FALSE SENSE OF SECURITY

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Where are we?

The flight crew knew that something was wrong.

The two CPL-rated pilots had just picked up the Pilatus PC-12 from the manufacturer's maintenance facility in Buochs (LSZC) central Switzerland, where it had undergone scheduled maintenance. Already during the initial climb on this ferry flight back to San Sebastian/Spain they observed puzzling indications on the two altimeters: there was a slight difference between the indications, which increased as the aircraft climbed. Using his altimeter for reference, upon establishing level flight at FL 100 the pilot in the left seat asked the Berne air traffic controller to check whether they were in fact at FL 100. The controller confirmed that he read the altitude as FL 100 on his radar screen. When the aircraft eventually had climbed to the cruise altitude of FL 270 (according to the left pilot's indication) the difference between the two altimeters had stabilized at 2000 feet. In addition, the left airspeed indicator (ASI) was indicating a mere 90 kts, while the right showed an indicated speed of 160 kts.

MUDDLE
A leak near the #1 static-line meant that the two altimeters on a PC-12 gave different indications.

The flight crew needed to resolve the issue of "which indicators can we trust?"

They referred to the altitude indication on the GPS, but the information was inconclusive.

The crew contacted sector T of the en-route southwest ATC center at Bordeaux (CRNA/SO) and advised them that one of the altimeters was indicating FL 270 while the other was indicating FL 290, and asked if the controller could determine the exact altitude if the transponder was put into stand-by. The controller responded that he could not do that with the available equipment, but that he would ask for information from the military ATC. Several minutes later the controller informed the crew that he checked with the military, and that they were at exactly FL 270.

The crew of the Airbus A318 also knew that something was wrong.

The Airbus was established at FL 290 and the captain and co-pilot were preparing the arrival at Toulouse when they felt some "strange" slow roll oscillations of about 5 degrees for a few seconds. There was no unusual indication on their Primary Flight Display (PFD) and so they continued head-down with the preparation of the arrival. The pilot-non-flying was intrigued by new oscillations that reminded him of wake turbulence. He looked up again and saw the PC-12 aircraft, on same course and very close, slightly above and to the right. He maintained visual contact with the other aircraft while he disconnected the autopilot and made a left descending control input.

The Airbus overtook the PC-12 with a differential speed of about 170 kts and, according to the statements of the crews, with a separation between 15 to 30 meters horizontally and about 100 feet vertically. Or, as a representative from Pilatus put it, they passed within less than a wingspan.

Murphy at Work

This PC-12 was equipped with two independent pitot-static systems. The #1 system supplied the instruments on the pilot (LH) side, and the #2 system supplying the instruments on the co-pilot (RH) side. Each pilot position is provided with an airspeed indicator (ASI), a vertical speed indicator (VSI) and an altimeter. The Air Data Computer which supplies data to the transponder and the cabin altimeter (differential pressure indicator) of the pressurization system are both connected to the #1 static system.

The maintenance activities prior to the ferry flight included the incorporation of an Airworthiness Directive which required the temporary disconnection of the Cabin Altitude Indicator from the static line. Prior to releasing the aircraft, the static system was tested on the ground per maintenance instructions and proved to be leak-free. However, when the system was subjected to the vibrations of operation and flight, a leak developed the #1 static-line near the cabin altimeter connection. The investigation found a deformation of the connecting line where the leak occurred (the cause for the deformation could not be determined). The result was that pressurized air from the cabin entered the #1 static line, effectively reducing the pressure differential between the pitot and the static pressure. The evident result is an altitude and an airspeed indication which is lower than actual. The rate of leakage was such that it placed the aircraft exactly 2000 feet higher than the left pilot's altimeter indicated.

Is Two Better than One?

This airprox incident raises a number of important and interesting issues. The detailed discussion and resolution of all of them is beyond the

scope of this article, but they sure provide some wholesome food for thought.

One issue is the fundamental question of the usefulness of dual redundancy in indication systems: "If the two don't agree, which one do you trust?" Ideally, a third system would be available, and the two that agree rule out the third one. Actually, this PC-12 *was* installed with a third altimeter, the cabin altitude indicator. And the cabin altitude indicator is used in the Emergency Procedures in the case of failure of the pitot and static system. If the aircraft is below 10,000 feet, the procedure calls for the cabin altitude to be set to the aircraft altitude, dumping of the pressurization, and using the cabin altimeter for an approximate altitude indication. This procedure leaves the question of what to do if the malfunction is detected above 10,000 feet: if the crew intends to descent to below 10,000 feet to apply the procedure, which of the two altimeters is used to determine when the required altitude is reached? Furthermore, in this particular case the cabin altitude indicator was connected to the faulty static line; the cabin altimeter would actually have confirmed the incorrectly indicating altimeter.

If the correctly indicating system cannot be directly confirmed by a third system, then additional information must be indirectly used for cross reference. The left ASI indicated an unreasonable airspeed which was in no relation to the weight, altitude and power setting. A quick check of the flight manual performance table would have showed that the #2 ASI was spot on and that a fault most likely exists in the #1 system.

A second confirmation could have been obtained from the GPS system. The PC-12 crew indeed referenced the GPS altitude to confirm the altimeter indications. The results were inconclusive. The GPS indication is based on a geometric calculation of the altitude while the altimeters are based on barometric pressures which are subject to variations in pressure, density and temperature. So the crew correctly did not take the GPS altitude information into consideration. However, the GPS speed indication would very likely have further confirmed the unreliability of the #1 pitot-static system.

Communication

In spite of this hard evidence available on board, the crew relied on external assistance from air traffic control. Civilian air traffic control generally does not have the means to directly determine the altitude of an aircraft from primary radar data. Instead, the aircraft transmits its altitude via the Mode-C transponder signal which is then displayed on the controller's screen. If the transponder receives the signal from the Air Data Computer which is itself connected to the erroneous static-pressure system then the situation is set-up for a faulty checks-and-balances control loop as it occurred with Berne ATC.

The communication issue was even more delicate in the exchange with the French CRNA/SO. Having no means to clear the doubts raised by the PC-12 crew the controller contacted the Military Coordination and Control Center (CMCC). The CMCC was located in the same room as the CRNA/SO and only had the same display and information available. It could therefore not provide additional support. But he contacted the Detection and Control Center (CDC) with the request for a confirmation of the aircraft's altitude. While some military control centers have the capability to approximately determine the altitude of aircraft solely from primary radar data, at this time CDC could only read back the Mode-C altitude of FL 270, which was reported back through CMCC and CRNA/SO to the pilots. Remember the Telephone Game children play? The first player whispers something to the next player and this is repeated a few times. The last player announces to the group what he or she heard. The results are usually quite hilarious because the original message has become garbled. In this case, however, the message received back in the cockpit has erroneously become identical with what the crew had expected to hear, with the added credibility of coming from the military Air Traffic Control. What was lost in the communication is the crucial information that CDC ultimately also simply read the Mode-C altitude, thus confirming the incorrect starting information. This confirmation dispelled the last doubts of the crew and the reliance on external information led them to disregard the hard evidence available on board.

Safety Lessons

As often in the examples presented in these "safety sense" articles, automated detection and alarm systems did not work. Murphy was so hard at work here that the aircrafts' TCAS systems or the controller's Short Term Conflict Alert (STCA) system blindly considered the aircraft to be safely separated by 2,000 feet of air.

The safety lessons to be learned are obvious and basic:

❍ The need for continuous external visual vigilance cannot be overstated.

❍ Weak signals, such as the roll oscillation in this case, may be an important indication that something unexpected is about to happen. Mindful perception and intelligent processing of impressions provided by all senses broadens situational awareness.

❍ False altimeter values may render onboard and ground based protection systems (STCA or TCAS) useless. Avoid over-trusting automated systems.

❍ ATC controllers only know about an airplane's altitude what the airplane is telling them. If the airplane is unable to correctly determine its altitude, then the controller cannot do it either.

❍ Beware of the reinforcement and confirmation of a preconceived mindset and uncritical "wishful thinking".

❍ And as always: Know your systems! You may need to use your intelligence to outsmart some of them.

Reference French BEA Investigation Report found at: http://aviationreport.blogspot.com/2011/02/report-air-france-a318-near-aurillac-on.html

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