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Accident on November 15, 2007
at Toulouse Blagnac Airport
to Airbus A340-600 serial number 856

CAUTION

This report presents the technical conclusions reached by the BEA on the circumstances and causes of this accident.

In judicial terms, this occurrence does not constitute an aviation accident or incident, since none of the people on board intended to perform a flight. Nevertheless, the term 'accident' will be used in this report, as commonly understood and accepted.

In accordance with Annex 13 of the Convention on International Civil Aviation, with EC directive 94/56/CE and with Law N°99-243 of 29 March 1999, the investigation of the accident is intended neither to apportion blame, nor to assess individual or collective responsibility. The sole objective is to draw lessons from this occurrence which may help to prevent future accidents or incidents.

Consequently, the use of this report for any purpose other than for the prevention of future accidents could lead to erroneous interpretations.

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GLOSSARY

AESA Agence Européenne de la Sécurité Aérienne
AMM Aircraft Maintenance Manual
BEA Bureau d'Enquêtes et d'Analyses
(BEAD-Air) Bureau Enquête Accidents Défense Air
CAM Customer Acceptance Manual
CEV Centre d’Essais en Vol
CVR Cockpit Voice Recorder
EPR Engine Pressure Ratio
FDR Flight Data Recorder
GSAC Groupement pour la Sécurité de l’Aviation Civile
JAR Joint Aviation Rules
UTC Coordinated Universal Time

SYNOPSIS

Date of accident
Thursday November 15, 2007 at 1610 hrs (1)

Aircraft
Airbus A-340-600
Registered as F-WWCJ

Location of accident
Toulouse Blagnac Airport

Owner
Airbus

Purpose of flight
Engine ground run test

Persons on board
9

Note (1): Unless stated otherwise, the times quoted in this report refer to Coordinated Universal Time (UTC). One hour should be added to obtain the local time in France at the time of the event.

1- FACTUAL INFORMATION

1.1 Summary of the event

On 15 November 2007, the Airbus A-340-600 F-WWCJ was undergoing static engine ground runs on the Toulouse-Blagnac airfield. The purpose was to test various systems with technicians of the airline that had ordered the aircraft. No wheel chocks were used. On completion of these tests, after having stopped and inspected the engines, the technicians started the engines again for another engine run at high power to find the origin of oil leaks.

Approximately three minutes after power up, the aircraft began to move forward. The technician in the left seat perceived the motion and informed the Airbus technician in the right seat. The latter acted on the brake pedals and then released the parking brake. The DFDR (digital flight data recorder) then indicates a partial release of the brake pedal command. Since the aircraft continued to move forward, he tried to modify its trajectory by using the nose wheel steering. The nose wheel gear quickly skidded sideways as the aircraft accelerated.
The aircraft struck the slope of the anti-blast wall. The forward fuselage broke and fell down on the other side of the wall.

There were thirteen seconds between the start of aircraft movement and the collision with the wall.

1.2 Injuries and fatalities

Fatal - 0
Serious - 4
Slight/None – 5

1.3 Aircraft damage

The aircraft was destroyed.

1.4 Other damage

The anti-blast wall was damaged.

1.5 Personnel information

The ground tests during the customer delivery phase are performed under the responsibility of only one ground test technician, an Airbus employee. He was usually accompanied by one or more persons representing the customer, and sometimes by other Airbus employees. Airbus had no special qualification requirement toward the customer representatives attending testing. The representatives of the customer sitting in the cockpit normally had observer roles, but it could happen that the ground test technician allowed the representative of the customer to participate, for example by allowing him to taxi.

During this test, the technician in charge of ground testing was in the right seat, an aeronautical technician representing the customer was in the left seat and a flight test engineer was on the jump seat. The customer representative and the flight test engineer had no specific function in the aircraft handling. The role of the customer representative was to observe the parameters during testing to ensure compliance with the requirements of the customer.

1.5.1 Persons on the flight deck

1.5.1.1 Ground test technician in the right seat:

Male, 41 years old, Airbus employee, responsible for the test
• Line maintenance technician since 1992
• Ground test technician since 1998
• Course for engine tests and ground runs on A330 - A340 in 1998.
• RR Trent 500 familiarization course in May 2000
• Attached to the Flight Test / Aircraft Delivery Department since 2004
• Flight test engineer since 2004
• Recurrent training for A-330/340 engine test in October 2006

1.5.1.2 Aeronautical technician in the left seat:

Male, 36 years old, employee of a maintenance company (GAMCO), which maintains the Etihad Airlines aircraft and carries out their acceptance tests.
• Technician for the GAMCO company since 1997
• Courses at Lufthansa Technik and Airbus in 2002
• A-340-600 engine ground run training in 2006

1.5.1.3 Flight test engineer on the jump seat:

Male, 42 years old, Airbus employee
• Flight test engineer in 2000
• Attached to the Flight Test / Delivery Department since 2000
• Authorized to perform engine tests on Airbus family aircraft
• Commercial airplane pilot since 1998
• A-320 type rating in 2004
• ATR-42 type rating in 2006

1.6 Aircraft Information

Airframe:

• Manufacturer: Airbus
• Type: A340-600
• Serial Number: 856
• Provisional Registration: F-WWCJ

Engines:

Engine #1 Engine #2 Engine # 3 Engine #4
Manufacturer Rolls-Royce Rolls-Royce Rolls-Royce Rolls-Royce

Type Trent Trent Trent Trent
556A2-61 556A2-61 556A2-61 556A2-61

Serial Number 71492 71490 71491 71493
Total Time 24 h 26 h 24 h 23 h

Engine control parameter

The thrust of the A-340-600 engines is expressed in terms of the EPR (Engine Pressure Ratio) which represents the ratio of total pressure between the turbine outlet and compressor inlet. This ratio varies approximately between 1 (ground idle) and 1.41 (full thrust, or around 28000 daN).

Weight and balance

The aircraft weight was 223 tons including 40 tons of fuel, and the CG was at 25.8%. Ground tests are usually performed with 80 tons of fuel. The maximum certified take-off weight is 380 tons.

Braking system

Description of the system

The A-340-600 has two Main LG, one on the right side and one on the left, one Central LG and one Nose LG. Each MLG and the CLG have 4 wheels each. The CLG is slightly aft of both MLG. Each MLG wheel and CLG wheel is equipped with a braking system, and each brake is powered by two independent hydraulic systems. The NORMAL braking pressure is controlled through the green system. The blue system powers the ALTERNATE braking.

When the parking brake is set, the blue system applies 2500 psi to both MLG. The CLG brakes are not operated by the parking brake.

When the brake pedals are pressed, the green system operates both MLG and the CLG, with the amount of pressure applied depending of the position of the brake pedals. The green system pressure is inhibited as long as the parking brake is activated.

If the parking brake is released while simultaneously pressing on the brake pedals, the system allows both circuits to be pressurized together, while the ALTERNATE circuit depressurizes. This applies only to both MLG and the total amount of pressure from both circuits is limited to 2770 psi.

In addition, the braking of the CLG wheels is automatically reduced when the nose wheels are steered. When the nosewheel steering command is greater than 20 degrees, the CLG braking is completely inhibited.

Certification standard

The JAR25.735d regulation for certification indicates that the parking brake must be designed to prevent the aircraft from moving on a dry paved runway with one engine at maximum thrust, the others being at ground idle. In these circumstances, the A-340-600 parking brake must develop a minimal braking force of 28000 daN or 3500 daN per braked wheel. The system was designed to develop a braking force of 8500 daN per braked wheel with a brake pressure of 2500 psi.

1.7 Meteorological conditions

At 1600 hrs, the meteorological conditions measured at the Toulouse Blagnac airfield were:

-Wind 330°/16 knots, visibility greater than 10 km, cloud cover few at 4100 feet, temperature 5°C, dewpoint -5°C, QNH 1019 hPa.

1.8 Communications

The ground test technician, who taxied the aircraft, was in contact with the ground controller of the St-Martin watchtower. This frequency, specific to Airbus, makes it possible to control the traffic during the taxiing of aircraft on the Airbus site of the Toulouse Blagnac airfield.

1.9 Airfield information

The accident occurred on the BIKINI ramp. This area is dedicated to testing and is part of the manufacturer's facilities.

No grip data for the surface of the test area were available before the accident. To enable a quantitative analysis of the braking performance, it was necessary to undertake measurements of slipperiness. These measurements were carried out in conditions close to those on the day of the accident. The measured friction coefficients were between 0.65 and 0.68. These values correspond to the coefficient of a dry runway in good condition.

1.10 Flight recorders

In accordance with the applicable regulations, the aircraft was equipped with a cockpit voice recorder (CVR) and a flight data recorder (FDR).

1.10.1 CVR

The CVR is a recorder with static storage capable of storing the last two hours of recording.

• Manufacturer: L-3 Communications
• Model: FA 2100
• Type Number: 2100-1020-02
• Serial Number: 455462

The following tracks are recorded:

1. VHF and mouth microphone from the third seat (rear location)
2. VHF and mouth microphone from the captain's seat (left side)
3. VHF and mouth microphone from the first officer's seat (right side) and FSK signal
4. Area microphone

The recording quality was good and lasts a little more than two hours. The event has been recorded in its entirety.

1.10.2 FDR

The FDR is a recorder with static storage capable of reproducing at least the last twenty five hours of recording.

• Manufacturer: L-3 Communications
• Model: FA 2100
• Type Number: 2100-4043-02
• Serial Number: 440952

The data are of good quality and the event could be identified at the end of the recording. The graphs of the recorded significant parameters appear in the annex.

1.10.3 Readout of the flight recorders

The CVR and FDR have been synchronized using the UTC time recorded in the FDR and the "Master Caution" "Single Chime" identified on the CVR.

The aircraft arrives at the BIKINI area approximately 14:19
It is at a magnetic heading of 312 degrees. The parking brake is set and active.

During the tests between 14:19 and 14:58 the maximum EPR values are between 1.04 and 1.22

The last engine ground run is started at 15:58. The aircraft is still not moving.

Between 15:58:10 and 15:59:03 the thrust is increased gradually from idle to a steady value of 1.25 EPR. This engine thrust setting corresponds to a position of the thrust levers between MCT (Max Continuous Thrust) and MTO (Max Take Off Thrust).

The ALTERNATE pressure values are close to 2600 psi for the wheels 1,2,5,6 (left gear) and 3,4,7,8 (right gear). They are at 64 psi for the wheels 9,10,11,12 (central gear) (2).

Note (2): Brake pressure values are recorded in increments of 64 psi

At 16:02:06 the person in the right seat starts talking but is interrupted at 16:02:08 by the person in the left seat who announces :
“Euh ... cabin is ... aircraft is moving forward”

The first significant LONGITUDINAL ACCELERATION parameter values showing a forward acceleration of the aircraft are observed around 16:02:07. The recorded ground speed starts to increase at 16:02:09 (3)

Note (3): Ground Speed values are recorded in increments of 1 kt.

Between 16:02:08 and 16:02:13 the ground speed increases from 0 to 4 kt.

At 16:02:11 the person on the left seat again says :
“Aircraft is moving forward”

An action on the brake pedals is recorded from around 16:02:11

The parking brake is deactivated around 16:02:13
The person on the right seat announces :
“Parking brake off”

From the moment the park brake is released:
• the brake pedals are briefly released on two occasions
• the ALTERNATE circuit braking pressures drop below 192 psi
• the NORMAL circuit braking pressures on the MLG are consistent with the brake pedals position on both right and left sides, and increase from 300 to 2500 psi in one second
• the NORMAL circuit braking pressures for the CLG reach a maximum of 192 psi at 16:02:14 and then decrease to 64 psi and stabilize at that value
• the wheel speed values which were still recorded as zero (the sensors do not work until a wheel speed of 3 to 5 kt) become positive and are consistent with recorded ground speed and aircraft movement
• the recorded ground speed increases rapidly from 4 to 31 kt in seven seconds

Between 16:02:13 and 16:02:15 the command given from the right-hand side to the NWS (Nose Wheel Steering) goes from 0 to -75 degrees (full right command against the stops). The evolution of the nose wheel angle until impact is consistent with that command. From 16:02:15 the magnetic heading of the aircraft begins to increase; it goes from 312 to 349 degrees in seven seconds.

The angle of the nose gear reaches 77 degrees right at 16:02:19 and remains at that value until the end of the recording. From 16:02:18 we can hear on the CVR severe vibration noises followed by impact noises.

The thrust levers did not move until 16:02:20 when they are retarded to the IDLE detent. The EPR values of the 4 engines start to decrease immediately afterward.

The longitudinal acceleration becomes significantly positive, indicating an aircraft deceleration, around 16:02:20.5

FDR recording ends between 16:02:21 and 16:02:22
CVR recording ends at 16:02:23

1.11 Information on the site and the wreckage

The aircraft was involved in a collision with the anti-blast wall located at the north side of the BIKINI ramp. It came to rest leaning on the wall, pointing to the north. The tail cone and the tip of the right wing were in contact with the ground. Only the right MLG was touching the ground.

The aircraft had struck the anti-blast wall at an angle of about 30 degrees. The underside of the forward cabin was torn over about fifteen meters and folded to the ground when passing the anti-blast wall.

The cockpit crashed to the ground north of the wall. The avionics bay containing most of the flight control computers, located under the cockpit, was completely destroyed.

Engine #1 and #2 hit the wall and were severely damaged. The #2 pylon was twisted. Engine #3 and #4 kept running after impact and did not stop immediately. It was not possible to shut them down, neither by activating the fire extinguisher handles nor by positioning the thrust levers on OFF. Water and foam spray on engine #4 managed to extinguish it at 18:48.

Due to the proximity of the wall this was not was not possible with engine #3 in a similar manner to engine #4. It shut down by itself only on November 16 at 01:25 after it had consumed all the fuel from its collector tank.

The NWG was broken and separated from the fuselage. The wheels were oriented to the right and had a steering angle close to the maximum value. The nosewheel tires had cuts in them, and showed marks of rubbing at right angles to the tread.

Ground tire traces

For the following descriptions, the distance reference is taken from the point of impact on the wall, and back along the aircraft trajectory.

A first tire trace, corresponding to one of the internal wheels of the right MLG, is visible starting at 120 meters over a length of approximately 10 meters. The trace of the external tires is present but less marked. Those traces are oriented along an axis with a magnetic heading of 330 degrees. No trace of the left MLG tires was observed.

At 83 meters, we can see the first NWG marks. They curve toward a northerly heading. They are initially parallel, then at 50 meters converge to leave only one single trace. By then, the NLG is no longer directional.

Symmetrical braking traces from both MLG are present from around 60 meters until the wall.

1.12 Medical and pathological information

The investigation did not highlight any medical anomalies likely to have deteriorated the capacities of the occupants.

1.13 Tests and research

Video camera

The recording of a video camera permanently filming the BIKINI area was reviewed. It shows the aircraft during the last test. At first the aircraft moves slowly then suddenly accelerates. While the path begins to slowly turn to the right, the NLG starts skidding sideways. The plane continues on its path until it hits the wall. The forward section rises, falls back on the wall and the fuselage breaks. There are flames at engines #1 and #2 as well as on the aft section of the aircraft.

By looking at the recordings from several days before the accident, it can be seen that some tests are carried out with wheel chocks and some others without.

Analysis of braking force and surface grip

The braking system of the aircraft has been modelized, in order to better understand the cause of the aircraft having started to move. The modelling uses the theoretical system functioning as described in paragraph 1.6 and is based on the values of the brake pressure parameters recorded by the FDR. The values of the EPR parameters of the four engines have also been used to determine the total thrust.

Braking force

For each of the braked wheels, the maximum braking force created by the brake pressure is determined based on the specification of the brakes, as a function of the recorded pressure. The overall braking force is obtained by summing the braking forces from the 12 wheels. When the parking brake alone is used, the brake pressure on the CLG wheels is zero and only the MLG wheels contribute to braking.

Slip resistance force

For each of the wheels, the value of the slip resistance is equal to the weight supported by the wheel multiplied by the friction coefficient μ between tire and tarmac. The simulation allows computation of the limit friction coefficient value below which the wheels would slip, under certain mass distribution assumptions. In the same way, the forces of slip resistance for each of the wheels are summed to obtain the overall slip resistance force.

Engine thrust

The thrust of the engines was calculated from the recorded EPR parameters and from manufacturer data, based on the day conditions (320 ft, nil speed, ISA -9C, no bleed air from engines). It stabilized at approximately 83500 daN.

Results

The model allows calculation of the theoretical changes in thrust and the maximum braking force developed by the braking system, and compare these to the slip limit force above which the wheels start to slip. For the aircraft to remain motionless, it is necessary that the thrust is less than both the maximum braking force developed by the system and the slip limit force.

Throughout the last test, the thrust of the engines and the maximum braking force on the parking brake are very close. To obtain under the same conditions a slip limit force equivalent to the thrust force, a friction coefficient μ of 0.687 is necessary. Given the measured friction coefficient values, it is reasonable to believe that the aircraft was quickly on the edge of slipping.

The fact that a balance, even fragile, has existed for about three minutes confirms that the brakes were functioning in accordance with their specifications.

Therefore, modeling has allowed to establish, with a reasonable confidence level, that during the last test the thrust and braking forces compensated each other, but that the balance of those forces was particularly precarious.

Thus, the aircraft remained motionless with 8 wheels braked through the parking brake, then started moving. Several factors may have contributed to the aircraft starting to move, notably :

- the vibrations created by the engines
- the reduction of weight due to fuel consumption (about 1270 kg)
- a slight local brake pressure reduction on one of the wheels

When the parking brake was released, the application of the brake pedals never allowed to attain the same level of braking action despite the fact that brakes were applied to 12 wheels. This is due to two factors: first, the actions on the brake pedals were not sustained at the maximum level, and, secondly, the action on the NWS very quickly led to inhibiting the CLG braking. The resulting braking during the motion varied between 65 and 95% of the braking level obtained before the aircraft movement.