DC-10-30, N35084, 29 August 1997

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Aircraft Type and Registration:	DC-10-30, N35084
No & Type of Engines:	3 General Electric CF6-50C2 turbofan engines
Year of Manufacture:	1979
Date & Time (UTC):	29 August 1997 at approximately 1000 hrs
Location:	Near Knutsford service area, M6 Motorway
Type of Flight:	Public Transport
Persons on Board:	Crew - 14 - Passengers - 103
Injuries:	Crew - None - Passengers - None
Nature of Damage:	Loss of right engine core cowl, damage to left cowl, exhaust nozzle and EGT sensing system
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	N/K
Commander's Flying Experience:	N/K
	Last 90 days - N/K
	Last 28 days - N/K
Information Source:	AAIB Field Investigation

At approximately 1000 hrs, motorists on the M6 motorway just Southof Junction 19 reported seeing sizeable pieces of metal fallingfrom the sky and landing on, or near, the verges. No reportswere received of any injury or damage caused on the ground. Apolice patrol was sent to investigate and gathered-up about eightpieces of what was clearly aircraft debris, the largest piecebeing a stiffened sheet metal panel measuring roughly 4 feet x2 feet. The police contacted Manchester Air Traffic Control (ATC)who, in turn, advised the AAIB Duty Co-ordinator.

ATC were asked for a list of aircraft which had used the particularStandard Instrument Departure route which would take the aircraftover the debris location and they replied that there had beentwo aircraft in the vicinity, one a Boeing 737 and the other aDC-10 on a scheduled flight to Newark, New Jersey. The pieceswere despatched to AAIB and were quickly identified as comprisingabout 70% of a DC-10 engine right-hand core cowl (see Diagram).

The operator of the flight was contacted for information, andadmitted that the aircraft in question, registration N35084, hadindeed landed at Newark with the right-hand core cowl of No 3engine missing. The flight crew were apparently unaware of theloss but had noted a loss of Exhaust Gas Temperature (EGT) indicationshortly after take off. Although the FAA Operational DifficultyReport filed by the operator stated that both left and right cowlswere missing on arrival, subsequent enquiries by AAIB produceda response that the left cowl had remained on the aircraft, ina badly damaged state. Other damage required replacement of theEGT strakes, lower vent system manifold and the exhaust nozzle.

Inspection of the parts held at the AAIB showed that only oneof the three hinge fittings had remained on the cowl - the remainderhaving torn out of the cowl structure, as had the lower lockingclasps. Both halves of the hinge were present, including thehalf normally fastened to the engine pylon using three steel bolts. The upper two of these bolts locate in captive, self-aligningnuts retained within the hinge fitting and the remains of thebolt shanks were still in place (see photograph). The lower attachmentwas a more conventional nut-and-bolt arrangement, passing througha hole in the fitting. No parts of this bolt were present, butthe distortion of the fitting at this location strongly suggestedthat the bolt had been fitted and had failed under overload forces.

This was not the case with the upper bolts and the clean, flatappearance of the fracture faces suggested that failure had occurredunder fatigue conditions. The bolts were sent for metallurgicalexamination which confirmed that tension fatigue was present inboth fractures. One bolt had fractured completely under medium-cyclefatigue loading whilst the other, failing later, also had an areaof fast fracture. Hardness testing showed that the material strengthof both bolts exceeded the minimum drawing requirements. Whenremoved for this purpose, it was found that both bolts were 'threadbound'ie they had bottomed-out in the self-aligning captive nuts.

The two halves of the hinge fitting itself were made from Titanium. The half which was normally attached to the pylon had been quiteextensively damaged apparently by contact with its correspondinghalf in the closed position. This damage was not reflected inthe other half of the hinge, which only had minor witness marksand was probably not the original part which mated with the fixedhalf mounted on the pylon (see photograph 1). This latter halfalso had evidence of quite severe wear around one of the holesthrough which the fractured bolts had passed. One of the holeshad been repaired by bushing but the other was unrepaired andwas oversize and ovalised (see photograph 2). There was evidenceof red primer paint on the hinge and the bolt shanks and, indeed,some of the paint had penetrated the fatigue crack in the boltfrom the unbushed hole, indicating that the crack was presentwhen paint was applied in the area. The bolt which had suffered100% fatigue cracking had been in the bushed hole.

Maintenance History

The aircraft had been purchased by the current operator in 1997when it was sent to a third party maintenance organisation inthe USA for a 'C' check and customisation to their specification. This work was done in June 1997. At the time of the incidentthe aircraft had flown 70,584 hours and accumulated 14,995 landings. When approached for detail regarding significant work in thesubject area, the operator could not provide any relevant history. The external appearance of the panel, which had a highly polishednatural metal finish, suggested that the 'C' check had includedat least some cosmetic work in the area.

Discussion

Information from Douglas Aircraft (Boeing) suggests that thisis probably a unique occurrence. Although engine cowling lossesare not unknown on virtually any make of engine/airframe, theusual reason is improper fastening or installation following maintenance. Fatigue failures of attachment hardware is less common and thereasons for it more complex unless it is simply accepted thatcomponents have reached the end of their fatigue life, in whichcase similar reports might be expected from other, higher time,aircraft.

There were no metallurgical reasons for the fatigue of the hingeattachment bolts. The material exceeded the minimum strengthrequired and the dimensions and manufacturing processes (as faras could be determined) appeared correct. However, it is significantthat the first bolt to develop fatigue was associated with therepaired, bushed hole. Clearly this was the one which was takingthe majority of the load, presumably because of the clearancewhich had opened-up as the other hole fretted. It is logicalto presume that, at the time the bushed repair was done, the otherhole was not judged sufficiently worn to justify such action,although the wear present at the time of the incident was fairlygross, as can be seen from the photograph. When the first boltfailed in fatigue, all the load transferred to the unbushed boltwhich started to fatigue before failing in overload.

The effect of both bolts being threadbound is difficult to quantifyas is the reason. Because the other halves of the fractured boltswere not recovered, a check on their total length was not possible. It is possible that washers had been omitted on assembly but,again, this could not be verified. The fitting itself did notshow signs of significant frettage on its inboard face which mighthave suggested that there was insufficient clamping force betweenit and the pylon. It was suspected that the bruising damage tothe hinge fitting shown in photograph 1 might have been causedby a previous cowl attachment problem but no records were availableto confirm this and, in any case, metallurgical examination ofthe fractured pins did not suggest that a single overload eventhad initiated fatigue.

The operator was approached for information regarding the conditionof the left side forward hinge attachment bolts. Unfortunatelythey replied that this fitting had also been replaced but theparts were not examined in detail and were discarded at Newark.

Subsequent Actions

Boeing have advised that they propose to revise their MaintenenanceManual such that if any damage, such as bolt hole damage, elongation,loose bolts etc., is noted in the area, then bolt replacementwill be required. Additionally, rebushing of the holes in thefitting will again require fitment of new bolts. They also intendto revise the Maintenance Planning Document to include a regularinspection of the area at 'C' check intervals (roughly every 12to 24 months).