

## Suggestions for pen and ink changes to your own personal copy of an AFM or POH

as reminders for maintaining control after engine failure, i.e. for getting home safely

The AFM/POH of your two-engine airplane might not contain appropriate warnings, notes, reminders and other information for safe operation and continuing a flight safely after engine failure, as required by FAR/CS 23.1581, and do not include the associated conditions for preventing the loss of control. Although the contents of the Approved parts of the AFM/POH is protected, you are allowed to add pen and ink notes to your own AFM/POH and checklist (or reference guide) as reminders. Below you find a few suggestions for maintaining control and performance after engine failure. Add the ones you need to the appropriate definitions, procedural steps, and to performance charts, in your own words. On the next page, these subjects are briefly explained.  $V_{MC}$  is the same as  $V_{MCA}$ . Keep flying safely. Don't let a failing engine turn into a killing engine.

1. When an uncommanded yaw and/or roll occurs during the takeoff run due to an engine failure while the speed is below  $V_1$  or  $V_{MCG}$ , abort the takeoff by closing the throttles.
2. When uncommanded yaw and/or roll occurs during takeoff, counteract immediately with up to maximum rudder and aileron as required for maintaining the (current) heading, and with a  $5^\circ$  bank angle to the same side as rudder (foot) pressure. This keeps both  $V_{MC}$  and drag low.
3. After engine failure maintain straight flight, while also maintaining a small bank angle, but  $\leq 5^\circ$  into the good engine, to the same side as rudder (foot) pressure. When maintaining  $V_{YSE}$ , bank  $3^\circ$ .
4. The red-lined or placarded  $V_{MC}$  is only valid when maintaining  $5^\circ$  into the good engine; the actual  $V_{MC}$  that you will experience in-flight when banking away from this bank angle to either side will be much higher. The increase of  $V_{MC}$  when the wings are kept level is already 6 kt for a small twin, and up to 30 kt for a 4-engine turbojet. A non-feathered propeller increases  $V_{MC}$  as well.
5. Never turn (shallow) at airspeeds less than 20 kt above  $V_{MC}$  or  $V_{MCA}$  (for small airplanes), until a safe altitude has been reached. The required speed increases with bank angle and weight.
6. When no climb performance remains while in straight flight with  $5^\circ$  bank, find a landing spot ahead. Don't bank away from the favorable  $5^\circ$  bank angle when still at maximum asymmetrical thrust. Landing wings-level in the dirt is more survivable than with a banked airplane.
7. For maximum Rate of Climb (ROC) maintain straight flight at  $V_{YSE}$ , maximum thrust, and a  $3^\circ$  bank angle into the good engine for minimum drag. Climb to a safe altitude where a turn can be made at a little less than maximum asymmetrical thrust, temporarily; some altitude will have to be sacrificed. The time to climb to a safe altitude might be 30 minutes or more. Be patient, don't panic, concentrate on both the straight flight and bank angle conditions for minimum drag and lowest actual  $V_{MC}$ . The probability of the second engine to fail is very small.
8. During turns in the pattern for landing, never ever increase thrust to maximum, or control will be lost. A long straight-in approach is much safer. Keeping wing-fuel balance helps; a little heavier wing on the good-engine side reduces rudder and aileron deflections.
9. Add to the  $V_{MC}$  definition that the furnished  $V_{MC}$  is only valid for straight flight while maintaining the small bank angle (FAR/CS 23.149). You should ask the manufacturer for which bank angle the AFM/POH-furnished  $V_{MC}$  is valid. The actual  $V_{MC}$  encountered in-flight might be much higher. You as a pilot control the magnitude of  $V_{MC}$  with thrust and bank angle. Selecting or maintaining maximum thrust during banking to either side is killing.
10. Keep in mind that your takeoff speeds  $V_1$ ,  $V_R$  and  $V_2$  are calculated using the  $V_{MC}$  that is determined using a small bank angle. Keeping the wings level increases the actual  $V_{MC}$  which could increase above the calculated  $V_1$ ,  $V_R$ , and/or  $V_2$ .
11. When adjusting the thrust, adjust rudder and aileron as well to keep sideslip minimal.

**Engine-out flight is not coordinated flight.**

Below, a few explaining words are presented on the notes provided above.  $V_{MC}$  (and other airspeeds) are explained [here](#). More information can be found in the papers presented on the Downloads page of the website of AvioConsult, click [here](#). These papers are written using academic college books and test pilot school course books (for which references and download links are presented) and explain actual experimental flight-test facts, not opinions of incompetent pilots on the subject of airplane control after engine failure (who caused more than 4,000 casualties due to more than 250 engine-failure accidents during the past 25 years, see a list on the [Accidents page](#)).

- 1) At airspeed  $V_{MCG}$ , the deviation from the takeoff path on the runway is 30 ft when an engine fails and maximum thrust is set. At lower speeds, the deviation is larger and the runway vacated.
- 2) Uncommanded yawing generates a sideslip, and hence drag. The sideslip angle can be up to  $14^\circ$  or more. Rudder is required to minimize sideslip and drag and hence, maximize the ROC.
- 3) The rudder and ailerons are sized and only have to be sized by FAR/CS 23 to be able to maintain straight flight when one engine is inoperative, and the other is operating at the maximum thrust the pilot can set from the cockpit, the airspeed is as low as  $V_{MC}$ , and a small  $5^\circ$  bank angle is being maintained into the good engine (same side as foot pressure). A small bank angle into the good engine generates a side force due to Weight in the center of gravity which replaces the counteracting sideslip side force portion by the rudder; then the rudder only has to counteract the asymmetrical thrust and can be smaller. A smaller vertical tail saves weight and cost.
- 4) FAR 23.149 requires the  $V_{MC}$  to be determined during straight flight while maintaining a small  $5^\circ$  bank angle into the good engine. When, while maintaining  $V_{MC}$ , the wings are kept level, the actual  $V_{MC}$ , i.e. the  $V_{MC}$  that you will experience in-flight, will increase, because the small rudder needs a higher speed to generate the force required to counteract both the thrust and sideslip side forces.
- 5) When banking, the side force generated by the weight increases, as does the sideslip. When the counteracting rudder is maximum deflected, a much higher airspeed is required; actual  $V_{MC}$  is much higher. This increase for small twins is at least 20 kt, for turboprops be 30 kt or more. When two engines on the same wing are inoperative, the increase due to banking is even larger. Reducing the yawing moment (temporarily during the turn) will decrease actual  $V_{MC}$ . During banking  $>6^\circ$  into the good engine, the rudder needs to be reversed to maintain the equilibrium of forces and moments.
- 6) If the airplane is too heavy, a turn will increase  $V_{MC}$  and control will be lost. A wings-level landing straight ahead, or reducing asymmetrical thrust before banking, might prevent a catastrophe.
- 7) A  $3^\circ$  bank angle at  $V_{YSE}$  reduces the sideslip angle to a minimum, and maximizes the ROC.
- 8) Increasing the (asymmetrical) thrust during a turn increases the thrust yawing moment which must be counteracted by a larger rudder deflection, or a higher airspeed if the rudder is already maximum, to prevent the Loss of Control.
- 9) The manufacturer should have published for which bank angle the furnished  $V_{MC}$  is valid.
- 10) No further remarks.
- 11) No further remarks.

Please remember that  $V_{MC}$  is not a constant,  $V_{MC}$  varies with many variables of which the most important are thrust and bank angle. Compare with stall speed  $V_S$  which varies with flap setting and bank angle. No pilot will bank an airplane when the stall horn sounds or the stick shaker is activated.  $V_{MC}$  is a silent killer which cannot be announced with a sound or shaker, and therefore requires a simple rule:

**When maximum asymmetrical thrust is required, attain and maintain straight flight first, while banking a small  $5^\circ$  bank angle into the good engine.**

**Minimum Control speed  $V_{MC(A)}$  is the lowest airspeed which can be obtained during steady straight flight while maintaining  $5^\circ$  bank towards the good engine, with full rudder and/or aileron control inputs when one engine fails or is inoperative, and the opposite engine is set at maximum thrust.**

**The actual  $V_{MC(A)}$  increases while banking to either side and with the thrust level of the good engine and hence, is controlled by the pilot.**