Lockheed L1011-500 Tristar, CS-TMP

AAIB Bulletin No: 10/2004	Ref: EW/C2003/08/04	Category: 1.1
Aircraft Type and Registration:	Lockheed L1011-500 Tristar, CS-TMP	
No & Type of Engines:	3 Rolls-Royce RB 211-524B turbofan engines	
Year of Manufacture:	1983	
Date & Time (UTC):	19 August 2003 at 1106 hrs	
Location:	Runway 23 at Stansted Airport, Essex	
Type of Flight:	Public Transport (Positioning)	
Persons on Board:	Crew - 13	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Scoring and deformation to underside of aft fuselage, damage to No 2 engine translating cowl and hot stream duct	
Commander's Licence:	Airline Transport Pilot's Licence and Type Rating Instructor	
Commander's Age:	54 years	
Commander's Flying Experience:	11,300 hours (of which 1,200 were on type)	
	Last 90 days - 60 hours	
	Last 28 days - 28 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The accident occurred during an automatic landing at Stansted when the rear of CS-TMP struck the ground on landing. The recorded airspeed on touchdown was 120 kt, while the calculated V_{ref} was 145 kt. During the final stages of approach, the Auto Throttle System was inoperative but the crew did not detect the consequent diverging parameters of aircraft attitude and airspeed.

Background

The aircraft left Lisbon Airport at 0845 hrs for a positioning flight to Stansted to pick up passengers for an onward flight. The positioning flight was being used for a final line check to upgrade a company pilot to commander.

The pilot being upgraded was seated in the left cockpit seat. He was the holder of a current Airline Transport Pilot's Licence and had a total of 5,700 hours flying experience, of which 1,800 hours were on type. The designated commander for the flight was seated in a jump seat directly behind the left-seat pilot. The pilot in the right cockpit seat was the holder of a current Commercial Pilot's Licence and had a total of 337 hours, of which 37 hours were on type; she had completed her company training. An experienced flight engineer was also in the cockpit seated at his usual position.

There were no significant defects recorded in the aircraft Technical Log. Initially, the crew stated that no unserviceabilities had been noted pre-flight or during the flight prior to the ILS approach. Later, it was reported that Autopilot (A/P) 'A' had failed at least one pre-flight check. It was checked during the flight and, although it appeared to work correctly, the crew decided to use A/P 'B' for the cruise. There was no reference to this in the aircraft's technical log, either before or after the accident.

As part of his command upgrade, the left-seat pilot was required to complete a Category II Autoland and he briefed the crew for this approach before commencing descent towards Stansted Airport.

Accident flight

Prior to the approach, the crew received ATIS information 'Tango' timed at 1050 hrs. This indicated that Runway 23 was in use with the following weather: Surface wind 260°/ 08 kt variable between 220° and 290°; visibility greater than 10 km; cloud BKN 5,000 feet amsl; temperature 21° C/ dew point 6° C; QNH 1020 hPa.

The following sequence of events has been derived from information provided by the crew and data from the FDR.

During the transit, A/P 'B' had been engaged and, after the 'Approach' mode had been armed, A/P 'A' was also engaged. The aircraft was fully configured with the gear down and with Flap 33 prior to glideslope capture. By 3,000 feet amsl, CS-TMP was fully established on both the localiser and glideslope. The AutoThrottle System (ATS) was already engaged and the speed appeared steady at approximately 150 kt; V_{ref} had been calculated as 145 kt. In accordance with company procedures, at 1,500 feet amsl, the first officer called "Approach and landing, I have control". Then, at about 400 feet radio height, A/P 'A' disengaged and an amber 'NO DUAL' annunciation was displayed on the Avionic Flight Control System (AFCS) warning panel in front of each pilot.

The commander instructed the crew to re-engage A/P 'A' and this was done successfully. Around this time, the flight engineer called "three hundred feet". Then, at the decision height (DH) of 100 feet, the flight engineer called "Decide" and the left-seat pilot responded with "Landing, I have control". At 50 feet radio height, the first officer saw 'FLARE' displayed on the AFCS Mode Panel and called this out. At about this time, the left-seat pilot felt the thrust levers retard. The commander's impression was that the aircraft flared as normal but that the flare continued past the normal landing attitude of about 7° nose up. Touchdown was firm and the commander heard a 'metallic' noise from the rear of the aircraft. At about this time, the A/Ps disconnected, the left-seat pilot lowered the nosegear to the runway and then selected reverse thrust on all three engines. On the landing roll, the crew were advised on R/T that the tail of the aircraft had struck the runway on landing. Once clear of the runway, the aircraft was stopped to allow the Airport Fire Service (AFS) to review the damage. The AFS then followed the aircraft to its assigned parking area.

An aircraft had been cleared to line-up once CS-TMP had landed. The commander of this aircraft subsequently stated that CS-TMP appeared to be in the landing attitude at about 50 feet agl and that the nose attitude continued to increase until the point of touchdown. He considered that the aircraft landed in a three-point attitude with the tail and the main gear touching the runway simultaneously.

Flight data recorder information

The aircraft was fitted with a Flight Data Recorder (FDR)[1] capable of recording a range of flight parameters on a continuous 25-hour tape loop whenever power was applied to the aircraft. Analysis of the FDR data for this accident was made difficult because, for each flight recorded, the FDR only started receiving data late into the climb or during the cruise portion of the flight, and therefore did not record any takeoffs[2]. The aircraft was also fitted with a Cockpit Voice Recorder (CVR)[3] which recorded crew speech and area microphone inputs on a continuous 30-minute tape loop whenever power was applied to the aircraft. The 30 minutes duration was, however, insufficient to capture the approach and landing phases of the accident flight because it had been overwritten with more recent information after the landing, while the aircraft was stationary on the ground with electrical power on.

A time history of the relevant parameters during the landing at Stansted is shown in Figure 1. From this figure, it can be seen that A/P 'B' was already engaged when A/P 'A' was selected during the descent, at about 3,750 feet amsl, just under 5 minutes before touch down. No other distinct A/P mode discrete parameters, such as ATS or Approach/Land Mode, were available on the FDR. At A/P 'A' engagement, the localiser and glideslope deviation signals become active shortly followed by changes in the engine pressure ratios (EPRs), which had remained fairly constant at values between 1.02 and 1.05, for the previous 100 seconds. These changes in the EPRs were consistent with the ATS being active.

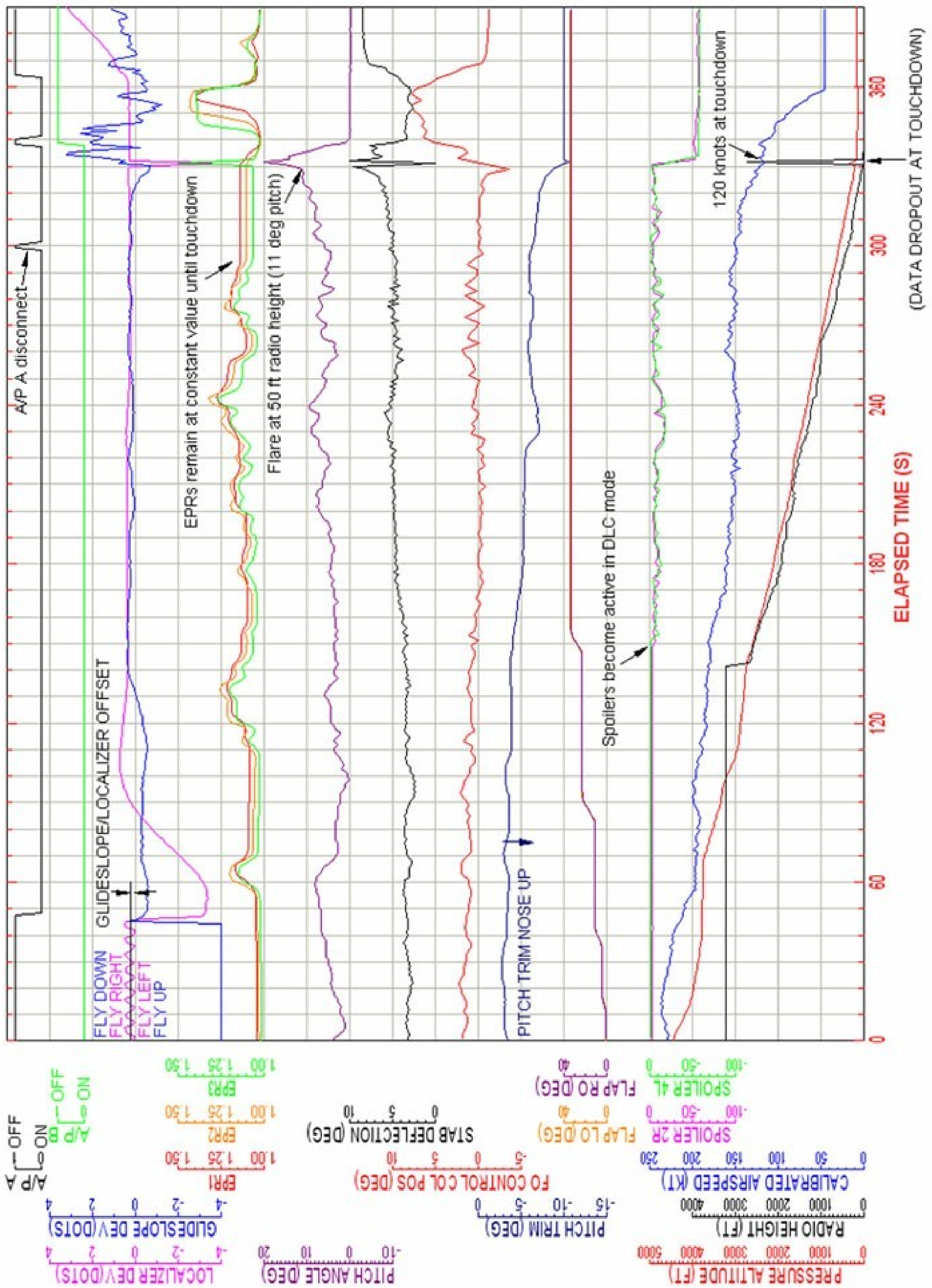
Figure 1 Salient FDR Parameters

[1] Lockheed 209F FDR: *Part Number 10077A500, Serial Number 2524.*

[2] Takeoffs are important as they enable many recorded parameters to be calibrated or verified against known or expected values: eg calibrating or verifying control wheel movement against control surface deflection.

[3] Fairchild A100A CVR: *Part Number 93-A100-80, Serial Number 55562.*

Figure 1



Salient FDR Parameters
(Accident to CS-TMP on 19 August 2003 at Stansted Airport)

Just over three minutes before touchdown, at 2,750 feet amsl, the aircraft was established on the localiser and glideslope with gear down and Flap 33. As Flap 33 was reached, spoilers 2 and 4 were seen to move and vary around 7° deflection, consistent with the Direct Lift Control (DLC) mode becoming active. The final approach was carried out at about 150 kt, 5 kt above V_{ref}, at a descent rate of approximately 800 ft/min. The pitch attitude during the descent averaged 6° nose up varying ±3° about this value to maintain the glideslope. Throughout the descent, the EPRs varied almost continuously with changes in aircraft pitch attitude. There were however several periods of up to 10 seconds duration, where the EPRs were constant, which corresponded to when the aircraft was on or above the glideslope.

At about 30 seconds prior to touchdown, 350 feet agl, A/P 'A' disconnected and then re-engaged. From this point, the three EPRs remained fixed at values between 1.06 and 1.14 and remained at these values until touchdown. (Five seconds prior to this point, the EPRs were already at these values, following a period where the aircraft was on or above the glideslope.) Thereafter, the aircraft pitch increased, the airspeed reduced and there was an increasing divergence below the glideslope.

At 50 feet agl, four seconds before touchdown, the pitch attitude was 11° nose-up and the airspeed was 128 kt. At touchdown, the aircraft pitch attitude was in excess of 15° nose up and the recorded airspeed was 120 kt.

Air Traffic Control aspects

The crew had not informed Stansted ATC that the aircraft would be performing an autoland, so enquiries were made to ascertain whether the aircraft had been subjected to outside influences during the approach. Runway 23 ILS had last been flight checked successfully on 19 May 2003 and no indication of unserviceability was highlighted during the time of the accident. Since the time of the flight check, no work had been carried out within the ILS protected area. The airport had recently introduced new Cat I holding positions for aircraft waiting to depart. However, the aircraft which had been cleared to line up after CS-TMP had landed, was holding at 'R3', the Cat III holding position. Additionally, the crew of CS-TMP, which had landed some 1 minute 50 seconds after another aircraft had taken off, reported that their cockpit ILS indications appeared normal during the approach, and so it was unlikely that the ILS had been affected by the presence of another aircraft. Other crews subsequently making approaches also reported the ILS as serviceable. Immediately following the accident, ATC checked and confirmed that no vehicles had been within the protected area.

Operational information

The company L1011-500 Tristar aircraft was cleared to Cat II/ III operations as a 'Fail Operational' system. The company operational procedure manuals included the following information:

1. *'The L-1011 500 airline policy requires that during CAT II/ III approach the captain (left-seat pilot on this flight) monitors the approach and takes the decision to land or overshot at DH'.*

2. *'The First Officer has the task of flying the approach using maximum auto flight capability to make the appropriate call outs and to go-around if the decision of overshoot is made at or before the DH/100 ft RA (Radio Altitude)'.*

3. *'The Flight Engineer cross checks and monitors the appropriate systems and makes the decision call out'.*

4. *'It has been established 300 feet AAL as the altitude down to which, upon detection of an abnormal operation or system failure, subsequent actions can be taken and decision to continue with the approach, revert to a higher DH or overshoot the approach can be made.'*

5. For a CAT II automatic landing, one A/P and one Flight Director (F/D) with dual display was required.

6. For a CAT II automatic landing, the ATS was not required.

7. At Approach/ Land (A/L) on the AFCS Mode Panel, the right-seat pilot was required to call *'Approach and Land engaged. I have control'*; the left-seat pilot was required to respond with *'You have control. I have communications.'*

8. At 300 feet AAL (above airport level), the flight engineer was required to call 'Three hundred'; no response was required.

9. At DH CAT II, the flight engineer was required to call *'Decide'*; with the required visual references, the left-seat pilot should respond with *'Land'* and take the handling duties.

10. The company procedures recommended the use of both autopilots but, if one was inoperative, an autoland could be made to CAT IIIA limits.

Within the company manuals, there were no specific instructions for crew monitoring duties during an autoland. However, the company training personnel stated that, following the call of "300" by the flight engineer, the right-seat pilot's priority was to monitor the flight parameters; the priority for the left-seat pilot was to look outside for the required visual references. Once the decision to land was called by the left-seat pilot, he/she would take the handling duties while maintaining outside references. The right-seat pilot would also monitor the 'FLARE' and 'ROLLOUT' annunciations and call them as appropriate. Throughout the approach, the flight engineer would monitor the flight and system instruments.

In the company Quick Reference Handbook (QRH), there was a list of *'Autopilot Warning and Pilot response in Approach/Land Mode'*. The appropriate response to a display of 'NO DUAL' was for the crew to continue the CAT II approach. There was also a response required *for 'AP Disc and Wailer'*. The 'Wailer' would only sound if both A/Ps disconnected or if only one A/P had been engaged and disconnected. Below 300 feet, the crew were to overshoot but above 300 feet, the crew were to *'Attempt to re-engage A/P and if normal continue CAT II'*.

During the CAT II approach to Stansted by CS-TMP, the crew reported that the disconnection of A/P 'A' resulted in the display of 'NO DUAL' and a flashing 'ALERT' light on the two AFCS Warning Panels, but no 'Wailer'. A single press of one of the 'ALERT' lights would have cancelled both lights but the 'NO DUAL' displays could only be cancelled by reselecting A/P 'A', disconnecting the other autopilot or engaging the Go-Around mode; in this case, the 'NO DUAL' displays were cancelled by the reselection of A/P 'A'. On CS-TMP, the engagement status of the A/P was determined by visual reference to the engagement handles position located in the glareshield panel in front of the pilots and by monitoring of the correct control response. The second autopilot could only be engaged once the A/L mode had been selected.

The engagement status of the ATS was determined by a light in the ATS selector push button located in the glareshield panel and by monitoring of the correct throttles response. The ATS could be manually disconnected by either pushing the illuminated selector push button or by using one of the disconnection buttons on the outside of the No 1 and No 3 throttle levers. Any of these actions would cause the illumination of the flashing 'ALERT' light on both of the AFCS Warning Panels and an 'ATS DISC' annunciation on the same panels (directly to the right of the 'NO DUAL' annunciation). An 'ATS DISC' annunciation could be cleared by a double press of either an 'ALERT' light or a throttle disconnect button.

Engineering examination

Preliminary examination

Runway 23 at Stansted Airport is in excess of 2,400 metres, and so the touchdown zone, which extends from 150 metres to 900 metres from the runway threshold, contains an aiming point marker 400 metres from the same threshold. The aiming point is essentially where the ILS glide slope intersects the runway. An assessment of the geometry of the ground markings and external aircraft damage was consistent with a tail-strike having occurred, and indicated that ground contact with the rear fuselage took place at a pitch angle in excess of +17°. The evidence of a fresh tailstrike on the runway, close to the centreline and the Runway 23 designator numbers, was located more than 300 metres short of the aiming point.

The damage to the aircraft extended aft from the region forward of the APU access doors, and included the lower face of the No 2 engine bypass duct translating cowl and the corresponding surface of the No 2 engine hot stream exhaust duct at the extreme rear of the aircraft. A number of external protuberances were damaged or completely separated. (Note: that the -500 Series L-1011 was not equipped with a tail bumper.) The tips of the horizontal tail surfaces were not damaged.

On initial examination of the aircraft, it was noted that the Flight Information Data System (FIDS) had recorded several events, one of which was recorded as a code of *'24-20'*. This indicated *'No Dual Auto-Pilot, Pitch Servo, Servo Comparison, 0 Kft, 150 Kt, Lwd 2 deg, 30 deg Flap, A/L Track'*. The flight condition described is understood to refer to the speed and height bands in which the logged event occurred.

A preliminary check of the aircraft was carried out shortly after the accident by company personnel in the presence of the AAIB. This included checks of the flight controls, pitch and roll control systems disconnect, flap extension tests, Direct Lift Control (DLC) and auto-ground spoiler (AGS) tests, A/P and autoland tests (using a Nav/Comm test set), stall warning systems, Inertial Navigation Systems (INS), pitch control operation and AFCS test. None of the above revealed any problems, with the exception of the AFCS test, which identified an 'accelerometer 1 first fail' at the right outboard wing position.

Examination of the accessible structure in the region of the No 2 engine and the rear pressure bulkhead revealed no evidence of major damage. To fully evaluate the structural condition of the engine mounting and the pressure cabin, however, would have required removal of the engine and of a large number of components in the rear equipment bay. In, addition, the long-term viability of the No 2 engine after a tail-strike could not be assessed in situ. The aircraft was then authorised by its National Authority for a two-engine, un-pressurised ferry flight to a contracted repair base, but with the centre, No 2 engine, at idle thrust throughout. The destination/repair base chosen was Amman in Jordan. The distance was such that at the low flight level and reduced take-off weight dictated by the flight restrictions, a number of sectors were required. The fuel consumption proved to be such that on the last of these sectors it was necessary to shut down the No 2 engine completely.

Subsequent aircraft rectification

It was reported that following arrival in Amman, the No 1 Flight Control Computer (FCC) was removed on the advice of Lockheed-Martin (the aircraft manufacturer) and forwarded to Rockwell-Collins (the equipment manufacturer) for testing. It arrived at the manufacturer on or about 20 October 2003. A full acceptance test of the unit was subsequently carried out, including temperature cycling. No faults were detected. During the repair of the aircraft in Amman, Inspection Discrepancy Sheets were raised, with certain examples being forwarded to the AAIB. These showed that the No 1 autopilot did not engage when the full Auto-Flight Systems check (known as the Gold Wire test) was carried out on 13 November 2003. They note that the No 1 FCC was then changed. The Gold Wire test was repeated and no fault was found. The replacement FCC fitted was itemised as the unit previously forwarded to Rockwell-Collins for test.

The discrepancy sheets also showed that a series of checks of the thrust levers micro-switches, carried out between 13 and 18 September 2003, revealed intermittent operation/mis-setting of the ATS reverse-thrust interlink micro-switch, apparently on one of the thrust levers. This was adjusted, tested and then found to be operating correctly.

On completion of repair and return to service, the aircraft was reportedly experiencing a number of problems. These included periodic disconnection of the auto-throttle on reaching flight idle (with apparently, on occasions, no disconnect indication displayed) and inaccurate vertical guidance (fly down indication) from the flight directors during ILS approach(es). These returned to correct indication as the threshold was reached. The aircraft was also reportedly having problems with the AGS system during landing.

On 6 January 2004, the aircraft was ferried to a contract maintenance company in Abu-Dhabi for a Check A to be carried out. Prior to this process, Air Luxor engineers had found wiring damage within the F/O control wheel and similar damage was suspected in the corresponding wiring on the Captain's wheel. The damaged wiring in the F/O control wheel was replaced by the operator. During the Check A, this area on the Captain's wheel was examined but no fault was found. The wiring in question was part of the Autopilot Flight Director System, APFDS, a subsystem of the AFCS.

The Spoilers Actuating Cable, part of the Flight Control Electronic System (FCES), also a subsystem of the AFCS, was found almost broken. This cable connects the spoiler handle to the DLC servo and was found to be causing the system to fail due to high friction. After cable replacement, the problems with the DLC/AGS appeared to cease. Additionally, one of the No 1 throttle lever switches, understood to be the reverse-thrust interlock switch, was found to be out of adjustment. This was re-set in accordance with the maintenance manual.

On completion of the Check A and associated rectifications, the maintenance company assured the operator that *'All the AFCS should be at 100% in accordance with all the tests carried out during maintenance'.*

Discussion

Prior to flight, A/P 'A' failed a pre-flight check at least once. However, this was not a limitation requiring cancellation of the flight. Once established in the cruise, the crew engaged A/P 'A' and it appeared to work satisfactorily. Nevertheless, it was decided to use A/P 'B' during the cruise and this was sensible considering the performance of A/P 'A' during the pre-flight checks.

As part of his final upgrade check, the left seat pilot was required to complete a CAT II automatic landing and he briefed the crew for this approach prior to descent. The weather was good and low visibility procedures were not in force at Stansted. For a CAT II automatic landing, only one A/P was required, although it was company procedure to use both. With the history of A/P 'A', it was a surprising omission that the crew did not apparently consider only using A/P 'B' for the approach. Nevertheless, with the good weather, both autopilots could have been engaged but with a clear understanding that the crew would revert to a manual landing if an autopilot problem became apparent.

The subsequent approach was initially normal with the aircraft correctly configured and established on the ILS. Then, at about 350 feet agl, A/P 'A' disengaged and 'NO DUAL' was displayed. In response to this alert, the company procedures were to continue the approach. However, the commander recognised that this had occurred because of the A/P 'A' disconnect and immediately took the decision to attempt to reselect A/P 'A'; this reconnection was successful. (There were no limitations related to engagement of autopilot contained within the aircraft Flight Manual and discussions with the manufacturer have revealed that no likely adverse effects would have resulted from this action.) Thereafter, the AFCS appeared to have worked correctly, except for the ATS, which appeared to stop controlling the engines. At this time, the aircraft was on the glideslope, the airspeed was above V_{ref} and pitch attitude was normal at about 7° nose-up. Over the next 30 seconds, with no change in the recorded engine parameters, the aircraft diverged below the glideslope, the airspeed decreased to 25 kt below V_{ref} and the pitch attitude increased to greater than 15° nose-up, this being a normal reaction of the AFCS under these circumstances in trying to maintain the glideslope. None of the crew took any action to recover the situation.

The subsequent investigation looked at both the engineering and operational aspects. The engineering investigation looked for a defect within the A/P 'A' system. Additionally, attempts were made to try and identify faults within the ATS, which is part of the AFCS, and particularly any that could have occurred without the alert system being activated. The operational investigation looked at the possibility that the ATS had been disconnected inadvertently by one of the crew and why none of the crew reacted to the deteriorating situation.

Engineering aspects

The accident occurred after the AFCS degraded to single channel A/P operation and the ATS apparently ceased to function, both these events occurring within a short time frame. An attempt was made during the investigation, to establish the reason for both of these events and to try and determine the resultant warnings actually displayed at the time. On the evidence available, this proved not to be possible.

Although the manufacturer reports that a simultaneous A/P and ATS disconnect is possible if, for example, a major failure had occurred in the No 1 FCC, the unit in question exhibited no problem after prolonged testing. Although such testing is not infallible, a major failure is unlikely to go undetected.

The evidence that two reverse thrust interlock micro-switches had been found subsequent to the accident to be mis-set/intermittent in operation, suggested that one or both of these faults could account for a disconnection of the ATS. The logic of the system operation indicated that this could readily occur at inappropriate times but, under such circumstances, the logic also dictated that an ATS warning would be displayed.

No reason for the reversion of the AFCS to single channel operation was determined. It would seem, so far as could be determined from the aircraft documentation, that the system initially failed the Gold-Wire test but passed after it had been repeated with the original No 1 FCC re-installed. This unit had been found fault free on extensive testing by the manufacturer. Since it appears not to have recurred once removal and installation of a number of FCCs had taken place in this position, it is possible that a simple contact resistance condition accounted for the problem.

It should be noted that older avionic systems tend to suffer from deterioration as a result of both calendar time and hours of operation. Although this process is slow, it presents particular diagnosis problems as aircraft age when components in 'un-lifed' Line Replaceable Units (LRUs) may begin to suffer intermittent malfunction. Logical 'trouble shooting' is relatively straightforward when only a single fault in a system or sub-system is present. If that is not the case, extensive periods of associated and unresolved problems can be expected. So far as could be determined, the problems identified above did not account for the events which occurred during the Stansted accident.

The process of investigating the technical aspects of this accident was hampered by the geographically diverse location of the 'trouble-shooting' and rectification operations. The presence of a robust system within an operator for monitoring/co-ordinating maintenance trouble-shooting, particularly when carried out by diverse organisations, is generally a recognised ingredient of a maintenance system for the reliable and safe operation of complex aircraft. Such a system did not appear to exist in the operator of CS-TMP. Therefore the following safety recommendation is made:

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The Instituto Nacional de Aviacao Civil Portugal should assure themselves that Air Luxor has in place an appropriate and robust system for the monitoring and co-ordination of maintenance 'trouble-shooting' procedures and the rectification of faults on their aircraft, so that when maintenance is conducted by third party organisations which may be physically distant from the operator's main engineering base, the reliable and safe operation of such aircraft as CS-TMP is assurred.

Operational aspects

At the time A/P 'A' disconnected, the first officer should have been covering the control wheel and the throttles; the rest of the crew should have been monitoring the flight instruments. All should have been aware of the runway aspect and the aircraft pitch attitude. Once A/P 'A' had disconnected and 'NO DUAL' had annunciated, the normal company procedure was for the commander (left seat pilot in this situation) to decide on the subsequent action. However, the commander on the jump seat of CS-TMP decided to re-engage A/P 'A'. Although it is preferable to have both autopilots working throughout an autoland, this action was unnecessary and inappropriate in this case, when at a height of about 300 feet and with the recent history of A/P 'A'. As the designated commander of the aircraft, he had the right to take whatever action he considered necessary but in this situation, the decision to re-engage the autopilot may have had an adverse effect on the subsequent effectiveness of the crew. Rather than the left seat pilot demonstrating his command potential, the crew may have been (subconsciously) reminded of the actual commander's authority. Apart from distracting their attention from their primary tasks, they could have been left with the impression that the commander had effectively taken control of the approach.

With the ATS ceasing to work at about this time, the possibility of one of the crew members manually disconnecting this system was also evaluated. It was considered unlikely that the ATS selector button on the glareshield would have been pushed without any of the crew being aware of this action, because of its location. The only realistic possibility of a manual disconnection would be by using one of the throttle disconnect buttons. The only member of the crew who could have done this would have been the first officer, as the handling pilot at the time. However, she had no recollection of any such action, although ATS disconnection is a common crew action and is often done as a double click. Any disconnection should have illuminated the 'ATS DISC' annunciation which is on the same panel, and immediately adjacent to, the 'NO DUAL' annunciation. With no crew recollection of this, the ATS annunciation either did not illuminate or was possibly illuminated for only a very short time and not seen by any of the crew. The possibility remains, therefore, that the ATS may have been disconnected inadvertently by the first officer. However, there were mitigating circumstances should this have occurred, for example, her low experience level, particularly so in the company of three other experienced aviators. Nevertheless, the ATS disconnection should not have resulted in the accident. To do so, required all of the crew to fail to react to visible cues and primary instrument information.

During the time from when the ATS ceased operating up to touchdown, a period of some 30 seconds, there was an increasing divergence from the parameters established for the normal stable approach. Nevertheless, each of the crew should have been aware of the increasing pitch attitude of the aircraft and should have been monitoring the decreasing airspeed. Factors such as confidence in the automatic system and a break in routine, because of the autopilot disconnection and re-engagement, may have been relevant in the failure to detect the change in parameters. One other aspect was the company procedure of requiring a handover of the control of the aircraft at decision height. With one pilot handling the controls throughout the approach and landing, he/she may have been in a better position to detect the lack of throttle movement.

Following the accident, the company carried out a review of their procedures. This resulted in certain changes. The handling pilot for an autoland is now always the left seat pilot and he/she retains handling duties throughout the approach. Additionally, the company has now introduced a minimum experience level before any crewmember can be used in support of check flights.

With this action complete, it is not considered necessary to make any formal recommendations concerning Air Luxor's operational procedures relating to the conduct of automatic landings and check flights.