ICELAND M-03096/AIG-03

AIRCRAFT ACCIDENT REPORT

(Ref. Act on Aircraft Accident Investigation No. 59/1996, para 1.)

Private aircraft
N904WA. Type: Pilatus Britten-Norman BN2A-21,
Near Innri Njardvik, Iceland.
17 March 1996

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Aircraft Accident Report

Aircraft: BN-2A-21, Islander. A/C serial No. 904.
Registration: N904WA.
Registered Owner: [redacted]
Operator/User: [redacted]
Crew: One.
Number of passengers: None.
Place of accident: Near Innri Njardvik, Iceland.
Date and time: 17 March 1996, at 12:12 hrs. *)

SYNOPSIS:

The accident was notified to the aircraft accident investigating authorities by the Reykjavik Air Traffic Control Centre and the investigation was commenced on the same day.

The aircraft took-off at 11:51 hrs from Reykjavik Airport to Narssarssuaq, Greenland. At 12:02 hrs the pilot requested permission to return for landing and a brief stop, in order to find her portable GPS she had lost. She was then cleared to Keflavik Airport that was more convenient for her. During the flight towards the airport the right hand engine lost power and stopped running. The pilot states, that she was unable to feather the propeller. She did not try to restart the engine, the heavy aircraft was unable to maintain altitude with the remaining power, it descended and crash landed in a rough ground, 5.5 km from the end of runway.

This report concludes, that the cause of the engine failure could not be established with certainty.

*) All times in this report are UTC.

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1. FACTUAL INFORMATION:

1.1 History of the flight:

The aircraft was previously registered and operated in Nigeria. According to the aircraft documents, it was sold to the United States of America, and registered there as N904WA 7 June 1995. Some time after 5 July 1995 it was ferried from Kaduna in Nigeria to Niamey in Niger and further via Dakar in Senegal to Stansted, England, where it arrived in July 1995. There it was prepared and equipped for the continuing ferry flight to the United States.

On February 26 1996, the aircraft took off from Stansted Airport UK on the ferry flight to the new owner in Wisconsin, USA. The ferry pilot landed at several airports en-route to Reykjavik, the last leg was on the 3 March from Vaagar in the Faroe isles to Reykjavik Airport. The fuel tanks were filled immediately after landing, holding 1500 liters total. The pilot had a second thought on the weight and on 7 March, she had 200 liters drained, or 100 liters from two of four ferry fuel drums. The pilot was repeatedly delayed by unfavourable or changing weather on the planned route. During that period, she had one wing-tip fuel tank cleaned, as she became aware of water in it. This was done by the technical department of Islandsflug ltd.

On the morning of 17 March she made a flight plan to Narssarssuaq, Greenland. Estimated flying time enroute was 7:10 hrs. The fuel aboard was 1300 liters, the planned fuel endurance was 12:30 hrs and the cruising altitude was planned at Fl-100 or at 10.000 feet. The aircraft took-off at 11:51 hrs from Reykjavik Airport and the aircraft climbed in the direction of WSW, that would take the aircraft north of Keflavik. At 11:53 hrs the pilot changed the radio frequency from Reykjavik Airport Control Tower to the Reykjavik Approach Control (RK-APP). (See Appendix 5.2). The wind was 3-5 kts in the area and according to radar data, the ground speed of the aircraft was steady or 80-90 kts during the climb or until 11:58:17 hrs. when it started to fluctuate between 90 and 110 kts.

At 11:59:20 hrs the pilot informed Reykjavik Approach Control and reported that she had "lost a bit of an equipment" on the floor and that she would not be able to maintain heading or altitude while she was searching for it. This equipment was her portable GPS, which she had placed on top of the instrument panel.

At 12:02:09 the pilot requested a turn back and landing at Reykjavik Airport just for a brief stop, in order to find the GPS and then continue according to the flight plan. This was approved and the pilot was given vectors for runway 02, and descent to 2000 feet. At 12:03:44 The pilot was offered to land at Keflavik Airport and she accepted. She was then cleared to descent to 2000 feet and given the track 250° to Keflavik. Then the ground speed was steady at 110 kts. according to the radar reading.

At 12:06:23 the pilot was given landing instructions at Keflavik and the runway in use was 02. The pilot responded and reported that she had "got one engine with a bit of a trouble". This is in conformity with the radar data, as at this time the ground speed abruptly dropped to 80 kts. The height of the aircraft at that time was about 1000 feet above the ground level.

At that time RK-APP requested altitude information. The aircraft did not have a "Mode C" altimeter and therefore the altitude could therefore not be observed on the radar screen. The pilot reported at 12:07:21 hrs that the aircraft was at 1000 feet, also that she could not maintain 1500 feet which is the minimum vectoring altitude (MVA) for this area. She also reported that she was gradually loosing height all the time. At 12:09:34 hrs she reported at 700 feet and loosing height at about 300 feet a minute.

At 12:11:07 the aircraft was transferred to the Keflavik Airport Control Tower (KF-TWR. At that time it was on the base leg for runway 02, but as it was as well on the extended final for runway 29, the pilot was offered landing on runway 29. The pilot reported at 12:11:40 hrs, that she was at that time at 200 feet, descending rapidly. The ground speed remained 60-70 kts until the aircraft disappeared from the radar screen at 12:12:42 hrs. During this period, the pilot was engaged in very heavy communication that took place between the aircraft and the ATC. A total of 48 transmissions took place in 5 min 38 sec, or one transmission every 7 seconds.

The aircraft crash landed in a rough ground, about 300 meters from the coast, 5.5 km from the end of runway 02 and 4.8 km from runway end 29.

1.2 Injuries to persons:
The pilot was seriously injured.

1.3 Damage to aircraft:
Destroyed.

1.4 Other damage:
Minor damage to a fence.

1.5 Personnel information:

1.5.1. The pilot. - A [redacted]emale, born 25 May 1928. She was holding a valid FAA Commercial Pilot's Licence [redacted], issued [redacted] 1995. Ratings and limitations: Airplane Single & Multi-engine Land, Instrument rating. Last Medical Certificate II-nd Class, was issued [redacted] 1995. Limitatios: Holder shall wear correcting glasses for near vision, whilst exercising the privileges of her airman certificate". The pilot was also holding a valid UK Commercial Pilot's Licence [redacted]

According to information given by the pilot, she had approximately 18.500 hrs total flying time, whereof approximately 10.000 hrs were on this type of aircraft. The total flying time during the previous 90 days was approximately 15 hrs, all in this particular aircraft. She had been working as ferry pilot for many years and had made numerous trips over the North Atlantic ocean across Iceland and she was current on the route.

1.6 Aircraft information

The aircraft was manufactured in 1981 by Pilatus Britten Norman Ltd., Bembridge Airport, Isle of Wight, England. It was the type BN2A-21, Manufacturer's Constructions number 904. The aircraft had two reciprocal AVCO Lycoming IO-540-K1B5 engines, 300 HP each, with two bladed fully feathering Hartzell HC-C2YK-2UF propellers. It was registered in Nigeria in June 1981 as 5N-AVI and operated in Nigeria. It was removed from the Nigerian Civil Aircraft Register on 17 May 1995 and registered in the United States on 7 June 1995, in the name of [redacted]

The last flight time entry in the aircraft logbooks was made on 4 July 1995, prior to the ferry flight from Niamey to Stansted. According to the aircraft logbooks, the total flying time of the aircraft since manufacture was at that time 1579:25 hrs and the total number of landings was registered as 1088. At that date, the left hand engine, serial no. L-21307-48A, had a total flying time of 253:10 hrs since new. The right hand engine, serial no. L-21012-48A, then had 7:15 hrs total flying time since overhaul. It was installed 9 June 1995, after being overhauled by Aero Power Inc., [redacted] USA.

There was no entry in the "Variable Propeller Pitch Log Books", after 6 May 1991. According to the aircraft logbook, the last annual inspection was carried out 6 June 1991. Then the total flying time of the aircraft was1573:10 hrs. The last recorded inspection carried out was a 100 hr inspection on 30 June 1996 for the L/H engine on 10 June 1996 for the R/H engine, and on 4 July 1996 on the aircraft itself.

According to the aircraft records, the aircraft was some time after 5 July 1995, ferried to Niamey in Niger and then further via Dakar in Senegal to Stansted Airport, England. The owner/operator applied to FAA for a special authorization to ferry the aircraft from England to USA, but the British CAA grounded the aircraft on the 25 July 1995, as it did not have the required documentation and the ferry fuel tank system that had been installed was not approved or considered safe.

A ferry fuel tank system to a design by Pilatus Britten-Norman Ltd., was installed in the aircraft by Inflite Engineering Services Ltd and the aircraft was weighed on 15 January (See Appendix 5.3) when all modifications were completed and it was inspected and found safe for the ferry flight. This was certified in the aircraft logbook and signed on 19 February 1996 by Inflite Engineering Services Ltd at Stansted Airport.

The aircraft did not have a valid Certificate of Airworthiness, but on the basis of the supplied application and documents, the Federal Aviation Administration issued a "Special Flight Permit" or authorization for the ferry flight for N904WA on 23 January 1996, valid until 15 February. It expired before the aircraft could be ferried and it was re-issued on 21 February, valid until 21 March 1996. The "Special Flight Permit" issued for the ferry flight, was subjected to the "Special Operating Limitations" (Appendix 5.4) and was valid only for flights over U.S. territory. The pilot did not apply to Icelandic authorities for an over flight permission over Icelandic territory, which is required as the aircraft did not have a valid standard Certificate of Airworthiness.

On 20 February, Rollins Hudig Hall of Kansas, Inc [redacted] USA, insured the aircraft N904WA, for the ferry flight from England to Wisconsin. The Certificate of Insurance was valid until 19 April 1996.

1.7 Meteorological information:

At the time of the accident, a high pressure area was over Iceland. The weather was good in the area. Wind was 050° at 3 kts, CAVOK, visibility unrestricted, temperature +4°C, dew point -1°C and QNH 1029 hPa.

1.8 Aids to navigation:

Not applicable.

1.9 Communications:

The aircraft was in contact with Reykjavik Airport Control Tower, Reykjavik Approach Control and with Keflavik Airport Control Tower. See Appendix 5.2.

1.10 Aerodrome information:

Not applicable.

1.11 Flight recorders:

Not required, not installed.

1.12 Wreckage and impact information:

The accident area was in an an open area at 63°58′29′′N 022°29′36′′W and 300 meters from the ocean coast line. The elevation was about 100 feet above sea level. The area was rather rough, slightly down sloping, with mixed turf banks and rocks.

The ground track was in a straight line 260° magnectic and almost perpendicular to the coast line. The first impact was made simultaneously by the left main landing gear and the left wing tip. The nose landing gear was torn off and both main landing gears were bent backwards. The fuselage touched the ground, the aircraft slid through a barbed wire fence and came to a halt about 50 meters from the first point of impact. The fence was torn down for about 60 meters.

The right hand engine was not running at impact and it′s propeller was not feathered as it was in a low RPM (cruise/climb) position. One blade was slightly bent backwards at the impact. The left engine was running at high speed, the propeller tips were torn off, showing high engine power.

Both aircraft main fuel tanks and wingtip tanks were still full. The ferry fuel system included 4 drums, 2 holding 200 liters each and 2 holding 100 liters each. There was only minor fuel leak to one of the drums, caused by impact damage.

The instruments readings and control settings were set as follows:

Basic instruments

Altimeter 90 feet, QNH set at 1029 hPa.

Engine controls	**Right engine**	**Left engine**
Throttles:	Full open	Full open
Propeller controls:	Low RPM (Not feathered)	Between low and high RPM
Fuel mixture controls.	Idle cut-off.	Lean mixture
Carburettor heat:	Off	Off
Magnetos:	Both on	Both on
Generator	On	On
Electrical fuel pumps:	Off	Off
Aircraft controls		
Elevator, rudder, ailerons:	Normal	
Flaps:	Up	
Rudder trim:	Slightly nose left	
Elevator trim:	Nose up.	
Fuel selectors	**Right side**	**Left side**
Main fuel tanks	Tank to engine	Tank to engine
Ferry Fuel system		
Ferry fuel tanks:	All selected off	
Ferry fuel pump:	Off.	

The nose of the aircraft broke and the whole cockpit section was torn and twisted to the left. The pilot was thrown forward by the impact forces and the left engine propeller slashed through the cockpit door and the pilot´s seat aft of her back, into the cockpit floor where it stopped abruptly. The ferry fuel system resisted the impact forces and there was only a minor fuel spill and there was no fire.

The first witnesses to arrive at the scene were two firemen from Keflavik Airport Fire Department, who happened to be in the proximity, on their way from duty. They cut the unconscious pilot loose from the wreck, disconnected the aircraft battery and secured the wreckage.

1.13 Medical and pathologicalinformation:

Not relevant.

1.14 Fire:

There was no fire.

1.15 Survival aspects:

The ferry fuel system resisted the impact forces and the rear part of the fuselage sustained relatively little damage. The front part of the fuselage was crushed and the cockpit was torn to the left. The pilot had the safety belt and a single shoulder harness fastened. The pilot was thrown forward, narrowly escaping a propeller blade, that slashed through the seat behind her back. The cockpit was crushed and there was very little space left for the pilot who survived.

1.16 Tests and research:

1.16.1. Right hand engine and it´s systems:

The right hand engine, a AVCO Lycoming, IO-540-KIB5, serial no. L-21012-48A, was not running during the crash landing. It was removed from the wreck and inspected by AAIB investigators.

The inspection revealed the following:

The engine was in a good condition, except for impact damage on left side of the accessory case. L/h magneto was torn back- and sideways. The magneto spacer was heavily cracked and distorted. The baffels were also severely damaged. The area around the FCU was not damaged.

- The propeller had not been turning at impact. It had sustained severe impact damage during the impact. A small rock was embedded in the propeller hub. The cylinder had been deformed severely after impact with a hard solid object. One blade was slightly bent backwards, the other blade was not damaged. The propeller governor appeared to be in a good condition.
- Nothing abnormal was found relating to the engine controls. The cables were intact and not displaced or dislocated.
- Both magnetos were examined. The timing was correct for the right hand side magneto but it could not be determined for the left hand side magneto with any accuracy, but appeared to be correct. General condition of the magnetos was good and the breaker point was correctly set. The magneto harness appeared to be in a good condition, apart from damage sustained by the impact forces.
- The upper spark plugs were removed and found in a good condition.
- The cylinder compression was checked with a leak calibration equipment and it was very good. The engine oil filter inspection revealed some carbon particles and a few non-ferrous flakes of no consequence and the engine oil was clean and transparent.
- The engine fuel system was inspected. All fuel lines were normal and full and no restriction was found in the engine fuel system. No water was found anywhere in the system except for 2-3 drops in the bottom of the fuel strainer bowl. The fuel distributor, injector nozzles and fuel lines appeared in good condition.
- The engine driven fuel pump gear train and drive shaft were intact, however, the condition of the fuel pump was questionable so it was decided to send the pump and the FCU to a qualified repair station for further investigation (See para. 1.16.5).

1.16.2 Fuel samples taken from the aircraft fuel system. Fuel samples were taken from the right hand engine fuel system. A analyse of these samples did not reveal anything that was considered to be contributory to the power loss or the engine failure.

1.16.3 The right hand electric driven fuel boost pump. This pump was manufactured by The Weldon Tool Co., part number A10050B, serial number 3138. It was removed from the wreck and tested at the CAA facility in Reykjavik, where it was found to function normally.

1.16.4 The Fuel Control Unit (FCU). Manufacturer: Precision Airmotive, Part No. 2524556-8.

This unit was sent to Canadian Aero Accessories ltd., Calgary, Alberta, Canada, for examination. The test report concluded:

"The unit was tested as received. It was found to be serviceable within specs.
There was 1) Excessive play in M/C clevis, 2) Throttle bushings worn and 3) O - rings flat. Overhaul of the unit was recommended. No evidence of failure was found. The unit was functional as received. Internal findings could not cause a failure of the unit".

1.16.5 The engine driven fuel pump. The right hand engine driven diaphragm fuel pump was a Lear Siegler Inc, Romec Division. Part number RG-17980D, serial number B-9979. According to the engine documents, this pump was not supplied with the engine by Aero Power Inc., the engine overhaul facility. Therefore it most likely was fitted to the engine as it was installed in the aircraft, 9 June 1995 in Kaduna, Nigeria.

According to the AVCO Lycoming IO-540-K1B5 type Certification Data, the maximum fuel pressure for the engine is 40 psi The minimum fuel pressure is 18 psi and the minimum idling fuel pressure is 12 psi. The normal pressure output should be about 24 psi.

The fuel pump was removed and tested at the CAA facility in Reykjavik, but it was not installed and tested on another aircraft engine. As it initially did not work properly or unless it was primed, it was sent for testing to Canadian Aero Accessories ltd., Calgary, Alberta, Canada.

According to the test report the pump and the fuel injector unit was functionally tested together. The pump did only work after priming and the output pressure was about 6 psi. The pump was then disassembled and inspected. It´s by-pass valve spring is cone shaped, the narrow end is down and resting on the valve disc. The spring was found to be installed upside down and jammed between the valve disc and housing, causing by-pass at all times. The pump became functional when assembled correctly. There was no evidence of leaky gasket or diapragm failure.

The report states as following:" Because the valve was only partially open and stuck in either direction, this may have caused restriction in fuel supplied by the booster pump which I assume was running at the time".

As previously stated in this report, the electrical boost pumps were in the "OFF" position at the time of the landing.

1.17 Organisational and management information:

The pilot was the owner and in charge of the aircraft ferrying company.

1.18 Additional information:

1.18.1 Maintenance carried out in Reykjavik. - On 5 march 1996, the pilot contacted Islandsflug ltd. at Reykjavik airport. She brought a glass with a fuel sample and this sample contained water and dirt, which she had drained from the R/H wing-tip fuel tank of N904WA and requested that the fuel tank would be drained, cleaned and refuelled. The following is quoted from the report made by Islandsflug´s Quality Manager.

"On the 5 March the aircraft was towed to the Islandsflug´s hangar and the R/H wing-tip fuel tank drained by removing the drain valve. Approximately 100 liters were drained from the tank. The drain valve was then re-installed and the tank flushed several times with a fuel from a fuel truck. The content from the tip tank was not examined to my best knowledge. After this process the drain valve was re-installed, safetied and the fuel tank was re-fuelled with approx.100 liters of fuel. Two days later the pilot requested removal of 200 liters of fuel from the ferry tank barrels in the cabin. Approx. 100 liters were sucked from each of the two most aft barrels".

1.18.2 The tightness of the fuel tank caps.

The right hand wingtip fuel tank cap was found to be in a poor condition, as it´s valve cap ring was hard and worn and did not seal properly. Rainwater could therefore rather easily leak into the tank. The tank however was closed during this flight.

1.18.3 The weight and performance of the aircraft: The aircraft was weighed when the approved ferry fuel system had been installed at Stansted airport. The quantity of the fuel aboard N904WA at take-off from Reykjavik airport is known, as well as the weight of the pilot and other items aboard. Therefore the actual take-off weight of the aircraft at Reykjavik airport has been calculated to be 7189 lbs (3291 kg). (See Appendix 5.3). The Center of Gravity was within the authorized limits.

The maximum certified take-off weight for this aircraft in a normal category is 6600 lbs (2994 kg). The "Special Flight Permit" that was issued for this flight, was subjected to certain conditions (See Appendix 5.4). The maximum authorized take-off weight for this flight was 6950 lbs (3150 kg) and the maximum authorized landing weight except in an emergency was 6300 lbs (2850 kg).

The actual weight of the aircraft at take-off was approximately 7189 lbs (3291 kg). Therefore the actual weight of the aircraft at the time of the accident must have been about 7130 lbs (or 3265 kg). This is 539 lbs. (297 kg) in excess of the maximum take-off weight figures shown in the performance data tables.

The Supplement No. 8 to Section 7 of the Approved Flight Manual, contains performance data, assuming 100% engine power, full throttle, flaps up and mixture at the recommended leaning. It also includes single engine climb data for the aircraft. This data does not go beyond the 6600 lbs (2994 kg) weight limit. Therefore the single engine performance can not be calculated at this weight.

1.18.4 The Manufacturer's opinion.

Pilatus Britten Norman, the manufacturer of the BN2A-21, was requested to give their opinion of the performance of the aircraft during the single engine portion of the flight. The following is quoted from the answer:

"We are unable to calculate the single engine climb performance with the right propeller not feathered. The engine failure mode will vary and hence predicting the drag of the unfeathered propeller will be impossible. In addition the drag of the large amount of rudder that the pilot was applying would be impossible to calculate" . ..... "I do not believe however that in this case the weight had a material affect on the outcome of the situation".

1.18.5 The Pilatus Britten-Norman BN2A-21 Approved Flight Manual.

The following is quoted from the N904WA AFM:

ENGINE FAILURE PROCEDURES:

The AFM stipulates, that in the event of an engine failure whilst the aircraft is climbing at safe altitude, the following procedure must be effected:

1. Ensure full power is applied to both engines and that the mixture controls are selected fully RICH.
2. Determine the inoperative engine.
3. Select mixture control lever - IDLE CUT-OFF.
4. Select propeller control lever - CLOSED.
5. Ensure that the generator on the operative engine is selected ON.
6. Select throttle lever control lever - CLOSED.
7. Select appropriate fuel tank - OFF.
8. Select appropriate magnetos - OFF.
9. Select appropriate auxiliary fuel pump switch - OFF.
10. Select appropriate generator field switch - OFF.

WARNING: It is essential to raise the flaps to the fully UP position, to achieve the optimum climb gradient.

HANDLING ON ONE ENGINE

General:

The aeroplane is perfectly docile on one engine and should maintain a height of 7000 feet at a gross weight of 6300 lbs in ISA conditions.

LANDING WITH ONE ENGINE INOPERATIVE:
Make an initial approach at approximately 65 kt IAS with the flaps selected to TAKE_OFF (25 degrees). When committed for landing, select FLAPS DOWN (56 degrees) and reduce speed over the threshold to a valuable compatible with the information scheduled in sect. 5 and land normally.

LANDING WITH FLAPS UP
Make an approach at 65 kt IAS and a normal landing.

1.18.6 The last stage of the flight: The pilot's memory of events preceding the accident was unclear and she had great difficulties in remembering details from the flight. She said that she had climbed normally to about 2500 feet when her portable GPS, that she had put in the front window on top of the instrument panel in order to activate it, accidentally fell on the floor. She said that as she was unable to find it, she had after a while decided to return and land in order to find it.

During the descent, the R/H engine lost power and then stopped. The pilot stated, that she was unable to feather the propeller and that she did not try to restart the engine. She said that the aircraft descended very fast and she felt, that even if she had succeeded in feathering the propeller, the aircraft was not able to maintain altitude. The pilot also stated that she could not accidentally have moved the fuel mixture control to the "Idle cut-off" position, when searching the floor for the lost GPS.

According to the aircraft operating procedures, the electrical fuel pumps were "ON" during take-off and for some time during the climb. The pilot was unable to recall at what stage of the flight she moved the pumps to the "OFF" position (see para 1.12).

As previously stated, the pilot had some difficulties in locating the airport and during the last part of the flight, frequent communications took place between her and the ATC.

1.19 Useful or effective investigation technique:
None.

2. ANALYSIS:

The left engine was running at high power all the time to the end of the flight, but during the descent to Keflavik Airport, the right hand engine lost power and stopped rotating. The propeller was not feathered at the time of the landing.

The engine control handles are located on top of the pedestal, between the front seats. The positions are these from left to right; a) the two throttles left and right, b) the two propeller controls left and right and c) the two fuel mixture controls left and right. The right hand engine and propeller controls were consistent with normal power operation, except the right hand fuel mixture control handle at the end, was "aft" or in the closed position (Idle cut-off).

In the event of an engine failure in flight, after having identified the failing engine, the pilot must act quickly as the feathering process is based on the rotation of the propeller. The first action must be to move the fuel mixture control lever for the failing engine aft, or to "IDLE CUT-OFF", immediately followed by moving the propeller pitch control lever aft, or to the "FEATHER" position.

There was no evidence that the pilot had tried to restart the engine and the electric driven fuel boost pumps were both in the "OFF" position. The aircraft was not trimmed for the single engine flight and the pilot said that she had been using the rudder to keep the heading straight.

The failing engine was found to be in a good condition and there was no evidence of any kind of failure or malfunction found in the engine itself, that might have caused the power loss. However the engine driven fuel pump was not functioning properly, as it was not correctly assembled, resulting in a low pressure output. The engine was installed in the aircraft on 9 June 1995 in Kaduna, Nigeria, but the history of the fuel pump itself is not known.

When the electric pumps are switched "OFF", the necessary fuel pressure is maintained by the engine driven pumps. The normal operating procedure is to have the electric fuel boost pump switched to "ON" during take-off and keep them in that position whilst the aircraft is climbing to a safe altitude. Also in the event of an engine failure, the electric fuel boost pump for the "good" engine is kept "ON" during the single engine flight.

There were no difficulties concerning the fuel pressure reported by the pilot, since she started the ferry flight from Stansted Airport. The engine failure occurred during the descent to Keflavik Airport and at that stage the engine power had been reduced and possibly the efficiency of the engine driven fuel pump.

According to the test report from Canadian Aero Accessories ltd, the pump and the fuel injector unit was functionally tested together. The pump did only work after priming and the output pressure was about 6 psi. The pump was found to be incorrectly assembled and it became functional when it had been assembled correctly and re-tested. The inspection report stated, that because the valve was only partially open and stuck in either direction, this might have caused restriction in fuel supplied by the booster pump. As previously stated in this report, the electrical boost pumps were in the "OFF" position at the time of the landing. The efficiency of the engine driven fuel pump must therefore be considered questionable.

The maximum certified take-off weight of the aircraft in a normal category is 6600 lbs (2994 kgs). The aircraft however had a valid "Special Flight Permit", that was subjected to certain conditions and as the maximum take-off weight was concerned and the operation of the aircraft had to be in conformity with the Aircraft Flight Manual limitations, such as not exceeding the 6950 lbs (3150 kg) take-off weight limit, the maximum authorized weight for the "Special Flight Permit".

The performance data for the BN-2A-21 aircraft only gives information for aircraft weighing 6600 lbs or less. Therefore no information is available for weights between 6600 lbs and 6950 lbs. The actual weight of the aircraft at the time of the accident was very likely about 7130 lbs. This is 530 lbs in excess of the 6600 lbs limit or 180 lbs in excess of the maximum take-off weight authorized by the "Special Ferry Flight Permit". Also the actual landing weight was 830 lbs in excess of the maximum authorized landing weight 6300 lbs. According to the aircraft manufacturer's opinion, it is not possible to calculate the single engine climb performance of N904WA with the right propeller not feathered. In addition it is impossible to calculate the drag of the unknown amount of rudder, the pilot was applying.

The fact remains, that the right hand engine lost power and stopped. The pilot did not put the electric fuel boost pump "ON" or try to restart the failing engine. The propeller of the failed engine was not in the feathered position. The existing configuration of the heavy aircraft created a large amount of drag, that the available engine power could not overcome. The aircraft could not maintain altitude, it descended to the ground and crashed.

The pilot must have been under a great pressure during the last part of the flight, as one of the two engines had failed and the heavy aircraft was descending fast. The pilot also had some difficulties in locating her destination airport and during the last part of the flight she was communicating frequently, as 48 radio transmissions between N904WA and the ATC took place in 5 min 38 sec, or one transmission every 7 seconds on the average. This must be taken into consideration when the chain of events leading to the accident is analyzed.

The output fuel pressure of the R/H engine driven fuel pump was about 6 psi. Keeping in mind that the normal fuel pressure should be about 24 psi and that the minimum fuel pressure is 18 psi, the low fuel pressure must be considered a possible causal factor for the power loss and the subsequent engine failure.

3. CONCLUSIONS: Probable causal factors are marked with an asterisk *.

3.1 The pilot was properly licensed and rated and she was current on the route flown.
3.2 The aircraft had a valid "Special Flight Permit" issued by the state of registry, but no authorization had been granted for flying over Icelandic territory.
3.3 The meteorological conditions were favourable.
3.4 The pilot decided to return after take-off and land at Keflavik Airport, as she was unable to find her portable GPS, that she had lost.
3.5 The R/H engine lost power during the descent. The engine failure could not be explained with certainty.
* 3.6 During the single engine descent, the pilot was under a great pressure. She was uncertain of the location of the airport and there were 48 radio transmissions from 12:06:44 hrs to 12:12:22 hrs or during the last 5 minutes and 38 seconds of the descent.
* 3.7 The pilot did not attempt to restart the engine.
* 3.8 The electric fuel pumps were in the "OFF" position.
3.9 The mixture control lever for the R/H engine was found in the "closed" or "idle cut-off" position.
* 3.10 Neither the propeller of the R/H engine nor it´s control lever was in the feathering position.
3.11 The single engine climb performance of the aircraft with the right propeller not feathered is uncertain and the performance data does not incorporate the actual take-off weight.
* 3.12 The aircraft was heavy. At the time of the accident, it´s weight was about 530 lbs. (271 kgs) in excess of the maximum take-off weight shown in the aircraft performance tables.
* 3.13 The R/H engine driven fuel pump was incorrectly assembled and it´s output is questionable. It´s low pressure output must be considered a possible causal factor for the power loss and the subsequent engine failure.

4. SAFETY RECOMMENDATIONS:
None.

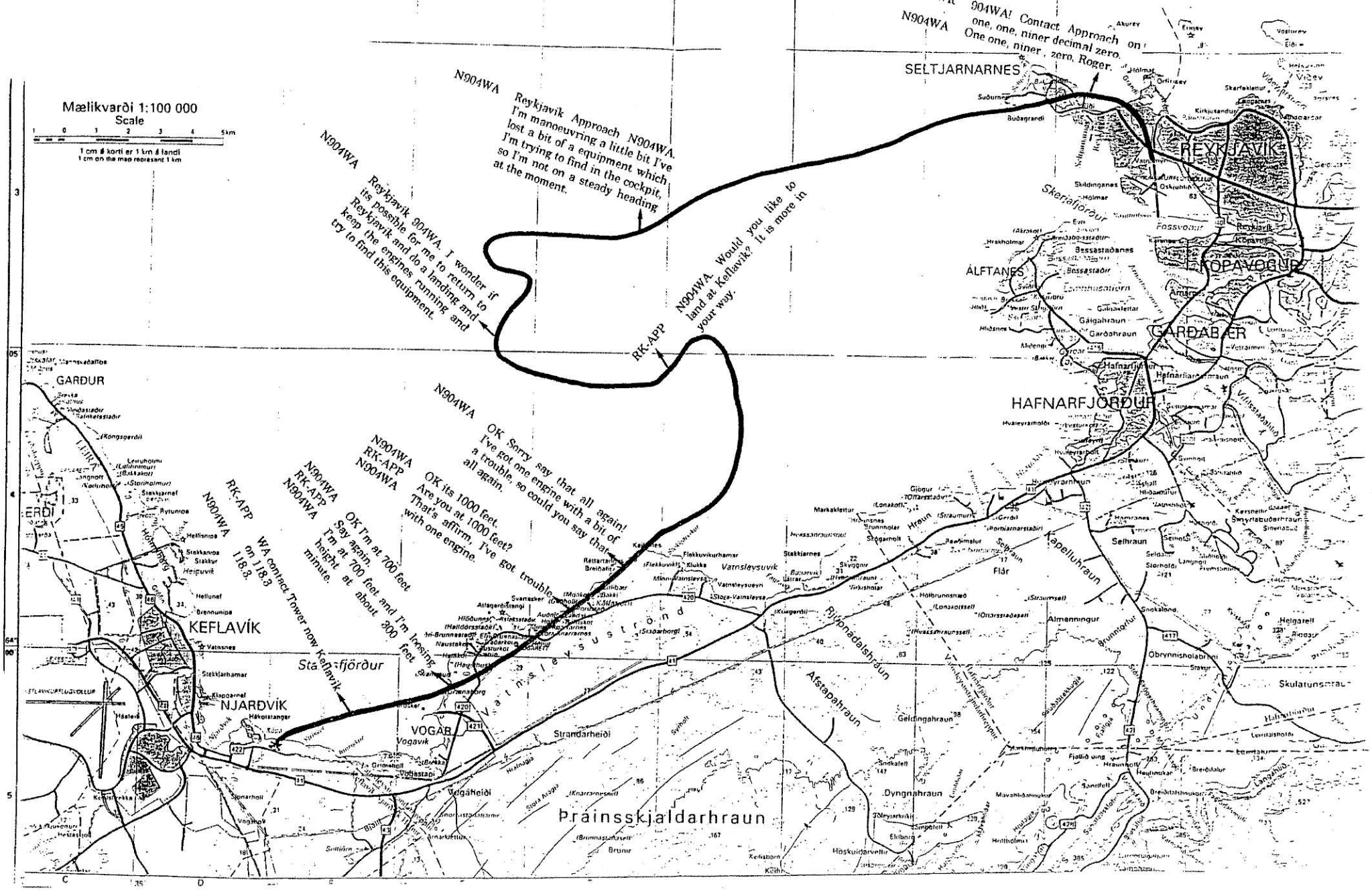
5. APPENDICES:
5.1 Map of the area, the track and the accident site.
5.2 Transcript of the ATC communications.
5.3 Aircraft weight calculations.
5.4 The Special Flight Permit.
5.5 A drawing showing the engine driven fuel pump.
5.6 Photographs

Reykjavík 12 July 1996

[redacted], Chairman
Aircraft Accident Investigation Board

5. APPENDICES

5.1. The track of N904WA.



5.2 TRANSCRIPT OF THE COMMUNICATION TAPES.

LEGEND:
RK-GR = Reykjavik Airport Ground Control
RK-TWR = Reykjavik Airport Control Tower
RK-APP = Reykjavik Airport Approach Control
KF-TWR = Keflavik Airport Control Tower
//

Time:	Source:	Text:
11:42:05	N904WA	Reykjavik, N904WA. With information Foxtrot.
	RK-GR	Reykjavik, N904WA. Roger, are you leaving now?
	N904WA	That is affirmative. Requesting start-up.
	RK-GR	N904WA. Start-up is approved, I will put your clearance on request. Information Foxtrot.
11:46:00	N904WA	Reykjavik, N904WA.
11:46:10	RK-TWR	N904WA. Hold short of runway 02
11:46:15	N904WA	Hold short of zero two.
11:46:20	RK-TWR	That is correct.
11:48:35	RK-TWR	N904WA! Backtrack runway zero two, expedite!
11:48:39	N904WA	OK Backtrack, expedite runway zero two.
11:50:30	RK-TWR	N904WA. Cleared for take-off, runway zero two, left turn on course.
11:50:35	N904WA	Cleared for take-off, runway zero two, left turn on course, WA.
11:52:51	RK-TWR	904WA! Contact Approach on one, one, niner decimal zero.
11:52:55	N904WA	One one, niner , zero, Roger.
11:54:19	N904WA	Reykjavik Approach N904WA.
11:54:24	RK-APP	N904WA good morning! Identified proceed on course direct Embla.
11:54:45	N904WA	This 904WA.
11:54:55	RK-APP	Roger.
11:59:20	N904WA	Reykjavik Approach N904WA. I'm manoeuvring a little bit I've lost a bit of a equipment which I'm trying to find in the cockpit, so I'm not on a steady heading at the moment.
11:59:40	RK-APP	N904WA that was you calling right?!
11:59:45	N904WA	That's affirm.
11:59:50	RK-APP	There is no traffic in your way.
11:59:59	N904WA	That's fine I'll try to find this bit of equipment.
12:00:03	RK-APP	Roger.
12:02:09	N904WA	Reykjavik 904WA. I wonder if its possible for me to return to Reykjavik and do a landing and keep the engines running and try to find this equipment.
12:02:27	RK-APP	WA Roger. Understand you want to come back to land at Reykjavik and try to find it?
12:02:37	N904WA	That's affirm I wonder if its possible to just pick it up and keep the engines running and establish this equipment and then take off again immediately.
12:02:44	RK-APP	There is no trouble. Fly heading of 100 now, 100 and descend to 2000 feet on QNH 1029 and this will be vectors for the visual final runway 02.
12:02:56	N904WA	OK, I copied all 20, 02.
12:03:44	RK-APP	N904WA. Would you like to land at Keflavik? It is more in your way.
12:04:10	N904WA	Yea, that would be fine to that's affirm.
12:04:56	RK-APP	OK. . Make a right turn and proceed to Keflavik, descend to 2000.
12:05:06	N904WA	Keflavik and 2000, Roger.

12:04:56	N904WA	What is the heading to Keflavik? I'm not picking up the VOR now.
12:05:06	RK-APP	Heading - Fly heading of 250.
12:05:10	N904WA	250. Thanks.
12:06:23	RK-APP	And WA. Runway 02 also at Keflavik. Wind is 070 at 5 and the QNH 1029. Expect visual approach when you have the field in sight. It is about just to the right of twelve. Now 8 miles.
12:06:44	N904WA	OK Sorry say that all again! I've got one engine with a bit of a trouble, so could you say that all again.
12:06:56	RK-APP	Expect to land at Keflavik, runway 02, visual approach when you have the runway in sight. QNH 1029, wind 070 at 5.
12:07:06	N904WA	OK copied all OK and call you field in sight.
12:07:10	RK-APP	Roger.
12:07:14	RK-APP	What's your altitude now?
12:07:17	N904WA	Say again
12:07:19	RK-APP	What is your altitude?
12:07:21	N904WA	OK its 1000 feet.
12:07:26	RK-APP	Are you at 1000 feet?
12:07:30	N904WA	That's affirm, I've got trouble with one engine.
12:07:40	RK-APP	904WA can you maintain 1500 feet?
12:07:57	RK-APP	904WA Approach.
12:08:00	N904WA	Go ahead.
12:08:02	RK-APP	Can you maintain 1500 feet?
12:08:07	N904WA	Negative. I've lost one engine.
12:08:09	RK-APP	Lost one engine.
12:08:12	N904WA	That's affirm.
12:08:15	RK-APP	Roger.
12:08:25	N904WA	Tell me distance and heading.
12:08:30	RK-APP	Keep the same heading, and your distance now from Keflavik is 6 miles. It´s about your 12 o´clock just right of 12 o´clock.
12:08:40	N904WA	Got it.
12:08:43	RK-APP	And confirm there is only one soul on board.
12:08:45	N904WA	That's affirm.
12:08:51	N904WA	And I'm loosing height all the time.
12:08:53	RK-APP	Say again.
12:09:00	N904WA	Gradually loosing height.
12:09:09	RK-APP	WA could you say the last again, please?
12:09:12	N904WA	I'm gradually loosing height.
12:09:28	RK-APP	WA you can also come straight in for landing runway 29.
12:09:34	N904WA	OK I'm at 700 feet
12:09:36	RK-APP	Say again.
		12:09:38 N904WA I'm at 700 feet and I'm loosing height at about 300 feet a minute.
12:09:50	RK-APP	Roger are you able to land on some road there?
12:09:55	N904WA	Say again.
12:09:57	RK-APP	Say again.
12:09:58	N904WA	Say again.
12:10:00	RK-APP	Are you able to land on some road nearby?
12:10:03	N904WA	I'm coming over land now.
12:10:14	RK-APP	There is a small village there somewhere and some roads are you able to land on some road there.
12:10:20	N904WA	I'll try that.
12:11:07	RK-APP	WA contact Tower now Keflavik on 118.3
12:11:16	N904WA	118.3.
12:11:25	N904WA	Tower Keflavik N904WA!
12:11:35	KF-TWR	N904WA. You can use runway 29, wind is 050, wind is calm.
12:11:40	N904WA	That's copied sir, I'm 2 miles to the east. I'm descending rapidly I'm down at 200 feet at this time.

12:11:55	KF-TWR	We have you in sight. You're on a long final for runway 29.
12:12:05	N904WA	Say again please, I'm not going to make it.
12:12:19	KF-TWR	There is an old airport to your left try to use that.
12:12:22	N904WA	What's that.
12:12:27	KF TWR	There is an old airport to your left you can try to use that.
12:12:37	KF TWR	Do you find the old airport.
12:13:33	KF TWR	N904WA TWR.
12:13:46	KF TWR	N904WA TWR.

- END -

Planeweighs Limited
Aircraft weighing & technical services
Unit 14, Oxwich Court,
Fendrod Business Park,
Swansea SA6 8QP.
Tel: (0792) 310566
Fax: (0792) 310584

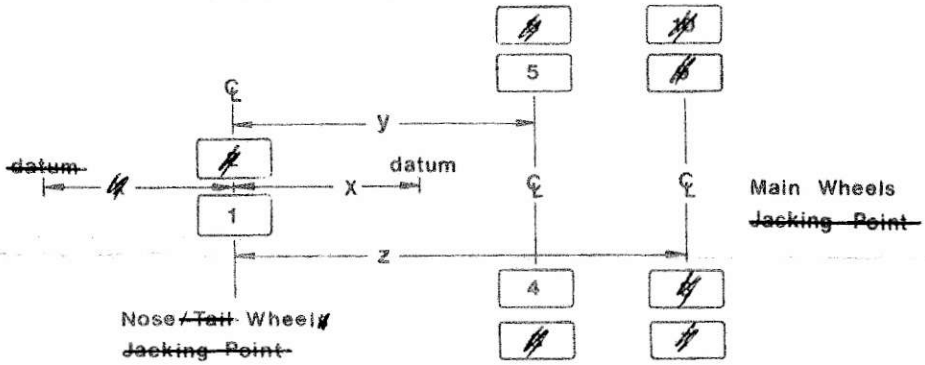
WEIGHING REPORT

No. 3573

Type	Registration	Serial No.
BN2A-21 Islander	N904WA	904

Place	Date	Weighed by
Stansted	15JAN96	[redacted]

Equipment: LPA400 platform scales - cal. due Nov 1996



Position	S/No.	WEIGHT (Each Reaction) lb/kg	WEIGHT (Totals)	ARM in/m	MOMENT lb.in/kg.m
1	C	460	460	x -116.5	-53,590
2				x	
3				x±y	
4	J	2,259	4,469	x±y 40.7	181,888
5	F	2,210		x±y	
6				x±y	
7				x±z	
8				x±z	
9				x±z	
10				x±z	
AS WEIGHED			4,929	26.03	128,298
Total Subtractions (Column 1, see over)			Nil		
Total Additions (Column 2, see over)			Nil		
AIRCRAFT WEIGHT			4,929	26.03	128,298

REMARKS:

The Aircraft Weight with fuel tanks empty ~~(completely~~/but including unusable fuel), oil tanks full/~~empty~~, systems primed and equipped as per Inflite Engineering Check List, dated 15JAN96, is 4,929 lb

The Centre of Gravity is 26.03 in Aft/~~Forward~~ of the Datum.

Certified that the above mentioned aircraft has been weighed in accordance with the terms of the order applicable thereto and unless otherwise stated above conforms fully to the standards/specifications quoted hereon and the requirement of the C.A.A.

Signed [redacted]

For and on behalf of
PLANEWEIGHS LIMITED
C.A.A. Approval No.: A1/8538/79.

Unless otherwise stated on this form, the aircraft was weighed with the fore-and-aft and lateral axes of the aircraft horizontal.

Column 1 - Subtractions Items weighed but not part of Basic Weight	Weight lb / kg	Arm in / m	Moment lb.in / kg.m
Total	—		
Column 2 - Additions Items not in Aircraft when weighed			
Total	—		

NOTES:

N904WA

Maximum authorized take-off weight: 6950 lb (3150 kg).

Actual take-off weight at Reykjavik Airport.

- **EMPTY WEIGHT** - Ferry fuel system & equipment installed.
  Weighed at Planeweighs Ltd., 15 Jan 1996 ..... **4.929 lb**

- **FUEL** - 2 wingtip fuel tanks ea. 27.5 USG = 55 USG
  2 main fuel wingtanks ea 65 USG = 130 USG
  - **WING:**

  Total 185 USG (185 x 3.7849 liters) = **700 liters.**
  - **FERRY FUEL SYSTEM:**

  Four 200 liter drums in the cabin.
  Holding a total of ..... = **600 liters.**

  Total fuel weight at take-off :
  600 + 700 = 1300 x 0.71 = 923 kg.
  923 x 2.20464 ..... **2.035 lb**

BAGGAGE -
All bags weighed (7+4+6+7+7) = 31 kg.
Aircraft manuals, logbooks e.t.c. = 8 kg.
Total = 39 kg x 2.20464..... **86 lb**

PILOT -
According to the FAA Medical Certificate..... **139 lb.**

Total: 7189 lb (3291 kg)
==========

International Field Office - LGW
c/o Aviation House
Gatwick Airport
South Area
Gatwick
West Sussex RH6 0YR

Tel: (01293) 573937
Fax: (01293) 573992

February 21, 1996

Authorization Number
96-05

FAX- Special Flight Permit
This Authorization must be displayed in the aircraft in accordance with Section 91.203(b) of the FAR

This Authorization Expires at Midnight March 21, 1996

Your request to ferry U.S. registered aircraft number N904WA, a Britten Norman Islander (BN-2A-21), serial number 904, registered to [redacted], is hereby authorized flight from Stansted Airport, Stansted Essex to Burlington , Wisconsin USA for the purpose of maintenance.

This authorization shall remain in effect from midnight February 21, 1996 through March 21,1996.

Day/night IFR/VFR flight is authorized provided all required equipment is operational.

Operation of the above aircraft is further limited to the following restrictions and limitations.

Special Operating Limitations

1. Aircraft must be properly registered.

2. A copy of this authorization will be displayed in the aircraft at all times when operating under the terms of this authorization.

3. Only essential flight crew with appropriate FAA ratings and their baggage shall be carried.

Note: Passenger carrying is prohibited.

4. All flights shall be conducted in compliance with applicable General Operating and Flight Rules of FAR Part 91, and the Operating rules of the countries intended to overfly.

5. This aircraft shall not be operated if an Airworthiness Directive applies except in accordance with the requirements of that Airworthiness Directive, (Reference FAR 39.3).

6. An FAA Airframe/Powerplant mechanic or an appropriately rated repair station shall make a logbook entry, certifying that the aircraft has been inspected and found safe for flight. A copy of this logbook entry must be sent or faxed to the London Gatwick International Field Office, prior to the beginning of flight.

7. The maximum gross takeoff weight and center of gravity must conform to the operating manual limitations.

8. This authorization constitutes authority for flights over U.S. territory only, permission for flight over or into countries must be obtained by the owner/operator of the aircraft.

9. Operation of the aircraft must be in accordance with limitations section of the AFM and/or other manufacturers limitations.

10. All flights will be conducted to avoid congested areas.

[redacted]
Principal Maintenance Inspector

5.5 A drawing showing the engine driven fuel pump.

PRESSURE WAS SET @ 6 PSI ONLY

LEAR SIEGLER INC.

ROMEC DIVISION

Power Driven Rotary Pump
Series RG17980

Table 3. Relief Valve Settings

MODEL	FLOW	DISCH PRESS	INLET PRESS	SPEED
RG17980	225 PPH	26 ± 2 PSI	28" HgA	2650 RPM
RG17980A	360 PPH	22 PSID (min)	20" HgA	2650 RPM
RG17980B	225 PPH	26 ± 2 PSI	28" HgA	2650 RPM
RG17980C1	360 PPH	22 PSID (min)	20" HgA	2650 RPM
RG17980D	10 PPH	16 PSID (min)	20" HgA	600 RPM
RG17980F	30 GPH	35 PSI	S/L	1750 RPM
RG17980E	10 PPH	16 PSID(min)	20"HgA	600 RPM
RG17980J	225 PPH	26± 2 PSI	28"HgA	2650 RPM

Table 4. Troubleshooting

RG17980R 133 PPH 24-26 PSI 1450 RPM

TROUBLE	PROBABLE CAUSE	REMEDY
Air Leakage	Defective relief valve gasket; preformed packings; diaphragm; cracked casting(s).	Disassemble and replace defective parts.
Poor Pressure Regulation	Defective diaphragm; damaged seal surfaces of poppet or valve housing seat.	Replace damaged diaphragm. Repair minor seal surface damage per paragraph 5.E.
Low Inlet	Damaged or worn pumping elements.	Disassemble and inspect elements per tolerances given in figure 1. Replace faulty part
	Binding.	Inspect drive coupling or associated hardware for damag Replace faulty parts.

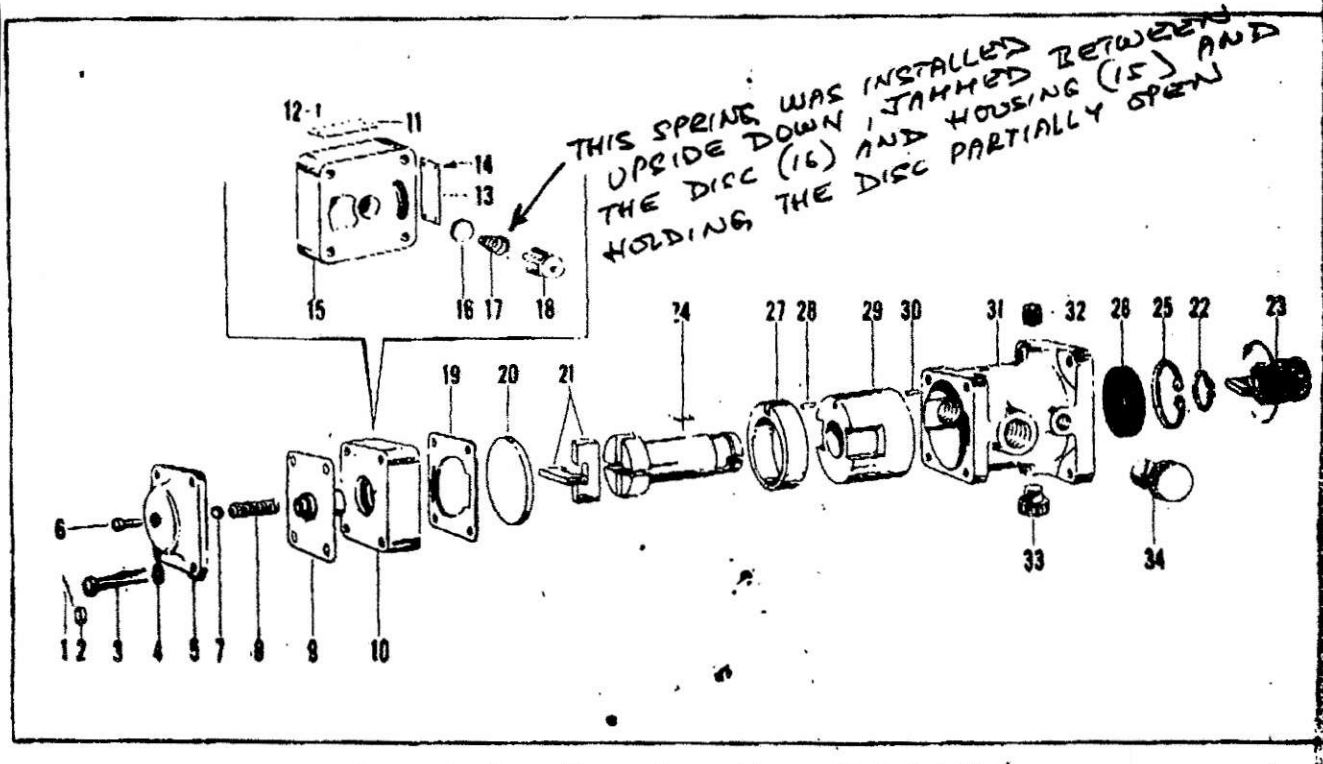


Figure 4. Power Driven Rotary Pump - Exploded View

May 22/6

The ground track of N904WA. Keflavik Airport upper left.