AIRCRAFT ACCIDENT REPORT 2/83

Accidents Investigation Branch

Department of Transport

Report on the accident to Britten-Norman Islander G-BDNP at St Andrew Guernsey Channel Islands on 18 September 1981

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Department of Transport
Accidents Investigation Branch
Bramshot
Fleet
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Hants GU13 8RX

7 July 1983

Sir Charles Frossard
Bailiff of Guernsey

Sir,

I have the honour to submit the report by Mr D A Cooper, an Inspector of Accidents, on the circumstances of the accident to Britten-Norman Islander G–BDNP which occurred at St Andrew, Guernsey, Channel Islands on 18 September 1981.

I have the honour to be
Sir
Your obedient Servant

G C Wilkinson
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Aircraft Accident Report No: 2/83
(EW/C 768)

Operator:		Jersey European Airways Ltd
Aircraft:	*Type:*	Britten-Norman Islander
	Model:	BN-2A-27
	Nationality:	United Kingdom
	Registration:	G–BDNP
Place of Accident:		St Andrew, Guernsey, Channel Islands Latitude: 49° 27′N Longitude: 002° 35′W
Date and Time:		18 September 1981 at 1742 hrs.
		All times in this report are GMT.

Synopsis

The accident was notified to the Department of Trade Accidents Investigation Branch, by Air Traffic Control at Guernsey Airport, at 1900 hrs on 18 September 1981. The Bailiff of Guernsey ordered an Inspector's Investigation to be conducted under the Civil Aviation (Investigations of Accidents) (Guernsey) Order 1972.

The aircraft was on a scheduled flight between Jersey and Guernsey when, shortly before arrival at Guernsey, the starboard engine lost power. Adjustment of the engine controls failed to rectify the situation and during the final approach to the runway at Guernsey the port engine also lost power. An emergency power-off landing was carried out in a field and all occupants evacuated the aircraft. The passengers suffered minor injuries, but the Commander received serious injuries caused by the aircraft's impact with a stone wall. There was no fire.

The report concludes that the accident occurred because of the Commander's mismanagement of the aircraft's fuel system in that both engines failed through fuel starvation when the usable contents of the tip tanks, which were feeding the engines, became exhausted when there was ample fuel remaining in the aircraft's main tanks. Contributory factors were the Operator's procedures, inadequacies in the check lists, and the position of the fuel selector panel and switch levers in relation to the pilot's eyes.

1. Factual Information

1.1 History of the flight

Jersey European Airways Flight 245 departed from Jersey Airport at 1729 hrs on 18 September 1981 with one pilot and eight passengers. This was a delayed flight since the aircraft originally allocated to the service G–BESO, had developed an engine fault shortly after take-off and had returned to Jersey. Britten-Norman Islander G–BDNP was then made available as a replacement aircraft. The prevailing weather was a westerly wind with a cloud base of around 1,500 feet, and Flight 245 was cleared on a Special VFR flight plan to Guernsey at a height not above 1,000 feet. When about 8 miles from the Guernsey coast the aircraft, under Guernsey Approach Radar Control, was directed to turn north towards the island of Herm as a delaying manoeuvre to allow a Partenavia, G–BFSU, inbound from the north-east to approach first.

Shortly after making the turn the starboard propeller of G–BDNP began to hunt – a condition where the propeller blade angle alters in order to maintain a constant propeller RPM as the engine power fluctuates. The engine did not fail completely, so the Commander decided not to feather the propeller but requested from Air Traffic Control (ATC) a more direct approach to Guernsey Airport. This was agreed by ATC who then requested the Partenavia to carry out a right hand orbit in order to allow the Islander to approach first. Following closely behind the Islander was a Twin Otter, call sign G–BIMW. This resulted in a new landing sequence of the Islander, the Otter and then the Partenavia.

The Commander of the Islander meanwhile had been trying to rectify the erratic running of the starboard engine by adjusting the carburettor heat and mixture controls, and by switching 'On' the auxiliary fuel pumps, but this did not achieve any improvement. He was, however, able to maintain 600 feet until established on a long final approach to runway 27 when the port engine suddenly lost power. As the aircraft yawed to port due to the power loss the starboard engine suddenly regained power for about one second, further accentuating the yaw. Realising that he could not now continue his approach to the airport he chose a landing site in an area of fields. He then selected the engine fuel mixture controls to 'Off' in order to prevent a sudden burst of power upsetting the approach, lowered full flap and carried out an emergency landing. The pilot stated that after touching down in one field the aircraft cleared a 6 feet high stone wall and then landed in the next field. Ground marks showed that it then travelled about 190 feet before the port mainplane struck and then rode over a stone wall. This broke off the port undercarriage and deflected the aircraft to the right. It then continued through a five-bar gate, crossed a road, and came to rest in the driveway of a guest house.

There was no fire and the passengers and the Commander were able to leave the aircraft through the doors and emergency windows. The Commander sustained severe laceration of his legs, broken fingers, and a head injury, but was able to assist in the evacuation of the eight passengers who had received only minor injuries. One of the passengers went immediately to the guest house and made an emergency telephone call for fire and ambulance assistance.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Serious	1	0	0
Minor/None	0	8	

1.3 Damage to aircraft

The aircraft was extensively damaged and beyond economic repair.

1.4 Other damage

There was damage to farm gates, walls and hedges.

1.5 Personnel information

1.5.1 Flight crew

Commander:	Male, aged 38 years
Licence:	Commercial Pilot's Licence valid until 28 April 1990 Aircraft Ratings: DHC1, PA31, BN2A and 2B Instrument Rating valid until 1 April 1982 Certificate of Test Islander aircraft valid until 3 February 1982
Medical certificate:	Class One certificate valid until 31 March 1982 with no limitations
Flying experience:	
Total hours on all types:	5,400
Total hours in command:	5,300
Total hours on type:	250
Total hours last 28 days:	43 (24 on type)
Duty period:	10 hours 10 minutes
Rest period:	13 hours since previous duty

The Commander had operated into Guernsey Airport on many occasions.

1.5.2 Air Traffic Control

The Approach and Aerodrome Controllers were properly licensed and medically fit to carry out their duties.

1.6 Aircraft information

1.6.1 Main particulars

The Islander is a high wing monoplane powered by two Lycoming O–540–E4C5 normally aspirated engines driving Hartzell constant speed, fully feathering, propellers. There are seats for ten persons including the pilot(s). The BN-2A-27 model differs from the standard Islander in that it is fitted with modified wing tips which incorporate additional fuel tanks.

Registration:	G–BDNP
Manufacturer:	Pilatus Britten-Norman Bembridge, Isle of Wight
Type:	Islander BN-2A-27
Serial No:	496
Date of manufacture:	1978
Certificate of Airworthiness:	Transport Category (Passenger) valid to 19 September 1982
Certificate of Maintenance:	Issued 4 September 1981 at 2,163 flying hours, valid for 62 days or 150 flying hours
Total airframe hours:	2,174
Total engine hours:	Starboard 2,174 Port 2,656 (378 since overhaul)
Maximum take-off weight:	6,600 lb (2994 kg)
Maximum landing weight:	6,300 lb (2858 kg)
Fuel contents – main tanks:	
Usable Unusable	65.0 US gals (54 Imp gals) in each of the two tanks 3.5 US gals (2.9 Imp gals) per tank
Fuel contents – tip tanks:	
Usable Unusable	27.5 US gals (23 Imp gals) per tank 2.0 US gals (1.7 Imp gals) per tank

1.6.2 Description of the fuel system

The aircraft's fuel system is illustrated at appendices 1 and 2. Fuel from the main or tip tank in either wing is led to an electrically actuated tip tank cock interposed between the inner wing tank and two booster pumps, known as 'auxiliary pumps'. The position of each cock is electrically selected by operation of a switch which is mounted on a small console panel on the windscreen centre post; the selection options are for the main or tip tanks to supply fuel to the respective auxiliary pumps. The position achieved on the cocks (not necessarily the position to which they are switched) is indicated by four green lights, labelled MAIN and TIP, adjacent to the selector switches. Between the lights is a switch labelled IND LTS which allows the pilot to render the indicating lights inoperative.

The auxiliary pumps are operated by two ON/OFF switches adjacent to their respective main tank fuel contents gauges on the roof instrument panel. The tip tank contents gauges are mounted at the forward end of the right side passenger service panel. From the auxiliary pumps fuel is supplied to either engine via the respective main fuel cock, situated just inboard of the nacelle and operated from its respective three position selector handle in the centre roof panel by means of a Bowden cable and chain-and-sprocket loop. Selector positions, for the port engine, are labelled OFF, PORT TANK, and STBD TANK. With the selector to PORT TANK, the port engine is supplied with fuel from its associated wing. With the selector to STBD TANK, the port engine is supplied with fuel from the opposite wing. The starboard engine fuel selector is labelled and operates similarly in the opposite sense.

1.6.3 Operation of the fuel system

The Flight Manual states that for structural reasons 80lb of fuel (11 Imp gals, 13.5 US gals) should be retained in each wing tip tank at all times except that this fuel may be used as reserve for flights to alternate airfields and holding. A yellow sector is marked on the tip tank contents gauge to indicate the 80lb structural reserve fuel. This 80lb of fuel includes the un-gauged 1.7 Imp gals (2.0 US gals) which are unusable in each wing tip tank due to attitude limitations. The wing tip tanks must always be refuelled before the main tanks and used in flight after the main tanks are exhausted. The fuel in the main tanks may be used below the zero marking in cruise flight until the tanks are empty. Between 40 and 50 seconds of warning are given before engine malfunction occurs due to fuel exhaustion. The warning is characterised first by a drop-off of fuel pressure followed by a gentle hunting of the propeller. At no time may take-off or landing operations be conducted on main tanks when the fuel contents gauge of either main tank indicates three gallons or below.

The following extract is taken from Supplement 17 to Section 7 of the Flight Manual: "Handling in Flight

1. Before take-off, check the functioning of the electrically actuated fuel cocks by selecting from main tanks to tip and returning to main tanks checking that the appropriate indicator lights illuminate. Select the appropriate tank for take-off and again check that the position lights are correctly illuminated. The lights may be selected 'On' or 'Off' by a switch mounted in the centre of the auxiliary panel.

2. For take-off the manually controlled main fuel cocks may be selected in the normal way. In this way the pilot's main fuel cock selectors in the cabin roof determine whether the fuel is fed from the left-hand or right-hand side to an appropriate engine. The auxiliary fuel panel switches then select whether the fuel comes from the tip tank or the main tank on the selected side.

3. The auxiliary fuel pumps should be used in the normal manner for take-off or landing with either the tip tanks or main tanks selected. In addition, the auxiliary fuel pumps should be used whenever below zero fuel quantities are indicated for the main fuel tanks and the process of transfer to the wing tip tanks is completed with satisfactory engine operation established. The pumps should also be selected when the fuel quantity falls below 5 gallons in the tip tanks."

1.6.4 Aircraft check lists

The aircraft's Flight Manual, Section 4 Normal Operating Procedures, contained check lists for the operation of an Islander not fitted with tip tanks. The Operations Manual stated that the approved Company check lists were to be used at all times, and the Flight Manual check lists were reproduced in the Operations Manual. The information given in Supplement 17 on checking the functioning of the fuel cock selection system had not been incorporated in the Operations Manual check lists, which were thus for an Islander not fitted with tip tanks.

A separate set of Check Lists and Emergency Drills had been compiled by the Operator and was included as part of the aircraft library of all the Islanders for day to day use on the flight deck. The sequence of checks in this flight deck check list was significantly different from that in the Operations Manual. There was no reference to checking the contents of the tip tanks, or the operation and setting of the fuel cock switches and indicator lights.

1.6.5 Weight and Centre of Gravity

1.6.5.1 The weight and centre of gravity schedule

The Air Navigation Order, Article 15, requires that an aircraft be weighed, the position of the centre of gravity established, and that the Operator prepare a Weight Schedule showing this information. This Weight Schedule was included in the Flight Manual carried in G–BDNP and was in four parts.

Part A was concerned with the basic weight of the aircraft. This weight was established from a weighing report produced by the manufacturer and included the weight and centre of gravity of the airframe, engines, fixed equipment, and also 44lb of unusable fuel and 10lb of unusable engine oil.

Part B Variable Load. This comprised the equipment placed on board by the Operator so that the aircraft might carry out a specific role as a passenger, freighter or ambulance aircraft. In the case of G–BDNP in the passenger role this included the weights and centres of gravity of the passenger seats and lifejackets. The summation of the weights and moments of Parts A and B was listed in Part C as the Operating or Aircraft Prepared for Service (APS) Weight.

Part D gave the Loading Information (Disposable Load). The moment arms were listed for the fuel, engine oil, baggage hold, and for each of the passenger seat rows to enable the centre of gravity of the aircraft to be calculated prior to take-off.

In the Operations Manual there was a statement of the APS weight, centre of gravity moment and basic index. It was intended that this information be used by the pilot to establish the correct loading of the aircraft. In the case of G–BDNP, this information had been incorrectly calculated; the centre of gravity moment and the basic index for the aircraft in a passenger role was shown as 818.8 (lb.ins/100) and 19.6, whereas the correct figures should have been 970.8 (lb.ins/100)and 23.3 respectively. There were similar errors in the figures for the aircraft in a freighter role.

The Operations Manual included "Instructions for Correct Loading". Company pilots were instructed to record the weights and moments of crew, passengers, baggage, cargo, fuel and engine oil. However, there was a further contradictory and incorrect statement that the APS weight included full engine oil, whereas only the weight of the 10lb of unusable oil was actually included, a difference of 35lb.

1.6.5.2 The actual weight and centre of gravity

Take-off weight:	5,946 lb
Weight at time of accident:	5,896 lb

It is a requirement of the Air Navigation (General) Regulations 1981, Regulation 4, that the actual weights of the passengers be used for load and balance purposes, (on larger aircraft it is permissible to use 'standard weights'). The passengers were weighed prior to the flight and the total weight of the passengers recorded but not that of individual passengers. The passengers were not sitting in the same positions as were shown on the aircraft's Load Sheet, but the centre of gravity of G–BDNP for this flight has been calculated using the standard weights of 172 lbs for a male passenger, 150 lb for a female and 22 lb for an infant together with their known seating positions. The discrepancy between the known total weight of the passengers and the total weight using standard weights is only 25 lb and is not considered to be significant. It is calculated that the centre of gravity of the aircraft on this flight was 19.8 inches aft of datum. The Flight Manual allows a centre of gravity range extending from 19.2 inches to 25.6 inches aft of datum at an aircraft weight of 5,896 lb.

1.7 Meteorological information

The weather observation taken by Guernsey Airport meteorological office at 1745 hrs showed:

Surface wind:	250° true, mean speed 15 knots, gusting 19 knots
Visibility:	40 km
Weather:	Fine

Cloud:	1 okta Cumulus at 1,500 ft
	1 okta Cumulo-nimbus at 2,500 ft (not over the airport)
	1 okta Strato-cumulus at 7,000 ft
	1 okta Cirrus at 25,000 ft
Temperature:	15°
Dew point:	11°C
Relative humidity:	77%
Regional QNH:	1007.5 millibars
Airfield QFE:	996.5 millibars

The accident occurred in daylight, 26 minutes before sunset.

1.8 Aids to navigation

Not relevant.

1.9 Communications

All communications between the Islander G–BDNP and Guernsey Air Traffic Control (ATC) were recorded, as were the radio communications between ATC and the Aerodrome Fire Service (AFS). Recordings were also made of the emergency telephone link between ATC and the Guernsey Fire Brigade (GFB) at St Peter Port.

In the minutes prior to the accident the Approach Controller was controlling three aircraft: a Partenavia with the call sign 'Sierra Uniform' (SU) approaching from the northeast, the accident aircraft G–BDNP with the call sign '245' and a Twin Otter call sign 'Mike Whiskey' (MW) following just behind '245' and en route to Guernsey from Jersey. The original sequence for the approach was to have been 'SU' followed by '245' and then 'MW'. However, in order to achieve sufficient separation behind 'SU', '245' was given a course alteration to take it towards the island of Herm. Almost immediately after this turn the pilot of '245' informed the Approach Controller that there was a problem with the starboard engine and that he wished to proceed directly to the airport. This was approved by ATC who then arranged that 'SU' should orbit through 360° to allow '245' to approach first. The Approach Controller then used the intercommunication facility to the Aerodrome Controller with the intention of informing him of the revised landing order (245, MW, SU) and that '245' had an engine problem. However, he used the wrong identification and told the Aerodrome Controller that 'SU' was now 'Turning in number one, right-hand engine playing up ...' Shortly after that, he informed the Aerodrome Controller that 'SU' was going to carry out an orbit.

On the basis of this information, at 1738 hrs, the Aerodrome Controller put the AFS onto 'Local Standby', warning them that the Partenavia 'SU', now number 3 to land, had an engine problem.

1.10 Aerodrome information

Guernsey Airport is licensed annually by the Royal Court of Guernsey. The last inspection of the aerodrome had been carried out on 13 January 1981 and at the time of the accident to G–BDNP the airport was fully serviceable.

1.11 Flight recorders

Neither a flight data recorder nor a cockpit voice recorder was required or carried.

1.12 Examination of wreckage

1.12.1 Preliminary examination

Skid marks indicated that after a light touchdown the aircraft continued to run in a near straight line until after 190 feet of landing roll when the port wing rode up over a stone wall bounding the left side of the field. This collision broke off the port lower undercarriage leg and wheel assembly and deflected the aircraft to the right and through the far gateway of the field, across a road, and into the funnel shaped entrance to the driveway of a guest house opposite. The outer wings simultaneously struck the stone walls of the driveway entrance breaking off both outer wing sections. The aircraft was progressively decelerated as it continued into the narrowing entrance and although the fuselage broke away from the wing attachments it only travelled a further 12 inches before coming to rest. The cabin area survived substantially intact.

The pilot's seat had become partially detached from the seat-securing framework, and this framework had in turn become partially detached from the floor. All of the passenger seats had remained intact, although they had suffered slight lateral distortion to port; all of the seat harnesses and passenger seat harness attachment points were secure. The pilot and co-pilot positions were equipped with shoulder restraint harnesses which were in use at the time of the accident. The rear passenger door on the port side of the aircraft was still partially in position but the window frame was broken and the glazing panel had fallen out, providing a means of exit from the aircraft. The forward passenger door on the starboard side of the aircraft and the pilot's door had both burst from their frames and separated from the aircraft during the collision sequence.

The centre and inner wing structure extending to 3 feet outboard of the engine nacelles was in one piece and relatively undamaged, but the port main fuel tank had split and the whole of its contents was lost. The starboard main tank was intact and its contents of 24 Imperial gallons were drained by the emergency services. Both of the outer wings had suffered extensive damage but the wing tip fuel tanks survived with only minor damage, each tank contained a small amount of fuel which was later recovered. The main fuel selectors had been displaced to random positions as a result of impact forces affecting the cable operated system, but both tip tank selector switches were at the 'Tip' position and the associated indicator lights were switched to 'Off'. Both auxiliary fuel pump

switches were selected 'On'. The carburettor feed pipes were found to be dry and neither strainer bowl was found to contain more than a few drops of fuel. The carburettor float chambers were drained and although a small quantity of fuel was found in each bowl it was significantly less than the normal bowl capacity. Neither the filter bowls nor the carburettors had had any opportunity to drain prior to their contents being checked. The electrical screw-jack actuators which operate the main tank/tip tank selector valves were examined and each was found to be in the tip tank position.

Both engines remained securely attached to the inner wings. The starboard engine and its propeller were undamaged, the port engine had suffered only superficial damage and its propeller blades were bent rearwards. Neither propeller exhibited any evidence of power being developed at the time of the accident.

1.12.2 Engine tests

Both engines were test run in a test bed facility. Neither engine was disturbed prior to these tests, except for the removal of the oil cooler and exhaust systems to facilitate installation in the test stand.

The starboard propeller, which was undamaged, was not removed from its engine prior to testing. The operation of this engine, constant speed unit and propeller was found to be normal throughout the speed range. In particular there was no evidence of hunting – the constant speed unit maintained a smooth and positive control of the propeller speed. The power unit was run at cruise power for a period exceeding the duration of the accident flight and its performance remained entirely normal at all times.

Because of the damage to the port propeller and slight impact distortion of the propeller mounting flange, the tests which were carried out on the port engine were necessarily more restricted than those carried out on the starboard power unit. Nevertheless, it was possible to run the engine using a wooden test club propeller to approximately 1800 rpm. Throughout the period of test running the port engine responded normally. The port engine propeller constant speed unit was strip examined for evidence of contamination but none was found. Its performance was rig checked and found to be normal.

1.12.3 Fuel system

Both wing tip fuel tanks had been punctured during the accident sequence. Each tank was set up in an attitude approximating as closely as possible to that in which it was found immediately after the accident. The tanks were filled with water and the contents allowed to leak out of the punctures until all leakage ceased, whereupon the quantities remaining in the tanks were checked. It was found that the starboard tip tank could hold in excess of 11 Imperial gallons and the port tip tank could hold 3½ gallons. Less than 1 pint of fuel had been recovered from each of these tanks; it can therefore be stated that this low fuel quantity was not a result of post crash leakage of fuel since the tanks were capable of holding considerably more fuel than the amount found.

The porting of the main tank/tip tank selector valves was checked and in each case was found to be selected to tip tank. All fuel lines in the vicinity of the selector valves were empty. The electrical operation of the selector valves was checked and both valves were

found to operate normally; the selector valve switches and valve position indicating lights were checked and all found to be serviceable. The operation of the fuel system as a whole, between the inlet port to each pair of auxiliary fuel pumps and each engine, was checked with the main fuel selectors in both direct feed and crossfeed positions. In all cases adequate quantities of fuel were delivered to the carburettor float chambers until the valves were selected to 'Off' when the systems were effectively stopcocked.

The operation and history of the electrical fuel gauging system was examined. Some impact damage had occurred to the tip tank gauges and this was repaired before a check calibration was carried out. There is no reason to doubt that the two main tank gauges and the port tip tank gauge had been operating normally. However, it could not be established whether the starboard tip tank indicating system had been serviceable at the start of the flight.

There was no evidence of water anywhere in the fuel system. Samples of fuel taken from the fuel system were sent for laboratory examination and all were found to conform to the specification for Avgas 100 LL.

1.12.4 Electrical System

The electrical system was examined and it was found that the wiring to the main battery bus bar relay had been torn away in the impact. As a consequence the main DC bus bar which feeds, among other services, the main tank/tip tank selector actuators would have lost all power before the aircraft had come to rest. No evidence of any pre-impact abnormality was discovered.

1.12.5 Flying controls

The flying control system was examined and no evidence of any disconnection or other abnormality was found. The wing flap operating mechanism was in the fully extended position.

1.12.6 Aircraft maintenance documents

G–BDNP's maintenance documents showed no defects in the aircraft's history which might have had a bearing upon the engine failures. The aircraft had been maintained in accordance with a United Kingdom CAA approved maintenance schedule. A Certificate of Maintenance had been issued on 4 September 1981 and was valid at the time of the accident. A flight test for the renewal of the Certificate of Airworthiness had taken place on the 9 September 1981 and the renewal certificate had been issued to take effect from the 20 September 1981, being valid for a further year. This flight test had been carried out by the Commander of the accident flight. He has stated that he did not prolong the use of the tip tanks beyond the 3 minutes needed to satisfy the requirements of the Certificate of Airworthiness because the gauges were already indicating low contents – i.e. below the 11 gallons needed for wing load relief. There is no record of the tip tanks having been refuelled after this flight.

1.13 Medical and pathological information

There were no medical or pathological factors.

1.14 Fire

There was no fire.

1.15 Survival aspects

1.15.1 The Commander and a passenger who had been sitting in the co-pilot position wore full seat harness, the other passengers had their lap straps fastened. Minor injuries were sustained by the passengers as a result of the decelerative forces. The Commander received serious injuries resulting from the aircraft's impact with the walls of the driveway. All the passengers evacuated the aircraft through the door openings and emergency windows under the supervision of the Commander.

1.15.2 Action by the emergency services

Three units of the Aerodrome Fire Service (AFS) took up pre-arranged stations on the airport in the state of readiness known as 'Local Standby' and watched the three aircraft on approach. They had been informed by Air Traffic Control that the third aircraft, the Partenavia 'SU', had an engine problem. Consequently they were surprised when the first aircraft, the Islander 'G–BDNP', suddenly turned away from the airport and disappeared below their horizon in a descending right turn. All three units of the AFS responded rapidly by leaving the airport on the instructions of their Section Leader and proceeded towards the direction of the likely accident site. This left the airport without fire service cover for G–SU which, fortunately, was not in difficulty as had been believed. The Aerodrome Controller had also seen the Islander disappear below his horizon and immediately alerted the Guernsey Fire Brigade Headquarters in St Peter Port using the direct telephone link, directing them to an approximate accident site 3 miles north-east of the airport.

The Guernsey Fire Brigade (GFB) then received an emergency telephone call from one of the aircraft's passengers using the telephone at the guest house where the aircraft had crashed. Units of the GFB and the St John Ambulance Service were then directed to the exact location, arriving at 1747 hrs. This information was not passed to the control tower at Guernsey Airport because the direct telephone link could not be used in the reverse direction i.e. from the GFB to ATC, and the public telephone system was not used. As the radio equipments in GFB and AFS vehicles were incompatible with each other the information could not be passed by radio. The consequence of this was that the AFS had to search for the crash site, and when they arrived they found the GFB and ambulance services already in attendance.

The AFS then laid a foam blanket under the port side of the aircraft where there was a fuel spillage, using 25 gallons of foam concentrate and 400 gallons of water. A saw-dust dam was built to prevent fuel from flowing into a nearby stream from where it might have contaminated the Island's water supply. The battery was removed from the aircraft. The AFS returned to the airport and the GFB remained in attendance providing fire cover until the fuel had been drained from the starboad main tank of the Islander.

1.16 Tests and research

None.

1.17 Additional information

1.17.1 Technical Log and Load Sheet

A combined Technical Log and Load Sheet was used by the Operator. This form was used as follows: On arrival at a destination, the incoming aircraft Commander filled out the top of the form with details of the flight and also any unserviceabilities, leaving the remainder of the form for details of the outgoing flight. The outgoing Commander then included the fuel uplift and the passenger load and calculated the take-off and landing weight for the next flight.

The fuel consumption figures quoted in the Operations Manual were in Imperial gallons per hour while the fuel contents gauges in G–BDNP were calibrated in US gallons. The gauge readings in US gallons had to be converted into Imperial gallons for entry into the Technical Log. The fuel uplift, metered by the fuel bowser in litres, also required conversion to Imperial gallons for comparison with the fuel contents and entry into the Technical Log. The entire fuel load had then to be converted into pounds for the Load Sheet calculations.

The passenger and baggage weights were normally supplied to the Commander in kilograms, and these figures therefore also required conversion to pounds for entry on the Load Sheet.

In summary, there were five conversions needed to provide Load Sheet details prior to the departure of every flight:

(i) US galls to Imperial galls (contents on arrival)

(ii) Imperial galls to Litres (fuel uplift requirement)

(iii) Imperial galls to US galls (fuel uplift, gauge confirmation)

(iv) Imperial galls to Pounds (Fuel, Load Sheet entry)

(v) Kilograms to Pounds (passenger and baggage weights, Load Sheet entry)

The Load Sheet made provision for entry of the tip tanks fuel contents but the Load Sheets for the 309 flights prior to the accident showed no record of any entry having been made of these. Both the Commander of G–BDNP and the then Senior Training Captain believed that the minimum fuel load of 80 lbs (11 Imperial gallons) carried in each tip tank to provide a wing relieving load was already included in the APS weight of the aircraft. This was not the case, only the 44lb of total unusable fuel was included in the basic weight, and therefore the APS weight of the aircraft. The combined effect of the omission of the weight of this fuel in each tip tank and also of the 35 lb of unusable engine oil from the Load Sheet meant that every operation was potentially 171 lb overweight. Further examination of the Technical Logs and Load Sheets for the previous 309 flights showed that this omission had allowed the Maximum Permitted Take-off Weight to be exceeded on one occasion and the Maximum Permitted Landing Weight on 24 occasions. It was also noticed that there had been numerous discrepancies and omissions in the compilation of these documents.

2. Analysis

2.1 The forced landing

The accident followed the almost simultaneous failure of both engines whilst the aircraft was making an emergency approach to Guernsey Airport. Once the engines stopped the Commander was faced with carrying out a forced landing short of the airfield. There are extensive areas of glass-housing on the Island of Guernsey and the fields are in the main small and bounded by earth and stone walls. In these circumstances due credit must be given to the Commander for carrying out a successful forced landing in difficult circumstances and in which the passengers received only minor injuries.

2.2 Cause of the engine failures

Atmospheric conditions were conducive to carburettor icing and the possibility could not be confirmed nor discounted from the examination of the wreckage. However, both carburettor heating systems appeared to be operable and the Commander stated that he applied carburettor heating and that it functioned, although it had no effect upon the engine malfunctions. It is considered, therefore, that carburettor icing was not a factor in the accident. Although the Commander had suspected that the fuel had become contaminated by water the satisfactory result of the fuel sample analysis allows this to be ruled out. Finally, the results of the investigation of the engines, the propellers, and the fuel system lead to the conclusion that all were in sound working order at the time the engines stopped. It is concluded therefore that the engine failures were due to fuel starvation.

2.3 Cause of the fuel starvation

There can be no doubt that the wing tip tanks were selected to feed the engines at the time of the accident; not only were the selector switches found in the 'Tip Tank' position but the electrical actuators and the change-over cocks were also in their corresponding positions. Since electrical power to the relevant bus bar had been disrupted before the aircraft came to rest and the battery had been removed as soon as the emergency services arrived at the accident site, there was no possibility that the selection had been made after the accident. Furthermore there was very little fuel remaining in the tip tanks and it was established that the fuel could not have leaked from these tanks as a result of impact damage. The quantities of fuel found in the various sections of the fuel system were all very much less than would have been found had the system been fully charged at the time of the accident, and no significant drainage or evaporation could have taken place before the system was examined. Moreover, the technical examination established that there was no possibility of a fuel leak that could account for a simultaneous loss of fuel from both port and starboard sides.

It is evident that neither engine could be expected to run with the fuel system selections and contents as they existed immediately prior to the accident. In each case the fuel starvation of the engines was the result of their being fed from the tip tanks until no usable fuel remained in them. It is also evident from the statements made by the Commander that he was unaware that the fuel for the engines was being drawn from the tip tanks rather than the main tanks, which contained more than adequate fuel for the flight.

The normal fuel burn-off for the flight from Jersey to Guernsey is about 7 Imperial gallons. Clearly this flight alone should not have exhausted the tip tanks for they should, for structural reasons, have contained a total of 22 gallons. It must therefore be concluded that the flight commenced with less than the correct amount of fuel in the tip tanks. Furthermore, what fuel there was must have been disposed in almost equal quantities in each tank since the engine failures were almost simultaneous. This suggests that the rest of the 22 gallons had been consumed during earlier flights. It could not be established when, or by whom, the selector switches had last been moved to the 'Tip' position. It is thought unlikely that it was the action of the Commander during the accident flight for two reasons. Firstly, if it had been his action then it would be reasonable to suppose that he would be aware that he had done so – the flight had only lasted for 10 minutes when the first engine failed – and he would then have reversed the selection before the second engine failed. Secondly, it was only when told of the position of the selector switches after the accident that he realised the reason for the engine failures. It is of course possible that he selected the switches to 'Tip' inadvertently instead of switching the auxiliary fuel pumps 'Off' after take-off, but this is unlikely because he recalls switching the pumps 'On' when the engine started to malfunction and this was witnessed by one of the passengers.

It is probable, therefore, that the fuel tank selector switches were already selected to the 'Tip' position when the Commander boarded the aircraft, and that he failed to recognise this when carrying out his pre-flight checks. The Commander's experience in having to return to Jersey several minutes after take-off on the previous flight in Islander G–BESO because of malfunctioning of the starboard engine which he incorrectly diagnosed as due to water in the fuel, may well have influenced his thoughts when he experienced a power surge and failing engine on G–BDNP, considering the problem to be again one of contaminated fuel. Although the Commander tried to regain power from the starboard engine (which had failed first) by adjustments of the mixture controls, applying carburettor intake heat, and by switching on the auxiliary fuel pumps, the selection of an alternative supply of fuel from a different tank did not occur to him. Nor did he recognise the symptoms as being caused by fuel starvation, although these symptoms are described in the Flight Manual as being characterised first by a drop-off in fuel pressure followed by a gentle hunting of the propeller.

It is evident that the engine failures resulted from the Commander's failure to realise, both on the pre-flight check and during the flight, that the wing tip tanks were selected to feed the engines and that they contained insufficient fuel. When first the starboard engine and the the port engine malfunctioned the Commander did not recognise the symptoms as those of fuel starvation, and in any case time was then crucial. If the aircraft had been fitted with a means, separate from the fuel gauge system, of alerting the Commander when the fuel state in the tanks feeding the engines reached a pre-determined low value no doubt he would have assessed the situation, recognised his error and changed over to the main tanks before there was any chance of the engines stopping. Depending on the pre-determined value this warning might have operated before the aircraft took-off from Jersey. While there was no requirement for aircraft to be fitted with a 'fuel low' warning system at the time the Islander was Certificated, such systems are now available and the CAA should consider whether aircraft should be so equipped.

2.4 The fuel tank selection system

The short-haul nature of the Company's operations, which did not require the use of the tip tanks, and the lack of a flight deck drill to check the operation of the fuel cock actuators, meant that the fuel tank selector switches were never operated and the indicator lights were seldom switched on. In the absence of the indicator lights only the position of the switch levers can warn the pilot of an incorrect fuel tank selection. Yet unless a careful flight deck check is performed it is not readily apparent that the switches are in the tip tank position because the pilot's eye line is almost end-on to the switch levers, a point made by the Commander in his statement.

Moreover the two switches for the auxiliary fuel pumps are mounted on the roof panel only 9 cm away from the fuel selector switches. These fuel pump switches also move in a vertical sense, down being the 'Off' position. The pumps are used during take-off and then switched 'Off' when above 1,000 ft, and are also used during the approach and landing being switched 'Off' again as part of the 'After Landing Checks'. The Operator's pilots were aware of a risk of selecting the fuel tank selector switches instead of the auxiliary fuel pump switches, and the Commander had been warned of this possibility during his initial training with the Company. Although documentary evidence of such mis-selection having actually occurred on Islanders is scarce – possibly because of a reluctance by pilots to admit to what might be regarded by their employers as a lapse of airmanship – it is known to have happened at least once before in another Company. The occasions when mis-selection might occur are when there is a requirement to select the fuel pumps 'On' or 'Off', and the pilot might never be aware of the error unless either the main or tip tanks run out of fuel. If after take-off the fuel tank selector switches were to be selected to 'Tip' instead of the fuel pumps being switched 'Off', then the error would only manifest itself if the flight were long enough for the tip tanks to become empty. Potentially more serious would be the approach to landing case where, after a long flight with the main tanks already empty, the engines were running on fuel from the tip tanks. If in these circumstances a pilot switched the fuel tank selectors back to 'Main' instead of switching the fuel pumps 'On', then the ensuing engine failures might occur when the aircraft was too close to the ground for the pilot to detect and correct the erroneous selection.

In the report on an accident to another Islander * there was a recommendation that a modification be made to the Islander Tip/Main selector switches in order to draw the attention of pilots to the fact that fuel supply is being drawn from the tip tanks. It is now also proposed that a modification to the switches to obviate the possibility of inadvertent operation should also be considered. The points that need to be examined are:

1) Whether the auxiliary fuel panel needs to be positioned so close to the pilot's sight line that the indicator lights may be switched off to avoid distraction.

2) Whether the vertical action of the fuel tank selector switches should be changed to a horizontal one, being selected to 'Tip Tanks' in the outboard position and to 'Main Tanks' in the inboard position, so as to reduce the chance of confusion with the auxiliary fuel pump switches.

*Aircraft Accident Report 7/82
Report on the accident to Islander G–BBRP on 20 February 1982

3) Whether a guard should be placed on the fuel tank selector switches so that they cannot be moved inadvertently.

2.5 Operating standards

As the Islander aircraft were utilised by the Operator on short range routes between the Channel Isles and to nearby airports in England and France G–BDNP's extra range capability was never exploited, and the Operator's policy had been to ignore the tip tanks and to operate all three Islanders as identical aircraft. The wisdom of this approach must be questioned. Where there are subtle differences between aircraft in a fleet then these differences need to be highlighted rather than diminished, or else the aircraft and its operation modified so that the differences can be safely ignored. In this case the differences between G–BDNP and the rest of the fleet were diminished because of the omissions in the check list. On the other hand one method of modifying the aircraft by wire locking G–BDNP's fuel selection switches in the 'Main' position had been discussed at a meeting between the Chief Pilot and his Training Captains a year prior to the accident but no action had been taken to implement the proposal.

There was an erroneous belief among the Operator's pilots that the 80 lbs weight of the minimum tip tank fuel was included in the APS weight of the aircraft and so they did not include it in the Technical Log or Load Sheet. No justification could be found for this belief; the information in the Operations Manual referring to the weight and balance and to the APS weight did not imply that the APS weight had been adjusted to account for the weight of the fuel. While it is evident that the aircraft was not overloaded on the accident flight, nevertheless there had been serious errors in the completion of both the Technical Logs and Load Sheets within the Company. The failure of pilots to record the contents of the tip tanks in the Technical Log, or to take account of the weight of this fuel in the Load Sheet, must be regarded as potentially hazardous. The extra weight, coupled with that of the unusable engine oil which had been omitted from the APS weight in the Operations Manual, approximated to that of an extra male passenger and had resulted in the aircraft's weight limitations being exceeded on 25 occasions in the previous 309 flights.

It is also significant that there were so many numerical errors and omissions of data from the Technical Log and the Load Sheet, and there is every indication that their completion had often been done in haste and with insufficient atttention to accuracy. The unnecessary complexity of documents is not conducive to safety especially in a single crew operation with short turn-around times. The multiplicity of conversions between Imperial gallons, US gallons, litres, kilograms and pounds was inherently prone to error, and is a problem to other operators as well as Jersey European Airways. A simpler presentation of data in Operations Manuals and in the design of the Load Sheets could obviate some of these conversions and reduce the likelihood of errors.

It is usual on short-haul scheduled operations for the passenger and baggage weights to be the last items of information available to the commander as he calculates the take-off weight, landing weight and the balance of the aircraft. Where such passenger weights are presented in kilograms there would seem to be logic in using kilograms throughout the Load Sheet to avoid the need for conversions between units of weight at the last moment when the pilot is under greatest pressure to achieve a scheduled departure time.

No justification could be found for the fuel consumption data in the Operations Manual being expressed in Imperial gallons per hour when the fuel gauges on the aircraft were calibrated in US gallons. The Operator's procedure whereby the arrival and departure fuel figures were to be recorded in the Technical Log in Imperial gallons served no useful purpose whatsoever, but only increased the Commander's workload and the possibility of error.

It is considered that if there had been more rigorous standards applied by the Operator in the compilation of the Technical Logs and Load Sheets, with particular reference to calculating and recording the contents of the tip tanks, then the pilot would have been more alert to the different fuel system in G–BDNP and this accident might well have been avoided.

2.6 Air Traffic Control

It was perhaps an unfortunate slip of the tongue whereby the Approach Controller informed the Aerodrome Controller that 'Sierra Uniform' and not '245' had a 'right hand engine playing up', and it would be unfair to be unduly critical of such a mistake made in the heat of the moment. What is more important is that there was no method for detecting or correcting this error. The procedures in use at Guernsey Airport were not significantly different from those in use at other ATC units. Much of the information passed from controller to controller on the intercom system serves to confirm documentary information already available to each controller and a read-back procedure such as is used between aircraft and ATC might be unduly time consuming. However, an instance such as this where an aircraft declares that it is in difficulty and where the emergency services are to be brought to 'Local Standby' is important enough to merit a more formal approach. Certain items of information now become vital – the identity of the aircraft, its position, the number of persons on board, and the nature of its distress. If this had been read back to check its accuracy then the initial mistaken callsign would almost certainly have been detected. During the investigation a submission was made that the Manual of Air Traffic Services does not require information of this nature to be read back. In the light of the events in this accident it is therefore suggested that the CAA should consider whether the Manual should be amended accordingly.

2.7 The Emergency Services

In the event the Aerodrome Controller acted on the incorrect information and alerted the AFS to standby for a possible emergency landing by 'SU' the third aircraft on approach, instead of '245' which was the first aircraft. This error by ATC was compounded when the AFS, standing by for the emergency landing by 'SU', saw the Islander '245' turn off from its approach path and disappear from sight. The AFS then reacted by leaving the airport with all three appliances and proceeding towards the assumed crash area. The airport was consequently without fire service cover for the other aircraft on approach, and especially for 'SU' which at that time was believed to be the one with the engine problem.

The Guernsey Airport Emergency Orders did not specify the controlling authority for the deployment of the AFS to an off-aerodrome accident as is usual in the orders of CAA licensed aerodromes. Two provisions in the Civil Aviation Authority's Model Emergency Orders (CAA Document No 174) are of particular interest in this context. The first is an instruction that AFS appliances will not proceed to an off-aerodrome accident without the

agreement of ATC (Para 1.2.1). The second is a requirement that while all AFS appliances must attend an on-aerodrome accident, attendance of an off-aerodrome one should be at a pre-determined level (Para 1.2.2). In the light of the circumstances that pertained on this occasion consideration should be given to amending the Guernsey Airport Emergency Orders along these lines.

The communication system between the Control Tower at Guernsey Airport and the headquarters of the Guernsey Fire Brigade (GFB) is worthy of comment. This direct telephone link enabled the ATC to alert the GFB of an aircraft emergency but being a 'one-way' system, the GFB could not originate a call to ATC. The result of this was that when, after the GFB had dispatched their appliances, they were informed by an emergency telephone call of the exact location of the crash and were able to direct their own appliances to the site, they were unable to pass this information to ATC on the direct link – and did not attempt to do so using the public telephone system. Further as the radios in the GFB and AFS vehicles were not compatible the information could not be passed by this means. In consequence the AFS wasted potentially valuable minutes in searching for the exact location of the accident site. Fortunately on this occasion the delay had no effect upon the survivability of the accident as the passengers were able to evacuate from the aircraft with the assistance of the Commander. Following the accident a two-way telephone system was installed between the GFB headquarters and ATC and, later, action was taken to make the radios in the AFS vehicles compatible with those of the GFB.

3. Conclusions

(a) Findings

(i) The Commander was correctly licensed to fly the BN2 Islander aircraft.

(ii) The aircraft had been maintained in accordance with the approved Islander Maintenance Schedule.

(iii) The Technical Log had been incorrectly completed in that no record was made of the contents of the tip tanks.

(iv) The Aircraft Prepared for Service (APS) weight and the moment about the datum stated in the Operations Manual were incorrect.

(v) The aircraft Load Sheet was unnecessarily complicated by having a multiplicity of conversions between units of weight and capacity.

(vi) The Load Sheet had been incorrectly completed in that no account had been taken of the weight of the fuel in the tip tanks nor the weight of the usable engine oil.

(vii) The passengers were not seated in the positions indicated on the Load Sheet.

(viii) The aircraft was below the maximum permitted weight and the centre of gravity was within the prescribed limits.

(ix) Fuel consumption data in the Operations Manual was expressed in Imperial gallons per hour whereas the aircraft fuel gauges were calibrated in US gallons.

(x) There was sufficient fuel in the main tanks of the aircraft for the proposed flight.

(xi) The tip tanks contained less than the 11 Imperial gallons in each tank required by the Flight Manual for wing loading relief.

(xii) The check list in use in the aircraft made no reference to checking the fuel tank selector switches and indicating lights before flight as required by the Flight Manual.

(xiii) On his pre-flight check the Commander failed to notice that the fuel selector switches were in the 'Tip' position.

(xiv) The aircraft suffered a double engine failure caused by fuel starvation when the tip tanks became exhausted of fuel.

(xv) There was erroneous information passed from the Approach Controller to the Aerodrome Controller about which aircraft had suffered an engine failure. This error remained undetected and resulted in the AFS being alerted for the wrong aircraft.

(xvi) There was an immediate response by the Aerodrome Fire Service but all units attended the accident leaving the aerodrome without cover for landing aircraft.

(xvii) The Aerodrome Fire Service was handicapped in locating the accident site because of restricted communications between the Guernsey Fire Brigade Headquarters and the Control Tower, and between AFS and GFB appliances.

(b) Cause

The accident occurred because of the Commander's mismanagement of the aircraft's fuel system in that both engines failed through fuel starvation because the usable contents of the tip tanks, which were feeding the engines, became exhausted when there was ample fuel remaining in the aircraft's main tanks. Contributory factors were the Operator's procedures, inadequacies in the check lists, and the position of the fuel selector panel and switch levers in relation to the pilot's eyes.

4. Safety Recommendations

It is recommended that:

4.1 The Islander TIP/MAIN selector switch panel be modified to draw the attention of pilots to the fact that fuel is being drawn from the tip tanks, and to obviate the possibility of inadvertent operation.

4.2 The design of aircraft Technical Logs and Load Sheets should be reviewed to minimise the need for conversions between different units of weight and capacity.

4.3 Consideration be given to requiring aircraft to have the means, separate from the fuel gauge system, of automatically alerting the crew when the contents of any tank capable of directly feeding an engine reaches a pre-determined low value.

4.4 Consideration be given as to whether the Manual of Air Traffic Services should be amended to require that a read-back procedure be used when ATC units pass vital information for use by the emergency services.

4.5 Guernsey Airport Emergency Orders be amended to specify the relative responsibilities of the Aerodrome Fire Service and Air Traffic Control concerning the deployment of the AFS to an off-aerodrome aircraft accident.

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