TEACHING BASICS LASTS *FOREVER*

PLEASE...

DO IT WELL

GHAFI FIRC 16JUL2011

AIR FRANCE 447

The Airbus A330-200 was enroute to Paris from Rio de Janeiro on June 1, 2009 when it experienced a high-altitude stall after it is thought ice blocked the plane's air speed sensor and flight instruments were therefore unreliable. French investigators have not released their final report into the crash that killed all 228 people aboard, but an initial report offers telling details about the flight's final minutes.

References:

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Initial analysis of the flight data and cockpit voice recorders is revealing more about what caused AF447 to crash on June 1, 2009: The aircraft stalled at 38,000 ft. and was never recovered. *The sequence of events suggests that proper stall recovery procedures could have prevented the accident.*

Inflight loss-of-control accidents were the most frequent cause of fatal airliner crashes and by far the deadliest in 2000-09. Of the 89 fatal accidents recorded in the period, 20 were attributed to inflight loss of control; 16 were caused by controlled flight into terrain.

Recent crashes linked to stalls include that of the Colgan Air Bombardier Q400 on approach to Buffalo, N.Y. (2009); Turkish Airlines Boeing 737-800 in short final for Amsterdam (2009); West Caribbean Airways MD-82 in Venezuela (2005); Thomsonfly Boeing 737-300 near Bournemouth, England (2007); and XL Airways Germany Airbus A320 off the coast of Perpignan, France (2009).

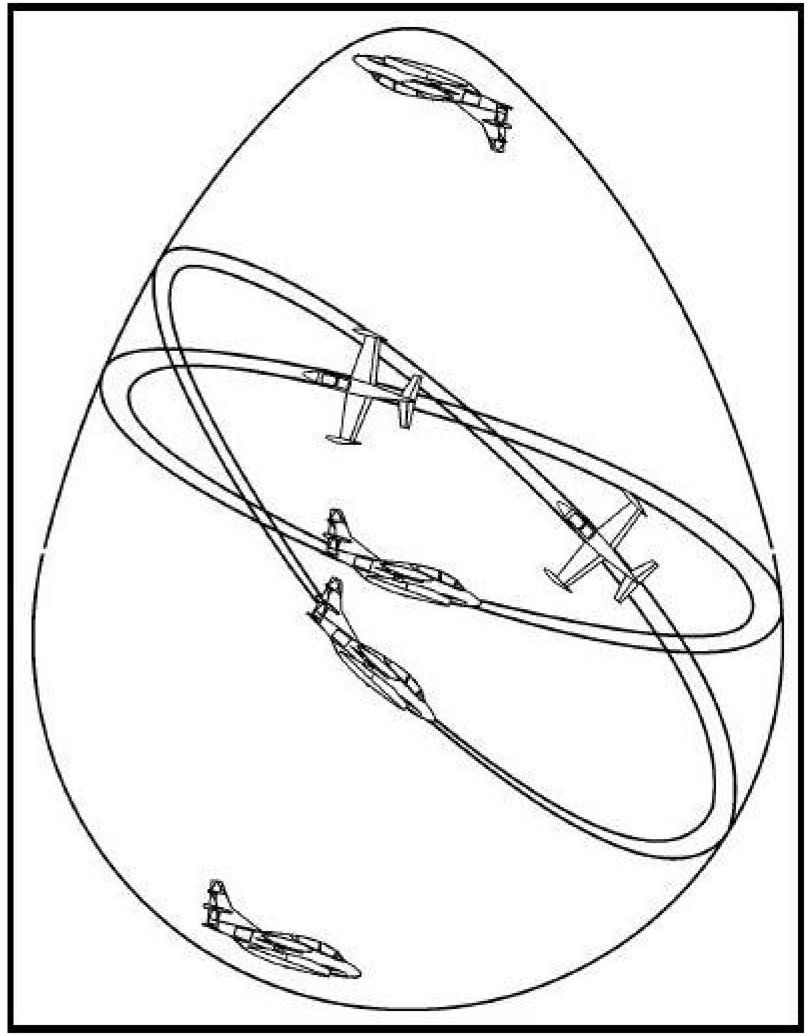
"Most approach-to-stall incidents and accidents occur with sufficient altitude available for the recovery," *Boeing Senior Safety Pilot Mike Coker* told delegates at the Flight Safety Foundation's European Aviation Safety Seminar in Istanbul this year. *"Incidents progress to accidents when the crew fails to make a positive recovery after the stall warning occurs."*

Flawed training is partly to blame, he asserts. Approach-to-stall training is typically conducted at simulated altitudes of 5,000-10,000 ft., but many stalls actually happen much higher. In the case of AF447, stalls occurred at 35,000 ft. and 38, 000 ft., respectively. That has important, negative implications, Coker concludes.

"Recovery stresses an increase to maximum thrust and recovery with minimal altitude loss," he says. Therefore, "students try to minimize the nose-down pitch change while engines spool up."

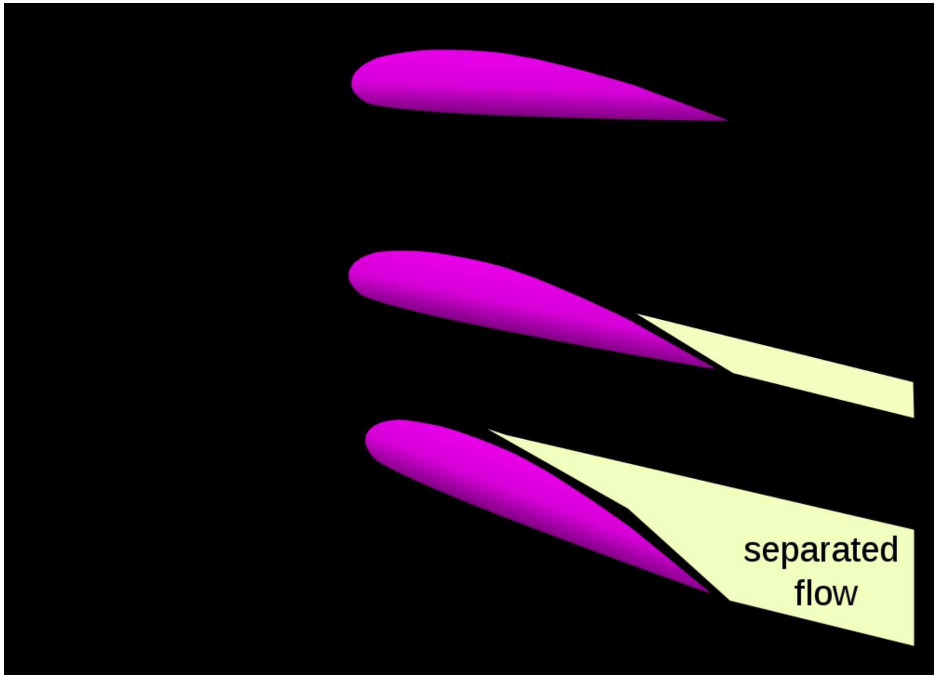
To make matters worse, engine margins at high altitude are much smaller than at lower flight levels, where pilots can count on a much greater response to power increases. Also, Coker says, "it is probable when pilots remain on a particular model for extended periods of time that their exposure to approach-to-stall indications and recovery occur as infrequently as once in a decade," when stall exercises should really be part of recurring training. He stresses that *training should focus on correct procedures, reducing the angle of attack and appropriate energy awareness, and not so much on minimizing altitude loss.*

THE ENEGRY EGG
THE TACTICAL EGG



Flight 447 was still at 35,000 feet, but the *angle of attack exceeded 40 degrees* (well past the normal stall angle) and the airplane was beginning its rapid fall. Over the next few minutes the pilots used various amounts of engine power and control inputs to regain control.

But according to the initial report from the Bureau d'Enquetes et d'Analyses[.pdf], the crew did not push forward on the control stick long enough to point the nose down, reduce the angle of attack on the wing and recover from the stall.



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LIFE VEST
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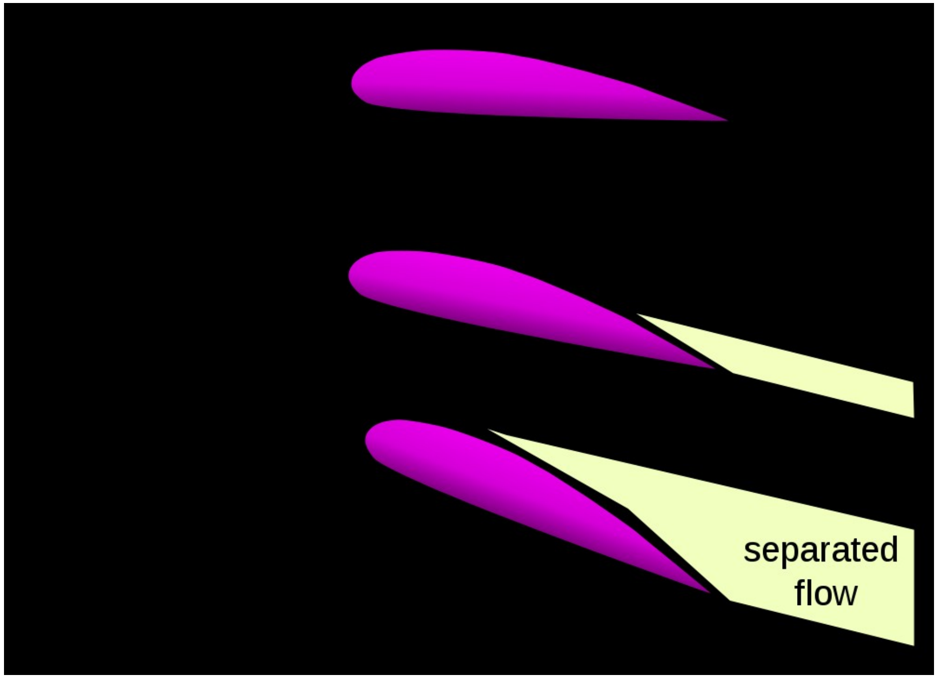

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Were they low time pilots?

ICAO MULTI-CREW LICENSE?
...minimum of 10 hours of solo time. In all, the candidate is required to log a minimum of 240 hours. The flight experience in aircraft must include cross-country navigation, night operations, upset recovery and flight by reference solely to instruments.

The pilot non-flying (PNF), a 37-year-old with 6,547 total hours and 4,479 hr. on type...
...the pilot flying (PF), the 32-year-old junior copilot with 2,936 flying hours and 807 hr. on type...

The initial chain of events was kicked off by erroneous speed readings at 2:10:05 (UTC), when both the primary flight display and integrated standby instrument system (ISIS) showed a sharp fall from 275 kt. to just 60 kt. The autopilot and auto-thrust disengaged and the flight management system switched to alternate law. The aircraft rolled to the right and the PF reacted by making a nose-up and left input. The stall warning sounded twice.

The nose-up inputs led the aircraft to climb fast, at a rate of up to 7,000 ft. per minute, but it almost leveled off at a slight climb of around 700 ft. per minute and Flight Level FL375. At 4 deg., the angle of attack was only slightly higher than in cruise flight (3 deg.). The return to normal of the primary speed indication after 40 sec., and after close to 1 min. on the ISIS, indicates the pitot tubes started to transmit valid data again and the icing issue appeared to have subsided.

At this stage, the event could have been over, with the aircraft still in alternate law and manual control but stabilized. There appears to be no technical, aerodynamic or meteorological reason that would have kept it from returning to its previously assigned altitude (FL350) by simply applying nose-down stick-forward control inputs.

But then things went terribly wrong. At 2:10:50, the PF continued to provide nose-up inputs, causing the trimmable horizontal stabilizer to go to 13 deg. nose-up from 3 deg. nose-up. The airspeed began decreasing, to 185 kt., and the angle of attack reached 16 deg.

Gerhard Huettig, a professor of aeronautics at the Berlin Technical University, says the change in the horizontal stabilizer position was due to a software malfunction that could have been neither recognized nor corrected by the pilots and was a key factor as to why they were unable to fly out of the subsequent stall. He consequently asserts that the entire A330 fleet should be grounded until the software is corrected. However, industry officials point out that the automatic trim only became active after the crew pulled back on the stick and that it worked as expected.

In this phase, the captain re-entered the cockpit. What role he played subsequently is not clear yet, because the full cockpit voice recorder content has not been published. According to one report, he immediately told his two copilots that they were in a stall and therefore should put the aircraft's nose down and reduce thrust. Others doubt that because there was hardly any nose-down control input in the remaining 3 min. of flight and from 38,000 ft. to sea level.

In fact, forward speed declined so much that even stall warnings stopped, in spite of the fact that the aircraft remained in a stalled situation for the remainder of its flight. *That only happens when measured speeds are below 60 kt. and angle-of-attack values are considered invalid. When speed drops below 30 kt., that is also registered by the flight management system as invalid*-and that is what seems to have occurred 30 sec. later, as the PF stated, "I don't have any more indications" and the PNF replied, "We have no valid indications." That second instrument failure is thus most likely due to the slow speed and not linked to pitot-tube icing.

Around 2.5 min. before impact, *there was one short period in which the PF did the right thing by pushing the side-stick forward. The angle of attack decreased and speeds became valid again, with the stall warning returning and indicating an acceleration in horizontal speed.* The stall warning may have caused the PF to pull back on the stick again, repeating his previous pattern; it was not corrected by either the PNF or the captain. "[The pilots] never made the inputs necessary to recover," says one official close to the investigation.

"We will learn a lot from this accident," says William R. Voss, president and CEO of the Flight Safety Foundation, who believes that AF447 should have fundamental consequences for the content of pilot training globally. "We are still training [for] the engine fire at V1, but the complexity of automated systems has grown. We have to develop crews that can deal with incidents such as QF32," the Qantas Airbus A380 that suffered an uncontained engine failure after takeoff in Singapore on Nov. 4, 2010, and returned to the airport severely damaged.

Voss argues that AF447 would not have crashed if the aircraft had been of an older generation. "Highly automated aircraft have saved many lives, but they fail differently than aircraft of 20 years ago," he says. He sees it as a "failure of the industry" that pilot training has not kept in step with the latest aircraft technologies. He also argues for improved upset recovery training, as "we are not explicitly training that" and *the AF447 A330 "seems to have had pitch-and-roll authority all the way down to the water."*

The BEA report plays down two other issues that have been in the spotlight. One is speculation that the aircraft entered a severe storm; the BEA document suggests it was merely turbulence that is standard for that region. During a crew briefing 2 hr. into the flight, in which all three pilots participated, the PF said that "the little bit of turbulence that you just saw, . . . we should find the same ahead . . . . *We're in the cloud layer. Unfortunately, we can't climb much for the moment because the temperature is falling more slowly than forecast.*" And 11 min. later, the PF told the captain that "in two minutes, we should enter an area where it'll move about a bit more than at the moment. You should watch out," adding that "I'll call you as soon as we're out of it." The PNF proposed 2 min. later that "you can maybe go a little to the left" and the aircraft turned left 12 deg. None of the actions suggest anything out of the ordinary.

The second speculation surrounded pitot-tube icing. Although the pitot probes appear to have iced over, the speed discrepancy between the primary flight display and ISIS lasted around 45 sec., not atypical for the phenomenon.

There remain some long-term questions related to the AF447 accident. Would better aural cues help focus pilot attention on recovering from a stall? One industry official doubts replacing the "stall" alert with a more specific instruction, such as "push stick," would make much of a difference. And should research be funded toward devising a better backup mechanism to pitot tubes or finding another way to determine true air space that is less susceptible to outside environmental factors? *"It would be interesting to have another technology," the industry official says.*

DIFFERENT CREW, DIFFERENT DAY:

On June 23, 2009, at 0301 coordinated universal time (UTC) an Airbus A330-323, US registration N805NW, manufacturer serial number 552, operated by Northwest Airlines as flight 08 between Hong Kong and Tokyo experienced airspeed and other flight deck anomalies while in cruise flight at FL390, 50 miles southwest of the Kagoshima Airport, Japan.

The flight was passing nearby an area of convective weather activity. The airplane was in level flight, on autopilot, at a speed of mach 0.81, heading approximately 065 magnetic along RNAV (area navigation) route M750. The flight crew was aware of the weather, and reported they were adjusting the airborne weather radar tilt and cycling between MANUAL and AUTO modes in an attempt to get the most complete picture to avoid penetrating the convective activity. Outside (static) air temperature was about -52ºC. They reported that the main cell appeared to be about 25 miles north of their flight path. However, *just prior to the event the airplane entered an area of cirrus clouds with light turbulence and moderate rain with a brief period of intense rain, and hail aloft.*

The crew received a master warning and master caution alert, and the autopilot (AP), autothrust (ATH) and flight directors disengaged. The crew reported airspeed fluctuations on the Captain's, First Officer's (FO), and the standby airspeed indicators. They reported receiving a stall warning, noted the flight law switched to Alternate Law, and saw messages indicating NAV ADR DISAGREE and NAV IAS DISCREPANCY. They reported the airspeed fluctuations and warnings lasted about one minute, and *they controlled the airplane by pitch and power reference*, per applicable checklist procedures until normal airspeed indications returned. They received ATC clearance to turn farther from the convective area, and after a short period the airspeed fluctuations and messages repeated for a duration of about two minutes. The airspeed indicators returned to normal and the crew re-engaged autopilot and completed the flight in alternate law.

ANOTHER CREW, DIFFERENT DAY:

On May 21, 2009, at 2147 eastern daylight time (EDT), an Airbus A330-233, Brazilian registration PT-MVB, manufacturer serial number 238, operated by TAM Airlines as flight 8091 from Miami International Airport, Florida, to Sao Paulo Guarulhos International Airport, Sao Paulo, Brazil, experienced a loss of primary speed and altitude information while in cruise flight at FL370 over international waters, south of Haiti. The flight crew noted an abrupt drop in outside air temperature and observed St. Elmo’s Fire, followed by the loss of the Air Data Reference System, disconnections of autopilot and autothrust, and loss of primary airspeed and altitude. The flight crew continued using backup instruments, and after a short time, primary data was restored. The airplane remained in alternate flight law and displayed a rudder travel limit flag. The crew determined they could not restore normal law and continued the flight under the appropriate procedures. The flight landed at Sao Paulo with no further incident and there were no injuries or damage. The Brazilian Centro de Investigação e Prevenção de Acidentes Aeronáuticos (CENIPA), delegated the incident investigation into this event to the NTSB.

A review of recorded flight data indicated that while level at FL370, indicating mach 0.8 (260 knots), and in moderately turbulent conditions with an outside (static) air temperature of -45º C the No.1 ADR airspeed dropped rapidly from about 260 knots to approximately 60 knots for a few seconds, then rose to 100 knots.

About 6 seconds after the autopilot disengaged, recorded data indicated two brief re-engagements of the autopilot. Concurrent with the re-engagement, a pitch up to about 7 degrees nose up and slight climb was recorded, and the pilot reported a stall warning. Left side stick pitch inputs were recorded about one second after the autopilot disengaged from the second brief engagement, as the airplane climbed to about 38,000 feet. The autopilot remained disengaged during the remainder of the event, and the crew turned about 60 degrees to the left to diverge from the weather area, and the altitude decreased to about 36,500 feet, before reversing and increasing again. About 3 minutes and 30 seconds after the initial airspeed drop, the No.1 ADR returned to 260 knots, and the 300 foot altitude discontinuity ceased, indicating an altitude of about 37,400 feet. Left nose down stick inputs and a decrease in pitch were concurrent with the altitude returning to 37,000 (FL370). Then autopilot and autothrust were then re-engaged and the flight continued to Sao Paulo in alternate law with no further incident, no injuries, and no damage. Post flight maintenance checks on the airspeed system revealed no discrepancies.

The Quick Reference Handbook abnormal procedure checklists for UNRELIABLE AIRSPEED INDICATION for Northwest, TAM, and the basic Airbus aircraft operating manual, all call for autopilot and autothrottle OFF, and instruct crews to use pitch and power reference tables to control the airplane in cruise flight.

Analysis of the maintenance messages makes it possible to group the fault messages and the cockpit effect messages together as foll.

Time Fault message with cockpit effect Cockpit effect messages

0210 PROBE-PITOT 1X2 / 2X3 / 1X3 (9DA)
AUTO FLT AP OFF
AUTO FLT REAC W/S DET FAULT
F/CTL ALTN LAW
FLAG ON CAPT PFD SPD LIMIT
FLAG ON F/O PFD SPD LIMIT
AUTO FLT A/THR OFF
FLAG ON CAPT PFD FD
FLAG ON F/O PFD FD
F/CTL RUD TRV LIM FAULT
0210
FCPC2 (2CE2) /WRG:ADIRU1 BUS ADR1-2 TO
FCPC2
MAINTENANCE STATUS EFCS 2
MAINTENANCE STATUS EFCS 1
0211 ADIRU2 (1FP2)
FLAG ON CAPT PFD FPV
FLAG ON F/O PFD FPV
0214
Note: this message is necessarily correlated
with a fault message, but this fault message
was not received
MAINTENANCE STATUS ADR 2

Fault messages without cockpit effect

0211 ISIS(22FN-10FC) SPEED OR MACH FUNCTION
Note: the flags on the ISIS are not
captured by this CMC
0213 FMGEC1(1CA1)
Note: the only cockpit effects
potentially associated with
this message had already been
generated and could not be
generated a second time

Cockpit effect messages without fault

0210 NAV TCAS FAULT
0212 NAV ADR DISAGREE
0213 F/CTL PRIM 1 FAULT
0213 F/CTL SEC 1 FAULT
0214 ADVISORY CABIN VERTICAL SPEED

FLIGHT CONTROL LAWS

Normal law offers complete protection of the flight envelope: in terms of attitude (the pitch and bank angles values are limited), load factor, at high speed and with a high angle of attack. Outside the protections, the longitudinal orders from the sidesticks command a load factor according to the aircraft's normal axis and the lateral orders command a rate of roll.

In *alternate law*, the longitudinal orders from the side-sticks command a load factor according to the aircraft's normal axis, like with normal law but with fewer protections. In *alternate 1*, the lateral orders from the sidesticks still command a rate of roll with the same protections as with normal law. In *alternate 2*, they command the ailerons and lift dumpers directly.

With *direct law*, the orders from the sidesticks control the position of the various control surfaces directly.

Another law, called the *abnormal attitudes law*, is triggered in certain cases where the aircraft's attitude is outside certain ranges, for example when the bank angle exceeds 125 degrees. This is an *alternate 2* law with maximum lateral authority.

As of 3 November 2009, Airbus had identified thirty-two events that had occurred between 12 November 2003 and 1st June 2009(18). According to Airbus these events are attributable to the possible destruction of at least two Pitot probes by ice. Eleven of these events occurred in 2008 and ten during the first five months of 2009.

Twenty-six of these incidents occurred on aircraft fitted with Thales C16195AA probes, two on aircraft with Thales C16195BA probes and one on an airplane equipped with Goodrich 0851HL probes.

As of 1st June 2009 Air France had identified nine events that might meet the above-mentioned criteria. After the F-GZCP accident the airline started a targeted analysis of recorded parameters and identified six additional events that occurred in 2008.

In addition, a foreign operator began a targeted analysis of recorded flight parameters recorded after June 2006 on its A330 fleet. As of 18 November 2009 it had identified fourteen events. Only four of them had been detected and reported by the crews to their airline.

Further, Airbus identified four events that have occurred since 1st June 2009.

On 15 April 2009, Airbus informed Air France of the results of the study carried out by Thales. *Airbus pointed out that icing with ice crystals was a new phenomenon that had not been taken into account in the development of the Thales C16195BA probe*, but that this model seemed to provide a significant improvement regarding the incorrect speed indications at high altitude.

Airbus proposed an "in-service assessment" of the C16195BA standard to Air France, in order to verify the behaviour of the probe in a real situation. Air France decided to immediately extend this measure to all of its long-range A330/ A340 fleet and to replace all of the speed probes. An internal technical document to launch the modification was issued on 27 April 2009.

The start of airplane modifications was planned to take place on reception of the parts.

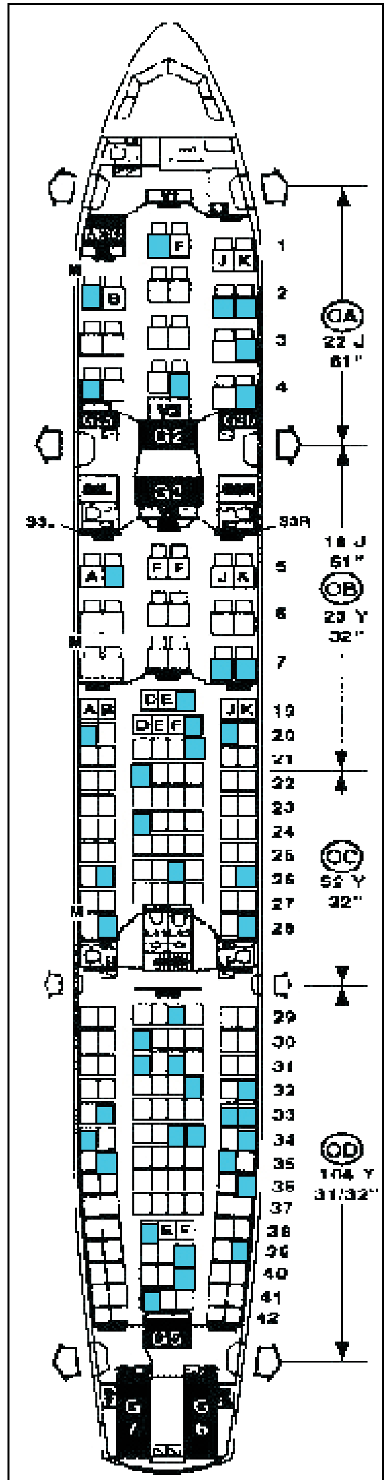
The first batch of C16195BA Pitot probes arrived at Air France on 26 May 2009, that is to say six days before the F-GZCP accident.

At the time of the accident, F-GZCP was equipped with C16195AA probes.

4 - RECOMMENDATIONS

4.1 Flight Recorders

The investigation into the accident to AF 447 confirms the importance of data from the flight recorders in order to establish the circumstances and causes of an accident and to propose safety measures that are substantiated by the facts. As in other investigations, it also brings to light the difficulties that can be encountered in localizing, recovering and reading out the recorders after an accident in the sea.



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Air France has already been charged with manslaughter in a French court, the allegations being that the speed sensors were defective and that the airline knew about it and had not fixed them. But *as in any plane disaster, no one reason is usually responsible. It's two or more causes, which, in concert, create a situation that cannot be overcome.*

And such is the case with AF 447. This much we know:

The equipment was defective.

The pilots were confused and eventually disoriented.

They pulled the nose up when they should have pushed it down.

The Continuing Mystery

Then there is the unexplained location and condition of the tail of the aircraft. It was one of the only large pieces of the plane initially found intact - dozens of miles from the impact location. A number of veteran investigators are suggesting that the tail itself may have been part of the probable cause.

It may eventually get down to the resilience and the performance parameters of the non-metallic materials used in the construction of the Airbus, which includes the tail. Composite materials are the new darlings of airplane manufacturers. On the plus side, they weigh less and they don't corrode. On the minus side, composite materials are brittle and can easily snap.

That is why those same investigators contend that if the tail had stayed attached to the plane at the point of impact, it would have fractured into hundreds of pieces. But the tail was found intact, floating on the surface of the ocean. The unanswered question: Did turbulence contribute to the tail of the plane literally breaking off?

MEMORY ITEMS A330 UNRELIABLE AIRSPEED

THRUST/PITCH………………….

Below THR RED ALT: **TOGA/12.5°**
Above THR RED ALT: **CL/10° Below FL 100**
CL/5° Above FL 100

AP……………………………………………………OFF
FD……………………………………………………OFF
A/THR…………………………………………….OFF
FLAPS…………….MAINTAIN CURRENT CONFIG
SPEEDBRAKES…………….CHECK RETRACTED
L/G………………………………UP WHEN AIRBONE

Birgen Air, Boeing 757, Turkish Registry TC-GEN, Near Puerto Plata Dominican Republic, February 6, 1996

There were discussions about airspeed indications early during the takeoff ground run and again after takeoff. While climbing through 7,300 feet, the sound of the stall warning stickshaker was heard. The airplane stopped climbing and started descending. The stickshaker sound continued for about 84 seconds until the end of the data. At the time the stickshaker activated, the recorded airspeed was about 335 knots. Data recorded from the ground based radar and other FDR data indicated a much lower airspeed.

Data are consistent with properly functioning flight controls, engines, and thrust reversers. Also, there is no indication of any unusual weather event or external forces acting on the aircraft.

AeroPeru Flight 603, 2 October 1996

...about 5 minutes after takeoff, the FO declared an emergency, telling Lima Tower that they had no airspeed or altitude indications. The Captain circled the 757 to the west, the tower controller providing altitude and position readouts to the pilots from the tower's radar (recently returned to service after a lengthy outage). However, the tower's altitude readouts come from the aircraft's Mode C transponder, which gets its altitude information from the aircraft's altitude system (i.e. the static ports). Some at least of these ports appear to have been taped over during maintenance and the tape not removed (see below).

Apparently, the pilots "did a good job, despite stickshaker, overspeed and other warnings", and eventually determined that the static system was yielding false readings. They used the radio altimeter to return to Lima at 1,500 ft. Nearer to the airport, they were apparently distracted by a ground-proximity (GPWS) warning. The FO queried the controller, who responded that the aircraft was indicating 9,000 ft. Believing that information, the Captain started a descent. The aircraft skimmed the ocean surface and one engine failed, (investigators presume from water ingestion). The Captain tried to continue flying, but a wingtip apparently hit the water and the aircraft cartwheeled and was lost.

AMERICAN AIRLINES FLIGHT 965, BOEING 757
NEAR CALI, COLOMBIA, DECEMBER 20, 1995

AA965 contacted Approach at 2134:40. The captain, making the radio transmissions [5] said, "Cali approach, American nine six five." The approach controller replied, "American niner six five, good evening. go ahead." The captain stated, "ah, buenos noches senor, American nine six five leaving two three zero, descending to two zero zero. go ahead sir." The controller asked, "the uh, distance DME [6] from Cali?" The captain replied, "the DME is six three."

The controller then stated, "roger, is cleared to Cali VOR, uh, descend and maintain one, fve thousand feet. altimeter three zero zero two.... no delay expect for approach. report uh, Tulua VOR." The captain replied, "OK, understood. cleared direct to Cali VOR. uh, report Tulua and altitude one five, that's fifteen thousand three zero.. zero.. two. is that all correct sir?" The controller stated, "affirmative." The captain replied at 2135:27, "Thank you. At 2135:28, the captain informed the first officer that he had "...put direct Cali for you in there."

Prepared for the WWW by Peter Ladkin Universität Bielefeld Germany

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The accident CVR indicated that from the beginning of their attempt to land on runway 19, the flightcrew exhibited a lack of awareness of fundamental parameters of the approach. From 2137:11, when the sound of rustling pages can be heard, the flightcrew attempted to both review the approach and determine the airplane's present and predicted position in reference to critical points on the approach. Their inability to effectively do both tasks is evidenced at 2138:49, when the first officer asked, "*where are we*," followed by a short discussion between both the captain and first officer regarding their position relative to the ULQ VOR. Again at 2139:30, two minutes before impact, neither flightcrew member could determine which navaid they were to proceed towards. The first officer stated, *"left turn, so you want a left turn back around to ULQ*." The captain replied, *"Nawww... hell no, let's press on to...*" The first officer stated, *"well we're, press on to where though?"* The captain replied, "Tulua." The first officer staid, "that's a right u u. *The captain stated, "where we goin'? one two.. come to the right. let' go to Cali first of all, lets, we got [expletive] up her didn't we." The first officer replied, "yeah."*

3.2 Probable Cause

1. The flightcrew's failure to adequately *plan* and execute the approach to runway 19 at SKCL and their inadequate use of automation.
2. Failure of the flightcrew to discontinue the approach into Cali, despite numerous cues alerting them of the inadvisability of continuing the approach.
3. The lack of situational awareness of the flightcrew regarding vertical navigation, proximity to terrain, and the relative location of critical radio aids.
4. *Failure of the flightcrew to revert to basic radio navigation at the time when the FMS-assisted navigation became confusing and demanded an excessive workload in a critieal phase of the flight.*

3.3 Contributing Factors

1. The flightcrew's ongoing efforts to expedite their approach and landing in order to avoid potential delays.
2. The flightcrew's execution of the GPWS escape maneuver while the speedbrakes remained deployed.
3. FMS logic that dropped all intermediate fixes from the display(s) in the event of execution of a direct routing.
4. FMS-generated navigational information that used a different naming convention from that published in navigational charts.

SO WHAT DO WE DO TO PREVENT “THE NEXT ONE”?

- ***SET A GOOD EXAMPLE***
- PLAN THE FLIGHT
- ADDRESS WEIGHT AND BALANCE
- REVIEW THE LOG BOOK
- USE THE CHECKLIST
- FOLLOW THE RULES
- *TEACH HOW THE AIRCRAFT FEELS*
- *TEACH KNOWN PITCH ATTITUDES AND POWER SETTINGS*

Learning Methods

There are two basic methods utilized for learning attitude instrument flying. They are “control and performance” and “primary and supporting.” These methods rely on the same flight instruments and require the pilot to make the same adjustments to the flight and power controls to control aircraft attitude. The main difference between the two methods is the importance that is placed on the attitude indicator and the interpretation of the other flight instruments.

Attitude Instrument Flying... Control and Performance Method

Aircraft performance is accomplished by controlling the aircraft attitude and power output.

aka: PITCH, POWER, TRIM

TAKE A BREAK!