Learjet 45, G-OLDC

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INCIDENT

Aircraft Type and Registration:	Learjet 45, G-OLDC
No & Type of Engines:	2 Honeywell TFE 731-20AR turbofan engines
Year of Manufacture:	2001
Date & Time (UTC):	15 March 2002 at 1745 hrs
Location:	North west of Rome Ciampino Airport, Italy
Type of Flight:	Public Transport
Persons on Board:	Crew - 2 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	9,000 hours (of which 250 were on type) Last 90 days - 180 hours Last 28 days - 60 hours
Information Source:	AAIB Field Investigation on behalf of the Italian authorities

History of the flight

The commander's report indicated that the aircraft departed from Rome Ciampino Airport, Italy, at 1735 hrs for a flight to Leeds-Bradford Airport, UK, with the commander as the handling pilot. After the landing gear and flaps were retracted, the commander found that the Autopilot would not engage. He therefore flew a manual Standard Instrument Departure by reference to the aircraft's Flight Management System. An Autopilot (AP) red indication remained on the Primary Flight Display (PFD) until the aircraft levelled off at FL280, whereupon it extinguished. A Rudder Boost (RB) caption was also displayed, indicating that the rudder boost system was inoperative. However, the RB system is normally only active whenever the flaps are selected to a position in excess of 3°.

After approximately 10 seconds in level flight, the aircraft began to 'Dutch Roll', with the aircraft "fishtailing" apparently uncontrollably. The commander reduced thrust and partially extended the spoilers to 15°, but this did not initially correct the problem.

The crew declared an emergency with Rome ATC and requested radar vectors to the nearest suitable airport. Rome Fiumicino Airport was suggested, which the commander accepted. The aircraft made a descending turn, which the commander described as being "hard to control". He also commented that the ailerons felt "spongy".

The commander reported that once the aircraft's speed had reduced, with flaps 20° and landing gear down, the aircraft became easier to control and the subsequent landing was uneventful at 1823 hrs.

The commander did not consider that the initial onset of 'Dutch Roll' was provoked by a wake turbulence encounter.

A company employee who travelled on the same aircraft on 11 March 2002 also reported that the aircraft had an uncomfortable tendency to 'Dutch Roll' and noted that the Autopilot seemed to "stick" when changing heading and could be quite "jerky".

Flight Data Recorder

Initial reports relayed from the crew indicated that excessively large bank angles had been observed during the 'Dutch Roll' event. The DFDR data was replayed but the reported excessive bank angles were not confirmed. Instead, the recorded data indicated that the bank angle was about ±5° during the 'Dutch Roll' event, which lasted for about 4.5 minutes in total. The onset of 'Dutch Roll' occurred as the aircraft reached FL280 at about 275 kt. It continued until the aircraft was descending through approximately FL180 at about 280 kt, with the spoiler lever selected to the fully extended position, and with the spoilers deflected to about 38°, in accordance with the automatic spoiler limiting speed schedule. The maximum bank angle recorded during the event was slightly in excess of 30°, while the aircraft was in the turn to the left as it commenced the diversion towards Fiumicino.

No attempt was made to re-engage the Yaw Damper after the onset of the 'Dutch Roll'.

Engineering investigation

A post-incident examination of the aircraft was carried out by a Field Service representative from the aircraft manufacturer. Uncommanded spoileron (spoiler/aileron) movement was eliminated as a possible cause at an early stage, as was flight control surface damage.

Fault codes were identified by examination of the relevant Autopilot computer, model number IC-600, part number 701700-82220, serial number 01044226. The fault codes logged were references 0226, 0268, 0269 and 9110.

As the aircraft was equipped with two IC-600 Autopilot computer units, the faulty unit was transposed with the remaining serviceable unit and the aircraft was inspected and certified as fit for a non-revenue ferry flight back to the UK, below FL240. The aircraft was then ferried back to its base without incident. On arrival, the faulty IC-600 unit was removed and sent to the component manufacturer for testing. Meanwhile, the operator conducted a comprehensive engineering assessment, replaced the faulty IC-600 unit and then conducted a flight test. Despite all attempts to induce 'Dutch Roll' up to FL410, with and without Autopilot and Yaw Damper engaged, no unusual flight characteristics could be replicated.

As a precautionary measure, the rudder servo and yaw force interface units were changed and the aileron gap seals were cleaned. The aircraft was then put back into service with no further recurrence of the problem.

IC-600 Examination

Bench testing of the defective IC-600 unit was undertaken at the component manufacturer's factory in the USA. After a few hours of operation, the Autopilot, Yaw Damper and Rudder Boost functions all appeared to be operating normally.

The fault codes logged by the unit during the incident flight were explained as follows:

0226 Trim runaway monitor - the recurrence of this code was a known problem with pre-modification phase III units (as fitted to G-OLDC). The time stamp of this occurrence coincided with the initial attempt at Autopilot engagement just after takeoff.

0268 Internal IC600 WOW (weight on wheels) monitor trip. This code was recurrent on all pre-modification phase III units and was considered not to be a true fault indication.

0269 Rudder Boost Internal Monitor. The time stamp of the occurrence of this code did not make it clear when this event occurred, but is consistent with the loss of Rudder Boost and the appearance of the RB Inoperative message reported by the crew. It is considered that this could have happened coincident with the Autopilot failure, but no confirmatory evidence was recorded on the DFDR.

9110 Yaw Axis Simulator within the IC-600 detected a fault condition. This was considered to be consistent with the rapid rudder pedal movement during the 'Dutch Roll' event.

In summary, the component manufacturer concluded that the Autopilot failed initially at the time of the first attempted engagement after takeoff. The Yaw Damper and the Rudder Boost have separate control laws using identical mechanisms to move the rudder. Their independent software operations are closely monitored by independent monitors in the IC-600. However, a failure in one system does not necessarily result in a loss of the other. The DFDR data did indicate that a loss of positive yaw damping occurred at the point when the 'Dutch Roll' began. There was no means available to indicate exactly how the Yaw Damper failed.

One possibility was the inadvertent pressing of the 'Instinctive Cut-out' button on the control column in order to remove the red 'AP' caption on the PFD, which would also have had the effect of disengaging the Yaw Damper. The manufacturer assessed that re-engagement of the Autopilot and yaw damper would have been possible, given the fault codes logged within the IC-600 unit.

The operator indicated that, with the Yaw Damper disengaged, the aircraft has a known tendency to 'Dutch Roll' when operating above approximately FL250, once disturbed from steady flight, such as would be the case in the event of a wake vortex or clear air turbulence encounter causing a lateral disturbance. The 'Dutch Roll' could have been prolonged by the attempted corrective manual aileron inputs applied in such circumstances.

The aircraft manufacturer indicated that above FL330, the aircraft does not positively damp, but neutrally damps any yaw tendencies, such that the Yaw Damper is required above FL330 to provide positive yaw damping. However, the manufacturer did find that some rudders did not provide positive damping throughout the flight envelope and, as a result, a revision to the Aircraft Flight Manual was issued that required the Yaw Damper to be engaged through all flight regimes except for takeoff and landing. In addition, Service Bulletin 45-55-6, approved in October 2002, modified the rudder and lifted the Yaw Damper requirement for any altitude.