

Jetstream 4100, G-MAJE

AAIB Bulletin No: 7/99 Ref: EW/G98/06/02 Category: 1.1

Aircraft Type and Registration: Jetstream 4100, G-MAJE

No & Type of Engines: 2 Garrett Airesearch TPE 331-14HR-802H turboprop engines

Year of Manufacture: 1992

Date & Time (UTC): 4 June 1998 at 0612 hrs

Location: Overhead Isle of Man

Type of Flight: Public Transport (Passenger)

Persons on Board: Crew - 3 - Passengers - 9

Injuries: Crew - None - Passengers - None

Nature of Damage: Nil

Commander's Licence: Commercial Pilot's Licence with Instrument and Instructor Ratings

Commander's Age: 32 years

Commander's Flying Experience: 3,497 hours (of which 734 were on type)

Last 90 days - 134 hours

Last 28 days - 35 hours

Information Source: Aircraft Accident Report Form submitted by the pilot and telephone inquiries by AAIB

History of flight

The aircraft had climbed to cruise level on a flight from Belfast to Southampton. The departure had been flown manually, with the aircraft in balanced trim. It had been in the cruise at an airspeed of 210 kt at FL 190 for approximately five minutes with the autopilot engaged and the First Officer (FO) as the handling pilot, when a 'TRIM L' amber caption illuminated on the forward coaming panel. The crew reported that the aileron trim indicator showed neutral. Conditions were VMC, with no apparent airframe icing, and the Outside Air Temperature was -20°C. It had climbed through what was described as a 'very moist layer' between 1,000 to 6,500 feet agl. The FO disengaged the autopilot and attempted to retrim the aileron but the aileron trim control was immovable; the application of substantial control wheel force by the FO was required to prevent the aircraft from rolling to the right.

The crew consulted the checklists but found none that fitted the circumstances. The autopilot trim power switch was selected off but without any effect. The crew then decided to divert back to Belfast, issued a PAN call and ATC provided radar vectors. The FO slowed the aircraft to manoeuvring speed and the commander informed the cabin crew and passengers of the diversion. After commencing a descent, the FO informed the captain that the control problem was worsening, but was still manageable. Between FL 160 to FL 140 during the descent the roll controllability began to improve. The captain decided to carry out the landing and took over the handling after the aircraft had been levelled at FL 140. Shortly thereafter the aircraft handling and the aileron trim control became normal, approximately 10 minutes after the 'TRIM L' warning. A landing was carried out at Belfast with no further problems.

Flight data recorder

A Flight Data Recorder (FDR) recorder readout showed that the aircraft was level at FL 190 at an indicated airspeed of 218 kt with the autopilot engaged. The record did not indicate when the 'TRIM L' caution occurred, but showed that over an 80 second period before autopilot disengagement there were two roll excursions to the right, to maximum angles of 10° and 7°.

Aircraft description

Primary roll control of the aircraft is by means of an aileron on each wing trailing edge, manually operated via mechanical linkages. Out of balance roll forces can be trimmed out by adjustment of a geared balance tab on the left aileron, connected to the fixed structure through an irreversible screwjack actuator (Figure 1). Rotation of the flight deck aileron trim wheel operates a cable/pulley system that terminates in a chain located on the input sprocket of the screwjack. The sprocket is splined to one end of a screwshaft that rotates in bearings in a bearing body and has a square-form acme thread formed on its other, inner end. The ram portion of the actuator consists of a translating shaft assembly with an internally formed nut that mates with the screwshaft thread. The translating shaft assembly is prevented from rotating by external splines that locate in internal splines in a splined body attached to the bearing body, and translates when the screwshaft is turned. Ram travel is 1.00 to 1.25 inch. Lubrication is by means of a grease nipple fitted in the body adjacent to the bearings.

The grease specified in the actuator manufacturer's Component Maintenance Manual was Aeroshell Grease 7; in December 1997 the aircraft manufacturer had amended the Aircraft Maintenance Manual to specify Mobil 28 instead, considering it to be less hygroscopic. The component manufacturer reportedly had been informed of the amendment after the incident and had no evidence to indicate that it provided a substantive increase in hygroscopic resistance. The Component Maintenance Manual listed over-greasing as one probable cause of the actuator sticking or having high resistance to movement. Standard procedures were for the screwjack to be exercised over its full range before the first flight of each day.

Autopilot roll inputs are via a servo acting on the aileron linkage in the flight deck in parallel with the manual controls. If the autopilot system detects an excessive out of trim condition persisting for more than 15 seconds a caption ('TRIM L' or 'TRIM R') illuminates to inform the crew and allow them to manually retrim. Electrical power to the autopilot is controlled by the autopilot trim power switch.

The aircraft manufacturer noted that roll trim requirements for the Jetstream 4100 did not normally vary with airspeed, but that some variation had been experienced on occasion during previous flight testing.

Other similar occurrences

Reports were found of 4 other occurrences of problems with G-MAJE's roll trim system:

- 1 26 May 1998, 9 days before the Incident:

During cruise at FL230, at 200 kt, a slight lateral trim imbalance was noted and the aileron trim control could not be moved. No adverse handling effects were reported and the control freed during the descent.

- 2 17 June 1998, 13 days after the Incident:

While in the cruise at FL190 the aileron trim caution caption illuminated. Trimming was not possible as the aileron trim control was found to be jammed. The system became unjammed as the Total Air Temperature (TAT) increased to zero. After landing, the aileron trim screwjack was lubricated and was found to operate normally over its full range of travel.

- 3 17 June 1998, 13 days after the Incident:

The aileron trim became very stiff to operate while in the cruise at FL250. It was reported that both the climb and the previous sector descent had been made through heavy rain.

- 4 31 October 1998, 5 months after the Incident:

At the top of descent at FL190 the aileron trim caution caption illuminated and the aileron trim control was found to be immovable. As the aircraft descended the control became progressively easier to operate.

The above incidents all occurred on G-MAJE. In addition, the following possibly related event had been reported on G-MAJG, another Jetstream 4100 of the operator's fleet:

5 30 July 1997:

While the aircraft was being manually flown on the approach to land a sudden stiffness was felt in the aileron controls and a coincident roll asymmetry to the right was experienced. The crew confirmed that the autopilot had not become engaged, selected the yaw damper off, reduced airspeed and controlled the aircraft to an uneventful landing. Readout of the FDR confirmed that the autopilot and yaw damper had been off. The TAT at the time of the incident was 4°C. Icing was suspected. The aileron hinges were lubricated and no further problems were experienced.

Component investigation

After the incident on 26 May 1998, the operator's maintenance organisation reported that grease in the aileron trim actuator was found to be contaminated with moisture. Worksheets indicate that the translating shaft was removed, cleaned and refitted and the actuator was then regreased and reinstalled.

Following the 4 June 1998 incident, the operator reportedly lubricated the aileron trim screwjack and found that the aileron trim system functioned satisfactorily over its complete range. It was again lubricated after the 17 June 1998 incident and at a C Check on 10 July 1998 the screwjack was strip inspected and relubricated, with no fault found. The aileron trim cable/pulley system was inspected on 26 June 1998, with no fault found.

The operator issued Technical Instruction (TI) No 72 on 16 July 1998 recommending an additional procedure for screwjack lubrication. This involved lubricating the screwjack in both the fully extended and fully retracted state, with extruded grease to be cleaned from the ram (translating shaft) after each lubrication.

Discussion

The above servicing of the aileron trim screwjack occurred after the Aircraft Maintenance Manual had been amended to specify Mobil 28 grease and the evidence suggested that this grease would have been used. However, the available evidence suggested that the jamming of the aileron trim control had probably been caused by freezing of water within the trim actuator. While over-greasing was listed as one of a number of probable causes of actuator sticking or high resistance, it did not appear likely that this would become manifest some time after the last lubrication, or would have an intermittent effect. It appeared possible for water to enter the actuator via the clearance between the screwshaft and the Bearing body at the input end or between the translating shaft and the splined body at the output end. The unit was not sealed at either of these points, and resistance to the ingress of water would appear likely to depend on the local distribution of grease on the relevant components. The aircraft manufacturer considered it probable that water had entered the actuator when the originally specified grease had been in use and had not been purged during subsequent lubrication and strip cleaning operations.

It did not appear that seizure of the aileron trim actuator could have caused a roll imbalance and the crew believed that the aircraft had been in trim when the autopilot was engaged. A right wing heavy roll asymmetry had clearly developed while the autopilot was controlling the aircraft and was present when the autopilot was disengaged. The imbalance remained after the autopilot trim had been switched off and it did not seem likely that it had resulted from an autopilot anomaly. With the available evidence the reasons for the lateral trim imbalance could not be established; it had possibly resulted from the effects of a change in airspeed.