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SUBJECT : ERRONEOUS AIRSPEED/ALTITUDE INDICATIONS

Note : This FCOM Bulletin has been revised to also address the A340-500 and A340-600 aircraft.

1. REASON FOR ISSUE

Two fatal accidents on non-Airbus aircraft and several reported incidents, attributed to unreliable speed and/or altitude indications, have prompted the need to improve flight crew awareness in identifying and tackling the failures described in this bulletin.

Most failure modes of the airspeed/altitude system are detected by the ADIRS.

These failure modes lead to the loss of corresponding cockpit indications, and the triggering of associated ECAM drills.

However, there may be some cases where the airspeed or altitude output is erroneous, without being recognized as such by the ADIRS. In these cases, the cockpit indications appear normal, but are actually false, and pilots must rely on their basic flying skills to identify the faulty source and take the required corrective actions. When only one source provides erroneous data, a straightforward crosscheck of the parameters, provided by the 3 ADRs, allows the faulty system to be identified. This identification becomes more difficult in extreme situations when two, or even all three, sources provide erroneous information.

This FCOM Bulletin provides the following information :

1 – Recall of pitot/static system layout ;

2 – Situations which may lead to erroneous, airspeed/altitude indications ;

3 – Consequences of various failure cases ;

4 – Recall of AI recommended operational procedures.

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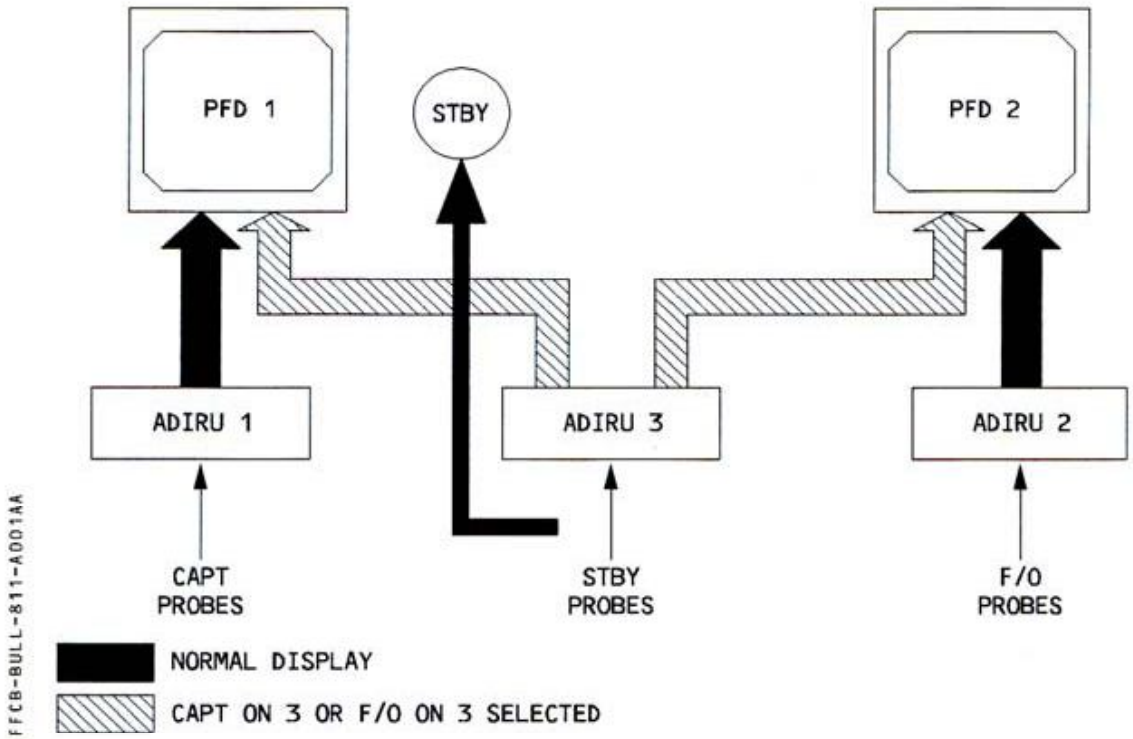
2. DISPLAY ARCHITECTURE

The CAPT pitot and static probes supply ADIRU 1, which is normally used for display on the CAPT's PFD.

The F/O pitot and static probes supply ADIRU 2, which is normally used for display on the F/O's PFD.

The STBY pitot and static probes supply ADIRU 3, which can be used for display on either PFD in case of failure. They also directly supply the standby instruments.



3. MAIN REASONS FOR ERRONEOUS AIRSPEED/ALTITUDE DATA

The most probable reason for erroneous airspeed and altitude information is obstructed pitot tubes or static sources. Depending on the level of obstruction, the symptoms visible to the flight crew will be different. However, in all cases, the data provided by the obstructed probe will be false. Since it is highly unlikely that the aircraft probes will be obstructed, at the same time, to the same degree and in the same way, the first indication of erroneous airspeed-altitude data available to flight crews, will most probably be a discrepancy between the various sources.

4. CONSEQUENCES OF OBSTRUCTED PITOT TUBES OR STATIC PORTS

All aircraft systems using anemometric data have built-in fault accommodation logics. The fault accommodation logics are not the same for the various systems ; but, all rely on voting principles whereby when one source diverges from the average value, it is automatically rejected and the system continues to operate normally with the remaining two sources. This principle applies to flight controls and flight guidance systems.

4.1 Normal situation

Each PRIM receives speed information from all ADIRUs.
It compares the 3 values.
Pressure altitude information is not used by the PRIM.

Each FE (Flight Envelope computer) receives speed and pressure information from all ADIRUs.
For each of these two parameters, it compares the 3 values.

4.2 If one ADR output is erroneous, and the two remaining ADRs are correct :

The PRIM and the FE eliminate it. On the basic A340-200/300, there is no cockpit effect (no caution ; normal operation is continued), except that one display is wrong and CATIII dual is no longer available on the FMA. On the A340-500/600 and on the enhanced A340-300, if one ADR deviates, and if this ADR is used to display the speed information on either the CAPT or F/O PFD, an IAS DISCREPANCY caution is triggered. Furthermore, as with the A340-200/300, CATIII dual is no longer available on the FMA.

4.3 If two ADR outputs are erroneous, but different, and the remaining ADR is correct, or if all three are erroneous, but different :

The autopilot and the autothrust are disconnected by the FE (whichever autopilot is engaged).

If the disagree lasts for more than 10 seconds, the PRIM triggers the ADR DISAGREE ECAM caution.
It reverts to Alternate 2 law (without high and low speed protection).
On both PFDs : The "SPD LIM" flag is shown ; no VLS and no VSW is displayed.

This situation is latched, until a PRIM reset is performed on ground, without any hydraulic pressure.
However, if the anomaly was only transient, the autopilot and the autothrust can be re-engaged when the disagree has disappeared.

4.4 If one ADR is correct, but the other two ADRs provide the same erroneous output, or if all three ADRs provide consistent and erroneous data :

The systems will reject the "good" ADR and will continue to operate normally using the two "bad" ADRs. This condition can be met when, for example, two or all three pitot tubes are obstructed at the same time, to the same degree, and in the same way. (Flight through a cloud of volcanic ash, takeoff with two pitots obstructed by foreign matter (mud, insects)).

Human beings (the pilot) tend to use the same type of "fault accommodation" principles to detect an erroneous IAS/altitude indication. Flight crews will tend to reject the outlier information, if the other two outputs are consistent. This choice is, in the great majority of cases, correct ; but, all flight crews should be aware of very extreme and unlikely situations where two (or even three) speed/altitude indications can be consistent and wrong.

BEWARE OF INSTINCTIVELY REJECTING AN OUTLIER ADR

The following chart provides a non-exhaustive list of the consequences of various cases of partially or totally obstructed pitot tubes and static ports on airspeed and altitude indications. It should be noted that the cases described below cover extreme situations (e.g. totally obsctructed or unobstructed drain holes), and that there could be multiple intermediate configurations with similar, but not identical, consequences.

FAILURE CASE	CONSEQUENCES
Water accumulated due to heavy rain. Drain holes unobstructed.	Transient speed drop until water drains. IAS fluctuations. IAS step drop and gradual return to normal.
Water accumulated due to heavy rain. Drain holes obstructed.	Permanent speed drop.
Ice accretion due to pitot heat failure, or transient pitot blocked due to severe icing. Unobstructed drain holes.	Total pressure leaks towards static pressure. IAS drop until obstruction cleared/ fluctuation, if transient erratic ATHR is transient.
Ice accretion due to pitot heat failure, or pitot obstruction due to foreign objects. Obstructed drain holes.	Total presure blocked. Constant IAS in level flight, until obstruction is cleared. In climb, IAS increases. In descent, IAS decreases. Abnormal AP/FD/ATHR behavior : a) AP/FD pitch up in OPN CLB to hold target IAS. b) AP/FD pitch down in OPN DES to hold target IAS.
Total obstruction of static ports on ground.	Static pressure blocked at airfield level. Normal indications during T/O roll. After lift-off altitude remains constant. IAS decreases, after lift-off. IAS decreases, when aircraft climbs. IAS increases, when aircraft descends.

The above table clearly illustrates that no single rule can be given to conclusively identify all possible erroneous airspeed/altitude indications cases. However, any erroneous speed/altitude indication case will always be associated with one (or more) of the following cues :

a) Fluctuations in Airspeed indications.
b) Abnormal correlation of basic flight parameters (IAS, pitch, attitude, thrust, climb rate) :
   - IAS increasing, with large nose-up pitch attitude ;
   - IAS decreasing, with large nose down pitch attitude ;
   - IAS decreasing, with nose down pitch attitude and aircraft descending ;

c) Abnormal AP/FD/ATHR behavior ;
d) Undue stall or overspeed warnings ;
d) Reduction in aerodynamic noise, with increasing IAS ;
e) Increase in aerodynamic noise, with decreasing IAS.

5. RECOMMENDED PROCEDURES

The procedures described below are intended to provide flight crews with general guidelines to be applied, in case of suspected erroneous airspeed/altitude indications.

FOLLOW ECAM ACTIONS. If failure undetected : CROSSCHECK ALL IAS/ALTITUDE SOURCES : ADR1, ADR2, ADR3, AND STANDBY INSTRUMENTS.

If it is obvious that the outlier is wrong, select the corresponding ADR OFF and reconfigure the PFD indications accordingly, by applying the ECAM drill which will be automatically displayed.

Flight crews should, however, be aware that in very extreme circumstances, it may happen that two, or even all three ADRs may provide identical and erroneous data. Therefore, the suspect ADR should only be switched OFF, if it is positively confirmed that the two other ADRs are correct. If in doubt :

DISCONNECT THE AP, FD, AND ATHR. FLY TARGET PITCH ATTITUDE AND THRUST SETTING.

The initial pitch attitude and thrust values given in the QRH should be considered as "Memory Items", since they allow "safe flight conditions" to be rapidly established in all flight phases (takeoff, climb, cruise) and aircraft configurations (weight and slats/flaps).

Once the target pitch attitude and thrust values have been stabilized, the expanded data of the QRH (Flight with Unreliable Speed Indication) should be followed to determine the precise pitch attitude and power setting required, depending on the aircraft's weight, configuration, and desired speed.

After applying the QRH procedure, and when the aircraft is stable, the flight crew should try to identify the faulty ADR (one or more). Once the faulty ADR has (or have) been positively identified, it (they) should be switched OFF. This will trigger the corresponding ECAM warnings and associated drills, which should be followed to address all the consequences on the various aircraft systems.