MERELY EXAMPLES.

c. Operation in the shaded area can occur during a swath run, a pull-up at the end of a run or on turn around. It is the product of low airspeed and high power settings which result in a high angle of attack. There are two ways out of the situation - by increasing power or by increasing airspeed. If possible, the combined use of both will be the best remedy.

d. If, through carelessness or complacency, the pilot permits the speed to get too low while on a swath run, he will have to add power just to maintain level flight. This can lead to his starting a pull-up with little or no additional power available and little airspeed to convert to altitude. Raising the nose increases the angle of attack and drag. Without additional power available for acceleration, there will be no means of obtaining the performance necessary to clear obstacles.

e. The unwary pilot may set up the same problem when turning around for the next run. A pull-up at high power setting and low airspeed with a time saving, steep bank thrown in will bring about operation in the region of reversed command and, possibly, altitude loss or stall. Shallowing the bank is one corrective measure. Altitude, if available, provides a second way out when it is sacrificed to gain airspeed.

f. Additional factors which may lead a pilot into power curve problems include up slope swath run, down wash over tree rows and gusty wind.

g. Stalls are another problem closely associated with operation in the "region of reversed command." Since the angle of attack is already high, a stall can occur at pull-up, during the turn or at level off for the swath run. Tight pull-ups at the beginning or end of a run may permit maximum crop coverage in spite of obstructions at the edge of the field but the "G" loads induced cause an increase in stall speed and the amount is predictable. Stall speed increases as the square root of the "G" load. A 1.4 "G" pull-up results in a stall speed 1.2 times the normal, unaccelerated stall speed. A constant altitude turn with 45° bank also produces 1.4G.

4. CONCLUSION. In no other flying situation is the association of region of reversed command and stall as intolerant of mishandling as in the low altitude, maximum performance operations typical of aerial application. Many factors involved are high or near maximum such as - gross weight, "G" load, power setting and angle of attack. Two critical items tend to be low - airspeed and altitude. Keep in mind, then, that alert, planned operation is necessary in avoiding the intersection of the PA PR curves and critical angle of attack unless there is altitude to spare for recovery from the stall that will occur.

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