

Avro 146-RJ100, G-BXAS

AAIB Bulletin No: 1/99 Ref: EW/C98/8/5 Category: 1.1

INCIDENT

Aircraft Type and Registration:	Avro 146-RJ100, G-BXAS
No & Type of Engines:	4 Lycoming LF-507-IF turbofan engines
Year of Manufacture:	1997
Date & Time (UTC):	12 August 1998 at 1100 hrs
Location:	Stand 10, London Gatwick Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 6 - Passengers - 32
Injuries:	Crew - None - Passengers - None
Nature of Damage:	Severe damage to the No 2 engine intake structure
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	42 years
Commander's Flying Experience:	3,937 hours (of which 278 were on type) Last 90 days - 138 hours Last 28 days - 45 hours
Information Source:	AAIB Field Investigation

History of flight

The aircraft arrived at London Gatwick Airport from Amsterdam. It landed, on Runway 26L, at 1047 hrs and taxied to Stand 10. This stand has a fixed jetty and it is the company policy to shut down Nos 1 and 2 engines prior to arrival on the Stand. The following procedure is in the Operating and Handling Standard Operating Procedures section of the Operations Manual Supplement:

"When the parking position is served by a fixed jetty and the APU GEN is available engines #1 and #2 will be shutdown approaching the stand with the following procedure:

AC Pump ON

Eng 2 Pump OFF

Gen 1 OFF/RESET

Thrust Levers 1 and 2 FUEL OFF"

The APU is required because it provides a second source of electrical power once the No 1 engine generator has been selected to OFF/RESET. The AC pump is selected ON to pressurise the yellow hydraulic system which is used for normal braking.

Although the APU was unserviceable the commander asked the first officer to configure the aircraft for Nos 1 and 2 engine shutdown. The normal position for the AC pump switch at this stage would have been AUTO. (This is a three position switch with AUTO at the top, a centre OFF position and ON at the bottom.) The first officer reported that, to do this, he first put his finger on the lower segment of the AC pump switch and the commander looked up and confirmed that it was the correct switch. He then operated the switch and called "AC pump on". The procedure was completed and the commander shutdown Nos 1 and 2 engines as the aircraft turned east onto Taxiway 2.

Data from the FDR indicated that as the aircraft turned right onto about 080°, the Yellow Hydraulic System Low Pressure discrete went to zero and shortly afterwards, both the Nos 1 and 2 engine N₁ reduced to zero. About 2 minutes later the aircraft stopped for about 45 seconds abeam Stand 20; the commander recalled that he applied the Park Brake; a step increase of about 750 psi was noted on both Yellow Brake Pressure traces. About 40 seconds later, the brake pressure was released and the aircraft continued to taxi. It turned right onto Stand 10 where the commander brought it to a halt on the appropriate line and applied the Park Brake. In the 5 minutes since the Yellow Hydraulic System Low Pressure discrete went to zero there had been about 15 minor brake application, all were less than 250 psi and the Yellow Brake Pressure recorded when the aircraft stopped was about this level. The Yellow Hydraulic System Low Pressure discrete had remained at zero throughout.

Very shortly after the Park Brake had been applied, the first officer noticed that the aircraft was moving slowly forward. He shouted "Stop, Stop" and at the same time applied pressure to his foot brake. The commander did the same but it was immediately evident that there was no brake pressure available. The first officer suggested Emergency Yellow brakes and, with the

commander's agreement, made the selection. The crew both thought that this action had stopped the aircraft before it hit the jetty, however this was not the case. The FDR showed a distinct longitudinal 'g' spike about 5 seconds before the Yellow Brake Pressure started to increase, initially rapidly to about 1,000 psi and then more slowly to 3,000 psi. The crew carried out the shutdown check and stopped the Nos 3 and 4 engines about 2 minutes later.

Cockpit voice recorder

The recording started shortly before the Park Brake was initially applied when the aircraft came to a halt on the Stand. The sound of the Park Brake coming off as the commander subsequently pressed his toe brakes confirmed that it had indeed been applied. Useful information was also obtained from the crew's initial analysis of the event.

Damage to aircraft

Initial examination of the aircraft confirmed that the No 2 engine nacelle had struck the hardware of the airbridge, inflicting severe damage on the engine intake structure. Once the aircraft had been moved clear of the ramp, the engine pylon and its attachment to the wing were subjected to a detailed non-destructive examination by a working party from the aircraft manufacturers. No structural damage was found in those areas. As a precaution, the engine was changed and the engine mounting bolts replaced.

Master Warning System (MWS)

The MWS provides the crew indication of aircraft systems malfunction and status. Indications are displayed by hidden legend, colour coded annunciators on the Master Warning Panel (MWP) which is located on the central instrument panel, and on the systems subpanels on the overhead panel. To draw attention to an annunciator on the overhead panel the relevant MWP systems annunciator has an arrow engraved on it pointing upwards.

Red and amber alert flasher are situated on the glare shield. A triple chime or fire bell is associated with a red warning and a single chime with a high category amber warning. Pressing the flasher will extinguish the alert lamp, initiate the dimming circuit and silence the audio tone. Any subsequent warning causes the MWS to return to bright and a further sequence of alert flashers and chimes

Shutting down Nos 1 and 2 engines **with** the AC pump ON would light the following annunciators:

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MWS

ENG 1 OIL PRESS (Red)

ENG 2 OIL PRESS (Red)

ELECT (Amber with up arrow)

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Overhead Panel

GEN 1 OFF LINE

Yellow system pressure gauge indicates 3,000 psi

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Shutting down Nos 1 and 2 engines **without** the AC pump ON would light the following annunciators:

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MWS

ENG 1 OIL PRESS (Red)

ENG 2 OIL PRESS (Red)

ELECT (Amber with up arrow)

HYD (Amber with up arrow)

Overhead Panel

GEN 1 OFF LINE

LO PRESS (Yellow system) after 3 seconds

BRK ACC LO PRESS after 5 seconds

Yellow system pressure gauge indicates zero after about 7 seconds

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As each MWS red annunciator lights there is an associated red alert flasher and a triple chime. Similarly as each MWS amber annunciator with an up arrow lights there is an associated amber alert flasher and a single chime.

Flying Staff Operational Instruction (FSOI)

Pending the outcome of the initial investigation the operator decided that all four engines should be kept running when taxiing onto fixed jetties. The Fleet Manager RJ issued the following FSOI RJ 15/98 on 13 August 1998:

"PARKING ON STANDS WITH A FIXED JETTY

All Flight Crew are reminded that the APU GENERATOR must be available prior to selecting the AC Pump ON and the Eng 2 (Hydraulic) Pump OFF.

If operating with the APU GEN unserviceable, the aircraft should be brought to a halt on stand with all four engines running, and a normal shutdown of all engines accomplished after the parking brake has been set and the brake pressure checked.

Background information

The recent accident to G-BXAS has highlighted the fact that some crews may have been shutting engines #1 & #2 down without APU GENERATED power being available."

Examination and testing

Repeated static functional testing of the brake system was carried out in the presence of AAIB, using the normal yellow hydraulic system, powered from the AC pump, mounted within that system. Brake pressure was satisfactory at all times. Comprehensive testing of the relevant electrical circuits was carried out to establish whether any intermittent electrical problem could

have been present capable of causing failure of the AC pump to operate when selected 'ON'. No evidence was found to account for such an event.

Once the replacement engine was fitted, the decision was taken to fit a replacement AC hydraulic pump as a precaution and to change the AC pump operating switch. After repairs and component changes were complete, the aircraft was subjected to a series of taxiing and braking tests, in conjunction with AAIB, initially on four engines and subsequently on two. No problems or operating defects were identified.

The aircraft was returned to service and has subsequently performed satisfactorily, with no defects occurring relating to the yellow hydraulic system or the brakes.

The hydraulic pump removed from the aircraft was comprehensively functionally tested and partly dismantled at the manufacturer's facility in the presence of AAIB. No evidence of any failure was revealed. The pump switch was also subjected to extensive testing under laboratory conditions with applied vibration over a wide spectrum of frequencies. These vibrations were applied in all three axes. No loss of electrical continuity across the switch between relevant terminals occurred in either closed circuit condition (ie with switch selected to either the 'ON' or the 'AUTO' position) throughout the tests.

Conclusion

The Yellow Hydraulic System Low Pressure FDR discrete went to zero and remained there indicating that the system was not being pressurised. Extensive post incident examination and testing of the relevant parts and components of the Yellow Hydraulic and braking system revealed no fault either permanent or intermittent. In the light of this, it is possible that the AC pump switch had inadvertently been selected to the centre OFF position and the crew had not noticed this or the consequent indications of Yellow Hydraulic System Low Pressure.