Supplementary Analysis
of the

Catastrophic Accident involving a Mitsubishi MU-2B-60, USA, 10 Dec. 2004

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References:

1) NTSB Identification: DEN05FA034
http://www.ntsb.gov/ntsb/brief2.asp?ev_id=20041221X02013&ntsbno=DEN05FA034&akey=1

2) Airplane Control after Engine Failure, abbreviated version:
http://www.avioconsult.com/downloads/Airplane Control after Engine Failure - Abbreviated.pdf

Author biography

Harry Horlings is a retired pilot and graduate Flight Test Engineer of the USAF Test Pilot School, Edwards Air Force Base, CA, December 1985. Following his Air Force career, which he concluded as Chief Experimental Flight Test, he founded Avio*Consult* and dedicated himself to improve aviation safety using his knowledge of experimental flight-testing. He researched many catastrophic accidents with multi-engine airplanes that occurred after engine failure or while an engine was inoperative. He published several papers and reports on the prevention of this kind of accidents and presented these to the European Aviation Safety Seminar of the Flight Safety Foundation, to the Dutch TSB, the Engine and propeller Directorate of the FAA and to a number of Airlines, Air Force and Navy organizations. He also wrote supplementary analyses of individual catastrophic accidents, of training and airplane flight manuals and of deficiencies in Aviation Regulations FAR, CS 23 and 25 and equivalent, all of which can be downloaded (for free) from the products page of www.avioconsult.com.

1. Introduction

1.1. After reviewing many accident investigation reports, it was noticed that there are huge differences in the interpretation and the use of the air minimum control speed V_{MCA} (and of takeoff safety speed V_2) of a multi-engine airplane between airplane manufacturers and experimental test pilots on one side and airline pilots as well as accident investigators on the other side. These differences in interpretation have lead to catastrophic accidents caused by the loss of control and/ or performance after engine failure and to incorrect conclusions in the accident investigation reports.

1.2. To improve the knowledge of airplane control while an engine is inoperative and to improve accident investigations, the report 'Airplane Control after Engine Failure' was written, using the theory and flight test techniques as taught at the USAF Test Pilot School, as well as using the criteria used for designing the vertical tail of an airplane as taught at the aviation faculties of universities around the globe.

1.3. Accident investigation is always performed to learn from the accidents and to recommend improvements in order to prevent similar accidents from happening again. From the reviewed investigation reports, it became clear that many, if not most accident investigation reports do not analyze the controllability of a multi-engine airplane after engine failure in the same way that was used to design the vertical tail and to flight-test the airplanes to determine V_{MCA}. Therefore, a supplementary analysis to the investigation report of a number of engine failure related accidents was written, including the subject accident.

To understand the analysis presented below, it is recommended to read the above mentioned report, that can be downloaded from the products page of website: www.avioconsult.com. An abbreviated version can be downloaded with the link in ref. 2).

2. The accident

2.1. Shortly after takeoff, the left engine failed. The pilot returned for landing via a left-hand circuit; the left propeller was feathered. The airplane did overshoot the final approach of runway 35R and was cleared to the next runway 28. A witness heard an aggressive throttle and the airplane make an immediate sharp bank to the left and descended to the ground. The landing lights were then seen turning down toward the terrain. The airplane crashed; the two souls onboard were fatally injured.

2.2. A performance study was performed to the remaining climb performance, but the increase of V_{MCA} due to banking into the inoperative engine was not subject of investigation, despite the statement in the accident investigation report that the bank angles to the left, into the dead engine, were considerable. Although banking (into the dead engine) should be avoided at all times (while the power setting is high), this might not lead to control problems if the airspeed is high enough. Nevertheless, the actual V_{MCA} will increase with banking. If the actual V_{MCA} increases above the indicated airspeed, control problems cannot be avoided. This is explained in Ref. 2.

2.3. The report states: *Minimum controllable airspeed (Vmc) for the airplane is 99 KCAS*. V_{MC} is not a minimum controllable airspeed, but a worst case minimum control speed at which only straight flight can be maintained, provided the same bank angle is maintained that was used by the manufacturer to design the vertical tail and during subsequent experimental flight-testing to determine V_{MCA}, in both cases most probably 5 degrees away from the inoperative engine.

2.4. The accident investigation report presents a part out of the MU-2B engine emergency procedures. One of the steps is:
Power Lever (Operating Engine) - Set as Required to Maintain Airspeed and Desired Flight Path. The recommended airspeed (flaps up) is V_{xse} =140 KCAS, with flaps 5º V_{xse} =130 KCAS and when landing is assured with flaps 20º, V_{xse} = 125 KCAS and 110 KCAS when over the runway.
No warning is provided to attain and maintain a small bank angle away from the inoperative engine as the power lever is moved forward, to keep V_{MCA} low. An increase of power increases the yawing moment and increases the requirement for rudder input to counter the yawing to be able to maintain heading. The lower the airspeed, the more rudder deflection is required. Rudder deflection also causes a side force to develop. A small bank angle can be used to reduce the resulting sideward acceleration and sideslip and therewith to reduce the drag and maximize takeoff or go-around performance. A small bank angle also decreases actual V_{MCA}. The actual V_{MCA} will never be higher than the worst-case V_{MCA} that is listed in the Airplane Flight Manual, provided the small bank angle is being maintained while the power setting is maximum. These are two of the conditions under which the vertical tail was designed and V_{MCA} was determined. But if the small bank angle is not maintained, the actual V_{MCA} can easily increase above the indicated airspeed. The airplane is out of control and turns into the direction of the inoperative engine. A catastrophe cannot be avoided, unless ... the recommendations are used that are presented in the Report '*Airplane Control after Engine Failure*', presented on the products page of the website of Avio*Consult*. The Report presents recommendations to improve engine emergency procedures, engine-out training, aviation regulations, etc.

3. Cause of the accident

3.1. The NTSB determined the probable cause(s) of this accident as follows:
The pilot's failure to maintain minimum controllable airspeed during the night visual approach resulting in a loss of control and uncontrolled descent into terrain. A contributing factor was the precautionary shutdown of the left engine for undetermined reasons.

3.2. To the opinion of experimental flight-test expert Avio*Consult*, which is based on the data provided in the report, the real cause of the accident is the pilot's failure to maintain a small bank angle (max. 5 degrees) away from the inoperative engine while the power setting was increased or was high and the airspeed was low. The manual listed V_{MCA} was 99 KCAS, but the actual V_{MCA} varies with bank angle. If maximum thrust is set on the operating engine while the bank angle deviates from the value that was used to determine V_{MCA}, then the actual V_{MCA} might have increased to a higher value, even above the indicated airspeed after which control was lost. In addition, the increased airflow over the wing behind the operating propeller (propulsive lift) caused a rolling moment into the dead engine. Control could not be regained because of the low altitude and the power setting, and therewith the high asymmetric thrust moment was maintained.

3.3. The pilot however, is not to be blamed. This accident was also caused by an incomplete and deficient engine emergency procedure, by inadequate pilot training on the subject of engine failures, and by imperfections and errors in FAR's and other publications. The real value and meaning of V_{MCA} was obviously neither clear to the pilot, nor to the accident investigators.

3.4. Similar accidents will happen over and over again until finally somebody within the FAA and/ or NTSB (or equivalent organizations) will read Avio*Consult*'s report and/ or attend the accompanying lecture and starts improving FAR's, training programs, manuals, etc. as recommended in the report.

It is the objective of the Report '*Airplane Control after Engine Failure*' that Avio*Consult* presents on the products page of its website to improve this, and to improve procedures, engine-out training, aviation regulations, etc. Many recommendations are presented. ■

