ACCIDENT REPORT

ACCIDENT
occurred to the Airbus A320 aircraft
registration marks N-536JB
at Los Angeles international airport (LAX)
September 21st 2005

INDEX

1.1. HISTORY OF FLIGHT

On September 21, 2005, at 1818 Pacific daylight time, Jet Blue Airways flight 292, an Airbus A320, N536JB, landed at Los Angeles International Airport, Los Angeles, California, with the nose wheels cocked 90 degrees. Jet Blue Airways, Inc., was operating the airplane as a scheduled domestic passenger flight under the provisions of 14 Code of Federal Regulations (CFR) Part 121. The airline transport pilot licensed captain, first officer, 4 flight attendants, and 141 passengers were not injured. The flight departed Burbank, California, at 1531 as a non-stop to JFK Airport, New York, New York. Visual meteorological conditions prevailed, and an instrument flight rules (IFR) flight plan had been filed.

The first officer (FO) was the pilot flying. He noted no problems during the initial departure, and observed a positive rate of climb. Information from the digital flight data recorder (DFDR) indicated that after liftoff the gear handle was positioned to the up position.

The flight crew noted an error message displayed on the Electric Centralized Aircraft Monitoring (ECAM) system. There was a fault (L/G SHOCK ABSORBER FAULT) message for a nose landing gear (NLG) shock absorber.

The DFDR data then indicated that the gear handle was positioned to the down position. The crew then received an error message of a fault for the nose wheel steering (WHEEL N/W STRG FAULT). There was no master warning so the FO continued flying the airplane while the captain troubleshot the ECAM system.

The FO flew the airplane over Palmdale, California, at 14,000 feet mean sea level (msl) while the captain consulted the flight crew operating manual (FCOM) and maintenance control. The FCOM noted that the nose gear "may be caught at 90 degrees." The captain continued to evaluate the problem to ascertain the systems' status. The flight crew continually updated the cabin crew and passengers.

The flight diverted to Long Beach, California. The captain decided to perform a flyby of the tower for verification on the gear status. The tower, Jet Blue ground personnel, and a local news helicopter advised him that the nose gear was canted 90 degrees to the left. The captain stated that after discussing the situation with company representatives, he decided to divert to LAX because it had optimum field conditions, runway length, and a better emergency/abnormal support services. The crew flew for several hours to burn fuel so that they could land at a lighter weight.

The captain took note of the fuel burn to ensure that the center of gravity stayed within limits. The captain also advised the cabin crew that in the event that the nose gear collapsed, evacuation from the aft doors was not available so everyone would deplane from the forward exits. The flight crew advised the cabin crew to take the emergency procedures up to the point of egress, at which time the captain would advise the method.

Prior to touchdown, the captain announced "brace" and the flight attendants also transmitted "brace" over the public address system.

The captain flew the airplane for the landing. He touched down at 120 knots, and applied normal braking at 90 knots. He held the nose gear off of the ground as long as possible. At 60 knots, the flight crew shut down the engines. They did not use ground spoilers, reverse thrust, or auto braking. During the landing, the forward cabin crew could smell burnt rubber. The cabin crew remained at their stations as previously defined by the captain. The air traffic control tower confirmed that there was no fire, and the captain announced this to the cabin crew. After this notification, the passengers deplaned normally using an air stair.

Upon touchdown, the NLG tires rapidly deflated and tore apart, and both wheels were worn into the axle. During landing, the airplane's trajectory was not affected by the abnormal NLG configuration or subsequent tire destruction, and the airplane stayed on the runway centerline.

Maintenance personnel jacked the airplane up, and removed the damaged wheels. They installed a right nose wheel, and towed the airplane to a maintenance hangar.

1.2. INJURIES TO PERSONS

No one on board the airplane sustained an injury.

1.3. DAMAGE TO AIRCRAFT

Damage was limited to the NLG assembly.

1.4. OTHER DAMAGE

There was no damage to any objects other than the airplane.

1.5. PERSONNEL INFORMATION

1.5.1 Captain

The operator reported that the captain held an airline transport pilot certificate with ratings for airplane single-engine land, multiengine land, and instrument airplane.

The captain held a first-class medical certificate issued on August 12, 2005. It had the limitation that he must wear corrective lenses.

The operator reported that the captain had a total flight time of 10,829 hours. He logged 160 hours in the last 90 days, and 39 in the last 30 days. He had en estimated 2,552 hours in this make and model.

1.5.2 First Officer

The operator reported that the FO held an airline transport pilot certificate with ratings for airplane single-engine land, multiengine land, and instrument airplane.

The FO held a second-class medical certificate issued on April 19, 2005. It had no limitations or waivers.

The operator reported that the FO had a total flight time of 5,732 hours. He logged 254 hours in the last 90 days, and 94 in the last 30 days. He had en estimated 1,284 hours in this make and model.

1.6. AIRCRAFT INFORMATION

The airplane was an Airbus A320, serial number 1784. The operator reported that the airplane had a total airframe time of 14,227 flight hours and 5,098 landing cycles. It was on a continuous airworthiness inspection program. Maintenance records indicated that Jet Blue maintenance technicians replaced a proximity sensor on the nose wheel prior to the previous flight's departure from New York earlier that day.

1.6.1 NORMAL OPERATION

The landing gear (L/G) normal extension and retraction system is electrically controlled and hydraulically operated.

The electrical system has a landing gear control lever, two Landing Gear and Control Interface Units (LGCIU), a gear electro-hydraulic selector valve, a door electro-hydraulic selector valve, 32 proximity sensors and their related targets, and a set of indicator lights. The electrical control system has two subsystems; each is governed by a separate LGCIU. At any given time, one LGCIU is in CONTROL and the other is in MONITORING mode (while using the data from the respective proximity sensors).

The hydro-mechanical components include three gear actuating cylinders, three door actuating cylinders, three gear uplocks, three door uplocks, three door by-pass valves (ground opening function for the door), a NLG downlock release actuator, and two MLG lockstay actuating cylinders. For this airplane, the green hydraulic system provides hydraulic power to operate the landing gear.

Upon movement of the L/G control lever, the LGCIU sends a signal to the electro-hydraulic valve assembly. The proximity sensors send signals to the LGCIU, which ensures that the L/G operate in the correct sequence.

The NLG retracts forward into a bay in the fuselage, and centers fore and aft.

When the nose landing gear is in the retracted/uplocked position there is clearance around the wheels. Therefore, if the mechanical centering of the nose wheels fails, the wheels can rotate a certain amount (approximately 20 degrees) until they contact the roof of the NLG bay. Airbus tests have shown that, even with this amount of rotation, the gear will still achieve a free fall, so the gear will not jam in the bay. Following retraction on takeoff, if the nose wheels deviate from their mechanically centered position while in the landing gear bay, a L/G SHOCK ABSORBER FAULT caution light will illuminate.

There are a pair of proximity sensors and targets on the NLG that detect if the gear is extended (airplane in air) or if the gear is compressed (airplane on ground). The proximity sensors also indicate that the wheels are aligned fore and aft. If the wheels are not aligned, retraction is prevented. When the gear is fully extended (flight condition), the sensors detect the targets as near. When the NLG gear is compressed, the targets move away from the sensors (target far), setting the ground/compressed condition. However, a failure condition can exist that results in the NLG system sensing "ground/compressed" when the gear is extended and a mechanical failure allows the NLG wheel to rotate to a position greater than 6 degrees.

1.6.1.1 Brake Steering Control Unit (BSCU)

The Airbus model A320 airplane has a NLG steering system that is electrically controlled by the BSCU and hydraulically actuated by the steering control module and two steering actuators. When commanded from the tillers and/or rudder pedals, the BSCU computes and electrically sends steering commands to a servo valve, contained within the steering control module, to hydraulically position the nose wheel assembly to the commanded position. The BSCU receives electrical NLG position feedback signals from sensors installed on the NLG and from a sensor that monitors the position of the steering control module servo valve. When both the nose and main landing gear are extended with their respective doors closed, the nose wheel steering control module is energized and applies hydraulic pressure to the steering servo valve. However, hydraulic pressure will not be available to the steering control module until all gear doors are commanded closed. The BSCU also controls the parking brake and applies braking to the main wheels during landing gear retraction. The A320 features two types of BSCU standards, the CONVENTIONAL and the Enhanced Manufacturing and Maintainability (EMM), which is also called the COMMON.

The airplane had EMM/COMMOM BSCU software standard L4.5 (P/N E21327003) installed, which, as does standard L4.1, features a pre-landing dynamic steering test, as does the CONVENTIONAL BSCU. However, the EMM/COMMON BSCU and the CONVENTIONAL BSCU pre-landing steering tests are significantly different. While both the COMMON and the CONVENTIONAL BSCU essentially work the same way, the COMMON BSCU results in significantly more physical movement of the gear while trying to rotate the gear (in the mechanically centered locked position) during the pre-land test.

Once the BSCU receives a signal indicating that the NLG is down and locked, it starts monitoring the angular position of the NLG. It begins a series of five steering tests. After a brake test has been completed and hydraulic system power is available to the steering servo valve (nose gear down and locked and all gear doors are commanded closed), the BSCU starts the steering test. After the first four test sequences are completed, the EMM/COMMON BSCU (Std L4-1 and L4-5 only) electrically commands the NLG wheel assembly to rotate 2.5 degrees left from center, back to center, 2.5 degrees right, then back to center. This cycle takes approximately 5.0 seconds to complete, and is continuously performed until touchdown of the main gear assembly. According to information provided by Airbus representatives, the NLG completes the left and right cycle an average of 57 times per flight. The CONVENTIONAL BSCU on the other hand applies a 10-degree rotation command for only 0.5 seconds, which achieves a pulse movement up to 1 degree.

After the landing gear is selected down, and 1 second after the NLG is down and locked, the BSCU determines the position of the NLG wheel assembly. If the BSCU detects that the NLG has deviated out of its mechanically centered 0-degree position, it will attempt to center the NLG. It electronically commands the servo valve to reposition the NLG wheel assembly to center. If the BSCU does not receive a position feedback response indicating that the servo valve moved as commanded, the BSCU will continue to monitor the servo valve position for 0.5 second. If there is still no response, the BSCU shuts off hydraulic pressure, and nosewheel steering is not available. The NLG cannot be moved without hydraulic pressure. Failure of the NLG to center initiates a WHEEL N/W STRG FAULT caution on the ECAM.

1.6.2 NLG ASSEMBLY

The nose landing gear assembly consists of a shock absorber in the barrel of the NLG leg structure, and its lower part consists of the wheel axle. It absorbs the landing shock and dampens oscillations when rolling. The upper part of the shock absorber is attached to the barrel of the landing gear leg. Wheel centering takes place at the end of the shock absorber extension phase by means of two centering cams on it.

On top of the NLG leg is an upper support assembly. A pair of anti-rotation lugs on top of a shock absorber inner cylinder mesh with slots on the upper support assembly. When engaged with the anti-rotation lugs, the upper support assembly lugs assist in connecting the NLG shock absorber to the NLG leg structure. They are intented to maintain the proper relationship between the shock absorber and the leg assembly in the longitudinal axis.

1.7. METEOROLOGICAL INFORMATION

Day visual meteorological conditions prevailed; the winds were from 250 at 8 knots.

1.8. AIDS TO NAVIGATION

The airplane flew an approach into Los Angeles International.

1.9. COMMUNICATIONS

The airplane was in contact with Los Angeles Air Route Traffic Control Center (ARTCC) Center, Southern California Terminal Radar Approach Control (SCT), the Long Beach airport air traffic control tower (ATCT), and the Los Angeles ATCT.

1.10. AIRPORT INFORMATION

The Airport/Facility Directory, Southwest U. S., indicated that Los Angeles International runway 25L was 11,096 feet long and 200 feet wide. The runway surface was concrete.

1.11. FLIGHT RECORDERS

1.11.1 A Safety Board specialist examined the DFDR, and prepared a factual report. Pertinent parts of the report follow.

The landing gear handle was positioned to the up position within a few seconds of the main gear leaving the ground. About 6 seconds later, which was 25 seconds after the nose gear squat switch first indicated AIR, the switch indicated GROUND for about 11 seconds. It returned to AIR for 2 seconds, and then indicated GROUND for the remainder of the flight.

1.12. WRECKAGE AND IMPACT INFORMATION

The airplane sustained minor damage when the tires deflated and tore apart. The nose wheels ground down into the axle.

1.13. MEDICAL AND PATHOLOGICAL INFORMATION

There were no injuries.

1.14. FIRE

Flames from runway contact flared each time the airplane's cocked nose wheel passed over a paint stripe on the runway centerline. The wheel assembly was scorched.

1.15. SURVIVAL ASPECTS

The cabin crew detected something out of the ordinary immediately after takeoff. They began to reference their manuals as they waited for information from the flight crew.

The captain communicated with the cabin crew and passengers. The cabin crew emptied the first three rows of seats, and moved baggage as far aft as possible. They placed able-bodied persons in the exit rows, and removed all baggage and paperwork from the seating area. They showed the able-bodied persons how to operate the doors, and gave additional instructions.

The lead flight attendant placed the in flight entertainment (IFE) master switch in the standby mode, which muted the audio sound and disabled the visual picture. She disabled the system entirely the last 50 minutes of the flight. The cabin crew provided blankets, pillows, water, and non-alcoholic beverages to the passengers.

The flight attendants spoke to the passengers individually prior to the landing to ensure that each one knew the emergency procedures that would take place and how to properly brace. The flight attendants checked and double-checked each other's work to ensure that everything was completed and would go according to plan.

JetBlue's policy did not allow use of personal electronic devices below 10,000 feet. However, they briefly allowed the passengers to call family members on cell phones while the airplane was at 6,000 feet. They instructed passengers to stow them and other personal belongings for the landing.

The cabin crew remained at their stations as previously defined by the captain, until he sent word that there was no fire. After this notification, the passengers deplaned normally through the L1 door to air-stairs brought to the airplane.

1.16. TESTS AND RESEARCH

1.16.1 BSCU

A post flight readout from the BSCU indicated 6.5 degrees for the NLG, which meant that the NLG was beyond 6.5 degrees from the centered position. It recorded two faults: at 1531, the L/G SHOCK ABSORBER FAULT, and at 1532, the WHEEL N/W STRG FAULT. Examination of the nose wheel assembly with a borescope revealed fractured and separated anti-rotation lugs.

1.16.2 NLG Upper Support Assembly Examination

A Safety Board metallurgist and a systems engineer supervised the examination of the NLG assembly at Messier Services, Sterling, Virginia. The examination of the NLG assembly revealed that two of the four anti-rotation lugs on the NLG upper support assembly had fractured and separated from the upper support assembly. The other two lugs contained cracks. A summary of the metallurgist's findings follows.

1.16.2.1 Materials Laboratory Report on Upper Support Assembly

The metallurgist arbitrarily labeled the fractured upper support assembly lugs one through four.

Bench binocular microscope examination of lug number one revealed that its fracture face contained ratchet marks (radial lines), typical of a fatigue crack. The fracture originated within the radius between the slot side of the lug and the lower surface of the upper support, near the inner diameter of the upper support. The fatigue crack propagated through more than 95 percent of the fracture face.

The fracture face of lug number two contained ratchet features (radial lines) typical of a fatigue crack. The fatigue crack propagated through more than 95 percent of the fracture face. For the most part, the last 5 percent of the fracture length showed ductile dimple features typical of overstress separation.

The contour of the crack at the base of lug number three was similar to the contour of the fracture path on lugs one and two. The fracture face contained crack arrests features typical of a fatigue crack.

The crack at the base of lug number four measured approximately 0.1 inch; the metallurgist did not excise it for examination.

1.16.3 Tests

The systems group chairman supervised examination and testing of the LGCIU's landing gear control lever, and the BSCU. The following paragraphs detail the results.

1.16.3.1 LGCIU (Landing Gear Control Interface Unit)

The internal BITE data from both LGCIUs was downloaded and analyzed; no faults were found. Functional and acceptance tests were conducted on each unit; the testing revealed no anomalies.

The landing gear control lever was also tested and found functional.

1.16.3.2 NLG Wheel Steering tests

The purpose of the test was to find the root cause of the steering anomaly detected by the airplane's BSCU. Data retrieved from the unit indicated that a WHEEL N/W STRG FAULT was displayed on the ECAM and failure code 671 was triggered and recorded by the BSCU internal memory (BITE). This fault code is triggered when the BSCU detects that the steering servo valve spool does not move. Testing was conducted to help understand why the servo valve spool did not move, preventing the BSCU from returning the nose wheels to the centered position.

The steering tests were performed on an Airbus test rig using the BSCU and hydraulic control unit 6GC from airplane N536JB. The testing verified that when hydraulic pressure was available to the unit, the BSCU automatically moved the nose wheel assembly from a position greater than 6.5 degrees to its mechanically centered position without triggering any fault code.

The testing also indicated that when hydraulic pressure was not available to the unit, the BSCU would not automatically move the nose wheel assembly from a position greater than 6.5 degrees to its mechanically centered position and fault code 671 would be triggered.

Testing also verified that when the BSCU was reset and hydraulic pressure was available, it was able to automatically move the nose wheel assembly from a position greater than 6.5 degrees to its mechanically centered position, and steering was recovered. Fault code 671 remained stored within the BSCU's bite to assist maintenance troubleshooting.

1.17. ADDITIONAL INFORMATION

CORRECTIVE ACTIONS

Airbus issued Operations Engineering Bulletin (OEB) 175-1 (post Flight Warning Computer standard E3) and OEB 176 (Flight Warning Computer standard E2) in October 2005. This provided a procedure for the flight crew to reset the BSCU in flight. It discussed steps to take if the L/G SHOCK ABSORBER FAULT ECAM message was triggered at any time in flight and the WHEEL N/W STRG FAULT ECAM caution light illuminated after landing gear extension. Under those conditions, it noted that the flight crew could reset the BSCU when all landing gear doors indicated closed on the ECAM WHEEL page. Successful NLG centering and nosewheel steering recovery would be indicated if the WHEEL N/W STRG FAULT ECAM light was no longer illuminated. FAA AD 2005-24-06 and EASA AD 2006-0174 were subsequently issued to perform a NLG shock absorber charge pressure check and a repetitive borescope inspection of NLG upper support/cylinder lugs to mitigate the fatigue cracks that were induced by the BSCU Standard L4.5 (or earlier EMM standards). Furthermore, FAA AD 2007-18-19 was issued to supersede FAA AD 2005-24-06 and defines the related investigative/corrective actions referencing Airbus SB A320-32-1310. The SB A320-32-1310 introduces a modified and more robust upper support. The FAA AD 2007-18-09 also provides optional terminating action for repetitive inspections.

RETROFIT

Airbus issued new software standards L4.8 (sb a320-32-1305) and L4.9B that cancelled OEBs 175 and 176. BSCU standard 4.8 reduced the number of pre-landing test cycles to eight per flight, which they felt reduced the likelihood of fatigue. Standard 4.9B has no effective pre-landing test cycles to induce fatigue. Airbus made a design change to the upper support assembly and provided specific inspection requirements at NLG overhaul. They consider those changes plus incorporation of Standard 4.9B to be terminating action for this issue.