No: 4/85	INCIDENT	Ref: EW/C905
Aircraft type and registration:	Pilatus Britten-Norman BN2T Turbine Islander G-MAFF (light twin engined fixed wing aircraft)	
Year of Manufacture:	1981	
Date and time (GMT):	21 February 1985 at 1227 hrs	
Location:	1 mile northwest of RAF Coltishall, Norfolk	
Type of flight:	Aerial work — coastal fishery surveillance	
Persons on board:	Crew — 2	Passengers — None
Injuries:	Crew — None	Passengers — None
Nature of damage:	Nil	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	52 years	
Commander's total flying experience:	11,785 hours (of which 923 were on type)	
Information Source:	AIB Field Investigation.	

History of the Flight

The aircraft was refuelled to full tanks, including two underwing pod tanks, on the morning of the day prior to that of the incident. This was completed at Ronaldsway, I0M, before the aircraft departed for a surveillance patrol off the north east coast of England flying en route at F.L.50.

The aircraft was then flown to Newcastle where 630 litres of Avtur were uplifted, again to full tanks, giving a total fuel load of 1,655 lbs. No fuel anti-icing additive was introduced into the fuel on either occasion. The aircraft was parked in the open overnight.

The following morning the aircraft was prepared for a surveillance patrol over the sea east of the coasts of Durham, Cleveland, and North Yorkshire. The fuel sump drains, however were reportedly not operated that morning. The aircraft took off from Newcastle at 0945 hrs where the surface temperature recorded at 0950 hrs was 0°C. Because of extensive fog to the east, and poor visibility, the patrol was terminated after approximately 1½ hours, and the decision was made to relocate the aircraft at Norwich, the intended base for subsequent flights. During this time, at a height of 1000 ft, an engine parameter check was made and the ambient temperature was recorded as +7°C in the northern area being patrolled.

A Meteorological Office aftercast indicated that the 0°C isotherm offshore between the Humber and Norwich was 1000 ft a.m.s.l.

After making contact with Coltishall, and being identified on radar, the flight was transferred to the Norwich Approach Controller. At 1217 hrs the aircraft was cleared from 2,000 ft on QNH, to 1,500 ft QFE and shortly afterwards the pilot reported level at 1,500 ft "India Mike" (IMC — in cloud). The current Norwich weather was passed to the pilot and included a light and variable wind, visibility of 5,000 m, 5 oktas of cloud at 400 ft, and a surface temperature of +2°C. At 1222 hrs the pilot reported that the right engine had failed, and later confirmed that the aircraft was maintaining height, and that he would "like to cut the corner" (i.e. intercept the runway 27 ILS localiser closer in than the 5 mile final approach previously requested). The controller, in addition to giving the radar headings, advised the pilot that there were 13 track miles to run to Norwich at 1225 hrs, and that the measured cloudbase was currently 600 ft. Some 20 seconds later the pilot reported that he was having problems with the left engine and could not maintain height. As the aircraft was close to RAF Coltishall and in the "dark area" of the radar head positioned there, suggested headings were passed by the controller for a possible attempt at a landing at Coltishall. The aircraft broke cloud at an estimated 350 ft agl, ½ mile short of the airfield and the pilot saw a suitable field approximately 90° to the right. The aircraft was manoeuvred over a power cable and between two tall trees for a safe landing on a cultivated field. The RAF emergency services at Coltishall were alerted when the second engine failed.

After the pilot had called Norwich, then Coltishall on RTF giving the location of the aircraft and field, the vehicles arrived at the aircraft within an estimated 2 minutes.

Examination of the aircraft

Aircraft — general

Damage to the aircraft was limited to very minor distortion of the undercarriage leg fairings, caused by the legs flexing rearwards as the aircraft ran over furrows in the field.

The "fuel consumed" indicator in the cockpit was reading 821 lbs and the fuel gauges, which monitor main tank contents only, were each indicating 44 US gals. The tanks were dipped and the dip levels subsequently calibrated to establish the actual levels in both main and pod tanks. The main tanks contained 43 US gals each and the pod tanks 23.5 US gals each. These values accord with the "fuel consumed" indicator reading and confirm that the aircraft started the flight with completely full tanks. The fuel level in each of the main tanks was approximately 7 US gals more than the amount which had been pumped up from the corresponding pod tank, confirming that the main tanks had not been run dry in the air.

The aircraft was equipped with fuel pressure gauges, which indicate the fuel pressures at the inlets to the engine driven pumps. Each of these gauges was found to stick very badly, requiring continual "rapping" of the instrument face to prevent the needle jamming, and rendering the instruments valueless in flight.

Fuel samples were taken from the aircraft tanks, from the water drain points, from the auxiliary and transfer pump filter chambers and the fuel injector feed lines. Visible moisture was noted during the sampling of the water drains and filter chambers, mainly in the form of "bubbles" of ice which adhered to the walls of the sampling cup. The sample from the port main tank drain contained a globule of free water approximately 1cc in volume.

Analysis of the samples showed that none contained excessive amounts of dissolved water, but significant amounts of free water were found in the samples from both of the main tanks, the starboard auxiliary pump and from both port and starboard fuel transfer pumps. In other respects the fuel conformed to the specification for Jet A1. Representative samples taken from the re-fuel points at both Newcastle and Ronaldsway were found to be within specification.

Fuel system checks

Gravity and pumped flow rates were measured at various point in the fuel system. Acceptable flow rates were achieved using both auxiliary and back-up pumps, but discrepancies were found between the flow rates achieved under gravity on the left and right sides of the aircraft: the flow rates at the base of the right auxiliary pump and at the right engine firewall were less than half those at the corresponding points on the left side. The apparent "obstruction" was traced to the fuel line between the right main tank sump outlet and the auxiliary pump. Following purging of this line with warm nitrogen, the flow rates under gravity improved to values identical to those achieved on the left side. During purging of the line, a container was held over the free end of the pipe but no foreign objects were ejected, nor were any subsequently found in the filter chambers. The cause of the restriction in the original flows could not be positively established, but could have been due to slight stiffness of the valves within the pump, which would be significant under gravity flow, but much less so under pumped flow conditions. It is also possible that ice was partially obstructing the line, but this is considered to be a less likely cause of the restriction.

With the exception of the temporary mismatch in the left and right gravity flow rates, no abnormality of any significance was found in the fuel systems.

Engine runs

The engines were started and ran normally on the fuel in use at the time of the incident provided the auxiliary pumps were switched on. However, in the case of each engine, if the auxiliary pump was switched off, the fuel flow fell to zero and it was necessary to immediately re-select the pump "on" to avoid flame out. With the exception of the need for auxiliary pumps to be "on", both engines performed satisfactorily.

The aircraft was de-fuelled and replenished with fresh fuel from RAF Coltishall, which contained an anti-icing additive, after which the engines were ground run. Both engines started normally, without the use of auxiliary pumps, and continued to run normally throughout the power assurance checks. Selection of auxiliary pumps "on" produced a transient rise in fuel flow, whilst the fuel system redatumed, and de-selection produced a transient fall in flow rate. The engines performed normally throughout.

The aircraft was subsequently flown out of an adjoining field to RAF Coltishall, where it was refuelled fully before departing to its home base at Hurn. Both flights were made with the auxiliary pumps "on" as a precaution*, but subsequent test flights were carried out using Jet A1 (with no anti-icing additive) and AVTUR (with anti-icing additive), and in each case both engines performed normally with the auxiliary pumps both "on" and "off".

Precautions against icing

The CAA approved Flight Manual for G-MAFF required the use of powerplant anti-icing during operation at temperatures less than +5°C in conditions of visible moisture. At the time of both engine failures, G-MAFF was in cloud at an outside air temperature estimated between 0°C and −2°C, based on meteorological aftercast data and the surface temperature passed to the pilot immediately prior to the first engine failure. The Flight Manual stated further that, in the event of powerplant icing being encountered unexpectedly, or suspected, then the igniters should be switched to "continuous on" followed by the selection of powerplant anti-icing. Neither igniters nor powerplant anti-icing were used at any stage during the incident flight.

The Flight Manual also stated that for prolonged operation at temperatures less than 0°C a suitable anti-icing agent should be blended with the fuel in order to prevent the possibility of filter icing, which can lead to engine flame out. Details are given in the Flight Manual of a suitable method of blending a proprietary anti-icing agent (supplied in an aerosol container) with the fuel at the time of refuelling. A supply of anti-icing agent was carried on

board the aircraft but was not used, either at Ronaldsway or at Newcastle. It is worthy of note that certain other aircraft having a similar type of engine, for example versions of the Bell 206 and Sikorsky S61 helicopters not having anti-icing modifications to the fuel system, require the use of an anti-icing additive in the fuel for operation at temperatures below +4°C.

*NOTE: The use of auxiliary fuel pumps outside the conditions laid down in the flight manual can, on certain aircraft types, lead to loss of engine power or complete engine failure.