Unreliable Speed

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1 Introduction

Unreliable speed is one of the difficult situations that a pilot has to face. Once the failure has been identified, a procedure, based on pitch angles and thrust settings, will assist the pilot in safely flying the aircraft.

But the main difficulty is to rapidly detect an unreliable speed situation. Reaction time is crucial, since the aircraft may stall and overspeed conditions could cause aircraft damage.

In issue #3 of the Safety First magazine (December 2006), an article described the effects of pitot probes obstruction on ground. It intended to make ground and flight crew more sensitive to the consequences of obstructed probes, and to prevent take-off with unreliable speed.

But once airborne, how can the crew handle an unreliable speed situation?

This article therefore provides guidelines to recall how an unreliable speed situation can be identified, but also how to deal with it.

Note: this article is based on A320/A330/A340 design. Cockpit effects, identification and troubleshooting, remains similar for wide body aircraft and A380, with some specificities covered in the operational documentation.

2 Effects and consequences in the cockpit

Water, ice, dust, ashes, etc. may partially or totally block pitot probes and static ports. Equally, tubes misconnected to the Air Data Modules (ADM), plastic covers not removed from the probes, insect nests, radome damage, may lead to erroneous pressure measurements.

The consequences of this erroneous pressure information, once used by the ADRs and/or the standby instruments, are the computation and the display of unreliable speed and/or altitude for all users.

CAPT PFD

F/O PFD

Erroneous speed or altitude indications can be suspected, among others, in the following cases:

- Speed discrepancy (between ADR 1, 2, 3 and standby indication),
- The fluctuation of the Indicated Air Speed or of the Pressure Altitude,
- Abnormal correlation between basic flight parameters (IAS, attitude, pitch, thrust, climb rate),
- Abnormal AP/FD/ATHR behaviour,
- STALL and OVERSPEED warnings or FLAP RELIEF on ECAM that are in contradiction with at least one of the indicated airspeeds,
- Inconsistency between radio altitude and pressure altitude,
- Impossibility of extending the landing gear by the normal landing gear system.

Nevertheless, it should be emphasized that identifying an unreliable speed indication is not always obvious: no single rule can be given to conclusively identify all possible erroneous indications and the display of contradictory information may confuse the flight crew. Pilots should therefore be aware of unreliable speed symptoms and consequences.

Depending on the affected probe, i.e. pitot probe or static port, different indications in the cockpit will become unreliable. Therefore the crew should be aware that some of the usual cues to fly could be unreliable as indicated:

Data	Pitot probe obstructed	Static port obstructed
Indicated Speed/Mach	Erroneous	Erroneous
Altitude	Ok	Erroneous
Vertical Speed	Ok	Erroneous
FPV	Ok	Erroneous
AP/FD	Erroneous	Erroneous
ATC altitude report	Ok	Erroneous

3 Identification and Handling of Unreliable Speed situations

Airbus has developed procedures and guidelines to help crews identify and handle an unreliable speed situation.

The Volume 3 of the Flight Crew Operating Manual (FCOM) and the Quick Reference Handbook (QRH) provide the UNRELIABLE SPEED INDIC / ADR CHECK PROC procedure.

In addition, Airbus has developed training material in the Flight Crew Training Manual (FCTM, available for A320/A330/A340/A380). The FCTM provides information about the causes and consequences of unreliable ADR computations. It also provides information on how to apply the UNRELIABLE SPEED INDIC / ADR CHECK PROC of the QRH.

An interactive training tool, the e-Briefing, is also available on **https://w3.airbus.com/** in the Flight Operations community, under the heading “Safety and Operational materials”.

4 Procedures

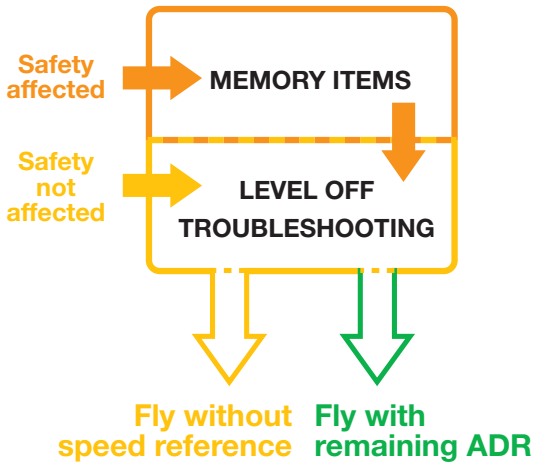
As soon as a doubt about airspeed indication arises, or a relevant ECAM alert is triggered (relative to ADRs failure or discrepancy for instance), the UNRELIABLE SPEED INDICATION/ADR CHECK PROC procedure should be applied by the crew, following this sequence:

1) **If the safe conduct of the flight is affected**, **APPLY THE MEMORY ITEMS**, i.e. fly a pitch with TOGA or CLB thrust,

2) **If the safe conduct of the flight is not affected**, or **once the memory items have been applied**, **LEVEL OFF,** if necessary, and start **TROUBLESHOOTING**,

3) If the affected ADR can be identified, fly with the remaining ADR.

4) If the affected ADR cannot be identified or all airspeed indications remain unreliable, **FLY WITH PITCH/THRUST REFERENCES**.



4.1 Memory Items

If the safe conduct of the flight is affected, the flight crew applies the memory items: these allow "safe flight conditions" to be rapidly established in all flight phases (take-off, climb, cruise) and aircraft configurations (weight and slats/flaps). The memory items apply more particularly when a failure appears just after take-off.

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UNRELIABLE SPEED INDICATION/ADR CHECK PROC

- **If the safe conduct of the flight is impacted :**

MEMORY ITEMS

- AP/FD ..... OFF
- A/THR ..... OFF
- PITCH/THRUST :
  - Below THRUST RED ALT ..... 15°/TOGA
  - Above THRUST RED ALT and Below FL 100 ..... 10°/CLB
  - Above THRUST RED ALT and Above FL 100 ..... 5°/CLB
- FLAPS ..... Maintain current CONFIG
- SPEEDBRAKES ..... Check retracted
- L/G ..... UP

- **When at, or above MSA or Circuit Altitude :**
  - Level off for troubleshooting

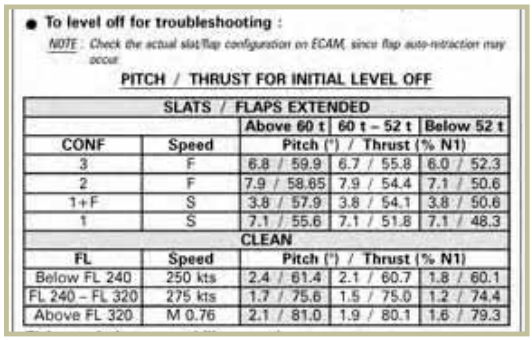
- GPS ALTITUDE ..... Display on MCDU

- **To level off for troubleshooting :**

Once the target pitch attitude and thrust values have been stabilized at or above minimum safe altitude, or when the safe conduct of the flight is not affected, the flight crew will enter the 2nd part of the QRH procedure: level off the aircraft and perform troubleshooting.

4.2 Troubleshooting and isolation

The table provided in the QRH gives the pitch (°) and thrust (%N1) to be applied to level off the aircraft according to its weight, altitude and configuration, along with flying technique advices.



- **To level off for troubleshooting :**

NOTE : Check the actual slat/flap configuration on ECAM, since flap auto-retraction may occur.

PITCH / THRUST FOR INITIAL LEVEL OFF

SLATS / FLAPS EXTENDED				
		Above 60 t	60 t – 52 t	Below 52 t
CONF	Speed	Pitch (°) / Thrust (% N1)		
3	F	6.8 / 59.9	6.7 / 55.8	6.0 / 52.3
2	F	7.9 / 58.65	7.9 / 54.4	7.1 / 50.6
1+F	S	3.8 / 57.9	3.8 / 54.1	3.8 / 50.6
1	S	7.1 / 55.6	7.1 / 51.8	7.1 / 48.3
CLEAN				
FL	Speed	Pitch (°) / Thrust (% N1)		
Below FL 240	250 kts	2.4 / 61.4	2.1 / 60.7	1.8 / 60.1
FL 240 – FL 320	275 kts	1.7 / 75.6	1.5 / 75.0	1.2 / 74.4
Above FL 320	M 0.76	2.1 / 81.0	1.9 / 80.1	1.6 / 79.3

In situations where most primary flight data are erroneous, some indications may still remain correct and should consequently be used to help the crew stabilize the flight path. This is the case for the Flight Path Vector (FPV), reliable if the static ports are not blocked, and for the GPS altitude displayed on the MCDU, when GPS is installed.

When the flight path is stabilized, the flight crew will start the troubleshooting, keeping in mind that sometimes two or even all three ADRs might provide identical but erroneous data (e.g. due to icing conditions, flight in volcanic ashes, etc.).
Therefor, **do not instinctively reject an ADR that is suspected to be affected.**

If the troubleshooting procedure enables the crew to identify the affected ADR(s), then a normal situation can be resumed.

But if the affected ADR cannot be identified, or all ADRs are affected, then the flight crew will fly without speed reference, using the pitch and thrust tables.

4.3 Flying using pitch/thrust tables

First, the crew has to switch OFF two ADRs and keep one ADR ON, to keep the Stall Warning Protection.

Then, the crew will **fly the aircraft without speed references**, using pitch (°) and thrust (%N1) settings.

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UNRELIABLE SPEED INDICATION/ADR CHECK PROC (CONT'D)

INITIAL AND INTERMEDIATE APPROACH IN LEVEL FLIGHT

The approach phase between Green Dot speed (clean configuration) and the landing configuration (CONF 3), is flown in level flight.

LANDING GEAR UP IN LEVEL FLIGHT				
		Above 60 t	60 t – 52 t	Below 52 t
CONF	Speed (kts)	Pitch (°)/Thrust (% N1)		
0	G-DOT	4.8 / 55.3	4.9 / 51.9	5.0 / 48.5
1	S	7.1 / 55.5	7.1 / 51.9	7.1 / 48.3
1+F (a)	S	3.8 / 57.9	3.8 / 54.1	3.8 / 50.6
2	F	7.2 / 58.8	7.8 / 54.5	7.8 / 50.8
LANDING GEAR DOWN IN LEVEL FLIGHT (EXPECT GRVTY EXTENSION)				
3	F	7.0 / 64.1	6.9 / 60.5	6.9 / 56.6

(a) Due to the fact that the speed is unreliable, the SFCC may select the 1+F configuration in approach, instead of 1.

To fly the aircraft using pitch and thrust settings, the crew will find in the QRH the tables relative to each phase of flight: Climb, Cruise, Descent and Approach, taking into account the aircraft weight, configuration and altitude. With these tables, the crew will be able to safely land the aircraft.

5 Back Up Speed Scale (BUSS)

In order to decrease the crew workload in case of unreliable speed, Airbus has developed the Back-Up Speed Scale (BUSS) that replaces the pitch and thrust tables. The BUSS is optional on A320/A330/A340. It is basic on A380, being part of the ADR Monitoring functions.

This indication is based on angle of attack (AOA) sensor information, and is therefore not affected by erroneous pressure measurements.

The BUSS comes with a new ADIRU standard (among other new system standards), where the AOA information is provided through the IRs and not through the ADRs. This enables selecting all ADRs off without loosing the Stall Warning Protection.

The AOA information provides a guidance area in place of the speed scale. When the crew selects all ADRs OFF, then:

- The Back-Up Speed Scale replaces the PFD speed scale on both PFDs,
- GPS Altitude replaces the Altitude Scale on both PFDs.

The Back-Up Speed Scale then enables to fly at a safe speed, i.e. above stall speed and below maximum structural speeds, by adjusting thrust and pitch.

Buss: "Fly the green"

The BUSS will be displayed once all ADRs are switched OFF. Therefore, on aircraft that have the BUSS, when the flight crew cannot identify the faulty ADR(s) when performing the troubleshooting, or when all ADRs are affected, the flight crew will switch OFF all ADRs, and will fly the green area of the BUSS.

However, if the safe conduct of the flight is affected, the memory items must still be applied before troubleshooting.

As the BUSS is associated to the ADR monitoring functions, some unreliable speed situations can be automatically detected (e.g. new ECAM warning "**NAV** ADR 1+2+3 FAULT"), and some ECAM procedures will lead to the BUSS activation by requesting to switch OFF all ADRs.

6 | Conclusion

An unreliable speed situation may be difficult to identify, due to the multiple scenarios that can lead to it. Therefore, training is a key element: indeed the flight crew's ability to rapidly detect the abnormal situation, and to correctly handle it, is crucial.

In case of any doubt, the pilot should apply the pitch/thrust memory items, and then refer to the QRH to safely fly the aircraft, and to positively determine the faulty source(s) before eliminating it (them).

In addition, to further assist the pilot in detecting the failure and safely fly the aircraft, Airbus has developed the BUSS, which provides a safe flying range indication.

Finally, to reduce the probability of experiencing unreliable speed situations, on-ground actions, such as comprehensive maintenance and thorough pre-flight exterior inspection, should be stressed.