INCIDENT

Aircraft Type and Registration:	Jetstream 4100, G-MAJE
No & Type of Engines:	2 Garrett Airesearch TPE331-14HR-805H turbprop engines
Year of Manufacture:	1992
Date & Time (UTC):	11 January 2007 at 0755 hrs
Location:	In the descent passing FL75, 27 nm north of Southampton
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 17
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	17,000 hours (of which 2,000 hours were on type) Last 90 days - 220 hours Last 28 days - 60 hours
Information Source:	AAIB Field Investigation

Synopsis

At about FL75 during the descent into Southampton Airport, the right engine ran down and the propeller speed reduced. The crew suspected that a double engine failure may have occurred and transmitted a 'MAYDAY' call. Subsequently, the left engine was found to respond normally to power lever movements and the 'MAYDAY' was downgraded to a 'PAN' situation. The aircraft levelled at FL70 and the right engine restarted without crew intervention. Both engines continued to operate normally, the 'PAN' was cancelled and an uneventful landing was made at Southampton. The aircraft was fitted with the original version of engine air intakes and had been flying in conditions conducive to ice accretion. A later version of intake, designed to minimise the risk of ice ingestion, is available but it is not currently mandated by the UK CAA for these to be fitted to the Jetstream 4100.

History of the flight

The crew reported for duty at 0610 hrs at Leeds Bradford Airport for a scheduled flight to Southampton. Due to strong winds, extra fuel was carried and potential icing conditions were discussed. It was decided that the 'continuous ignition system' would probably be used throughout the flight. The flight departed at 0649 hrs with the commander as the Pilot Flying (PF) and the co-pilot as the Pilot Not Flying (PNF). The engine anti-icing and continuous ignition, and propeller de-icing were selected ON, in accordance with the operator's Standard Operating Procedures (SOPs).

As the aircraft climbed to its cruising level of FL190, it experienced moderate turbulence up to FL150, with light-to-moderate airframe icing. During the flight, the crew occasionally heard ice being shed from the propellers, some of which impacted the fuselage, but airframe ice accretion was not sufficient to require operation of the pneumatic de-icing 'boots'. For approximately the first half of the cruise, the aircraft was continuously in cloud; for the second half, it was in and out of the tops of a cloud layer.

During the descent, the ice began to break off and, just prior to the incident, it was noticed that the accretion on the front of the propeller spinners, extended rearwards up to approximately four inches. The aircraft was cleared to descend from FL80 to FL70 and was given a radar heading to intercept the ILS localiser for Runway 20 at Southampton Airport.

The aircraft left FL80 and, as it passed FL75 and entered the tops of a layer of cloud, the crew heard the sound of what they thought were both engines running down. The power levers at this time were almost at the flight idle stop. The autopilot (AP) was engaged and no yaw was initially experienced. Both engine torque indications were perceived by the crew to be at zero and the right engine propeller speed had reduced[1]. After a brief discussion, the crew thought both engines may have failed and the PNF transmitted a 'MAYDAY' call, giving the aircraft's position and stating that they had an engine failure. The PF advanced what he thought was possibly both power levers, in order to level at FL 70, and, as he did so, the aircraft yawed to the right. He disconnected the AP, corrected the yaw and levelled off. He then confirmed that the left engine was operating normally and that the right engine had run down. The PF flew the aircraft manually at FL70, maintaining the intercept heading for the ILS, with the flight director bar set for the localiser. When both the crew had confirmed that only one engine had failed, the 'MAYDAY' call was downgraded to a 'PAN'. Shortly thereafter, the right engine restarted, without the crew performing the engine failure or relight procedures.

The flight crew matched the torque from the engines and, after confirming that their indications were normal, the AP was re-engaged. Following this, the 'PAN' call was cancelled.

Just after the cabin attendant had received the '10 minutes to landing' call from the PNF, she heard an engine run down. She secured the cabin and moved towards the flight deck and from the front right cabin window, she could see the right propeller turning slowly. She then made her way to the rear of the cabin, carrying out her normal pre-landing checks, and spoke to the PF on the aircraft interphone. Having confirmed to the crew that the cabin was secure she was briefed on the situation and instructed that normal landing procedures were to be applied. None of the passengers appeared to notice any abnormality.

The ILS approach was flown using the AP and a normal landing was made. The airport Rescue and Fire Fighting Service (RFFS) met the aircraft. Following a brief update of the RFFS on their dedicated frequency by the PNF that all was normal, the aircraft was taxied to its parking stand and shut down.

Footnote

[1] The manufacturer advises that the airline Operating Manual directs the crew to use propeller speed as the definitive diagnostic indicator for engine failure.

Weather

The synoptic situation at 0600 hrs was that a deep depression of 953 hPa, centred near Iceland, was feeding a gale force westerly flow over the British Isles. An area of frontal cloud and rain was also moving across the southern half of the country. The cloud for the route was 5/8 to 8/8 Stratus base 1,500 ft in thick multi-layers up to 11,000 ft to 12,000 ft. Further layers of cloud existed above 15,000 ft.

A radio-sonde was launched at Larkhill range on Salisbury Plain, approximately 25 nm west of the incident location, at 0638 hrs. This provided data on the winds and temperatures between 7,000 ft and 10,000 ft. The recorded data for the ascent is set out in Table 1 below.

The METARs for Leeds Bradford (EGNM) and Southampton (EGHI) airports covering the relevant times were:

EGNM 110650Z 24026G42KT 210V270 9999 RA SCT010 09/08 Q0992=
EGHI 110750Z 22024G40KT 220V290 9000 VCSH SCT018 BKN026 11/07 Q1010=

Use of Ice Protection Systems

Icing conditions are defined in the Company Operations Manual as:

'Outside air temperature (OAT) on the ground and for take-off is 5°C or colder, or total air temperature (TAT) is 10°C or colder, AND visible moisture in any form is present (such as clouds, fog or mist with visibility of one mile (1600 metres) or less, rain, snow, sleet and ice crystals).

The OAT on the ground and for take-off is 5°C or colder when operating on ramps, taxiways or runways, where surface snow, ice, standing water or slush may be ingested by the engines or freeze on engines, nacelles or engine-sensor probes'.

The Company Operations Manual sets out the following requirements for the use of ice protection systems:

'It is good airmanship to anticipate flight into icing conditions. Whenever possible flight crew should select the anti-ice protection system ON at least one minute before actual entry into such conditions. This serves two purposes; firstly it warms up the components and secondly checks for any malfunction of the anti-ice protection system.

In icing conditions before take-off or if the Captain considers icing conditions are likely to be encountered during the initial climb above 1600ft aal the following anti-ice selections should be made:

Height AGL	Wind speed and direction	Temperature °C	Dew Point °C
10,000 ft	260/80	-5.2	-5.2
9,000 ft	260/80	-3.2	-3.2
8,000 ft	260/80	-1.5	-1.6
7,000 ft	260/80	+0.7	+0.7

Table 1

IGNITERS.	*BOTH ON*
PROP ICE PROT.	*BOTH ON (Short or Long Cycle as required)*
ENG/ELEV ICE PROT.	*BOTH ON'*

The Operations Manual also defines the requirements for takeoff in icing conditions which are:

'If the temperature on the ground is 10° (OAT) or less and icing conditions exist at or below 1600ft AAL, take-off must be carried out with:-

APR armed

Engine and propeller anti-icing ON

Flow Selectors OFF'

The above procedures are consistent with the aircraft manufacturer's Aircraft Flight Manual (AFM).

Additional information

The aircraft manufacturer has advised that they know of only two previous occurrences of icing-related Jetstream 41 engine flame-outs in the last eight years; both occurred in South Africa.

The Met Office, who supplied the data included in the Weather paragraph, offered the following comment:

'*Based on this information* [weather data relating to that encountered by G-MAJE at the time of the engine rundown] *the risk of airframe icing looks to be high, indeed the temperature range-1 celcius through to -5 celcius could be considered the classic range for the phenomena to occur.'*

Flight Recorders

The aircraft was fitted with a Solid State Flight Data Recorder (FDR) and a Cockpit Voice Recorder (CVR). Both recorded details of the event.

The relevant FDR parameters are illustrated in Figure 1. Whilst flying at an altitude of 8,000 ft and an indicated airspeed of around 200 kt, engine torque was reduced from 40% to around 10% on both engines. This initiated a descent rate of around 1,500 ft/min. Total air temperature at that time was recorded as being +8.5°C. As the aircraft passed through 7,500 ft, the right engine speed began to decrease and its torque reduced to 0%. At the same time, the PF noted "SOMETHING NOT QUITE RIGHT THERE". The PNF responded with "TORQUES GONE BOTH DOUBLE FLAME OUT". Four seconds later, the PF responded with "YEAH WE GOT TORQUE ON THE LEFT", which the PNF acknowledged, following which he transmitted a 'MAYDAY' call.

As the right engine speed reduced, the aircraft began to yaw to the right, but this was counteracted by the application of opposite rudder. Torque on the left engine was increased, the autopilot was disconnected and the aircraft levelled at just under 7,000 ft.

Around 73 seconds after the onset of the initial decay, the right engine speed increased from 25% back to 100%; after a further 10 seconds, the right engine torque increased to 44% and, 15 seconds later, torque levels on both engines became symmetrical at 40%. Throughout this incident, the left engine speed was recorded at 100%.

No de-icing or power lever parameters were recorded on G-MAJE.

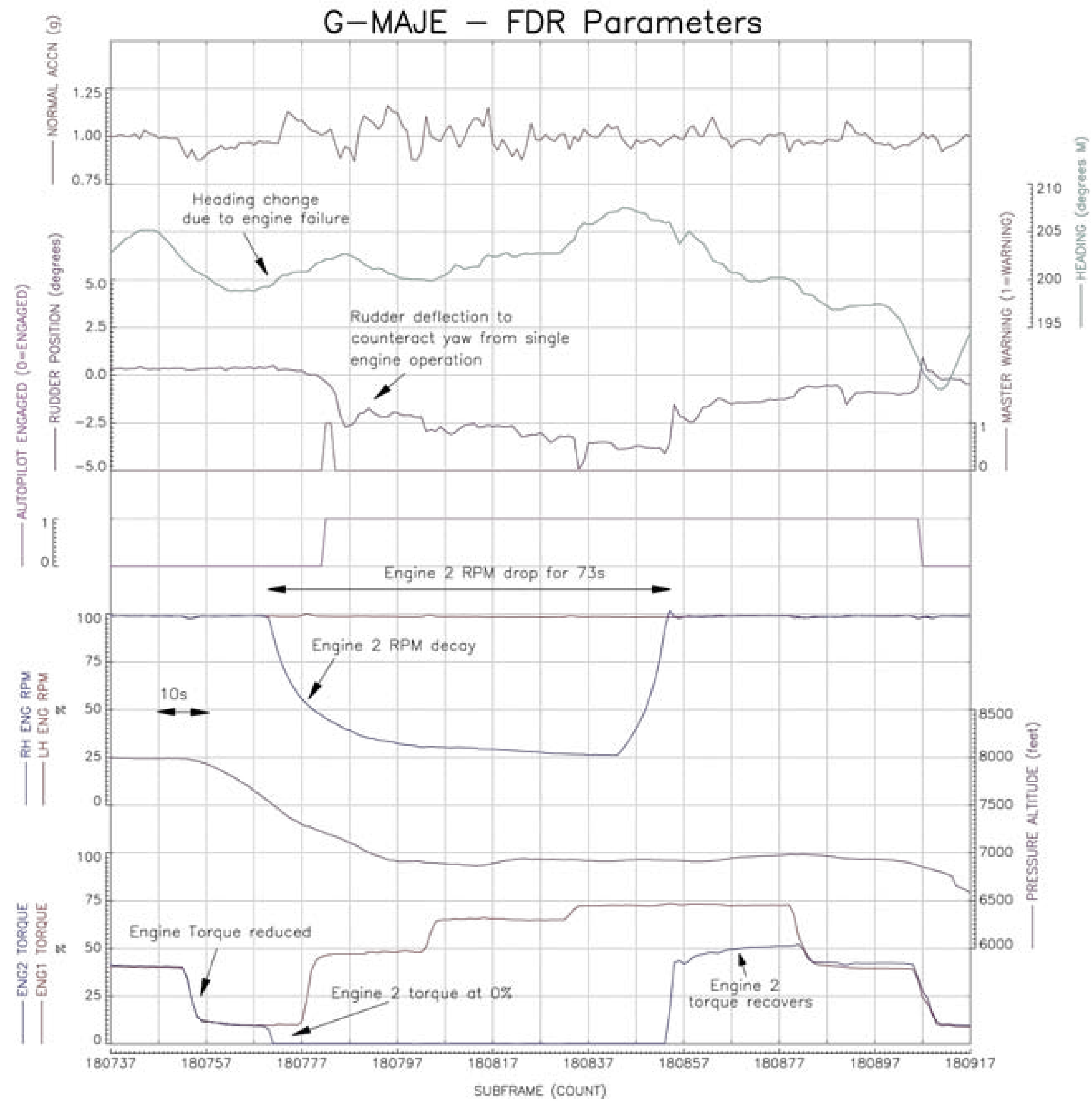

Figure 1

Engineering examination

Subsequent to this incident, the aircraft engines and anti-icing systems were examined and test run on the ground, up to full power. No technical defects were identified and the aircraft was subsequently returned to service.

Both engines were fitted with the original standard of air intake, Figure 2. Although the intake lip region is de-iced using hot air bled from the engine compressor, under certain icing conditions, it is known that ice may build up in the region between the intake upper lip and the spinner. Tests conducted by the manufacturer, following a number of in-flight flameout events soon after entry into service, identified that an airflow reversal occurs above the lip. This can allow accumulated ice to 'slip' down into the engine air intake, when the aircraft flies into warmer conditions. As a result, a number of design changes were introduced in 1993/94 to improve the intake heating capability and the intake lip profile to reduce its susceptibility to accrete ice. These changes returned the intake to the required airworthiness standard (Service Bulletin J41-A72-001) and, at that time, the AFM was amended to include the requirement of selecting 'continuous ignition' for flight in icing conditions. The continuous ignition system fitted to each engine employs two igniters and should restart the engine within five seconds following a flameout. The manufacturer reports that very few instances of icing related engine flameouts have occurred in the last eight years.

Figure 2

Original standard of air intake fitted to G-MAJE

Subsequently, a modified air intake, Figure 3, was made available for operators of the Jetstream 4100 to fit as a direct replacement, ref Service Bulletin J41-71-031 issued on 24 April 1998. The essential difference is that the upper section of the intake lip is faired to the shape of the spinner. Replacement of this item is not mandated for by the UK CAA, as the original airworthiness issue was addressed by the action stated above. The manufacturer's records show that six sets of intakes have been ordered, but only two are known to have been fitted to aircraft.

Analysis

The crew had the engine anti-icing system selected ON throughout the flight in accordance with the company SOPs. They had monitored the ice building up on the wing leading edges and propeller spinners but judged that it was not severe enough to require operation of the wing/tail leading edge de-icing system. Throughout the flight, the crew occasionally heard ice shed from the propellers impacting the fuselage and, during the descent, the propeller spinner ice accretion also reduced. However, it is likely that ice had accumulated above the upper lip of the air intake whilst flying through the tops of stratiform cloud, where the conditions were conducive to the formation of airframe icing, and slipped down

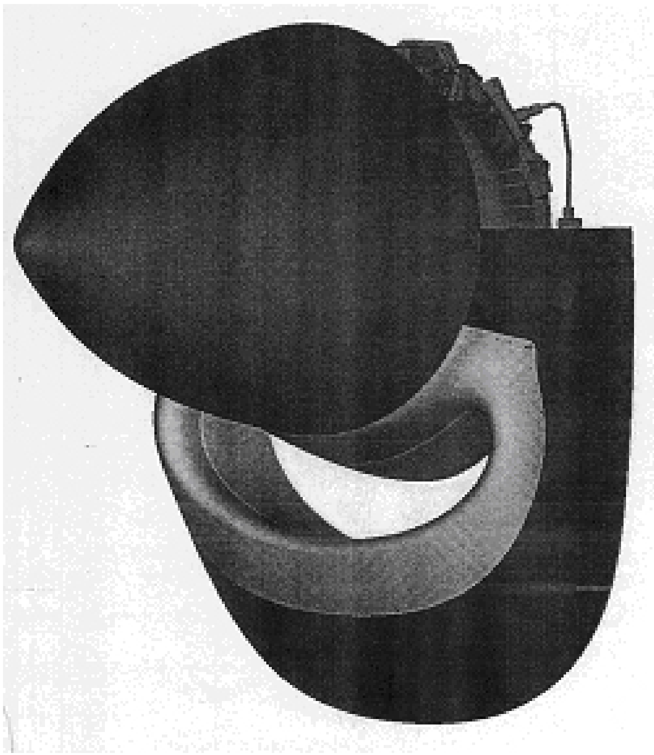

Figure 3

Diagram of the modified standard of air intake into the intake as the aircraft descended into slightly warmer air.

Before the right engine ran down, both engines were at a low power setting and initially, the low torque indications led the crew to believe both engines had failed, although only the right propeller speed indication, the definitive diagnostic parameter, had reduced. However, the yaw induced when the power levers were advanced, indicated that the left engine was in fact still operating normally.

The crew did not have the time to carry out the procedure to secure the failed engine, or attempt a relight, in accordance with the emergency checklist. Various factors were considered to have led to this situation: the benign nature of the failure, together with the necessary time taken to analyse the problem, the need to maintain control of the aircraft and comply with ATC instructions. In addition, some 62 seconds later, the right engine began an auto-restart as a result of the operation of the continuous ignition system, following which, both engines ran normally.

It was not established why the right engine did not auto-restart within five seconds or why, given that both engines were likely to have experienced exactly the same environmental conditions, only the right engine was affected. Given, also, that there have only been two reported incidences of flameout in the last eight years, the possibility that the right engine was predisposed to flame-out in the 'right' conditions (due to, for example, the condition of the igniters or fuel nozzles) could not be dismissed. Also, the current maintenance checks on the anti-icing system, such as were performed after this incident, address system integrity not the effectiveness of its performance. Since being returned to service, no further reports of problems with the right engine have been received.

Conclusions

In the absence of any technical defects being identified during the examination of the aircraft, it was concluded that the right engine run down may have resulted from the ingestion of ice accretion from the lip of the air intake, formed whilst flying through the tops of a cloud layer with an OAT of around -1ºC to 0ºC. With the standard of intake fitted to G-MAJE, it is a characteristic that ice may occasionally accrete in the region between the upper lip of the air intake and the spinner, in the right conditions, despite the engine anti-ice system being operative. It was not established why only the right engine was affected and why it took a relatively long time to auto re-start, giving rise to the possibility that the right intake and/or the igniters and fuel nozzles may not have been functioning optimally.