AAIU Synoptic Report No. 2003-008
AAIU File No.: 2001/0029
Published: 23rd Jul 2003

Aircraft Type and Registration:	AVRO RJ 100 G-BXAR
No. and Type of Engines:	Four Honeywell LF507 Turbofans
Aircraft Serial Number:	E3298
Year of Manufacture:	1996
Date and Time (UTC):	18 May 2001 at 13.38 hours
Location:	40 NM South East of Dublin
Type of Flight:	Public Transport
Persons on Board:	90 Passengers 6 Crew
Injuries:	Nil
Nature of Damage:	Engine Cowl Separated in Flight
Information Source:	Aer Rianta Duty Officer

SYNOPSIS

The aircraft took off from Dublin for London Gatwick. 40 NM south east of Dublin, after passing Flight Level (FL)170 and accelerating through 290 kt, part of No 2 engine cowling separated from the aircraft and fell into the Irish Sea. The aircraft returned to Dublin.

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft took off from Runway 28 Dublin at 13.38 hours and made a normal departure. At approx 40 NM South East of Dublin, passing through FL170 and accelerating through 290 kt a loud bang was heard and the crew felt the aircraft yaw slightly. The engine indicators were checked and No 2 Exhaust Gas Temperature (EGT) was found to be giving no reading. Engine thrust was reduced as a precaution. Then the purser informed the Captain that part of Engine No 2 cowl was missing. The Captain visually inspected the damage and Engine No 2 was shutdown as a precaution. The aircraft returned to Dublin where an uneventful landing was carried out.

Following a post flight inspection, the aircraft made a 3-engined ferry flight to Stansted for repair.

1.2 Damage to Aircraft

Post flight inspection revealed that the No 2 engine rear fan (Zone 2) cowling doors were missing along with the exhaust cone cowling. The engine jet pipe was damaged and the thermocouple leads torn off. Both zone 2 hinge fixings were missing from the underside of the aft portion of the shoulder cowl. The forward fixing had been ripped away from the shoulder cowl in a downward direction leaving a row of holes where the rivets had pulled through whilst the rear hinge fixing had moved aft, shearing all the retaining rivets. Both door maintenance stays had been ripped away at the attachment point to the fire proof bulkhead. There was no visible damage to the flaps, fuselage or wing structure.

1.3 Aircraft Information

1.3.1 Engine History

The Avro RJ100 is an improved derivative of the BAE 146-300 (whose production finished in 1993) but with the original Allied Signal ALF 502R-5 engines replaced by the Honeywell LF 507 turbofan engine.

The Aircraft Operator's Quality Assurance (QA) Department indicated that the No 2 engine suffered a sudden stop at Dusseldorf on 14 May 2001. This was due to turbine damage. The aircraft was ferried back to Gatwick on three engines where the unserviceable engine was replaced. The No 2 engine cowls were not fully removed during this engine change.

It was also reported that some time previously the aircraft had suffered an engine stoppage on the No. 2 engine position. However this could not be confirmed.

The operator said that during the engine change the cowls were opened and closed at least twice with no problems. During the post engine change ground runs, the pylon blow-out panels had popped open. The ducting was check tightened and the engine run completed without fault.

From 16 May 2001, the aircraft flew four sectors and on return to Gatwick on the following day, the blow out panels were open. No leaks were found during a leak check and after minor maintenance adjustments the aircraft was again released for service.

On arrival at Gatwick two sectors later the blow-out panels were open again. Inspection revealed that the fan air duct to the pre-cooler pylon seal was damaged. The left hand cowl was removed, the seal replaced and the aircraft put back into service. Four sectors later, the cowls blew off in flight.

There were also several unconfirmed reports of the No 2 pylon blow-out panels being found open since the engine change, without technical log entries.

1.3.2 System Description

The main components of the engine cowling are the top shoulder panel, front cowling doors, rear cowling doors and jet pipe fairing. The front cowling doors are attached to the top shoulder cowling by a continous piano type hinge and are fastened together at the bottom centre line by three adjustable hook-latches. For engine maintenance, the doors are retained in the open position by telescopic stays.

The rear cowling doors are attached to the top shoulder cowl by means of two hinge pins (pip pins). When closed, they engage structurally to the fan casing extension ring by means of "Vee" flanges and are fastened together at the bottom centre line by two adjustable hook latches. A small fairing strip secured in place by two Allen screw fasteners then covers each of these lower latches. The rear cowling doors cannot be opened until the jet pipe fairing has been removed.

The operation of the pylon blow-out panels either on an engine ground run or in flight, is indicative of fan exit air entering the engine core area and thus the pylon.

1.4 Flight Recorders

Both the FDR and CVR were removed from the aircraft for analysis. It was agreed that due to the time lapse between the incident happening to engine shutdown, the CVR would have been over recorded and therefore no replay was made. The FDR was removed and the recording downloaded by the aircraft manufacturers for analysis. The prints from the recording show the engine vibration and aircraft yaw as the cowling departed the aircraft and the point at which the engine was shut down.

1.5 Airline and Manufacturer's Research

The aircraft manufacturer carried out an investigation into this occurrence and issued a report in which the following conclusion was made:

Due to the lack of material evidence, it is impossible to determine the cause of failure. Pending the recovery of such evidence from the seabed, it is therefore concluded that the most probable cause was a failure of a zone 2 cowling door upper hinge, possibly due to the upper hinge pip pin working loose or not being fitted following the previous maintenance work.

The Operator also carried out an investigation and in the report concluded that a higher probability for the cowl loss was a structural failure brought on by the previously mentioned sudden engine stop. They also made the following recommendations to the aircraft manufacturers:

- *Amend the Maintenance Manual to include a visual inspection of engine pylon and shoulder cowl during engine change.*

- *Amend the Maintenance Manual to include a structural inspection of the pylon after a sudden engine stoppage.*

- *Replace cowl upper attachment pip pins with nuts and bolts*

Since this incident, at a company level, the Operator has incorporated the requirements for inspection of cowling attachment points into their Engine Change sheets, with additional inspections following a sudden stoppage as detailed below:

"Carry out a visual inspection of the Engine Pylon and shoulder cowl assembly including cowling attachment points.

If the engine is being changed due to a sudden stoppage carry out a detailed visual inspection of the pylon and nacelle as per AMM 05-50-11 paragraphs H & G."

2. ANALYSIS

2.1 The aircraft manufacturers state that no reason could be found for the continuing reports of blow out panels opening and the faults could not be reproduced on the ground. They concluded that if the upper hinge attachment was loose, possibly due to a pip pin migrating, then the cowlings would gape in flight, allowing a flow of air into the pylon, forcing the blow out panels to operate.

Also, they state, the gap would become so great that the airflow would force the doors open at the top, removing the force that was clamping them together around the Vee flanges.

2.2 The aircraft operator on the other hand, state that the structural failure of the forward upper attachment of the cowl to the shoulder cowl could have started as a result of the sudden engine stops. Failure could have become progressively worse on each sector with the result that one of the cowls upper section could have lifted in flight and allowed air to enter the core and pylon. They state that given the fact that the blow out panels pop outs started immediately after the engine change and the fact that the cowlings had been opened and closed more than once, and by different engineers, points to the structural failure being more likely.

They agree with the scenario whereby the cowling may not have been fitted or closed properly is a probability.

2.3 It cannot be stated which of the above scenarios contributed to this occurrence. In the light of this it does seem reasonable to carry out a general visual inspection of the pylon and shoulder cowling lower structure during an engine change. It would also seem appropriate to carry out an inspection of the pylon following an engine stoppage.

3 CONCLUSIONS

3.1 Findings

Both hinge fixings broke away from the underside of the aft portion of the shoulder cowl causing the No 2 engine rear fan cowling doors to separate from the aircraft along with the exhaust cone cowling.

3.2 Causes

The cause was due to one of the following:

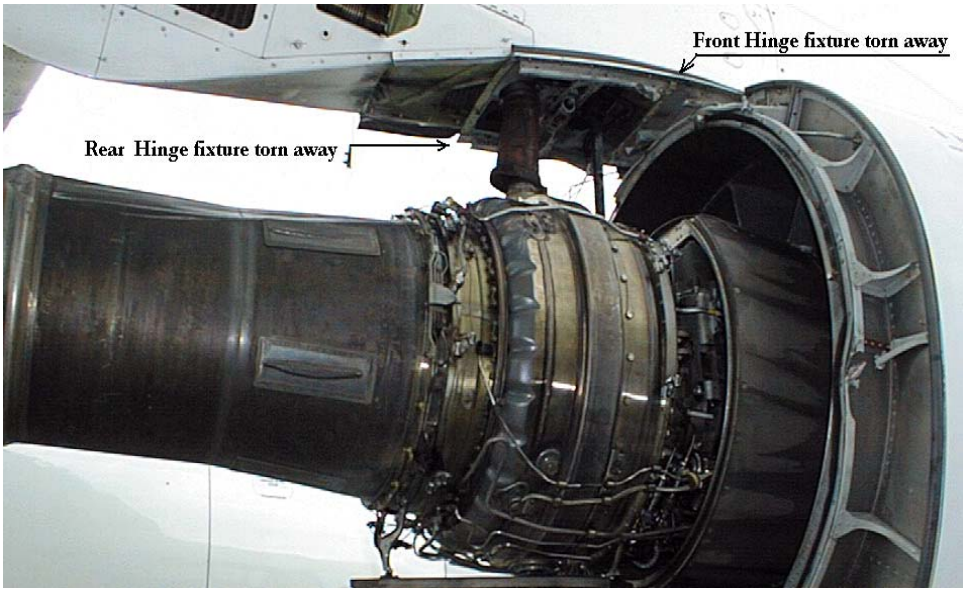
- Structural failure of the forward upper attachment of the cowl to the shoulder cowl possibly as a result of engine sudden stoppage on a previous occasion.
- Upper hinge pip pin working loose or not being fitted following previous maintenance.
- The cowling had not been fitted or closed correctly following maintenance.

4. SAFETY RECOMMENDATIONS

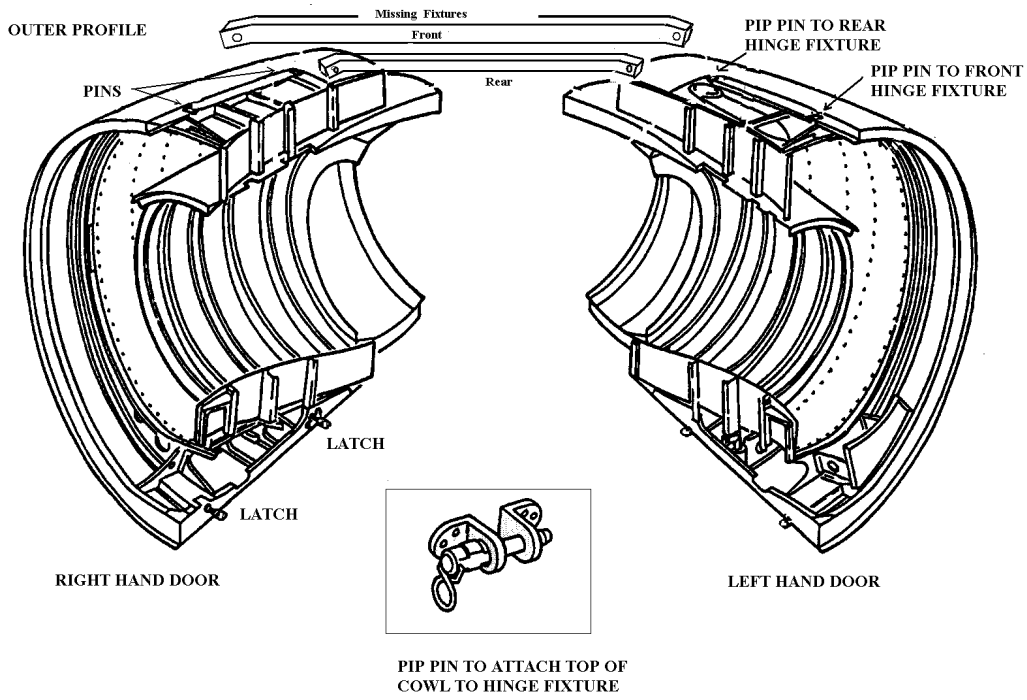
4.1 The aircraft manufacturer should advise operators to conduct a visual inspection of the shoulder cowl assembly, including cowling attachment points, during an engine change. **(SR 17 of 2003)**

4.2 The aircraft manufacturer should amend the Maintenance Manual to include a structural inspection of the pylon after a sudden engine stoppage. **(SR 18 of 2003)**

APPENDIX A



Above: Photo of No. 2 engine showing top shoulder from which the transverse fixture and cowling doors, complete with exhaust cone cowling, were torn away, the front rivets being pulled out vertically and the rear rivets pulled rearwards in shear.



Above: Sketch of missing cowling doors showing their attachment points to the missing transverse top shoulder fixtures.