Serious Incident

Aircraft Type and Registration:	Fan Jet Falcon Series D, G-FRAK	
No & Type of Engines:	2 General Electric Co CF700-2D-2 turbofan engines	
Year of Manufacture:	1969 (Serial no: 213)	
Date & Time (UTC):	14 November 2023 at 0930 hrs	
Location:	In-flight over South-West England	
Type of Flight:	Aerial work	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	None	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	56 years	
Commander's Flying Experience:	7,000 hours (of which 6,000 were on type) Last 90 days - 38 hours Last 28 days - 17 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and an investigation conducted by the operator in conjunction with the aircraft manufacturer	

Synopsis

The pitch control became restricted whilst operating at FL190. A MAYDAY was declared, and the aircraft diverted to the nearest suitable airfield. During the approach, the restriction cleared with a "thud" and the aircraft landed without further incident.

Subsequent investigation determined that the restriction was caused by rainwater collecting in a compartment under the pitch control idler link and then freezing at high altitude.

To prevent a recurrence, two safety actions have been taken; a modification by the operator to reduce the possibility of rainwater ingress and a modification by the aircraft manufacturer to increase drainage of the affected compartment.

History of the flight

The takeoff and climb in stages to FL190 were normal. After approximately 40 minutes at this flight level, and whilst turning, the pilots noticed the pitch control became restricted and it could no longer be moved sufficiently nose-up to maintain level flight in the turn. The aircraft was rolled wings level and stabilised in straight and level flight. The pilots felt the restriction had increased, and less nose-up pitch control deflection was available. A MAYDAY was declared, and the aircraft diverted to the nearest suitable airfield.

During the descent and approach the pilots noticed that the restriction seemed to initially be increasing but then, whilst attempting to move the pitch control, they felt the restriction clear with a “thud”.

The aircraft landed without further incident.

Recorded information

The aircraft’s flight data recorder was downloaded by the operator. The event data required for the investigation was shared with the aircraft manufacturer with AAIB permission. Relevant data relating to this serious incident was as follows:

- At the start of the flight until takeoff the OAT was 13°C.
- During climb after takeoff until the top of climb at FL170, the OAT reduced with height to minus 21°C for 5 minutes.
- A further climb to FL190 reduced the OAT to minus 25°C for 40 minutes until the restriction was felt.
- During the descent to 4,000 ft, the OAT increased over a period of 8 minutes, and was 4°C, when the restriction was overcome.
- The OAT continued to increase during further descent and landing until it was 13°C when the aircraft landed.

Analysis of recorded information by the aircraft manufacturer determined that the rear compartment skin would have been at minus 7°C, or lower, at the time of the occurrence.

Aircraft examination

Examination of the aircraft by the operator found evidence of trapped water in the control box compartment, at frame 37 in the rear fuselage, under the elevator (pitch) control idler (Figure 1). No other anomalies were found with the pitch control system or its components.

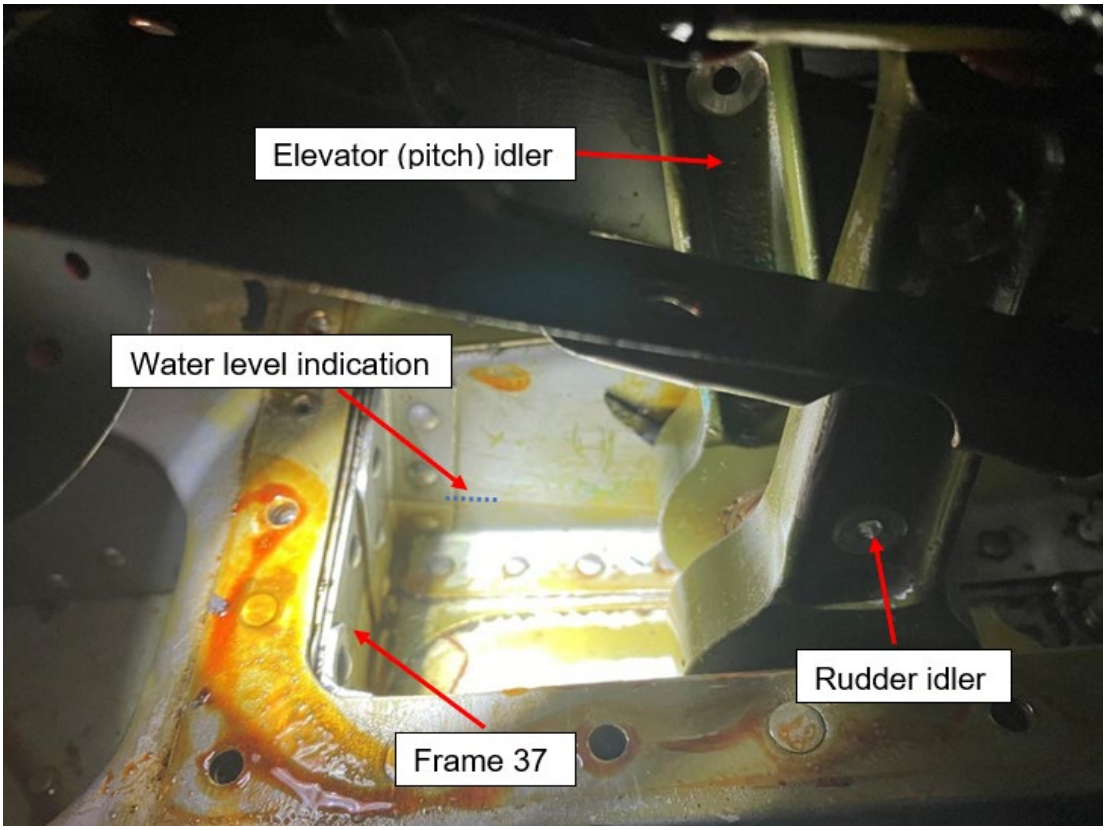

Figure 1

Control box area in rear fuselage
(Image used with permission)

Water drainage in this area is intended to be through natural gaps between the structural components to drains in the lower fuselage. On this aircraft, due to normal tolerances in the build process and the application of anti-corrosion fluid, the drainage path was restricted.

Tests and research

Subsequent investigation and testing by the operator found that if subjected to heavy rain, rainwater could enter the rear fuselage via the APU exhaust shroud and collect in a control box compartment.

The Fan Jet Falcon was not typically equipped with an APU; it was an option that could be installed or upgraded as part of a manufacturer modification or a third-party Supplemental Type Certificates. On the incident aircraft the APU exhaust was oriented upwards.

Testing using a model of the control box and a polymer to simulate the water level, showed that if this water froze into ice, it could restrict pitch control movement (Figure 2). The area of contact with the ice was a flat section of the idler that had been shaped to allow clearance with the aircraft skin.

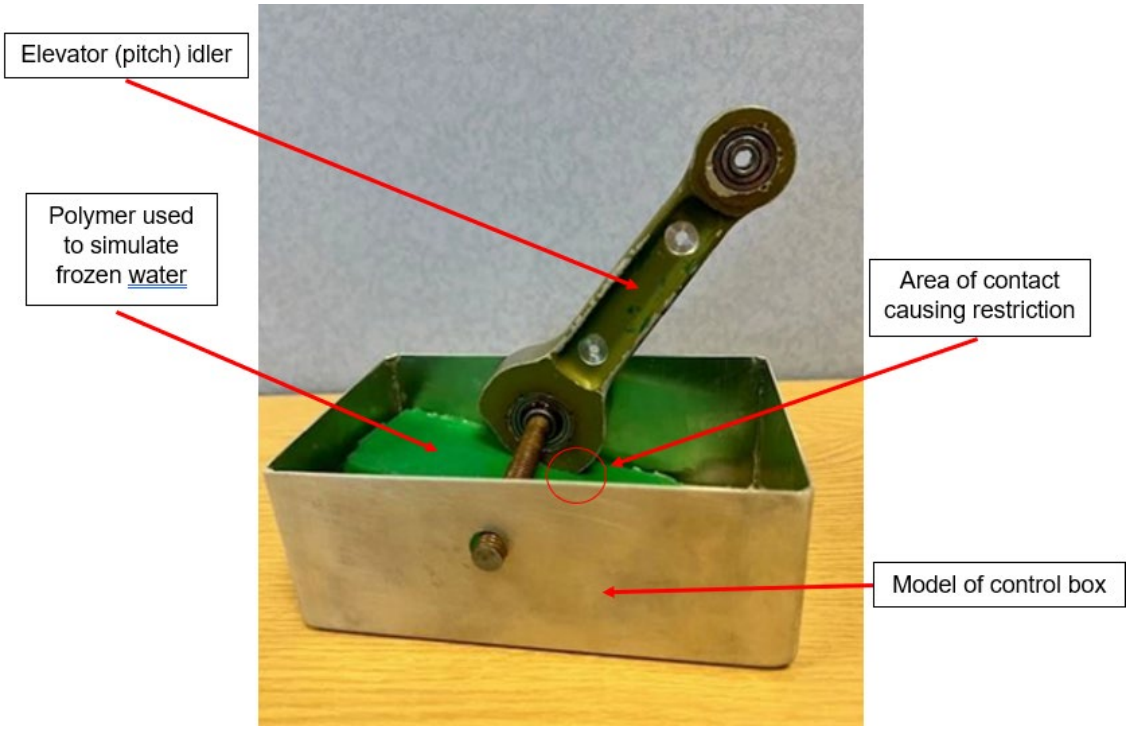

Figure 2

Test model showing how frozen trapped water could restrict control movement
(Image used with permission)

It is believed that only the operator's fleet and one other aircraft, with another operator, who has been informed of the issue, have a similar APU installation.

Rainfall leading up to the event

In the two months prior to this event, the Meteorological Office had recorded three storms with exceptional rainfall (Storms Babet, Ciaran and Debi). During the 41 days prior to the event, the aircraft had spent 23 nights outside and in the 12 days prior to the event the aircraft was parked outside overnight for 11 of them.

Analysis

Testing showed that in heavy rain, rainwater could enter the rear fuselage via the APU exhaust shroud. On this aircraft, the intended drainage path in the control box compartment was restricted due to reduced gaps between components, because of normal build tolerances, and the application of anti-corrosion fluid in the vicinity of the control box. This allowed the rainwater to collect in the control box beneath the elevator control idler in the rear fuselage.

Analysis by the aircraft manufacturer confirmed that the rainwater in the control box section would have had sufficient time to freeze in to ice, during the 40 minutes that the aircraft was at FL190, with an OAT of minus 26°C.

Once frozen, this ice would cause the restriction experienced by the pilots. It is likely that this ice then melted as the aircraft descended into warmer conditions, freeing the restriction.

Safety actions

As a result of this serious incident the following safety action have been taken by the aircraft operator:

To reduce rainwater ingress, a 'gutter rail' has incorporated above the APU exhaust to direct rainwater away from it (Figure 3).

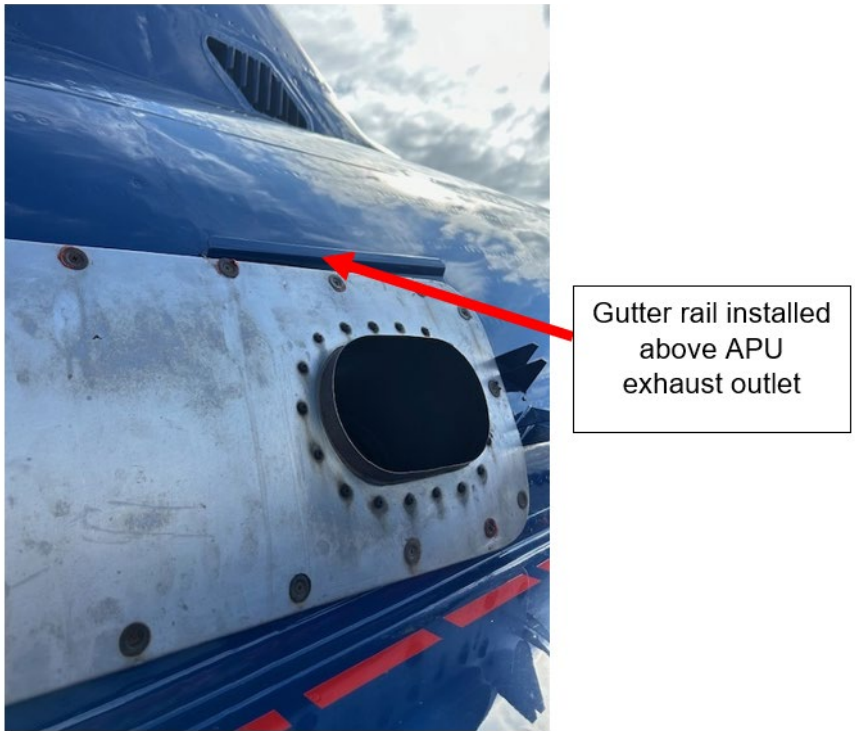

Figure 3

Gutter rail installation
(Image used with permission)

The following safety action has been taken by the aircraft manufacturer:

A modification has been developed to increase drainage in the compartment under the pitch control idler at frame 37, in the rear fuselage. This will be introduced as a service bulletin due to be published in September 2024.

Conclusion

During prolonged periods of heavy rain over several days' rainwater entered the rear fuselage and collected in the control box beneath the elevator control idler. When the aircraft was operating at altitude, the temperature in the rear fuselage compartment was sufficiently below freezing to cause this rainwater to freeze into ice. The control restriction experienced by the pilots, was due this ice restricting movement of the pitch control idler and this restriction cleared when the ice melted as aircraft descended into warmer air.