STAR 014 V1 – March 2013	**Flight with unreliable airspeeds**

Introduction

Following an accident over the Atlantic Ocean, EASA (European Aviation Safety Agency) has addressed recommendations to the airlines. These recommendations include, among others, the need to make flight crews proficient in the detection of unreliable flight instruments, as well as how to handle these kinds of situations. The procedures should be trained in simulator sessions.

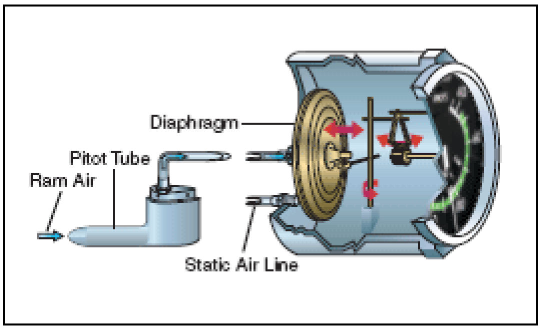
Discussion

On a modern aircraft, airspeed, altitude, vertical speed that are displayed typically come from air data computers. Nevertheless the measurement of such parameters relies almost exclusively on the Pitot-Static system accuracy. Some factors affecting the proper working of our Pitot-Static system include:

- Covers not removed from Pitot or static
- Ports or probes blocked (insects, mud, stickers)
- Hoses disconnected or leaking
- Water in the lines that freezes
- Water drain cap on Pitot-static lines missing
- Airplane Icing
- Volcanic ash
- Radome damaged

As you can see some of them can be avoided if the walk-around inspection is made properly and others can be avoided by proper aircraft maintenance.

Pitot-Static anomalies



Ram air pressure from the pitot tube is directed to a diaphragm inside the airspeed indicator. The airtight case is vented to the static port. As the diaphragm expands or contracts, a mechanical linkage moves the needle on the face of the indicator.

To study the effect of Pitot-Static system anomalies, we will consider an old airspeed indicator. We know that it is not the one installed in your aircraft but it will help us to better understand the problem. We will study three possible cases. The first one will be a complete blockage of the Pitot tube, the second one the static port blockage and the third, a complete blockage of the system.

Case 1: Pitot blockage

The airspeed is determined by the relation Pd=Pt-Ps where Pd stands for dynamic pressure, Pt for total pressure and Ps static. In case of Pitot blockage, we may consider Pt as constant value (Pt=k) since the pressure is entrapped into the line. So it will have the following consequences:

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- **During take-off roll**: Pt=k, Ps=k since altitude is constant. As a result, IAS will remain equal to 0 (Pd=k).
- **After lift–off and during climb** : Pt=k and Ps is decreasing, so the faulty airspeed indicator indication will continue to increase as the altitude increase. The higher we climb, the greater the airspeed. At a certain point the Vmo speed can appear to be exceeded. If you make the mistake to believe the faulty indicator, your natural tendency will be either to increase the pitch or reduce thrust or both. This could cause the airplane to exceed its stall angle of attack though the stall warning system operates normally.
- **During descent**, the opposite phenomena will occur. The IAS will decrease as the altitude decrease.

Case 2: Static port blockage
If the static port is blocked, Ps=k so during:

- **Take-off roll** : Pt increases as the airplane accelerates. Ps is constant, the airspeed indicator works normally.
- **After lift–off and during climb** : with respect to airspeed, the sensed dynamic pressure fails to increase as rapidly as it should during climb because of the trapped static pressure. (Remember Pd=Pt-Ps with Ps=k and having take-off elevation value which is higher compared to Ps value decreasing during a normal climb). Therefore, the airspeed indicator will indicate a lower airspeed than it should be. Typical mistake would be to lower the nose and/or increase thrust to recover the erroneous airspeed, causing the airplane to exceed its limits and this may be without any warning since the aural warning might be linked to the unreliable source.

Case 3: Both static and pitot blockages
In this case, both Ps and Pt will remain constant at the time of the blockage. As a consequence, the IAS will remain constant independently of the altitude and airplane acceleration or deceleration.

Finally let's consider the other flight instruments linked to the pitot-static system and the consequences of possible malfunctions.

Data	Pitot probe blocked	Static port blocked
Altitude	OK	Erroneous
Vertical speed	OK	Erroneous

How to recognize Pitot-static system problems
In addition to the consequences mentioned above, below you will find a list of hints to help you to identify erroneous speed or altitude indications.

- Speed discrepancy (between Air data computer and standby)
- Fluctuation of the indicated airspeed or of the pressure altitude
- Abnormal correlation between basic flight parameters (IAS, pitch, thrust, climb, rate)
- STALL and OVERSPEED warnings that are in contradiction with at least one of the indicated airspeed
- Abnormal autopilot/flight director/ auto-throttle behaviour
- Inconsistency between radio altitude and pressure altitude
- Difficulties, abnormal noise while extending/retracting the landing gear or the flaps
- Pressurisation problem

Recommendations
The following considerations will help you to deal with the situation:

- ✈ Keep the aircraft control with basic pitch and power (see QRH). Troubleshooting will be done later. If in a turn set wings level. If in descent level-off or climb to a safe altitude. Retract the speed brake if they are deployed. If climb is desired set a nominal pitch value and power to sustain climb (remember that stick shaker is reliable).
- ✈ Identify the unusual or suspect indications by cross-checking different sources (RA, INS…).
- ✈ Make an inventory of reliable and unreliable sources. See annex.
- ✈ Find or maintain favourable flight conditions. Historically speaking NO accident involving unreliable airspeed on large commercial airplanes has occurred when their crew managed to find or remain in daylight conditions. GET VISUAL, STAY VISUAL. Good instrument approach facilities and familiarity with the airport ARE NOT good substitutes for visual conditions.
- ✈ Get assistance from the others:
    - ATC may provide GS and wind or provide you heading to avoid hazards. Nevertheless altitude indication provided by ATC MIGHT NOT be reliable since most of the radar system rely on the aircraft transponder for altitude source and this one is using the pressure info from the air data computer.
    - Other airplanes: flying close enough to assess speed and altitude.
    - Company: if reachable may provide you technical assistance
- ✈ Use check-list, discuss the cross-check to be used and what assistance is expected from the PNF.
- ✈ Identify alternatives for back-up in case of future confusing indications. Elaborate a plan.

Conclusions
Despite system reliability and technological improvements, accidents related to erroneous flight instruments are likely to occur. Due to the fact that crew are seldom confronted to these situations contributes to increase the risk of accident. To deal with the problems involved by such a failures, flight crews should follow respective ops manual procedures and only use this STAR as guidance.