AvioConsult
Vlaskamp 14
2353 HT LEIDERDORP
The Netherlands

E-mail: info@avioconsult.com
Web: www.avioconsult.com

Reference: Report Prevention of Airplane Accidents after Engine Failure, AvioConsult, June 2005

Date: 27 Sept. 2005

Limited review of the Book "Multi-Engine Piston", edition 2004, by David Robson

1. Our national NTSB (OVV) asked me to review an accident investigation report of an accident with a PA-44-180, owned by the Martinair Flight School. I was also given a copy of your book that is being used during training, for review. Although I am impressed by the artwork and most of the contents, there are a few anomalies that require your attention because they might lead to accidents. Please allow me to address these to you; it is nearly a copy of what I sent to the OVV and to the Martinair Flight School. I did not review the whole book, only a few selected pages.

1.1. I wrote the comments using my knowledge from the USAF Test Pilots School where I learned how to flight-test multi-engine airplanes (including the determination of V_{MCA}) and from the results of 6 month research into many engine failure related accidents with multi-engine airplanes, ranging from big airplanes to small twins. I recently finished a report on the subject that is referenced above and that is available from my web site. In this report, almost all there is to know about V_{MCA} and V_2 is included.

2. In the paragraphs below, reference is made to page numbers. The original text is printed in *Italics*.

2.1. Page 76, 77. *Minimum Control Airspeed.*

- The author makes a difference between minimum control speed and V_{MCA}, the latter being for sudden and complete engine failure – the dynamic V_{MCA}. This might lead to the interpretation by the readers of the book that V_{MCA} does not apply during cruising or during the flight following the engine failure while turning back to the runway for landing. This is definitely not correct. Many accident investigation reports show evidence that if pilots succeed in surviving the dynamics of a sudden engine failure, they still crash on the way back to the runway. They are not made aware of a minimum control speed that applies as long as a power asymmetry exists. This speed is a V_{MCA} too, it is called the static V_{MCA}. Both the static and dynamic V_{MCA} are determined during flight testing, the highest of static and dynamic V_{MCA} is shown on the airspeed indi-

cator with a red radial line and as a number in the flight manual. In the specific list of factors for determining V_{MCA}, the following 'classic' errors are made as well:

- *critical engine suddenly failed…* In addition to a dynamic V_{MCA}, determined after failure of the critical engine, the static V_{MCA} is always determined. The higher of dynamic and static minimum control speed is listed as V_{MCA} in flight manuals as an operational limitation.
- *no more than 5° bank towards the live engine* . This sentence suggests that the pilot should keep the wings level and also that a max. 5° bank into the dead engine is not a problem. Most applicants (manufacturers) use a small 2 – 5° bank angle towards the live engine. This sentence is copied from FAR 23.149 that applies to the certification of an airplane. The manufacturer is allowed to select a bank angle; mostly 3 – 5 degrees is being used to determine V_{MCA}. This reduces V_{MCA} as well as the sideslip angle (drag) and maximizes one engine inoperative performance. The sentence does not belong in a flight manual; the manufacturer should present the exact bank angle used to determine V_{MCA} with V_{MCA} as a precondition for the listed V_{MCA} to be valid. Banking away from this small bank angle increases actual V_{MCA} considerably and leads to catastrophes (if the indicated airspeed is low and asymmetrical power setting is high). A larger angle than 5° leads to a high beta and fin stall.
- *maximum takeoff weight* should be 'lowest weight'. This provides the worst case, a higher, more unsafe V_{MCA} than when using maximum takeoff weight, provided a small bank angle is maintained. Normally the maximum takeoff weight is used to calculate V_S for takeoff.

2.2. Page 77 *Factors affecting V_{MCA} – Effect of bank*.

- Second sentence: *But only a small amount of bank (less than 5° – typically 3°), because larger angles cause a significant reduction in the vertical component of lift and so require a higher angle of attack to maintain altitude.* This in itself is correct, but is more aimed at performance than at controllability. For the analysis of the factors that influence the controllability after engine failure, it is better to use Weight, rather than the vertical component of lift. Weight and bank angle generate a side force $W \cdot \sin\phi$ that reduces the rudder deflection after which the speed can be reduced until the heading can no longer be maintained. This leads to a lower V_{MCA}, which is favorable to takeoff runway length for the takeoff weight. The worst case – highest – V_{MCA} is obtained at the lowest weight possible given a certain small bank angle. Greater bank angles lead to higher sideslip angle and to higher drag as well as a higher risk of the vertical fin to stall. Refer to ref. 7 for additional information and plots showing the influence of bank angle and weight.

2.3. Page 78. *Effect of CG position.*

- The effect of a forward cg is not only that it increases control power and stability, but also that it decreases actual V_{MCA} to a value lower than the listed V_{MCA} because V_{MCA} is determined with an aft cg, which is the worst case.

2.4. Page 79. *Conclusion V_{MCA}*.

- *Having examined V_{MCA} in detail, it must now be said that it is a practically meaningless speed. We only need to know it so we can stay well away from it and to minimize our exposure – just like stalling speed. In many ways, the greatest risk with V_{MCA} as with V_S, is practicing it.*
  This understatement of V_{MCA} is very disappointing; the author has obviously never studied accidents that occurred after engine failure, or accidents that happened while returning to land while an engine was inoperative. V_{MCA} is determined for a reason, it is listed in each and every flight manual of a multi-engine airplane, also for a reason. V_{MCA} looks to be a single constant and unconditional number, but it is not, as might

have become clear after reading these comments so far. V_{MCA} is also used to calculate takeoff safety speed V_2 on Part 25 airplanes.
The greatest risks are thinking that V_{MCA} is a practically meaningless speed and not practicing it. They who forget about V_{MCA} are deemed to loose control some day, and cannot prevent a catastrophe.

- *The minimum speed at any time during practice should be V_{SSE} …*
  While maintaining this speed, the pilot will not see the characteristics of flight as he would experience at an airspeed near V_{MCA} and recognize the impending loss of controllability. The airspeed is near actual V_{MCA} if either the rudder or the ailerons are at or near full deflection. At V_{SSE}, the deflection is far away from full.
  This limitation makes no sense and leads to pilots who will not be able to handle engine emergencies. The stall speed of an airplane cannot be demonstrated at an airspeed some 20 kt above V_S either.

2.5. Page 68. Options for control after engine failure.

- While describing three options for equilibrium following the failure of an engine, no reference is made to the magnitude of the three different V_{MCA}'s of these options. Bank angle would be necessary only for best climb performance. But the vertical component of the lift ($L \cdot \cos \phi$) hardly changes when using small bank angles. Controllability is however affected by a side force component of the weight: $W \cdot \sin \phi$. Side force $W \cdot \sin \phi$ changes a lot more with small bank angles, so V_{MCA} changes considerably with bank angle. However, actual V_{MCA} is lowest, is safest, provided the airplane is banked 2° – 5° towards the operating engine. V_{MCA} can be 10 kt higher if the wings are kept level. In fact, the listed V_{MCA} is only valid as long as the same bank angle is applied that was used to determine V_{MCA}. There is regrettably no requirement for manufacturers to list this bank angle as an operational limitation with V_{MCA}. This omission and the consequently misunderstood V_{MCA} led already to many accidents following the failure of an engine. Refer to the referenced report for a more thorough explanation.

3. Above, only a limited number of comments are given. But by reading this book as is only, multi-engine pilots might not be able to prevent an accident following the failure of an engine.

4. I recommend reading the Report referenced above for a full understanding of V_{MCA}. In case you need further assistance for reviewing your book, please do not hesitate and contact me.

Harry Horlings
Avio*Consult*