Fokker F27 Mark 500, G-JEAE

AAIB Bulletin No: Ref: EW/C2000/6/11 Category: 1.1

INCIDENT

Aircraft Type and Registration:	Fokker F27 Mark 500, G-JEAE
No & Type of Engines:	2 Rolls-Royce Dart 532-7 turboprop engines
Year of Manufacture:	1984
Date & Time (UTC):	29 June 2000 at 1830 hrs
Location:	London Stansted Airport
Type of Flight:	Cargo
Persons on Board:	Crew - 2 - Passengers - 1
Injuries:	Crew - nil - Passengers - nil
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	2,630 hours (of which 700 were on type) Last 90 days - 85 hours Last 28 days - 23 hours
Information Source:	AAIB Field Investigation

History of flight

The aircraft was given radar vectors to the ILS approach to Runway 05 at Stansted Airport. The commander was the handling pilot and the passenger was on the jump seat. The landing checklist was completed and the configuration was 26° flap with the landing gear down; V_{REF} was 100 kt. At 900 feet amsl, the aircraft was above the glideslope and the IAS was about 150 kt. The commander retarded the power levers to flight idle to correct this. There was a marked increase in propeller noise and the aircraft decelerated rapidly. It was evident that the propellers had gone into ground fine pitch (gfp); both pilots noticed that the two amber 'Flight Fine Unlocked' lights had illuminated; the commander noticed that both red 'Prop Below Lock' lights had also illuminated.

The commander tried to push the power levers forward but they would not move and it felt as if they had come up against a mechanical baulk. He took his hand off the power levers to operate the 'Throttle Lock Selector' which he hoped might free the power lever restriction. He also selected the landing gear up to reduce the drag.

When he replaced his hand on the power levers, they moved forward without restriction, the propellers responded normally and the aircraft started to climb. The After Take Off checks were completed and, when the aircraft was established safely in the climb, the crew discussed the event. They were aware that the propellers had gone into the gfp range but not why it had happened, in fact both pilots thought that this was not possible because of 'weight-on-wheels' protection. The aircraft was given radar vectors to the ILS approach to Runway 05. The commander was unwilling to retard the power levers too far and had decided to maintain at least 140 kt until over the runway threshold and to set and leave the torque between 120 psi and 130 psi. The aircraft went through the localiser and was above the glideslope, so the commander decided to carry out a further missed approach, from 2,000 feet amsl.

The commander requested an 8 nm final for the next approach. He planned to fly the approach with 16° flap and adjusted the V_{REF} to 105 kt. At 900 feet amsl the runway was visual and the commander decided to use 26° flap and rebugged V_{REF} to 100 kt. The first officer suggested isolating the 'Flight Fine Pitch Stop' (FFPS) electrical circuit until the aircraft was on the ground and this was agreed. The final approach was uneventful and the aircraft landed without further incident. The 'Isolating Switch' was returned to normal after touchdown, gfp was selected and the aircraft decelerated normally.

Flight recorders

The 30-minute duration, four channel, cockpit voice recorder (CVR) and the 25-hour duration, 5 parameter, flight data recorder (FDR) were replayed at AAIB after having previously been replayed on behalf of the operator. The recorded level of the incoming RT on the CVR was unacceptably low, otherwise both recorders were serviceable.

The 5 parameters recorded on the FDR did not include engine or propeller data, therefore it was necessary to obtain as much of this as possible from the CVR recording. The replay speed of the CVR was corrected and the CVR and FDR recordings were synchronised using common recorded events (see Appendix A). Both recordings were then used to reconstruct the history of flight and to analyse the incident.

The recordings confirmed that the flight was uneventful until the aircraft was about 500 feet agl when the CVR recorded the sound of a cockpit lever being moved. This was identified as the sound signature produced when an engine power lever is lifted and moved rearwards into the gfp position. The normal 'g' trace indicated the presence of a significant level of turbulence which caused variations of ± 0.6 g about the 1 g norm. Shortly after this, the handling pilot said: " WHY WON'T THAT MOVE". During the next 14 seconds the CVR recorded sounds consistent with attempts to move the power levers, and remarks from the handling pilot included: " IT'S STUCK IN REVERSE". Spectrum analysis of the CVR recording showed that the engine speed reduced from 10,750 rpm to 7,800 rpm during this time. The relationship between the propeller speed, obtained from the CVR recording, and recorded airspeed confirmed that the pitch of the propellers had moved to the 0° stop, i.e. the propellers were in gfp.

At about 190 feet agl, 15 seconds after gfp had been selected, a sound was recorded on the CVR which was consistent with the undercarriage lever being moved. Almost immediately a GPWS generated "TOO LOW GEAR" alert was recorded; this confirmed that the undercarriage was no longer locked down. The height decreased to 85 feet agl during the following 3 seconds and then the engine speed was heard to increase. The minimum height recorded on the FDR was about 25 feet agl in the vicinity of the perimeter track which crosses the undershoot of Runway 05.

Meteorology

There was a weak cold front to the east of the airport which was under the influence of a slack isobaric trough. The following Metars cover the period of the incident:

EGSS 291820Z 06006KT 6000 SCT010 BKN 018 14/12 Q1019

EGSS 291850Z 07006KT 6000 SCT 010 BKN 016 14/12 Q1019

At 1,000 feet the wind was 100°/8 kt.

The crew reported that they experienced some light turbulence in the lower part of the cloud layer.

Operating Staff Instruction (OSI)

OSI F30 was issued on 19 January 1999 following the accident to another company aircraft on 12 January 1999. (See AAIB Report 2/2000) It is reproduced in part below:

"With effect from 13 January 1999 ---- F27 operations will only use 26° Flap setting for landing. The Flap 40° landing setting is **not** to be used.

The use of 26° flap for landing will require pilots to be accurate on their V_{REF} speeds when approaching to land. Crews are reminded that their approach should be stabilised with landing flap and gear down by a minimum of 500 ft above aerodrome altitude. The decreased drag incurred by using 26° Flap for landing will reduce any deceleration in the later stages of the approach. It is therefor essential that a stabilised speed be established early, in order to achieve a successful landing at the 1000 ft point of the runway, at the correct landing speed."

Company advisory

The Company Advisory issued on 30 June 2000 had a section related to the incident. It is reproduced in part below:

" ---please be aware that the only protection against selecting ground fine pitch in the air is the mechanical baulk, which is overcome by raising the power levers. There is no protection against selecting ground fine pitch through the ground sense switch on either gear leg. It is therefore essential that, when closing the power levers in flight to correct a "hot and high" situation, great care is taken to ensure ground fine is not accidentally selected."

Propeller operation

Each engine drives a four bladed, hydraulically operated, constant speed, feathering propeller. There is no reverse pitch available but a 'ground fine' pitch of about 0° is used during the landing roll. The system incorporates the following locks and stops:

2 fixed stops; gfp stop (0°) and feathering stop (87°).

2 removable locks; flight fine pitch lock (20°) and flight safety lock (32°).

An electro-hydraulic stop, known as 'auto coarsening' (18°)

A panel on the right side of the glareshield has various lights and switches associated with propeller operation. The two blue 'Flight Safe Unlocked' lights illuminate if the propeller pitch is below 34°. Two red 'Prop Below Lock' lights illuminate if the propeller pitch is below 18° and gfp is not selected. Two amber 'Flight Fine Unlocked' lights illuminate when gfp is selected; the 'Prop Below Lock' lights are also on in this situation. An 'Isolating Switch' isolates the Flight Fine Pitch Stop removal electrical circuit.

With the gustlock selected, only one throttle at a time is free to be advanced beyond 12,800 rpm. The 'Throttle Lock Selector' is on the rear of the centre pedestal and permits the choice of which throttle lever is free to move.

Power control

In the Fokker F-27 the RPM control system is operated by control levers on the centre pedestal and these levers are mechanically linked to the control boxes on the engines. Within the centre pedestal the RPM control levers move a pair of camshafts which include a number of microswitches, including those allowing the propellers to move into the 'ground fine' range.

To operate these 'ground fine' microswitches, which are wired in parallel, at least one of the RPM control levers has to be brought back to the 'idle' RPM position, lifted against the force of a spring and retarded through approximately 13°. At this point the withdrawal solenoids for the 'flight fine' pitch locks are energised, allowing the propellers to move into the 'ground fine' range. With forward speed, operation in the 'ground fine' range creates high drag. In later designs of turboprop transport aircraft this motion towards the 'ground fine' range is generally inhibited if the aircraft is airborne, normally by a 'weight-on-wheels' logic. Some flight crews in F-27 aircraft are not aware that, in the F-27 design, it is possible to put the propellers into the 'ground fine' range in flight.

G-JEAE was examined by the AAIB and the operator's engineering company after the incident. It was noted that the forward movement of each RPM control lever, whilst lifted, is limited by the interaction between a baulking lug on the control lever and the flange of a stationary segment within the throttle box. It was found by experiment that, when the two control levers were gripped in a particular way, one or other of the baulking lugs could interfere with this flange, creating the impression of a 'throttle jam'. It was also found that releasing the operator's grip on the control levers allowed the springs to take the baulking lugs below the flanges, allowing the control levers safely to be moved forward into the 'flight' range.

Throttle lever movement test

The following forces were measured on G-JEAE and, for comparison, 4 other aircraft:

Out of Detent Force: the force required to lift the lever at the detent.

Force to Select gfp: the force required to move the lever aft into gfp

The Out of Detent Force was generally 7 lb to 7.5 lb. However, it was noted that the right lever on G-JEAE required only 5 lb.

The Force to Select gfp varied between 10 lb and 17 lb. Both levers on G-JEAE were in the middle of the range at 13 lb.

Past accident/incidents

As part of the AAIB investigation there was a review of various occurrence databases to search for similar incidents. This review revealed a substantial number of accidents and incidents involving the propeller control system in Fokker F-27s over a number of years, reflecting the type's longevity and number of aircraft in service. There were, however, no other instances reported which bore a resemblance to this one.

Discussion

The CVR record of the immediate post event discussion between the pilots confirmed that the selection of gfp was inadvertent rather than a deliberate act, done to slow the aircraft more quickly; in fact they both thought that gfp could not be selected in the air because of 'weight-on-wheels' protection. The commander thought it may have been caused by turbulence encountered coincident with the moment when he moved the power levers back to the flight idle position. The first officer confirmed the presence of slight turbulence but doubted that it was sufficient to cause the levers to be lifted over the gate. The presence of significant turbulence was confirmed by the level of normal 'g' recorded on the FDR. The system was found to be serviceable when examined subsequently and it is difficult to confirm, or find an alternate explanation to that given by the commander.

The most likely explanation for the restriction when the commander tried to return the power levers to the normal range, was that he was gripping them in such a way that one lever, probably the right one, was very slightly higher than the other and that the baulking lugs had interfered with the flange of a stationary segment within the throttle box, creating the impression of a 'throttle jam'. When he momentarily released his grip on the control levers, the springs would take the baulking lugs below the flanges, and allow the control levers to be moved forward into the 'flight' range.