FINAL REPORT

AIC 16-1002

AIRCRAFT ACCIDENT INVESTIGATION REPORT

Sunbird Aviation

P2-SBC

Pilatus Britten Norman BN-2T

1.2 Km west of Kiunga Aerodrome

Western Province

PAPUA NEW GUINEA

13 April 2016

The Papua New Guinea Accident Investigation Commission (AIC) was informed of an accident involving a Pilatus Britten Norman Turbine Islander BN-2T, on 13 April 2015. The accident occurred 1.2 km West of Kiunga Aerodrome, at 14:31 local time. An investigation was immediately commenced by the AIC and investigators deployed to Kiunga on 14 April 2016.

This Final Report AIC 16-1002, dated 13 February 2017, was produced by the AIC, PO Box 1709, Boroko 111, NCD, Papua New Guinea, and is published on the AIC web site. **www.aic.gov.pg**

The report is based upon the investigation carried out by the AIC, in accordance with *Annex 13* to the Convention on International Civil Aviation, and the Papua New Guinea (PNG) *Civil Aviation Act 2000 (as amended),* and the *AIC Policy and Procedures Manual*. It contains factual information, analysis of that information, findings and contributing factors, other factors, recommendations, and safety actions.

Readers are advised that in accordance with Annex 13 to the Convention on International Civil Aviation, it is not the purpose of an AIC aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the Final Report is the prevention of accidents and incidents. (Reference: ICAO Annex 13, Chapter 3, paragraph 3.1.) Consequently, AIC reports are confined to matters of safety significance and may be misleading if used for any other purpose.

When the AIC makes recommendations as a result of its investigations or research, safety is its primary consideration. However, the AIC fully recognizes that the implementation of recommendations arising from its investigations will in some cases incur a cost to the industry.

Readers should note that the information in AIC reports and recommendations is provided to promote aviation safety. In no case is it intended to imply blame or liability.

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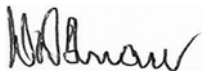

Mr. David Inau, ML

Chief Executive Officer

13 February 2017

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GLOSSARY OF ABBREVIATIONS

AD	:	Airworthiness Directive
AFM	:	Airplane Flight Manual
AGL	:	Above Ground Level
AIC	:	Accident Investigation Commission (PNG)
ALAR	:	Approach-and-Landing Accident Reduction
AMSL	:	Above Mean Sea Level
AOC	:	Air Operator Certificate
ATC	:	Air Traffic Control
ATPL	:	Air Transport Pilot License
ATS	:	Air Traffic Service
ASL	:	PNG Air Services Limited
ATSB	:	Australian Transport Safety Bureau
Avsec	:	Aviation Security
BOM	:	Basic Operation Manual
CAMP	:	Continuous Airworthiness Maintenance Program
CASA	:	Civil Aviation Safety Authority of PNG
CASO	:	Civil Aviation Safety Officer
CASR	:	Civil Aviation Safety Rules
CPL	:	Commercial Pilot License
COM	:	Company Operation Manual
CRM	:	Cockpit Recourses Management
CSN	:	Cycles Since New
CVR	:	Cockpit Voice Recorder
DFDAU	:	Digital Flight Data Acquisition Unit
DGCA	:	Directorate General Civil Aviation
DME	:	Distance Measuring Equipment
ECTM	:	Engine Condition Trend Monitor
EEPROM	:	Electrically Erasable Programmable Read Only Memory
EFIS	:	Electronic Flight Instrument System
EGT	:	Exhaust Gas Temperature
EIS	:	Engine Indicating System
FL	:	Flight Level
F/O	:	First officer or Copilot
FDR	:	Flight Data Recorder
FOQA	:	Flight Operation Quality Assurance
GPWS	:	Ground Proximity Warning System
hPa	:	Hectopascals
Hrs	:	Hours
ICAO	:	International Civil Aviation Organization

IFR	:	Instrument Flight Rules
IIC	:	Investigator in Charge
ILS	:	Instrument Landing System
Kg	:	Kilogram(s)
Km	:	Kilometer(s)
Kts	:	Knots (nm/hours)
Mm	:	Millimeter(s)
MTOW	:	Maximum Take-off Weight
Nm	:	Nautical mile(s)
NTSB	:	National Transportation Safety Board (USA)
°C	:	Degrees Celsius
PIC	:	Pilot in Command
QFE	:	Height above airport elevation (or runway threshold elevation) based on local station pressure
QNH	:	Altitude above mean sea level based on local station pressure
RESA	:	Runway End Safety Area
RPM	:	Revolution Per Minute
ROV	:	Remotely Operated Vehicle
SCT	:	Scattered
S/N	:	Serial Number
SSCVR	:	Solid State Cockpit Voice Recorder
SSFDR	:	Solid State Flight Data Recorder
TS/RA	:	Thunderstorm and rain
TAF	:	Terminal Aerodrome Forecast
TPL	:	Towed Pinger Locator
TSN	:	Time Since New
TT/TD	:	Ambient Temperature/Dew Point
TTIS	:	Total Time in Service
UTC	:	Universal Time Coordinate
VFR	:	Visual Flight Rules
VMC	:	Visual Meteorological Conditions

INTRODUCTION

SYNOPSIS

On the afternoon of 13 April 2016, a Pilatus Britten Norman Turbine Islander (BN-2T) aircraft, registered P2-SBC, operated by Sunbird Aviation Ltd, departed from Tekin, West Sepik Province for Kiunga, Western Province, as a charter flight under the visual flight rules. On board were the pilot-in-command (PIC) and 11 passengers (eight adults and three children). The aircraft was also carrying vegetables. The pilot reported departing Oksapmin at 13:56. The pilot had flight planned, Kiunga to Oksapmin to Kiunga. However, the evidence revealed that without advising Air Traffic Services, the pilot flew from Oksapmin to Tekin. On departure from Tekin the pilot transmitted departure details to ATS, stating departure from Oksapmin. The recorded High Frequency radio transmissions were significantly affected by static and hash.

The weather at Kiunga was reported to be fine. As the aircraft entered the Kiunga circuit area, the pilot cancelled SARWATCH with Air Traffic Services (ATS). The pilot did not report an emergency to indicate a safety concern. Witnesses reported that during its final approach, the aircraft suddenly pitched up almost to the vertical, the right wing dropped, and the aircraft rolled inverted and rapidly "fell to the ground". It impacted the terrain about 1,200 metres west of the threshold of runway 07. The impact was vertical, with almost no forward motion. The aircraft was destroyed, and all occupants were fatally injured.

The investigation found that the right-wing fuel tank was empty. There was no evidence of pre- or post-impact fuel leakage. The backing plate behind the fuel selectors was bent during the impact, and had jammed the left selector in its selected position. It appeared that the pilot may have been cross feeding fuel from the left-wing tank to feed the right engine.

The aircraft had been reweighed 5 months prior to the accident. The operator had not sought to obtain CASA approval of the new weight and balance data sheet for inclusion in the Aircraft Flight Manual (AFM). There was no evidence that the pilot had computed load distribution within the aircraft. The investigation determined that while the aircraft was within the weight limitations, the load distribution placed it in a significantly aft centre of gravity (c of g) situation for takeoff and landing.

When landing flap was set, full nose-down elevator and elevator trim was likely to have had no effect in lowering the nose of the aircraft. Unless the flaps had been retracted immediately, the nose-up pitch may also have resulted in tailplane stall, exacerbating the pitch up. The wings stalled, followed immediately by the right wing dropping. Recovery from the stall at such a low height was not considered possible. The elevator trim was set to full nose-down deflection and the rudder trim was set to full nose-left deflection.

The investigation determined that the right engine had failed, probably subsequent to the SARWATCH broadcast, but sufficiently before the aircraft pitched nose up, in order for the pilot to have had time to wind in full nose-left rudder trim to counteract the aerodynamic forces imposed by the failure of the right engine.

On 8 December 2016, the AIC issued two recommendations, which are included in this report, with respect to safety concerns that while not causal to the accident, nevertheless should be addressed with the aim of accident and serious incident prevention, and for safety of the travelling public.

1. Improvement of High Frequency radio communication capability. On 10 February 2017, PNG Air Services Limited, advised the AIC that it has commenced a holistic program that will enable clear and uninterrupted HF Communications throughout the Port Moresby Flight Information Region by 2018.

2. Ensuring the PNG Chief Pathologist has access to a Forensic testing laboratory to enable the Pathologist to obtain timely toxicology results of samples taken from deceased personnel who have been in control of a transport vehicle involved in a fatal accident. The Department of Health had not responded to the AIC at the time of publication of this report.

1 FACTUAL INFORMATION

1.1 History of the flight

On the afternoon of 13 April 2016, a Pilatus Britten Norman Turbine Islander (BN-2T)[1] aircraft, registered P2-SBC (SBC), and operated by Sunbird Aviation Ltd, departed Tekin[2], West Sepik Province for Kiunga, Western Province (Figure 1) as a charter flight under the visual flight rules[3] (VFR). On board were the pilot-in-command (PIC) and 11 passengers (eight adults and three children). The aircraft was also carrying vegetables. The pilot reported departing Oksapmin at 13:56 local time (03:56 UTC[4]), and subsequently cancelled SARWATCH[5], reporting in the circuit area at Kiunga at 14:31. The aircraft was observed to fly a left circuit to land on runway 07. The weather at Kiunga was reported to be fine.

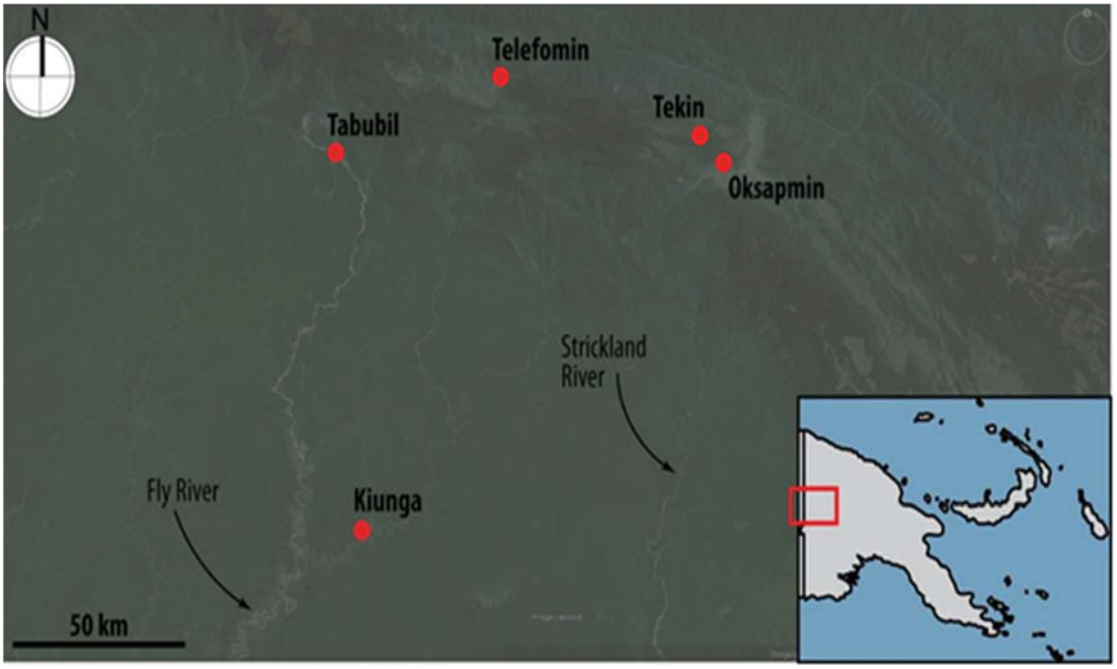

Figure 1: Area of the flight between Tekin or Oksapmin and Kiunga

Several witnesses reported that during its final approach, the aircraft suddenly pitched up almost to the vertical, after which the right wing dropped and the aircraft rolled inverted and the aircraft rapidly "fell to the ground". It impacted the terrain about 1,200 metres west of the threshold of runway 07 (Figure 2). The impact was vertical, with almost no forward motion. The aircraft was destroyed.

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1 Pilatus Britten Norman Turbine Islander (BN-2T) is a twin-engine fixed-wing aircraft, powered by two turbo-propeller engines.

2 The radio flight plan was for a flight Kiunga to Oksapmin to Kiunga. The flight manifest indicated a load from Tekin to Kiunga. From the available evidence, the aircraft flew from Kiunga to Oksapmin to Tekin to Kiunga.

3 Visual flight rules (VFR) are prescribed in Civil Aviation Rules Part 91, Sub-Part D. The rules allow a pilot to only operate an aircraft in weather conditions where the flight can be conducted clear of cloud and in sight of the surface with a flight visibility of not less than 5 km.

4 The 24-hour clock is used in this report to describe the local time of day, Local Mean Time (LMT), as particular events occurred. Local Mean Time was Coordinated Universal Time (UTC) + 10 hours.

5 SARWATCH stands for Search and Rescue Watch

The pilot did not report an emergency and did not transmit a “PAN” indicating a safety concern for his flight, such as an engine failure.

Witnesses at the aerodrome immediately raised the alarm. Help arrived at the accident site approximately 15 minutes after the accident.

Figure 2: Accident site and wreckage looking in an easterly direction

(Taken 90 minutes after the accident).

1.2 Injuries to persons

Table 1: Injuries to persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	1	11	12	-
Serious	-	-	-	-
Minor	-	-	-	Not applicable
Nil Injuries	-	-	-	Not applicable
TOTAL	1	11	12	-

The pilot-in-command was a dual citizen of Australia and France. The passengers were all Papua New Guinea citizens.

All occupants were fatally injured. Three adult passengers survived the impact, and were airlifted to Kiunga Hospital, where they later succumbed to their injuries. The pilot and the other nine passengers sustained fatal injuries during the impact.

1.3 Damage to aircraft

The aircraft was destroyed as a result of severe impact forces.

1.4 Other damage

The wreckage was confined to a small area during the near-vertical impact. It was situated in mixed grassland and low swamp forest, and there was no damage to the surrounding environment.

1.5 Personnel information

1.5.1 Pilot in command

Age	: 31 years
Nationality	: Dual citizen of Australia and France
Type of licence (Aeroplane) No. P2030	: PNG Commercial Pilot Licence
Valid to	: Perpetual
Rating	: C208, PAC 750XL, BN-2T
Total flying time	: 4,705 hours
Total on this type	: 254.6 hours
Total last 90 days	: 90.5 hours
Total on type last 90 days	: 90.5 hours
Total last 7 days	: 9.6 hours
Total on type last 7 days	: 9.6 hours
Total last 24 hours	: 2.5 hours
Total on the type last 24 hours	: 2.5 hours
Total on duty last 48 hours	: Not available
Total rest period last 48 hours	: Not available
Last recurrent training	: 18 January 2016
Last proficiency check	: 12 April 2016
Last line check	: 12 April 2016
Route recency	: 12 April 2016
Aerodrome recency	: 12 April 2016
Medical class	: Class one
Valid to	: 7 July 2016
Medical limitation	: Nil

Note: The pilot maintained his own flight and duty records and the company referred the investigators to the pilot's log book for details. No details were available from the operator for flight and duty times The pilot's records did not include duty times.

1.6 Aircraft information

The Pilatus Britten Norman Turbine Islander (BN-2T), SBC, was equipped with two Rolls-Royce Allison 250-B17C engines, and two Hartzell 3-blade, constant speed and feathering propellers. The BN-2T was a ten seat, high-wing, twin-engine aircraft, designed for short field/grass short take-off and landing operations, and capable of carrying nine adult passengers or one tonne of cargo.

Figure 3: Pilatus Britten Norman Turbine Islander (BN-2T) aircraft

1.6.1 Aircraft data

Aircraft manufacturer	: Pilatus Britten Noman
Model	: BN-2T
Serial number	: 3010
Date of manufacture	: December, 1983
Nationality and registration mark	: Papua New Guinea, P2-SBC
Name of the owner	: Catholic Diocese of Vanimo
Name of the operator	: Sunbird Aviation Ltd
Certificate of Airworthiness	**:** No. 259
Date of issue	: 8 August 2012
Date valid to	: non-terminating
Certificate of Registration	: No. 259
Date of issue	: 6 August 2012
Date valid to	: non-terminating
Total Hours Since New	: 2,407 hours
Total Cycles Since New	: 2,886 cycles
Total Hours Since Overhaul	: 2,407 hours
Total Cycles Since Overhaul	: 2,886 cycles
Total Hours Since Last Inspection	: 81 hours
Total Cycles Since Last Inspection	: 105 cycles

Note: The operator's maintenance records had not been updated since 11 November 2015. The airframe times listed in the above table were calculated by the investigators, using available Technical Log sheets.

1.6.2 Airworthiness and maintenance

The aircraft operator had a current Air Operator Certificate (AOC), and a current Maintenance Organisation Certificate issued by the Civil Aviation Safety Authority of PNG (CASA). The aircraft was not maintained in accordance with the operator's approved system of maintenance (see 1.6.2.1). At the time of the accident the aircraft had a current Certificate of Airworthiness (CoA), Certificate of Registration (CoR), and was certified as being serviceable for flight.

1.6.3 Scheduled maintenance

The investigation team conducted a review of all the available maintenance documentation, and could not find a record of the aircraft's last scheduled maintenance check. The aircraft's last scheduled major check was the right propeller change, carried out on 9 March 2016.

Based on information obtained by the AIC about a defect on SBC on 23 January 2016, the Aircraft Maintenance Engineer (AME) was interviewed. He confirmed that he had conducted defect rectification action when Licensed Aircraft Maintenance Engineers (LAME) were not available to supervise the work and sign for the work. The AIC examined the maintenance documents and there was no record of the maintenance having been conducted.

This was evidence of non-compliance with *PNG Civil Aviation Rules Part 43.105 Certifying release-to-service after maintenance, and Part 119.65, Records — personnel*.

1.6.4 Defects/Discrepancy

The aircraft's maintenance log was reviewed. The only documented defect/discrepancy found was the Certificate of Airworthiness, which was suspended by the PNG Civil Aviation Safety Authority on 27 November 2015 and reactivated on 13 December 2015.

The emergency locator transmitter (ELT) fitted to SBC bore a label stating 'Ameri-King/Replace by Date/Mar 2016' (Paragraph 1.6.8 and Figure 5). Therefore, the ELT had been unserviceable for at least 2 weeks prior to the accident. In accordance with the operator's minimum equipment list, the ELT was required to be fitted and serviceable.

1.6.5 Engines

The aircraft was fitted with two Rolls-Royce Allison 250-B17C engines. The engines are flat-rated at 320 shaft horsepower (830 lb ft torque at maximum normal governed propeller speed of 2030 rev/min) for all operations.

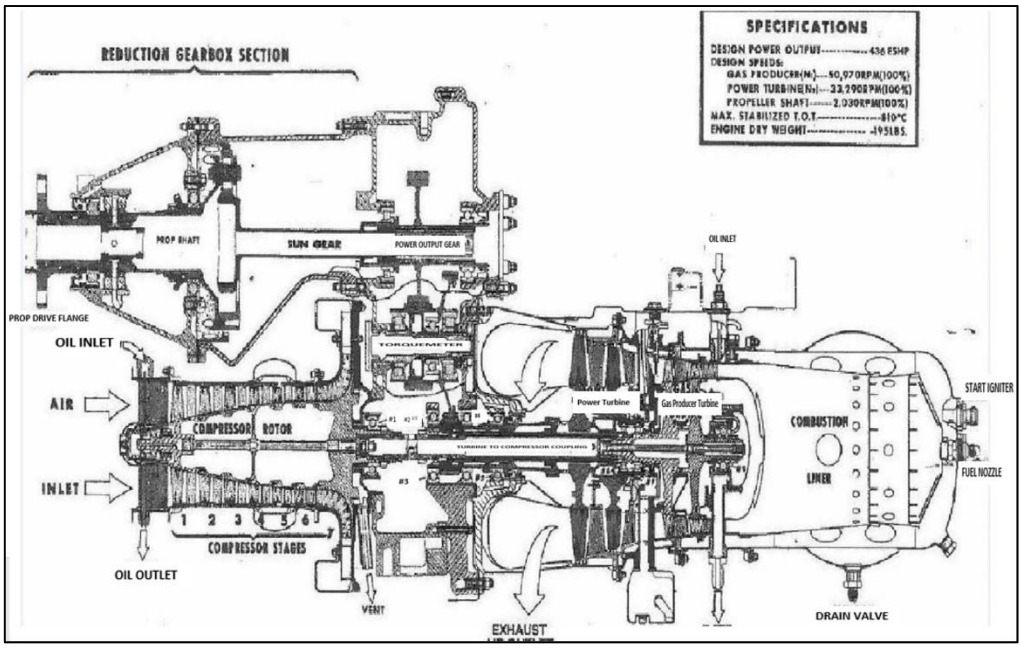

Figure 4: Rolls-Royce Allison 250-B17C engine sectional view

1.6.6 Engine data

Engine type	: Turbo-propeller
Manufacturer	: Rolls-Royce Allison
Type	: 250-B17C
Left engine	
Serial number	: CAE-880424
Total time since new	: 2,551.3 hours
Total time since overhaul	: 2,551.3 hours
Right engine	
Serial number	: CAE-880646
Total time since new	: 2,436.2 hours
Total time since overhaul	: 2,436.2 hours

The thrust reversing systems in these engines had been disconnected.

Note: The investigation revealed that the left engine was removed for repair (no date recorded), and the repair was completed on 6 February 2015. The engine was refitted to the left side of SBC on 27 March 2015. The engine logbook had an entry dated 6 February 2015, which stated "New". The *Engine Certification Log* for SBC had an entry dated 27 March 2015, which stated "Fit L/H engine". The operator's maintenance records had not been updated since 11 November 2015. The engine times listed in the above table were calculated by the investigators, using available Technical Log sheets.

1.6.7 Propeller

The aircraft was fitted with two Hartzell HC-C3YF-5F / FC8475FK-6, three-bladed, constant speed, feathering propellers, with electrical de-icing.

1.6.8 Propeller data

Propeller type	: Variable pitch, constant speed and feathering
Manufacturer	: Hartzell
Type	: HC-C3YF-5F / FC8475FK-6
Left propeller	
Serial number	: FR97
Total time since new	: Unknown *(Log books did not contain data)*
Total time since overhaul	: 82.97 hours
Right propeller	
Serial number	: FR36
Total time since new	: Unknown *(Log books did not contain data)*
Total time since overhaul	: 32.0 hours

Note: The operator's maintenance records had not been updated since 11 November 2015. The propeller times listed in the above table were calculated by the investigators, using available Technical Log sheets.

1.6.9 Weight and balance

The flight manifest for the accident flight (No.004084) was recovered from the aircraft wreckage. Several items were crossed out, and there was evidence of reworking of the arithmetic. (See Appendix 1, Section 5.1.3). The pilot's name and signature were not on the manifest. The loading agent at Tekin was interviewed by the investigation team, in order to clarify aspects of the loading of the aircraft prior to departure from Tekin.

The daily flight record (DFR) for the accident flight (13 April 2016) was not located in the aircraft wreckage. The file containing the DFRs for flights prior to 13 April 2016 were examined by the investigation team.

The *Weight and Balance Computation Sheet* for the accident flight, and flights for 12 April 2016, were not completed/computed by the pilot before the flights. There was no evidence that take-off weights and the load distribution within the aircraft had been computed before takeoff from Tekin.

The aircraft had been re-weighed on 10 November 2015 by an authorised Weight Controller, who stated that he had been contracted to reweigh SBC and prepare a new *Load Data Sheet*. The re-weighing was completed following major repairs after an earlier accident. The new weight and balance data is shown on the copy of the *Load Data Sheet* at Appendix 1, Section 5.1.1 of this report.

Following the re-weighing, the new *Weight and Balance Computation Sheet* (See Appendix 1, Section 5.1.2) had been loose-leaf inserted into the *Aircraft Flight Manual* (AFM). There was no evidence that the AFM had been amended to reflect the revised weight and balance data.

The data being used by the operator for the moment arm (balance) differed by 121 mm (4.84 inches), from the moment arm data that was issued following the re-weighing. There was evidence that following receipt of the new *Load Data Sheet*, the operator did not make adjustments to account for the shift of the moment arm as a result of the reweighing. Specifically, a reduction of allowable maximum weight in the baggage compartment.

The operator's *BN-2T Weight and Balance Sheet* (Excel spreadsheet) was an unapproved document. It used 590 mm (23.6 inches) as the moment arm. The operator was unable to provide evidence for the source of that moment arm data.

There was also no evidence in the AFM as a proof of oversight of the AFM by the Civil Aviation Safety Authority of PNG. There was also no evidence that the operator submitted the amended *Load Data Sheet* to CASA, nor was there evidence that the operator sought an amendment to the Aircraft Flight Manual from CASA.

The investigation team calculated the likely weight and balance for the flight, using the weights listed in the manifest and the distribution of passengers, baggage and freight, based on information provided by the Tekin loading agent, who assisted the pilot in loading the aircraft at Tekin. The aircraft was refuelled at Kiunga (full tanks) prior to departure for Oksapmin. Fuel usage data from the flight records from 12 April (two Kiunga to Tekin return flights completed) were used as indicative fuel consumption.

However, from the Air Traffic Services (ATS) radio flight plan, and the ATS flight strips[6] that had been completed and checked/marked off by the ATS officer communicating with SBC, it was apparent that the aircraft was flown from Kiunga to Oksapmin to Tekin to Kiunga.

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6 The recorded High Frequency radio audio files obtained by the AIC from PNG Air Services Limited for SBC's flight were unreadable, due to background static and hash. However, the ATS officer confirmed that the pilot reported departing from Oksapmin to Kiunga.

The pilot did not notify ATS of the Oksapmin to Tekin sector, and on departure from Tekin reported departing from Oksapmin.

The investigation determined that while the aircraft was within the weight limitations, the load distribution placed it in a significantly aft centre of gravity (c of g) situation for takeoff and landing.

Using the 10 November 2015 re-weigh data, the aft c of g limit remained at 26.4 inches aft of the datum. The basic empty weight c of g was 27.99 inches aft of the datum.

The c of g for takeoff at Tekin was conservatively 5.72 inches aft of the aft limit; i.e. 32.12 inches aft of the datum.

The c of g for the landing at Kiunga was conservatively 5.87 inches aft of the aft limit; i.e. 32.27 inches aft of the datum.

Completed Flight Manifest sheets had been signed by the pilot, as his confirmation that the aircraft's c of g was within limits. However, no documents showed how the pilot determined that the aircraft was loaded within the c of g limits.

1.6.10 Emergency Locator Transmitter (ELT)

The aircraft was fitted with an Ameri-King AK-451-(-12) series emergency locator transmitter (ELT), part number AK-451-(AF)(AP)(S), serial number 6503, in accordance with CAR 91.529. However, the ELT bore a label stating 'Ameri-King/Replace by Date/Mar 2016' (Figure 5). The ELT did not activate on impact, and no emergency signal was detected after the accident.

The ELT was not relevant to this accident, because the aircraft was immediately located by witnesses to the accident. However, the ELT was listed as a required item on the operator's MEL. Moreover, the carriage of a serviceable ELT on aircraft in PNG is mandated for the safety of aircraft occupants in the event of an aircraft accident away from habited areas. Because a serviceable ELT is a requirement for the safe operation of the aircraft in PNG, an out of date ELT rendered the aircraft unserviceable.

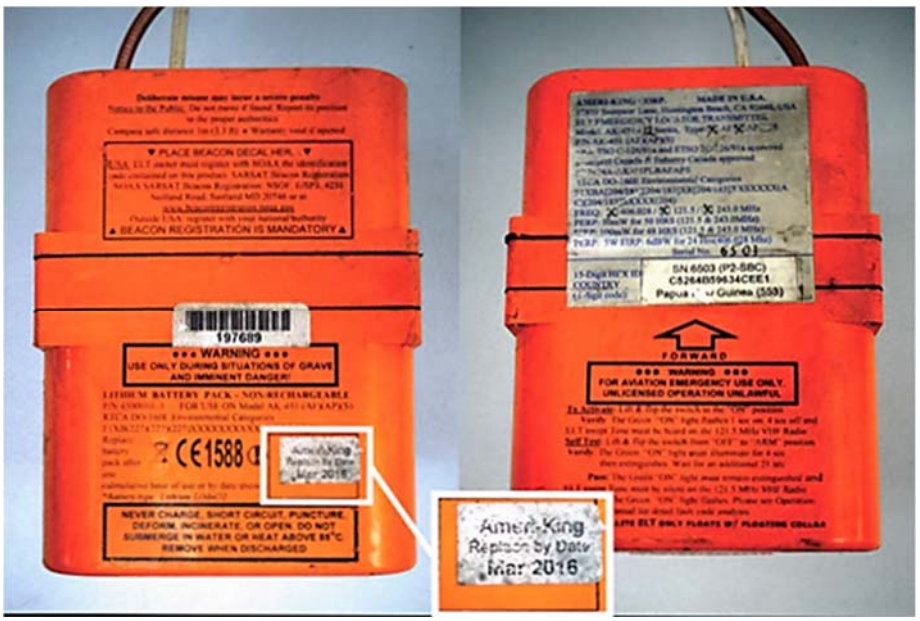

Figure 5: Emergency locator transmitter recovered from the wreckage of SBC

1.6.11 Minimum Equipment List

The operator's approved Minimum Equipment List (MEL) for SBC stated equipment and systems that were required for the safe operation of the aircraft. It specified restrictions or limitations to be applied in the event of any of the listed equipment or systems becoming unserviceable. These ranged from immediate grounding, to ferry flight permissible, or repair/rectification within a specified flight hour, or calendar day or time, timeframe.

1.6.12 Fuel information

The fuel used was Aviation Turbine Fuel Jet A-1 (AVTUR).

The aircraft was last refuelled at Kiunga Aerodrome on the evening of 12 April 2016. A quantity of 256 litres was uplifted. The Aviation Sales Release Receipt Tax Invoice completed by the aerodrome refueller did not indicate the quantity of fuel that went into each of the aircraft's wing main tanks; only a total uplift. The Sunbird DFR for the 12 April 2016 detailed flight sectors flown and fuel used during the day. No fuel was put in the wing tip tanks. The tip tanks were empty.

The "Fuel Remaining Kg" row on that DFR stated 184 kg (230 litres). Based on the DFR, and the fuel Company's Aviation Sales Release Receipt Tax Invoice documents, the 12 April 2016 total fuel load on board the aircraft would have been 486 L (855.36 lbs) at a specific gravity of 7.9 (0.79 kg / L).

The Aviation Sales Release Receipt Tax Invoice (0690639), and Daily Flight Record (130393) for 12 April 2016 respectively are at Appendix 2, Section 5.2.1 and 5.2.2.

1.6.13 Airframe and engine control systems

1.6.13.1 *Cockpit to engine control*

The power control system includes the aircraft and engine components necessary to control engine power settings during all phases of operations. This system includes the power lever, condition lever, propeller Beta valve and the engine coordinator, propeller power turbine governor, and the necessary linkage and lines to connect these components together.

1.6.13.2 *Condition Lever Control*

The aircraft was equipped with systems to allow the pilot to manage propeller speed as follows.

0°	Fuel Shutoff and Propeller Feathering
18°	Minimum propeller Speed Setting
40°	104% Propeller Speed

The condition lever was connected through linkages to a lever mounted on the top right side of the coordinator on the engine.

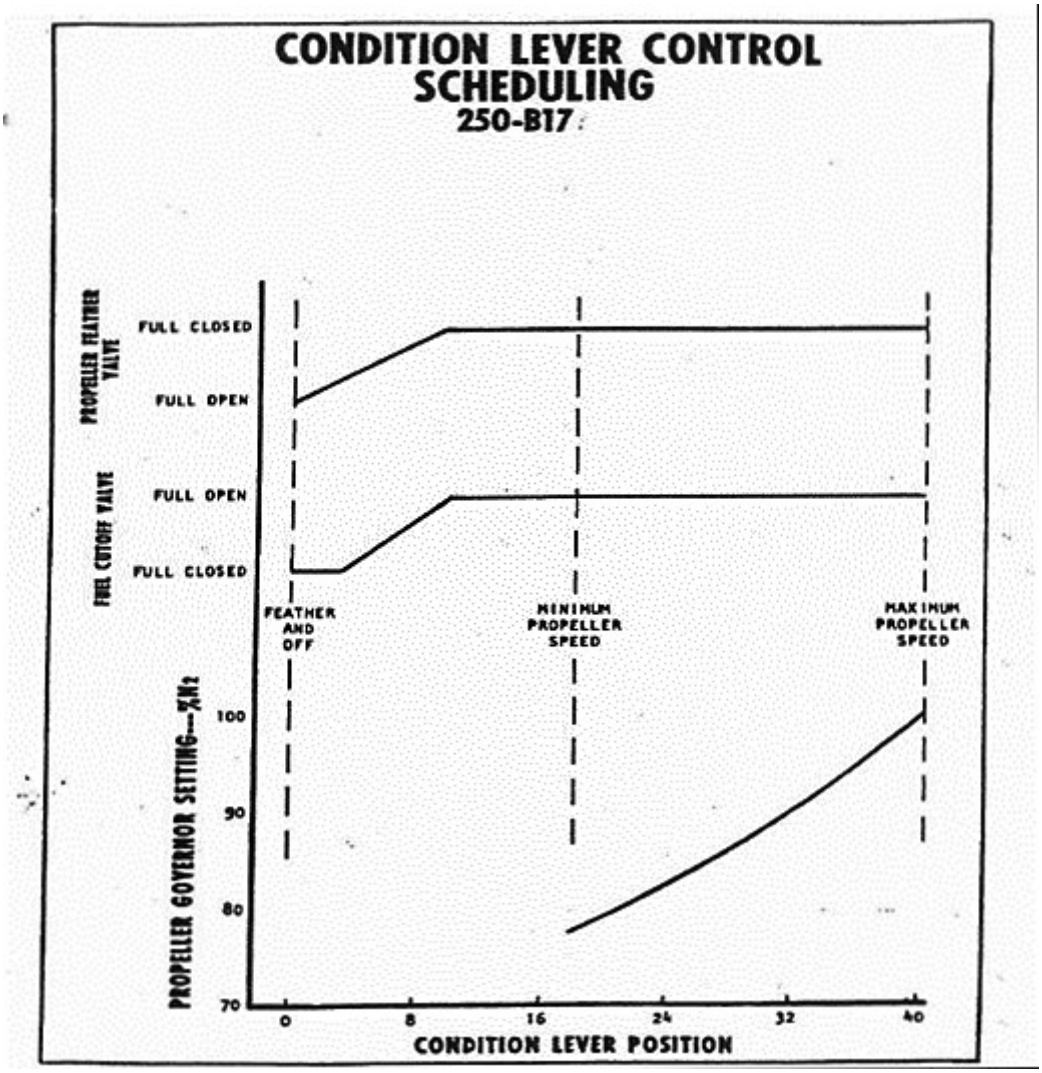

Figure 6: Rolls-Royce 250-B17 Condition Lever Control Scheduling

1.6.13.3 *Engine Power Lever*

The Power Lever allows the engine thrust modulation from take-off to maximum reverse[7] with a total angular travel of 95 degrees. This lever has the following specific positions.

0°	Maximum Reverse
30°	Ground Idle and Start
40°	Flight Idle
95°	Maximum

The power lever is connected through aircraft linkages to the input lever on the coordinator.

7 The reverse thrust mechanism had been removed from all BN-2T aircraft in the Sunbird fleet.

1.6.13.4 *Propeller Beta Valve*

The Beta Valve is installed inside the engine driveshaft.

The Beta valve is considered the hydraulic low pitch stop. It acts to cut-off oil from the propeller governor to the piston, which is tending to reduce pitch, when the piston reaches a predetermined low pitch position.

1.6.13.5 *Engine Coordinator*

The function of the coordinator is to provide automatic sequencing of the multiple power plant controls in response to input from the pilot-operated power and condition levers.

A condition lever assembly is attached to the top of the coordinator. This lever is connected by the aircraft linkages to the pilot-controlled condition lever and by engine linkage to the propeller governor lever and to the fuel cut-off valve on the fuel control. Any movement of the condition lever in the aircraft will then afford the necessary movement of these two levers for engine control.

1.6.13.6 *Propeller system control*

The propeller is a hydraulically actuated constant speed type, utilizing oil pressure from an engine mounted governor to supply oil pressure through the engine shaft. Oil is used to decrease pitch[8] (blade angle), and reverse pitch when the thrust reversing system is fitted. Oil pressure is opposed by the blade counter weights, plus the heavy spring mounted along the propeller axis. When the oil supply (oil pressure) is lost, the action of the counter weights and spring force, pushes the blades into the feathered position.

1.6.14 Flight controls and flaps

1.6.14.1 *Elevator trim*

The BN-2T elevator trim tabs have a range of movement of 22° trailing edge down (aircraft nose up) to 8° trailing edge up (aircraft nose down). Limit switches are installed at the travel limits that will prompt the display of Crew Alerting System (CAS) messages, notifying the pilot that the elevator trim tabs are at maximum displacement.

A pilot can manually control the amount of trim tab deflection by moving the elevator trim hand-wheel on the centre console. The elevator trim tab is operated by a chain and cable drive from a sprocket on the elevator trim hand wheel assembly. The cables are routed over pulleys beneath the cabin floor to a chain and sprocket at the base of the screw jack mounted on the rear fuselage bulkhead, and to a pushrod connected to the elevator trim tab. (Appendix 7)

A pilot has the option of electrically controlling the deflection of the elevator trim tabs. A push-button switch, labelled PITCH TRIM ENG / DISENG, located to the left of the standby flight instruments on the lower instrument panel enables electrical operation of the elevator trim switches mounted on the outboard side of the control yokes.

8 Propeller blade **pitch** or simply **pitch** refers to turning the angle of attack of the blades of a **propeller** into or out of the wind to control the production or absorption of power.

The Nose-Down/Nose-Up switches on the control wheel are connected to the elevator trim tabs via an electric motor. The red disconnect switch de-powers the electric trim servos for as long as the switch is depressed.

The manual trim wheel directly moves the elevator trim tabs, but do not have the mechanical leverage to overcome the electric trim servos. The electric trim servos can be disconnected using Nose-Down/Nose-Up switches.

The investigation determined that the elevator trim tab was fully deflected nose-down. There was no damage to the screw jack and push rod systems. There was no evidence that impact forces influenced the length of the screw jack extension, and the position of the elevator trim tab with respect to the degree of deflection. (Appendix 3)

1.6.14.2 *Rudder trim*

A pilot can manually control the amount of trim tab deflection by moving the elevator trim hand-wheel on the cabin roof. The rudder trim tab is operated from a sprocket and chain assembly on the rudder trim hand-wheel. Rotary movement of the hand-wheel assembly is transmitted through flexible cables to a similar chain and sprocket assembly on a screw-jack drive bearing bolted to the tailplane front spar. A universally-jointed extension rod, attached to the drive bearing, extends upwards, through the hollow lower mounting spigot of the rudder, into the leading edge of the control surface. The top end of this rod carries a lead screw which engages with a trunnion-mounted nut in a bell-crank, attached to the rudder front spa. A push-pull rod, with adjustable ends, is connected between the bell-crank and the rudder trim tab.

The investigation determined that the rudder trim tab was fully deflected nose-left. There was no damage to the screw jack and push rod systems. There was no evidence that impact forces influenced the length of the screw jack extension, and the position of the rudder trim tab with respect to the degree of deflection. (Appendix 3)

1.6.14.3 *Wing flaps*

The wing flaps were driven by an electric motor. A toggle switch on the central pedestal had “UP”, “STOP” and “DOWN” positions and was spring loaded to the centre “OFF” position. The flaps position indicator was an electrically operated gauge mounted above the windscreen. It was marked with white sections indicating “UP”, “TAKE-OFF (25°) and “LANDING” flap positions. Fully extended flap setting is 56°. These sectors were of finite width, and momentary deflection of the flap lever would “inch” the flaps over a small range within the sector. This was of particular value in the “UP” position where a 6° range was provided to enable selection of an optimum position, which varied with the aircraft’s all-up weight. When the flap lever was deflected for sufficient time for the flaps to travel beyond one of the white sectors, the flaps would continue to travel after the lever was released, until reaching the start of the next white sector.

The aircraft flight manual stated that the pilot should expect a nose-up change in pitch when the flaps are extended.

1.6.14.4 Airframe fuel system

The BN-2T was fitted with two wing main fuel tanks and two wing tip tanks. The tanks are interconnected through functionality of the cockpit fuel selectors, fuel transfer pumps, and auxiliary fuel pump/backup pump.

The main tanks feed fuel directly to the engine. The fuel from the main tanks is delivered to the fuel inlet port, where it is directed to the 5 micron absolute paper filters. Normally, all the inlet fuel flows through the filter to the inlet of the gear pump. The filter bypass valve, in parallel with the filter, is normally closed. As fuel flows through the filter, there will be a slight decrease in pressure, with the pressure on the inlet side being higher than the pressure on the outlet side. As the filter collects contaminants from the fuel, the pressure differential across the filter increases, to a point where the fuel by-passes the filter.

Cross-feed of fuel allows fuel from one wing tank to be burned by the engine on the other wing. The cross-feed provision allows the pilot to use all of the fuel on board and to maintain lateral balance limitations in the event of a failure resulting in single-engine operations.

The aircraft's fuel system is illustrated at Appendix 4. Each fuel cock is attached to the rear wing-spar, inboard of the respective wing fuel tanks. Each cock is selected by the operation of a selector, 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.

Selector positions achieved 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 form the opposite wing. The starboard engine fuel selector is labelled and operates similarly in the opposite sense.

A detailed description of the BN-2T fuel system is at Section 5.3, Appendix 4.

The investigation examined the aircraft maintenance history and found that following a previous accident, the aircraft remained at the accident site for almost 2 years. During the repairs, contaminants were found in the aircraft's fuel tanks and fuel systems. Following its return to service, contaminants were found in the wing tanks and fuel filters after flight operations, necessitating draining fuel from the tanks and cleaning of the tanks and filters. A pilot reported that on 23 January 2016, he informed the operator's engineers of a partial engine failure of the right engine on SBC during a take-off roll. The aircraft was checked, and returned to service. During the subsequent flight, the right-wing tip-tank was used. The right engine partially failed. Maintenance engineers reported that the right main tank was not being fed by the tip tank. The engineers found contaminants in the right wing's main and tip fuel tanks, and also a blocked filter.

During the accident investigation, the AIC's examination of the fuel system did not find evidence of contaminants in the aircraft's fuel system.

The cockpit fuel selectors were found as follows:

> Left selector. The selector was pointing to a position two thirds of the distance from the PORT TANK position, towards the OFF position.
>
> Right selector. The selector was pointing to a position two thirds of the distance from the OFF position, towards the PORT TANK position.

The left and right sides of the selector backing plate, under the selectors, was bent during the impact and there was no possibility of the left selector further rotating from its pre-impact position.

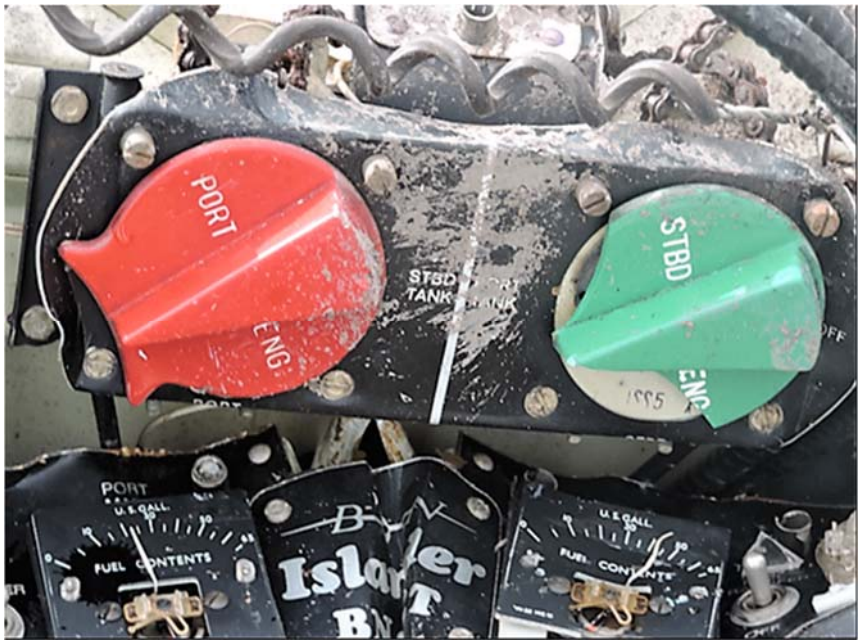

Figure 7: Fuel selectors powerplant systems

1.6.14.5 *Engine Control Trend Monitoring (ECTM)*

Engine Control Trend Monitoring (ECTM) is a process in which changes in certain performance parameters of engines are analysed to identify engine performance deterioration, and malfunction of engine components and accessories.

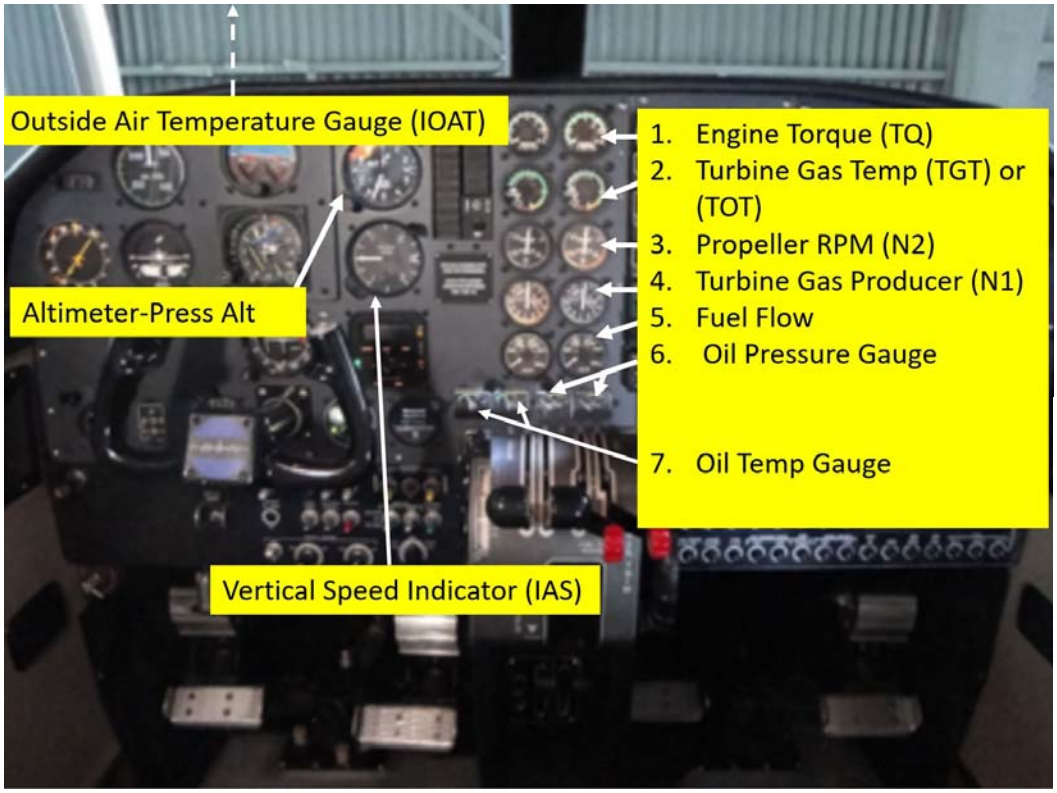

Figure 8: ECTM parameters gauges in the cockpit

The BN-2T (SBC) ECTM was recorded once per day if flown, usually at 8,000 feet in the cruise, at an established power setting, and was recorded after the engine has stabilised and no engine control adjustment has been made for 5 minutes.

The ECTM Data from 11 February 2016 to 8 April 2016, and 12 April 2016 respectively were examined. There was no evidence of abnormalities or malfunctions on those data.

1.6.14.6 *Engine accessories location*

Accessories required for the operation of the Rolls-Royce 250-B17C series turboprop engine were classified as driven or non-driven. All driven accessories were mounted on the accessory or reduction gearbox, and were driven either by the gas producer or the power-turbine gear trains.

1.7 Meteorological information

Witnesses reported that the weather at Kiunga was fine at the time of the accident (see Figure 2, picture taken 90 minutes after the accident). The prevailing meteorological conditions were not a factor in the occurrence.

1.8 Aids to navigation

The only navigation aid at Kiunga was distance measuring equipment (DME). The DME was unserviceable at the time of the accident. Ground-based navigation aids and on-board navigation aids, and their serviceability, were not a factor in this occurrence.

1.9 Communications

All communications between Air Traffic Services (ATS) and the pilot of SBC were recorded by ground based automatic voice recording equipment for the duration of the flight. All the High Frequency radio transmissions between ATS and SBC were significantly affected by static interference and a lot of hash, making reception difficult. The ATS officer reported that SBS reported departing Oksapmin for Kiunga. The ATS flight strips also showed that the aircraft reported departing Oksapmin for Kiunga.

The pilot cancelled SARWATCH on arrival in the circuit area at Kiunga at 14:31.

See Appendix 6 for the ATS transcript containing the cancellation of the SARWATCH, and the ATS flight Strip covering the flight.

1.10 Aerodrome information

Aerodrome Code	: AYKI
Airport Name	: Kiunga
Airport Coordinates	: 06°07′45″S, 141°17′15″E
Elevation	: 86 feet
Runway Length	: 1,125 meters
Orientation	: 07 / 25

1.11 Flight recorders

The aircraft was not fitted with a flight data recorder or cockpit voice recorder. Neither type of recorder was required by PNG Civil Aviation Rules.

1.12 Wreckage and impact information

1.12.1 Wreckage examination on the crash-site

The accident site was located approximately 1,200 metres to the west of Kiunga Aerodrome.

The on-site investigation team consisted of the AIC investigators, technical representatives of the operator Sunbird Aviation, and a technical representative from the Rolls-Royce Corporation.

1.12.2 Impact sequence and distribution of the wreckage

The aircraft impacted the ground almost vertically, consequently there was no wreckage trail. Vegetation approximately 4 to 5 meters in front of the aircraft's nose showed little evidence of disturbance as a result of the impact. Although substantially disrupted during the impact, the wreckage was largely confined to the immediate vicinity of the impact point.

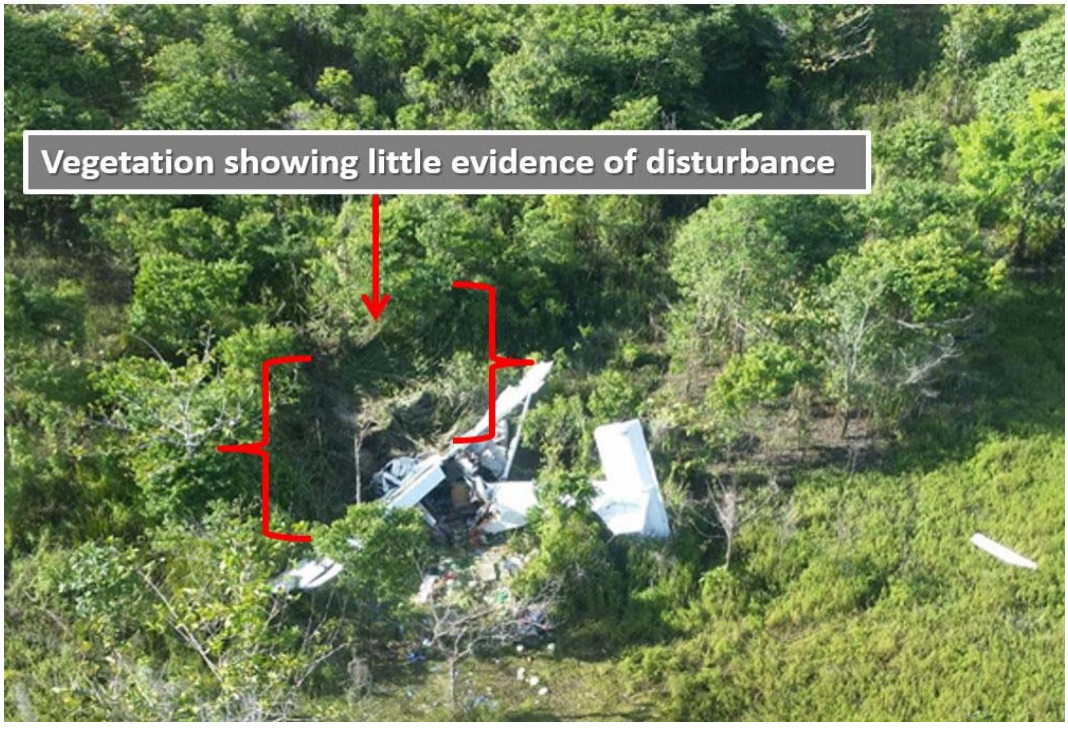

Figure 9: Accident site showing wreckage confined to general dimensions of the aircraft

The fuselage had fractured around the rear cabin, separating the top mounted wing assembly and the forward cabin from the rear fuselage and empennage. The fuselage and wing were horizontal to the ground, and the rear fuselage was resting on its left side, with the attached empennage resting on the tip of the left tailplane.

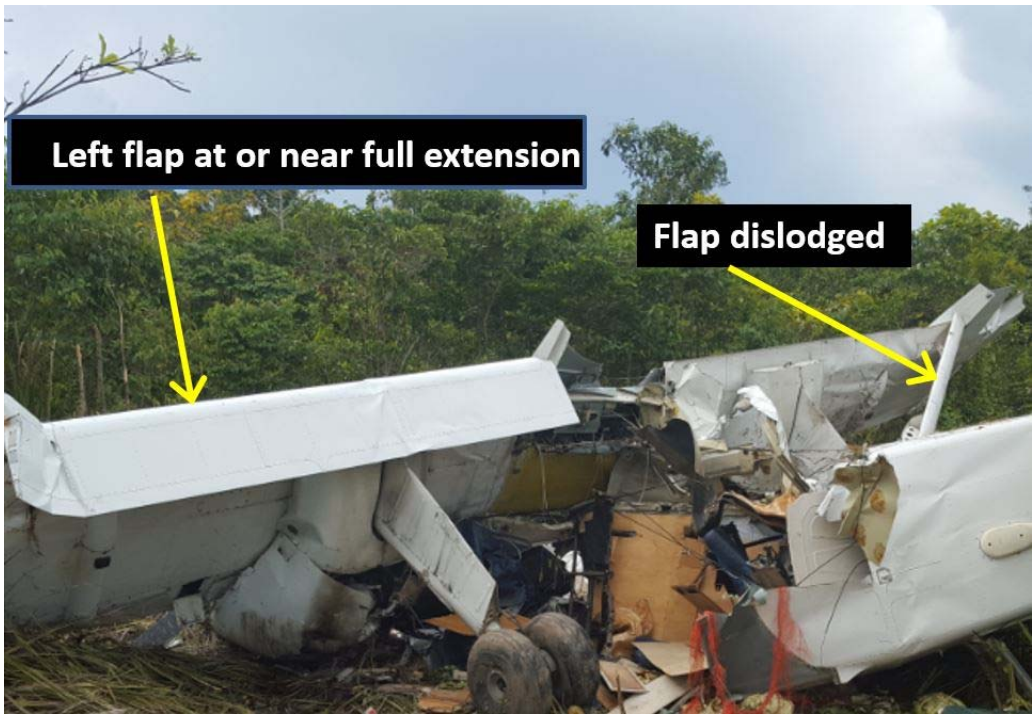

Figure 10:Wreckage viewed from the left side behind the left wing

Figure 11: Empennage supported on the left tailplane tip

The cockpit could not be inspected at the accident site, due to it having been crushed by the forward movement of the cabin during the impact. The wreckage was airlifted to Kiunga, where detailed examination was carried out.

Figure 12: Compressed Forward Cabin

All flight control surfaces were accounted for and identified. The investigation determined that despite the significant disruption of the airframe due to the impact forces, with the exception of the right-wing flap, the control surfaces remained connected to their respective cockpit controls. The elevator trim tab was in the full nose-down trim position. The rudder trim was in the full nose-left trim position. The rudder position had been affected by cable disruption during the impact, but the rudder trim screw jacks and push rods were not disrupted and the rudder trim was in the full nose-right trim position.

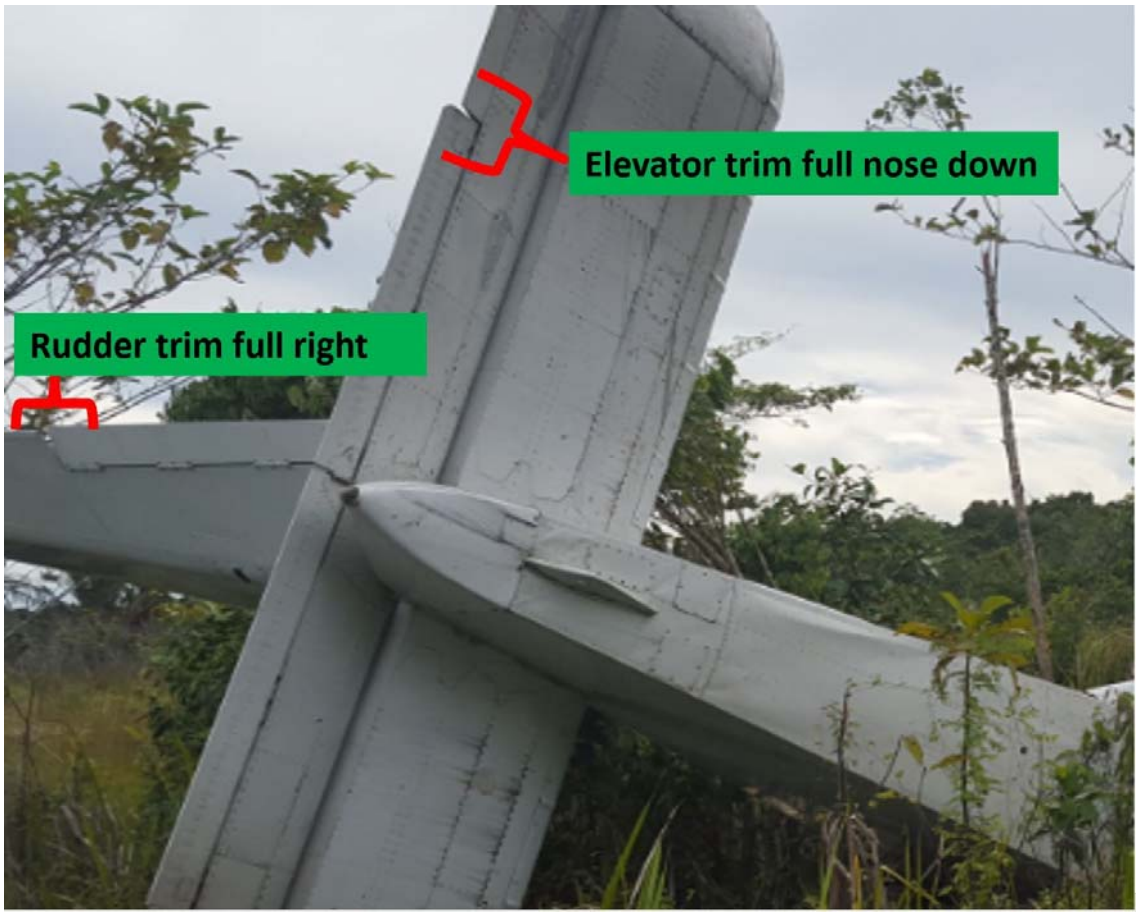

Figure 13: Elevator and rudder trim tabs

The force of the impact dislodged the right engine from its mount, with the right propeller assembly still attached. One propeller blade was buried in the mud. The propeller blades were identified in the feathered position. The blade buried in the mud was slightly bent in the opposite direction to the rotation of the propeller. Another blade was substantially bent in the opposite direction to the rotation of the propeller. However, that bending appeared to be largely due to it being tangled with the engine mount.

Figure 14: Right engine and propeller

The left engine was found separated from the airframe, but remained attached to its mount. The left propeller assembly was sheared (in torsional overload) from its drive shaft. The propeller blades were in a fine pitch range at impact, with the two blades embedded in mud showing bending opposite to the rotation of the propeller**.**

Figure 15: Left engine still attached to its mount

Figure 16: Left propeller

There was no evidence of in-flight structural failure of the wing flaps. The investigation determined that the wing flaps were at or near the fully extended position. There was no indication that impact forces influenced the position of the wing flaps with respect to the degree of deflection.

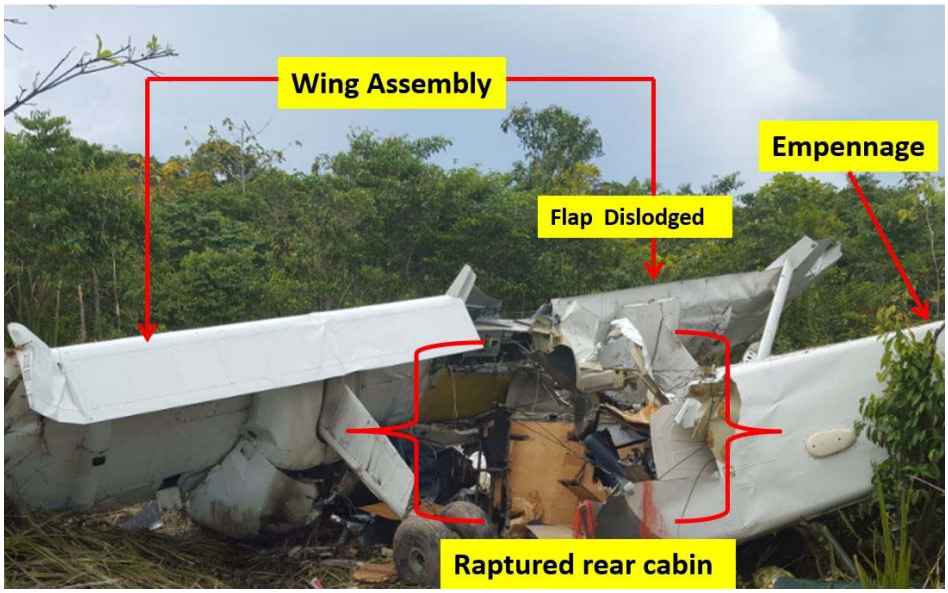

Figure 17: Left and right wing flaps

There were fractures along the whole wing assembly. The right wing outboard of the engine nacelle separated from the wing assembly during the impact. The aircraft's fuel tanks were not ruptured on impact.

There was no evidence of pre- or post-impact leakage from the fuel tanks and the caps of both fuel tanks were securely fastened. There was evidence of some fuel in the left main fuel tank, but the right main tank was dry.

Figure 18: Right wing outboard of the engine nacelle separated

Figure 19: Wing assembly showing caps of both fuel tanks secured

During the days following the accident, and the initial on-site examination of the wreckage, the weather prevented the full examination of the wreckage at the crash site by the AIC investigation team, and the manufacturer's representative from Rolls-Royce Corporation. There was torrential rain and flooding at the crash site. The wreckage remained partially submerged for 5 days, before being airlifted by helicopter to Kiunga Aerodrome.

Figure 20: Wreckage submerged
(Source: Rolls-Royce Corporation)

1.12.3 Wreckage examination at Kiunga Aerodrome9

1.12.3.1 *Airframe examination*

The cockpit was inspected when access was gained by removing the forward cabin at Kiunga Aerodrome.

The power levers and propeller (condition) levers in the cockpit had sustained a heavy impact from the left side, bending the levers to the right and effectively locking them in-place at their last setting immediately prior to impact. Both engines were set to low power (approximately 4cm above 'IDLE')[10] and both propellers were at the Minimum setting (above the aft detent), both typical settings for an aircraft on a short final approach to landing.

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9 The Rolls-Royce Corporation Field Report was sourced for additional details for this section of the report.

10 This may be the case, however caution should be exercised with such a determination due to cable slap and linkage movement during the impact sequence and subsequent airframe disruption. Cables between the cockpit and engines on the BN-2T are routed from the power-lever pedestal, through the floor and side pillars up to the overhead wings and engines. There are many turns.

Figure 21: Power and Control Lever approximately 4cm above IDLE
(Source: Rolls- Royce Corporation)

Located immediately adjacent to the engine controls was the elevator trim control and position indicator. Like the engine controls, the trim indicator had received impact from the left side, jamming it in-place. The trim indicator needle had been forced against its associated housing, leaving clear witness marks of its position at impact. The trim indicator needle was found at the full nose-down (- 4) trim position. The elevator trim tabs were also found to be in the full nose-down trim position.

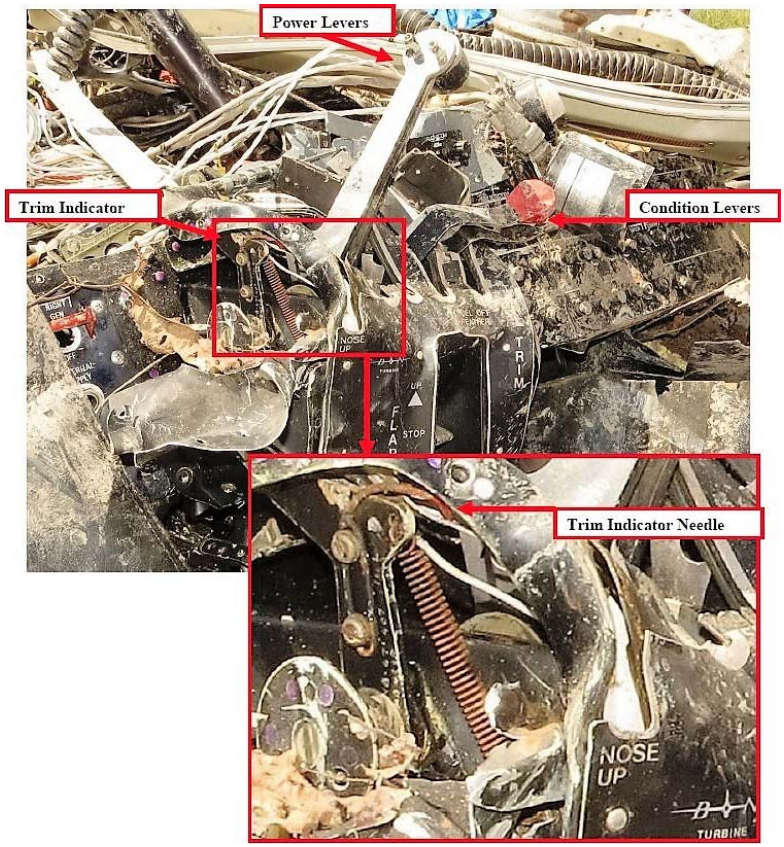


Figure 22: Cockpit Levers and Indicators were distorted due to force impact
(Source Rolls Royce Corporation)

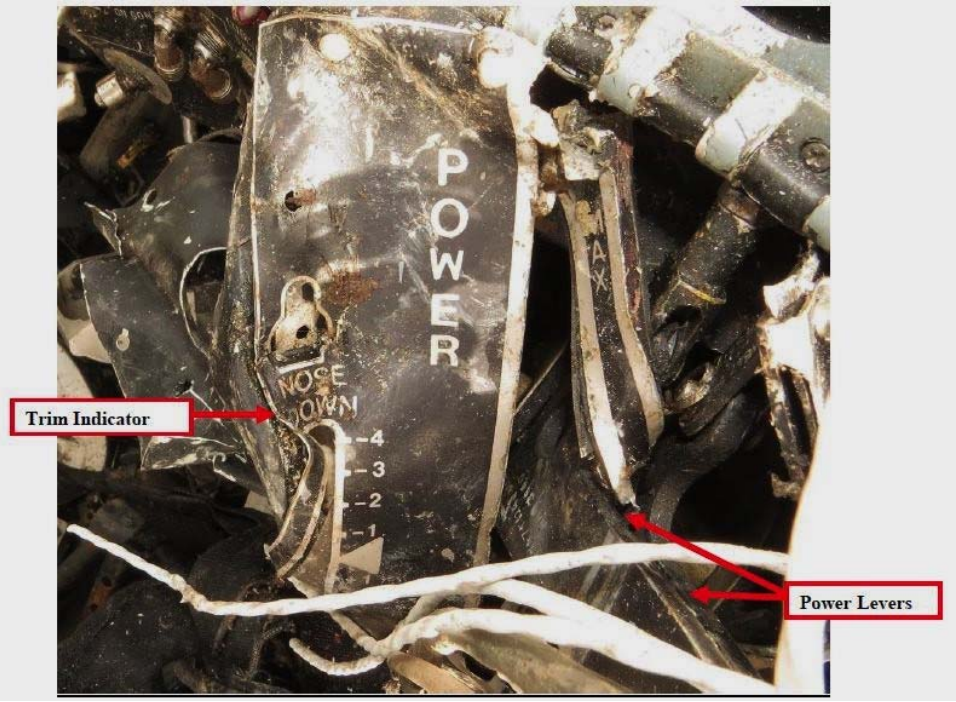


Figure 23: Trim Indicator scale
(Source: Rolls Royce Corporation)

1.12.3.2 Left engine examination

The left engine remained attached to the left wing by its engine mounts and associated control cables. The engine's propeller had detached from the propeller drive shaft during the accident sequence. The propeller drive shaft had failed in torsional overload. The propeller had penetrated the cockpit, and left evidence of rotation within the cockpit. Spiral witness marks on the propeller drive shaft splines are consistent with shaft rotation as the propeller was torn from the drive shaft.

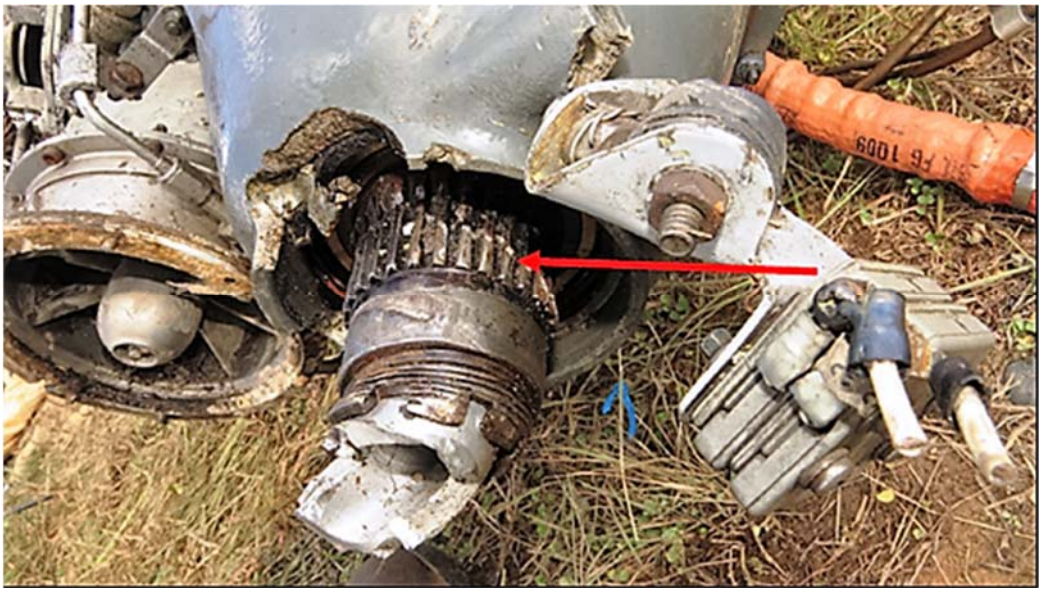


Figure 24: Spiral disengagement witness marks (arrows) on the left propeller drive shaft
(Source: Rolls-Royce Corporation)

The left engine was examined in detail. The engine exhibited only minor impact damage.

There was evidence of minor foreign object damage (FOD) to the compressor blades; with leading edge damage and minor tip bending in the direction opposite of rotation. Grass and leaves had been ingested by the compressor and were chopped progressively finer within the compressor, suggesting continued compressor rotation following impact.

Borescope examination of the compressor showed no evidence of blade or vane failure or operational distress. The compressor lining was intact and exhibited no evidence of erosion, cracking or flaking. The compressor could be rotated by hand.

Rotation of the compressor produced corresponding rotation of the gas-generator turbine and the starter/generator, thus confirming N1 continuity and drive through the accessory gearbox.

Figure 25: Left engine Compressor Inlet
(Source: Rolls-Royce Corporation)

A borescope was used to examine the gas-generator turbine, (turbine stages 1 and 2). Visual examination revealed no evidence of abnormal combustion or thermal distress. There was no evidence of FOD to the turbine blades or operational failure within the left engine. The turbine blades and vanes showed no evidence of thermal erosion, and the combustion liner showed no evidence of streaking, cracking or misalignment.

The left engine exhaust ducts exhibited crush damage, preventing access to the power turbine. The ducts exhibited no evidence of in-flight fire or high-energy debris exiting the engine. The ducts were removed and set aside.

A borescope was then used to examine the power turbine (turbine stages 3 and 4). Examination revealed no evidence of operational failure or distress. The turbine could be rotated a small amount by hand; this produced a corresponding rotation of the fractured end of the propeller drive shaft.

It was determined that the fracturing of the propeller drive shaft resulted in the shaft being bent and subsequently contacting the propeller gearbox housing, thus preventing full rotation of the power turbine and propeller drive shaft. However, there was no evidence to suggest any operational failure or malfunction of the power turbine or propeller drive components. All damage was determined to be impact related.

The fuel system was examined. During normal operation, the fuel supply line to the fuel spray nozzle will capture and protect approximately 3cc of whatever fluid the engine-driven fuel pump is delivering to the engine immediately after the engine stops running. That fuel line was loosened, and the contents drained. The line contained 3cc of clean, bright fuel, with no particulate contamination. The fuel sample was tested for water contamination; no water was detected.

The fuel spray nozzle was removed and examined. The spray face exhibited minor corrosion, which was expected after the wreckage was submerged by flood water. The nozzle was disassembled and the fuel filter examined for contamination; the filter was free of any contamination.

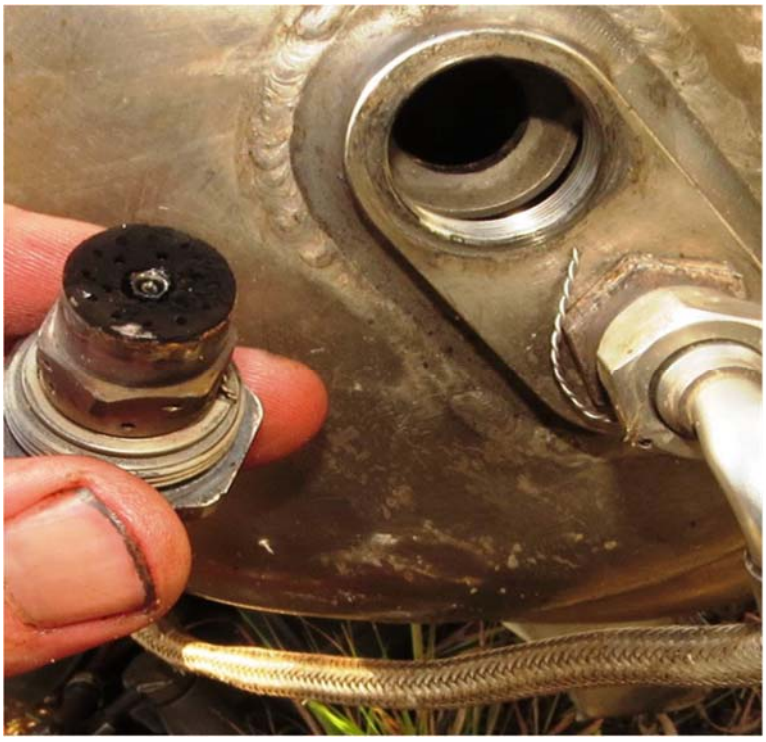


Figure 26: Left engine fuel spray nozzle removed from combustor
(Source: Rolls-Royce Corporation)

The left engine exhibited no evidence of operational failure or malfunction. Available evidence was consistent with the engine operating at low power at impact.

1.12.3.3 Right engine examination

The right engine had mostly separated from the right wing's nacelle. All engine mounts had fractured in apparent overload; only the engine's associated control cables, fuel and oil lines kept the engine attached to the wing. The engine exhibited minor impact damage.

Unlike the left engine, the right engine had been forced into the soft, grassy soil during the impact sequence. The engine's compressor was packed tightly with grass and mud, which was extruding from the compressor bleed valve. This mud prevented manual rotation of the compressor and N1 drive train. Long blades of grass were found to be tightly wrapped around the compressor rotor, as well as progressively finer chopped grass deeper within the compressor.

Grass was found tightly wrapped around the leading edges of all compressor blades. This evidence is consistent with engine rotation at low power during the impact sequence.

Figure 27: The wreckage at Kiunga Aerodrome
(Source: Rolls-Royce Corporation)

Figure 28: Right engine compressor mud extruding from compressor bleed valve
(Source: Rolls-Royce Corporation)

The engine's compressor module was removed for detailed examination. Removal of the compressor allowed the N1 drive train to be rotated by hand. Rotation was smooth, and produced corresponding rotation of the gas-generator turbine and starter/generator, thus confirming N1 continuity.

Figure 29: Compressor module, removed from right engine
(Source: Rolls-Royce Corporation)

Figure 30: Split-line bolts removed, exposing mud and grass
(Source: Rolls-Royce Corporation)

Borescope examination of the gas-generator turbine revealed no evidence of abnormal combustion or thermal distress. There was no evidence of FOD to the turbine blades or operational failure within the engine. However, small bits of burnt grass and blackened mud were present within the combustion chamber, confirming that the combustion chamber was hot at the time the muddy grass was ingested.

The turbine blades and vanes showed no evidence of thermal erosion, and the combustion liner showed no evidence of streaking, cracking or misalignment.

The N2 power turbine was also rotated by hand. Rotation was smooth and produced corresponding rotation of the propeller drive shaft, thus confirming N2 drive continuity.

Figure 31: Right engine's 4th stage (Power) Turbine

(Source: Rolls-Royce Corporation)

The fuel spray nozzle was removed and examined; the nozzle exhibited uniform carbon coating of the spray face and surface corrosion, similar to the nozzle from the left engine. Three cc of fuel was also drained from the fuel supply line to the fuel spray nozzle; this fuel was clean with no visible particulate contamination and tested negative for the presence of water contamination.

The compressor bleed valve was removed and examined. The valve poppet cycled normally by hand and exhibited no radial play.

Figure 32: Bleed valve face
(Source: Rolls-Royce Corporation)

The engine-mounted oil filter was removed and examined; it contained no metallic debris. The oil within the filter bowl was free of debris and exhibited no unusual odour. Both the upper and lower main chip detectors were examined and found to be free of any ferrous debris.

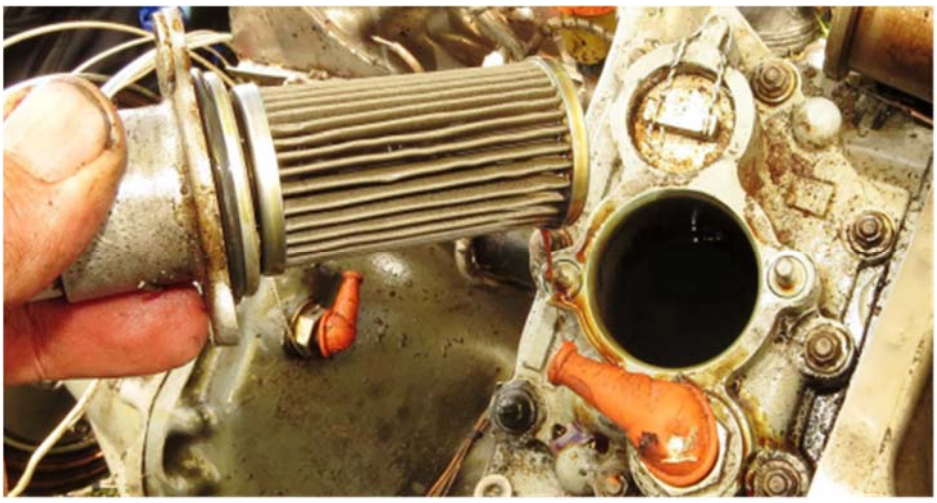


Figure 33: Oil filter and filter housing
(Source: Rolls-Royce Corporation)

The AIC investigation found that the evidence from the right engine was inconclusive in determining if it was operating at impact or spooling down.

1.13 Medical and Pathological Information

The PNG Chief Pathologist conducted an autopsy on the body of the deceased pilot. The examination revealed multiple fractures and massive body trauma, sustained during the impact. Examination of internal organs did not reveal any additional significant pathology.

The PNG Chief Pathologist sought toxicological testing, of samples taken from the deceased pilot, from State Government Forensic Laboratories in Australia. However, those laboratories declined to assist. Therefore, in his report to the AIC, the PNG Chief Pathologist was unable to assist the AIC with a section detailing toxicology results.

1.14 Fire

There was no evidence of pre- or post-impact fire.

1.15 Survival Aspects

Examination of the wreckage showed significant damage from high-energy, almost vertical impact. The accident was not considered survivable due to the severity of the impact, and the level of airframe disruption, and corresponding reduction of survivable space.

1.16 Tests and research

1.16.1 Examination of engine-driven fuel pumps and fuel control units[11]

Standard Aero in Sydney, Australia examined and tested the two Fuel Control Units and two Engine-Driven Fuel Pumps that the AIC had removed from the engines.

Left Engine

Fuel pump

Serial number: CAE880424

Part number (Rolls-Royce): 6899253

Time since overhaul: 868.6 hours

Fuel Control Unit

Serial number: 333623

Part number Honeywell: 2524654-27 (Rolls-Royce equivalent part number: 23070603)

Time since overhaul: 868.6 hours

[11] This section was sourced from the Standard Aero company report, prepared for the AIC.

Right Engine

Fuel pump

Serial number: CAE880464

Serial number: T106455

Time since overhaul: 868.6 hours

Fuel control unit

Serial number: BR54139

Part number Honeywell: 2524654-27 (Rolls-Royce equivalent part number: 23070603)

Time since overhaul: 943.7 hours

1.16.1.1 *Fuel Control Unit*

Both fuel control units (FCU's) and engine driven fuel pumps (EDFP) were examined at a Rolls-Royce approved overhaul facility (Standard Aero), in the presence of an AIC investigator. No anomalies were found, and EDFP fuel flow was satisfactory. The FCU idle, start derich and start acceleration settings were determined to be in accordance with specifications. During bench testing the FCUs and EDFPs functioned within manufacturer's service limits.

1.16.2 Examination of cockpit Instrument and warning lights

The gauges from the cockpit instrument panel were recovered and transported to AIC head office at Boroko, PNG. The gauges were subsequently sent to the Australian Transport Safety Bureau (ATSB) in Canberra, Australia for examination. The examination involved the following gauges:

- Fuel Flow (left and right engine)
- Oil Pressure (left and right engine)
- Engine Torque (left and right engine)
- Gas Generator (left and right engine)
- Propeller RPM (left and right engine)
- Turbine Gas (left and right engine)

While some gauges had signs of possible needle rub, chatter, or slight indentation, the evidence was inconclusive due to the disruption of the gauges during the impact, and therefore was considered unreliable. There was no evidence found to suggest that any warning lights from the annunciator panel were illuminated at the time of impact.

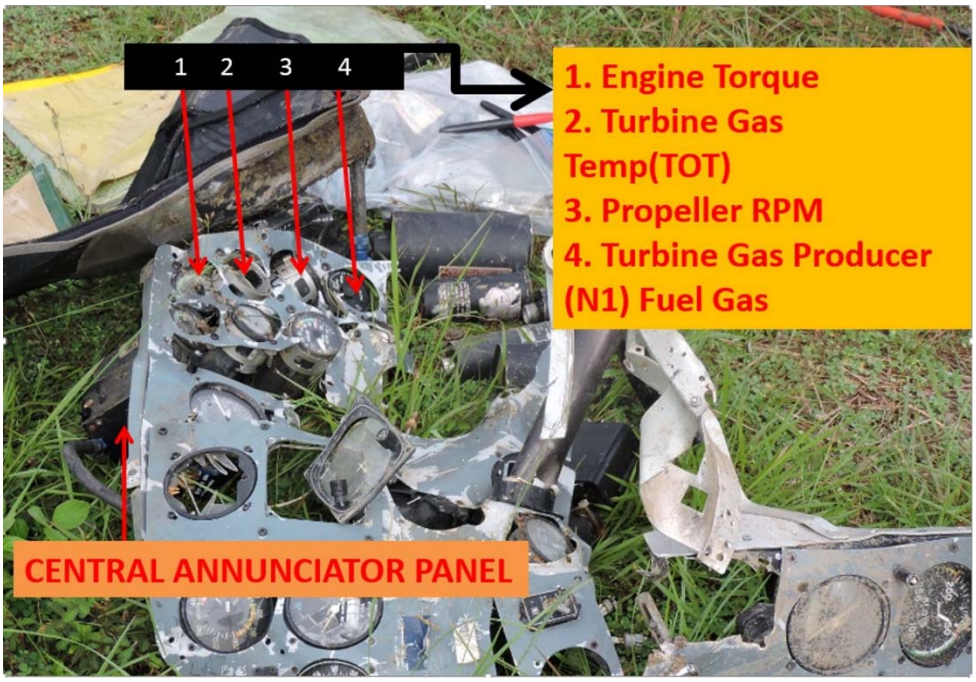


Figure 34: Cockpit instruments

1.17 Organisational and management information

Sunbird Aviation
PO Box 205
Vanimo
Sandaun
Papua New Guinea

Sunbird Aviation is a small non-scheduled aviation company. At the time of the accident it operated a fleet of two BN-2T islander aircraft. Sunbird Aviation served the more remote and under-serviced communities of rural Papua New Guinea.

The Maintenance Organisation Certificate listed the Sunbird Aviation maintenance facility as being located at Goroka. At the time of the accident here were two certifying engineers (Licenced Aircraft Maintenance Engineers), and one unlicenced tradesman (Aircraft Maintenance Engineer) who carried out scheduled maintenance inspections.

1.18 Additional information

The aircraft manufacturer provides guidance regarding the effects of aft centre-of-gravity. This is summarised in the following paragraphs.

It is estimated that rearward movement of the c of g beyond the aft limit by 2 or 3 inches would introduce negative static longitudinal stability.

There is a nose up pitching tendency when flap is lowered from “UP” to “TAKE OFF”, and to a greater extent from “TAKE OFF” to “LAND”.

Any extension of wing flap normally results in a nose-up pitch, requiring nose-down elevator to counteract the pitch up, however small that pitch up may be.

When an aircraft’s c of g is at the aft limit of the c of g envelope, the introduction of flap will increase the pitch-up tendency, and the introduction of landing flap will significantly increase the pitch-up tendency

If the c of g was significantly aft of the rear c-of-g envelope limit, the nose-up pitching moment would be high when landing flap was reached. The use of full nose-down trim would not necessarily overcome the nose-up pitch forces. At more extreme aft c-of-g positions, tailplane stall could occur, resulting in uncontrolled pitch up.

1.19 Useful or effective investigation techniques

The investigation was conducted in accordance with the Papua New Guinea *Civil Aviation Act 2000 (as amended)*, and the Accident Investigation Commission’s approved policies and procedures, and in accordance with the Standards and Recommended Practices of *Annex 13* to the Chicago Convention on International Civil Aviation.

2 ANALYSIS

2.1 Introduction

A BN-2T Islander aircraft, registered P2-SBC (SBC) was on a charter flight from Tekin to Kiunga[12], with 12 persons on board. At 14:31 local (04:31 UTC), SBC arrived at Kiunga Aerodrome and the pilot cancelled SARWATCH. During the final approach, approximately 1,200 metres from the threshold of runway 07, the aircraft was observed to pitch up steeply and roll to the right, then descend in a steep nose-down attitude. The aircraft impacted the ground almost vertically.

The cockpit instruments recovered from the accident were examined by the Australian Transport Safety Bureau (ATSB) in Canberra, Australia. The two Fuel Control Units (FCU) and the two Engine-Driven Fuel Pumps (EDFP) were examined and tested in Australia at an approved Rolls-Royce Corporation overhaul facility, under PNG Accident Investigation Commission (AIC) supervision.

The engines were examined at Kiunga Aerodrome by the Rolls-Royce Corporation representative.

2.2 Fuel

Section 1.12.2 Impact Sequence and Distribution of the wreckage, indicates that the right fuel tank was found to be empty. There was no evidence of fuel leakage in flight, or at the accident site.

Section 1.5.9 Fuel Information, presents calculations of how much fuel may have been on board SBC at the time of the accident. When the calculated amount of fuel on board was compared with a previous flight's fuel data for the same flight sector as shown in DFR 130393, the amount of fuel on board on 13 April 2016 should have been sufficient for the flight from Tekin to Kiunga, with a safe margin.

The pilot had previously operated the BN-2T aircraft on the sector Tekin to Kiunga, and he would have known how much fuel was required, and refuelled accordingly.

The results of the bench tests of the FCUs and the EDFPs, determined that they were capable of operating to the manufacturer's specifications.

No fuel was found in the right tank.

2.2.1 Airframe

Based on the photographs of the accident site and the examination of the wreckage at Kiunga Aerodrome, all major airframe components were accounted for, and were in close proximity to the main wreckage. That evidence showed that the accident was not the result of an in-flight breakup or in-flight fire.

The elevator-trim indicator needle was found at the full nose-down (-4) trim position, which corresponded with the position of the elevator trim tabs; full nose-down trim.

12 The radio flight plan and the ATS flight strip, and information from the ATS officer communicating with SBC for the duration of the flight, revealed that although SBC departed from Tekin, the pilot reported departing from Oksapmin.

Witnesses reported seeing the aircraft in the circuit area, appearing to enter a normal pattern for landing. Subsequently, during its final approach, the aircraft was observed to pitch up steeply.

Because SBC's c of g was significantly aft of the aft limit, full nose-down elevator and elevator trim were likely to have had no effect in lowering the nose of the aircraft. Unless the flaps had been retracted immediately, the nose-up pitch may also have resulted in tailplane stall, exacerbating the pitch up. A wing stall, followed immediately by a wing dropping, would inevitably result. At such a low height on the approach to land, unrecoverable loss of control was inevitable.

2.2.1.1 *Fuel tank selectors*

From the post-accident position of the fuel cock selectors[13], the AIC determined the following:

> Left selector. The selector was pointing to a position two thirds of the distance from the PORT TANK position, towards the OFF position. It was jammed at impact by the bent backing plate.
>
> Right selector. The selector was pointing to a position two thirds of the distance from the OFF position, towards the PORT TANK position.

In those positions, both engines would have been receiving no fuel.

It appears that at some stage, possibly late in the flight, the pilot may have attempted to cross-feed fuel to supply the right engine from the left fuel tank. The reason the selectors were in the positions as found, could not conclusively be determined. In the selected positions, both engines were being starved of fuel.

2.2.1.2 *Emergency Locator Transmitter (ELT)*

The Ameri-King AK-451-(-12) series emergency locator transmitter (ELT), part number AK-451-(AF)(AP)(S), serial number 6503, should have been replaced by Mar 2016. Because a serviceable ELT is a requirement for the safe operation of the aircraft in PNG, an out of date ELT renders the aircraft unserviceable.

2.2.2 Engines

The investigation considered that the change of engine sounds reported by the witnesses to the accident, may be consistent with an aspect change of the engines relative to the witnesses, and the propellers' constant-speed design and operation. During normal flight, the engines' exhaust ducts are pointed toward the ground with sound waves reflected downward by the wings. When the aircraft pitched up, dropped the right wing, and subsequently rolled inverted while rapidly descending, the exhaust ducts were then pointed away from the ground and the sound waves shielded from the ground by the aircraft's wings. The right engine had failed, possibly at the time of pitch up. This possibly explains witness accounts of engine sound changes immediately prior to the crash.

The right propeller was feathered at impact. There was evidence of small burnt grass particles and blackened mud in the combustion chamber, confirming that the combustion chamber was hot at the time the grass was ingested. The investigation considered that this may indicate that the right engine malfunctioned or failed at a low height during the final approach, causing the propeller to auto feather as it was shutting down, but that the compressor was still spooling down at impact.

Available evidence is consistent with the left engine running at extremely low power immediately prior to impact, and that the right engine failed prior to impact. There was no evidence of pre-impact fire, failure, or malfunction of the left engine.

2.2.3 Weight and Balance

The aircraft was re-weighed, and a new data sheet was generated 5 months prior to the accident. However, it was evident that the operator had not sought or obtained an amendment to the approved Aircraft Flight Manual. The Operator's weight and balance computation sheet, also had not been amended.

There was no evidence that the pilot calculated the aircraft loaded balance for the flight. The actual weight and balance of the aircraft could not be conclusively determined.

The investigation determined that while the aircraft was within the weight limitations, the load distribution placed it in an aft centre of gravity (c of g) situation for takeoff and landing. The c of g for takeoff at Tekin was conservatively 5.72 inches aft of the aft limit; i.e. 32.12 inches aft of the datum. The c of g for the landing at Kiunga was conservatively 5.87 inches aft of the aft limit; i.e. 32.27 inches aft of the datum. The aft limit of the c-of-g envelope was 26.4 inches aft of the datum.

The operator had not updated weight and balance charts in its manuals and available for pilots' flight operations. The operator also had not notified CASA PNG of the re-weigh data, and had not sought amendment to the Aircraft Flight Manual weight and balance supplement. This placed the operation of P2-SBC in a potentially adverse safety-signification position.

2.2.4 Aircraft serviceability

While the aircraft was certified as being serviceable for flight, the investigation determined that there was a lack of maintenance documentation. Despite engineers informing the AIC that they had carried out maintenance that required certification, the available documentation had no record of that maintenance having been carried out.

This was evidence of non-compliance with *PNG Civil Aviation Rules Part 119.65, Records — personnel,* and presents a degree of doubt as to the veracity of the maintenance conducted on the aircraft.

The ELT fitted to the aircraft was out of service life.

Therefore, the investigation determined that the aircraft was not serviceable for the flight.

2.2.5 Flight operation

As the aircraft entered the Kiunga circuit area, the pilot cancelled SARWATCH with Air Traffic Services (ATS). The pilot did not report an emergency such as a "PAN", indicating a safety concern for his flight, such as an engine failure.

The investigation determined that the right engine may have failed subsequent to the SARWATCH broadcast, but sufficiently before the aircraft pitched nose up in order for the pilot to have had time to wind in full nose-left rudder trim to counteract the aerodynamic forces imposed by the failure of the right engine.

3 CONCLUSIONS

Findings

1. Aircraft

a) The aircraft had a valid Certificate of Airworthiness, and was certified as being airworthy when despatched for the flight.

b) The aircraft was re-weighed on 10 November 2015 by an authorised Weight Controller.

c) The re-weighing generated new data as shown on the copy of the *Load Data Sheet* at Appendix 1, Section 5.1.1 of this report.

d) There was no evidence that the AFM had been amended to reflect the revised weight and balance data.

e) The *Weight and Balance Computation Sheet* data used by the operator differed from the *Load Data Sheet* that was issued following the re-weighing.

f) The *Weight and Balance Computation Sheet* data used by the operator differed from the *Load Data Sheet* that was in the AFM.

g) The *Weight and Balance Computation Sheet* for the accident flight, and flights for 12 April 2016, were not completed/computed by the pilot before the flights.

h) The loaded aircraft was within weight limits, but the centre of gravity of the aircraft was not within the prescribed limits; it was significantly aft of the aft limit of the centre of gravity envelope.

i) The Emergency Locator Transmitter (ELT) fitted in the aircraft did not activate on impact.

j) The Emergency Locator Transmitter (ELT) was not replaced by the due date of March 2016, rendering the aircraft unserviceable.

k) There was no evidence of any defect or malfunction in the aircraft that could have contributed to the accident.

l) There was no evidence of airframe failure or system malfunction prior to the accident.

m) The aircraft was structurally intact prior to impact.

n) All control surfaces were accounted for, and all damage to the aircraft was attributable to the severe impact forces.

o) The wing flaps were at or near the fully extended position.

p) The elevator trim was in the full nose-down trim position.

q) The rudder trim was in the full nose-left trim position.

r) The aircraft was destroyed by impact forces.

s) Given the positions of the fuel selectors, both engines would have been starved of fuel.

t) The fuel that remained in the aircraft's left fuel tank, was uncontaminated and of the recommended grade.

u) The right fuel tank was empty.

v) The left engine showed evidence that was consistent with the engine operating at low power at impact.

w) The right engine was spooling down at impact and delivering no power.

x) No evidence was found to suggest that any of warning lights from the annunciator panel were illuminated at the time of the accident.

y) The left propeller blades were in fine position and bent opposite to the rotation of the propeller.

z) The right propeller blades were in the feathered position and slightly bent due to being tangled with the engine mount.

2. Crew / Pilots

a) The pilot was appropriately licensed and qualified for the flight in accordance with existing Civil Aviation Rules.

b) The pilot was in compliance with the flight and duty time rules.

c) The pilot did not comply with Civil Aviation Rules Part 135.305(b), Aircraft Load Limitation.

3. Flight operations

a) The flight was not conducted in accordance with the procedures in the company Operations Manual; the weight and balance requirements were not met.

b) The pilot carried out normal radio communications with the relevant ATS units, as much as could be determined from the extremely static and hash affected High Frequency radio transmissions.

c) The pilot did the Oksapmin-Tekin sector without communicating with ATS, and on departure from Tekin reported departing from Oksapmin.

d) The pilot conducted the flight under the Visual Flight Rules (VFR).

e) The pilot cancelled SARWATCH on arrival in the circuit area at Kiunga.

4. Operator

a) The Operator was not in compliance with PNG CAR 119.63, Documentation.

b) The Operator's weight and balance computation sheet, had not been amended.

c) The operator had not notified CASA PNG of the re-weigh data, and had not sought amendment to the Aircraft Flight Manual weight and balance supplement.

d) Defect rectification action was carried out by an unlicenced engineer when Licensed Aircraft Maintenance Engineers (LAME) were not available to supervise the work and sign for the work.

e) The unsupervised maintenance work was not entered in any of the operator's maintenance documents.

f) The operator did not comply with *PNG Civil Aviation Rules Part 119.65, Records — personnel* in regard to this maintenance.

5. Air Traffic Services and airport facilities

a) The Distance Measuring Equipment (DME) was the only means of Aids to Navigation at Kiunga Aerodrome. However, the DME was unserviceable at the time of the accident.

b) All of the High Frequency radio transmissions between Air Traffic Services and SBC were significantly affected by static interference and a lot of hash, making reception difficult, and many transmissions unclear and unreadable.

6. Flight recorders

a) The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR); neither was required by regulation.

7. Medical

a) There was no evidence that the pilot was not medically fit to conduct the flight.

b) The autopsy found multiple fractures and massive body trauma caused during the impact. The internal organs did not reveal any additional significant pathology.

c) The PNG Chief Pathologist sought to obtain toxicological testing of samples from the deceased pilot, from Australian State Government Forensic Laboratories. However those laboratories declined to assist.

8. Survivability

a) The accident was not survivable due to the magnitude of the deceleration forces.

9. Safety oversight

a) There was no evidence in the AFM as a proof of oversight of the AFM by the PNG Civil Aviation Safety Authority.

b) The operator had not notified CASA PNG of the re-weigh data, and had not sought amendment to the Aircraft Flight Manual weight and balance supplement.

3.1 Contributing factor

The aircraft's centre of gravity was significantly aft of the aft limit. When landing flap was set, full nose-down elevator and elevator trim was likely to have had no effect in lowering the nose of the aircraft. Unless the flaps had been retracted immediately, the nose-up pitch may also have resulted in tailplane stall, exacerbating the pitch up. The wings stalled, followed immediately by the right wing dropping. Recovery from the stall at such a low height was not considered possible.

3.1.1 Other factors

Other factors is used for safety deficiencies or concerns that are identified during the course of the investigation, that while not causal to the accident, nevertheless should be addressed with the aim of accident and serious incident prevention, and the safety of the travelling public.

a) Following the reweighing of SBC, the operator did not make adjustments to account for the shift of the moment arm as a result of the reweighing. Specifically, a reduction of allowable maximum weight in the baggage compartment.

b) The pilot, although signing the flight manifest on previous flights attesting that the aircraft was loaded within c of g limits, had not computed the c of g. No documentation was available to confirm that the pilot had computed the c of g for the accident flight, or any recent flights.

c) All of the High Frequency radio transmissions between Air Traffic Services and SBC were significantly affected by static interference and a lot of hash, making reception difficult, and many transmissions unclear and unreadable. This is a safety concern to be addressed to ensure that vital operational radio transmissions are not missed for the safety of aircraft operations, and the travelling public.

4 SAFETY ACTIONS AND RECOMMENDATIONS

4.1 Recommendations

As a result of the investigation into the accident involving turbine Britten Norman Islander (BN-2T) aircraft, registered P2-SBC, about 1.2 kilometres west of Kiunga Aerodrome, Western Province, on 13 April 2016, the Papua New Guinea Accident Investigation Commission issued the following recommendations to address concerns identified in this report.

4.1.1 While not causal to the accident, the High Frequency radio transmissions being significantly affected by static interference and a lot of hash, making reception difficult, and many transmissions unclear and unreadable is a safety concern to be addressed to ensure that vital operational radio transmissions are not missed for the safety of aircraft operations, and the travelling public. Accordingly the AIC issued Recommendation AIC 16-R12/16-1002.

Recommendation number AIC 16-R12/16-1002 to PNG Air Services Ltd

The Accident Investigation Commission recommends that PNG Air Services Limited, take action to improve High Frequency radio capability to ensure, as much as possible, that transmissions are clear and readable so vital transmissions for the safety of aircraft operations are not missed.

4.1.1.1 PNG Air Services Limited response

On 10 February 2017, PNG Air Services Limited informed the Accident Investigation Commission of its safety action to address the AIC's safety concerns, as follows:

HF IMPROVEMENT – SAFETY ACTION STATEMENT

PNG Air Services Ltd has embarked on a holistic program of activities to greatly enhance HF Communications. In the short term, this has involved power system upgrades and related improvements at the Receiver site at 8 mile, Port Moresby. This has realized a recent marked improvement in HF performance. A project is underway to deploy and commission duplicated Transmitter and Receiver systems located at Nadzab Airport, Lae. These systems will be controlled, operated and monitored from Port Moresby through redundant satellite and terrestrial links. It is expected that on completion in 2018, these systems will enable clear and uninterrupted HF Communications throughout the Port Moresby Flight Information Region.

4.1.1.1.1 PNG Accident Investigation Commission (AIC) assessment of the PNG Air Services Limited response

The AIC has assessed the PNG Air Services Limited response as satisfactorily addressing the identified safety deficiency. Because the PNG ASL program to enhance HF Communication throughout the Port Moresby Flight Information Region is not expected to be completed until 2018, PNG ASL advised that it will inform the AIC when the project has been completed. With respect to AIC 16-R12/16-1002 addressed to PNG Air Services Ltd, the **Status of the AIC Recommendation: Monitor**

4.1.2 While not causal to the accident, the lack of readily available forensic medicine laboratories to enable the PNG Chief Pathologist to obtain toxicological testing of samples from deceased flight crew members is of concern. The PNG Chief Pathologist is unable to provide the PNG Coroner and the AIC with conclusive evidence of the presence or lack thereof, of substances that could affect the safe operation of the aircraft, including alcohol or illicit drug use. Accordingly the AIC issued Recommendation AIC 16-R13/16-1002.

Recommendation number AIC 16-R13/16-1002 to PNG Department of Health

The Accident Investigation Commission recommends that the PNG Department of Health should urgently establish a Forensic Toxicology Laboratory facility to support the work of the PNG Chief Pathologist.

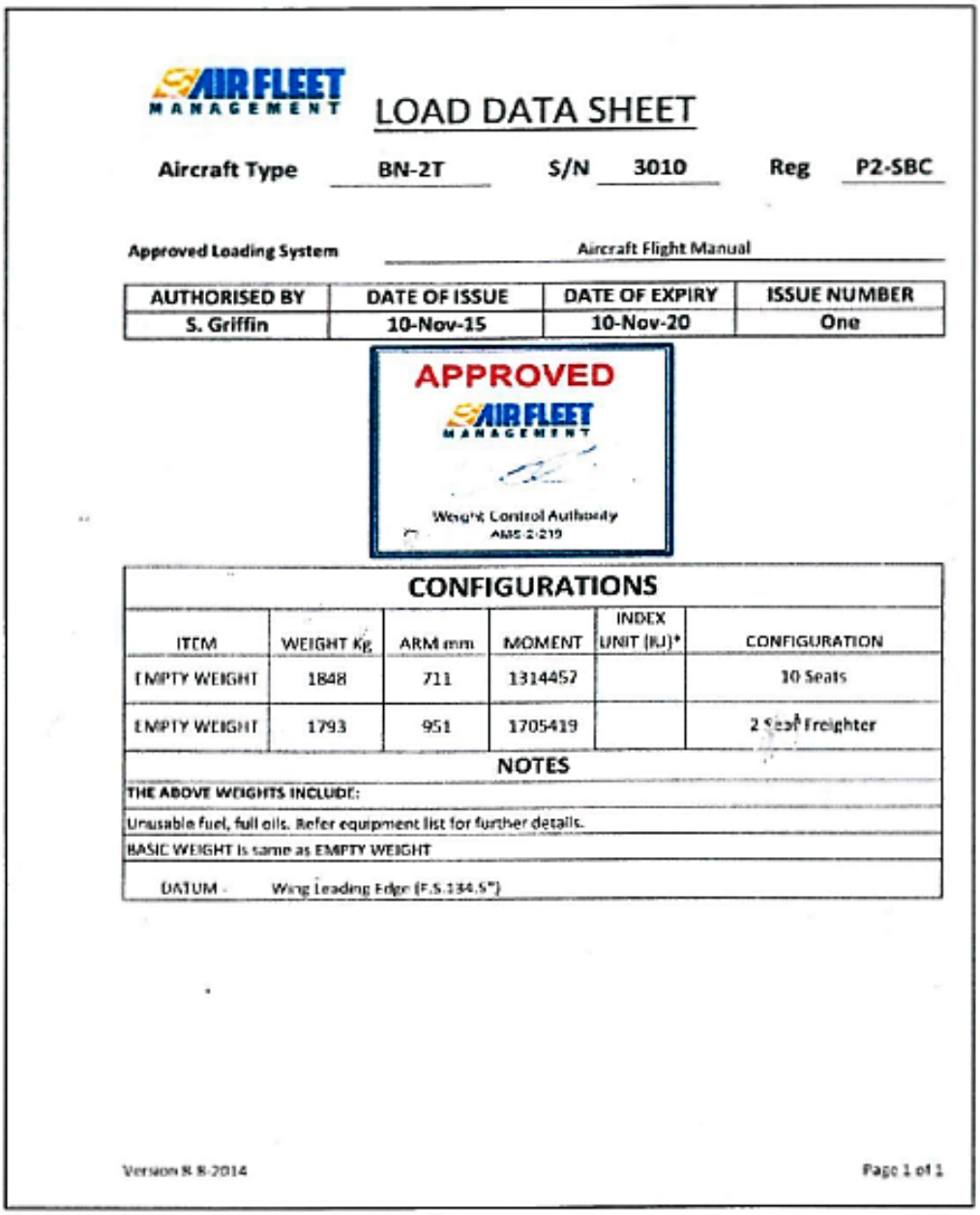
Until such a facility is available to support the Chief Pathologist, the Department of Health is urged to obtain a commitment from a PNG based commercial Forensic Medicine Laboratory, or other International Forensic Medicine Laboratory. These Laboratories must meet the requirements of the Chief Pathologist, to conduct testing of samples taken from deceased personnel who were at the controls of a transport vehicle that was involved in a fatal accident.

With respect to AIC 16-R13/16-1002 addressed to PNG Department of Health, because the AIC had not received a response from PNG Department of Health at the time of publishing the Final Report, the **Status of the AIC Recommendation: Active**

5 APPENDICES

5.1 Appendix 1: Weight and Balance

5.1.1 Load Data Sheet



AIR FLEET MANAGEMENT

LOAD DATA SHEET

Aircraft Type BN-2T S/N 3010 Reg P2-SBC

Approved Loading System Aircraft Flight Manual

AUTHORISED BY	DATE OF ISSUE	DATE OF EXPIRY	ISSUE NUMBER
S. Griffin	10-Nov-15	10-Nov-20	One

APPROVED
AIR FLEET MANAGEMENT
Weight Control Authority
AMS 2-219

CONFIGURATIONS

ITEM	WEIGHT Kg	ARM mm	MOMENT	INDEX UNIT (IU)*	CONFIGURATION
EMPTY WEIGHT	1848	711	1314457		10 Seats
EMPTY WEIGHT	1793	951	1705419		2 Seat Freighter

NOTES

THE ABOVE WEIGHTS INCLUDE:

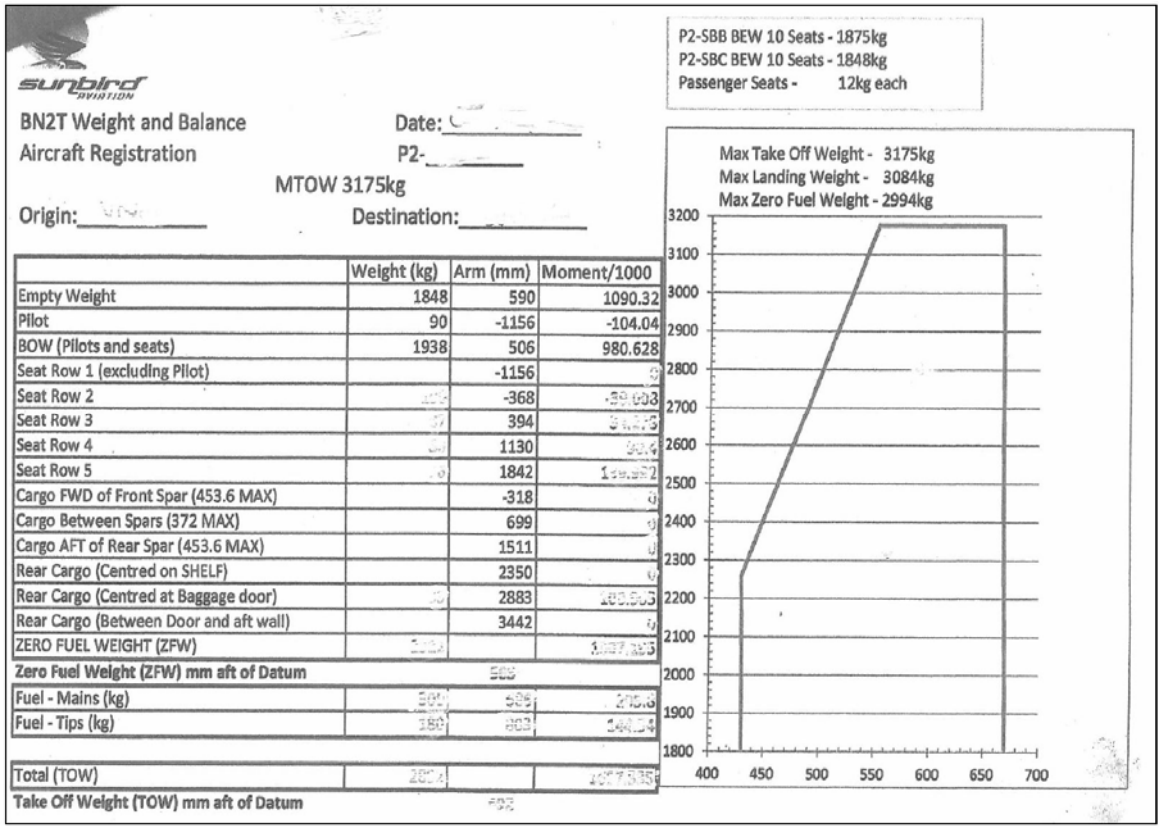
Unusable fuel, full oils. Refer equipment list for further details.

BASIC WEIGHT is same as EMPTY WEIGHT

DATUM - Wing Leading Edge (F.S.134.5")

Version 8 8-2014 Page 1 of 1

5.1.2 Weight and Balance computation sheet used by the operator



sunbird AVIATION

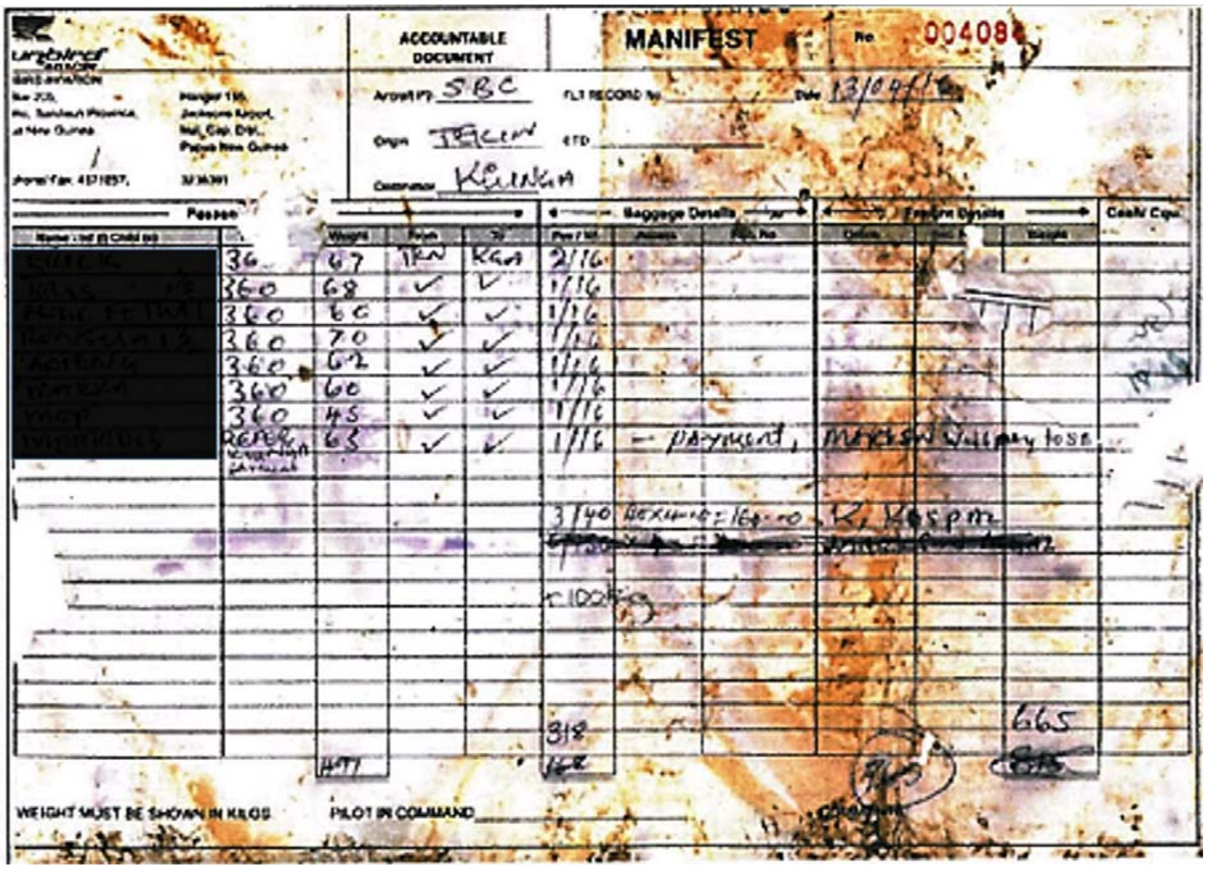
P2-SBB BEW 10 Seats - 1875kg
P2-SBC BEW 10 Seats - 1848kg
Passenger Seats - 12kg each

BN2T Weight and Balance Date:
Aircraft Registration P2-
MTOW 3175kg
Origin: Destination:

	Weight (kg)	Arm (mm)	Moment/1000
Empty Weight	1848	590	1090.32
Pilot	90	-1156	-104.04
BOW (Pilots and seats)	1938	506	980.628
Seat Row 1 (excluding Pilot)		-1156	
Seat Row 2		-368	
Seat Row 3		394	
Seat Row 4		1130	
Seat Row 5		1842	
Cargo FWD of Front Spar (453.6 MAX)		-318	
Cargo Between Spars (372 MAX)		699	
Cargo AFT of Rear Spar (453.6 MAX)		1511	
Rear Cargo (Centred on SHELF)		2350	
Rear Cargo (Centred at Baggage door)		2883	
Rear Cargo (Between Door and aft wall)		3442	
ZERO FUEL WEIGHT (ZFW)			
Zero Fuel Weight (ZFW) mm aft of Datum			
Fuel - Mains (kg)			
Fuel - Tips (kg)			
Total (TOW)			
Take Off Weight (TOW) mm aft of Datum			

Max Take Off Weight - 3175kg
Max Landing Weight - 3084kg
Max Zero Fuel Weight - 2994kg

5.1.3 Manifest (No.004084) the accident flight



ACCOUNTABLE DOCUMENT

MANIFEST No. 004084

Aircraft P2- SBC FLT RECORD No Date 13/04/16

Origin ETD

Destination

Name		Weight	From	To	Pcs / Wt						Cash/ Cque
[redacted]	36	67	[illegible]	[illegible]	2/16						
	360	68	✓	✓	1/16						
	360	60	✓	✓	1/16						
	360	70	✓	✓	1/16						
	360	62	✓	✓	1/16						
	360	60	✓	✓	1/16						
	360	45	✓	✓	1/16						
	[illegible]	63	✓	✓	1/16 – payment,						
					3/40						
					318				665		
		477			168						

WEIGHT MUST BE SHOWN IN KILOS PILOT IN COMMAND

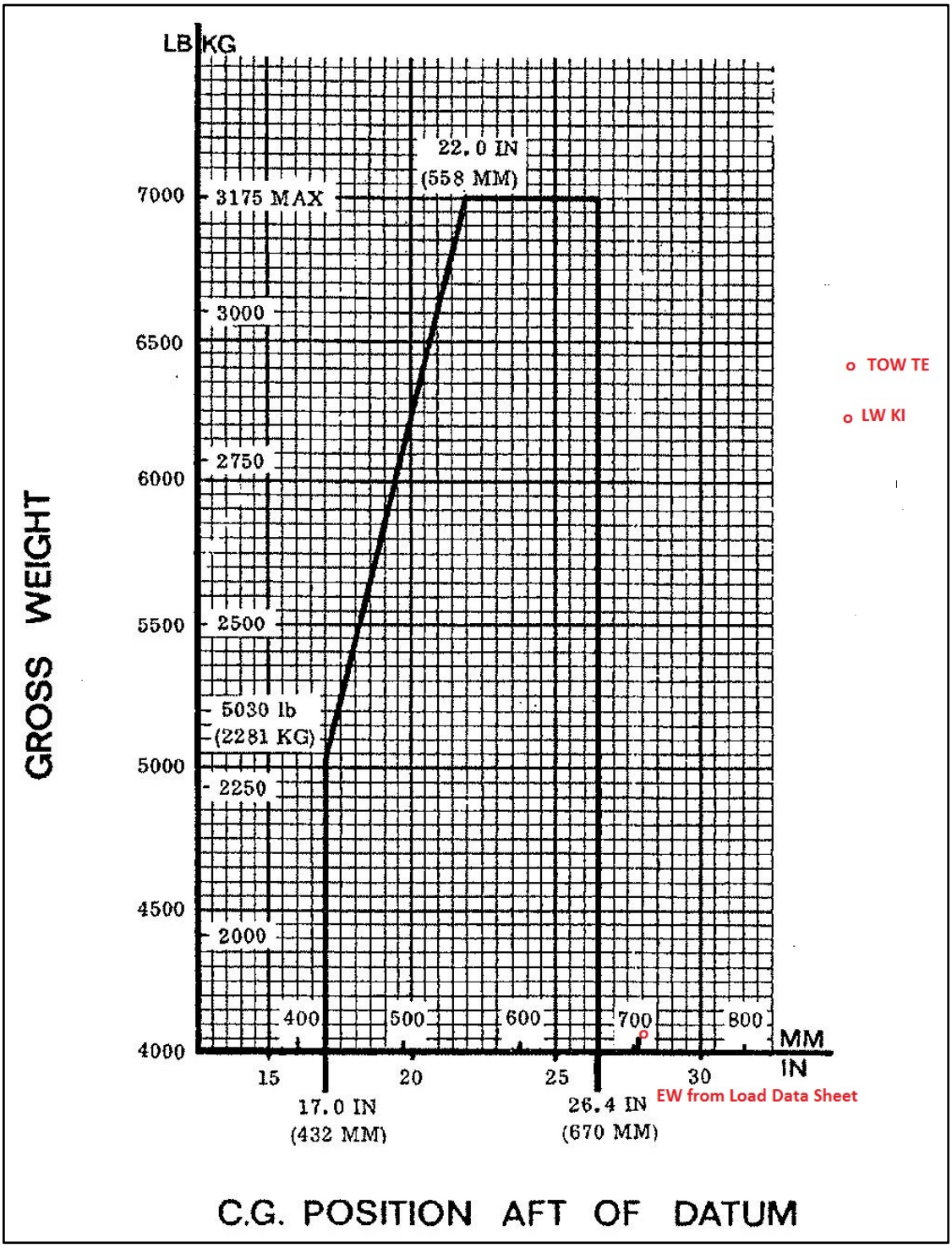
5.1.4 Weight and balance calculation estimate

BN-2T Turbine Islander P2-SBC at the time of the accident

Item	Pax and hand luggage	Weight (lbs)	Arm (inches)	Moment/100 (lb.ins)	
Basic Empty Weight		4074.1	28.013	+	1141.28
Pilot (table 5 AFM)		209.4	45.2	-	94.65
Passengers (table 5 AFM)					
Row 1	Male	136.7	45.2	-	61.78
Row 2	Male	132.3	15.0	-	19.85
Row 3	Male, Female	275.6	15.1	+	41.62
Row 4	Male+child, Female+child	478.4	44.4	+	212.41
Row 5	Male+child, Male	337.3	72.4	+	244.21
Cargo (table 2 AFM)					
Baggage (STA 240)		436.5	121	+	528.17
Baggage (STA 255)					
Fuel (Table 3)					
Usable Fuel (Mains)		755	27	+	203.85
Usable Fuel (Tips)		0	27	+	0
Total @ Take-off (Table 7)		6835.3	32.12		2195.26
Fuel Used (Mains)		198.28	27	-	53.54
Total @ Landing		6637.02	32.27		2141.72

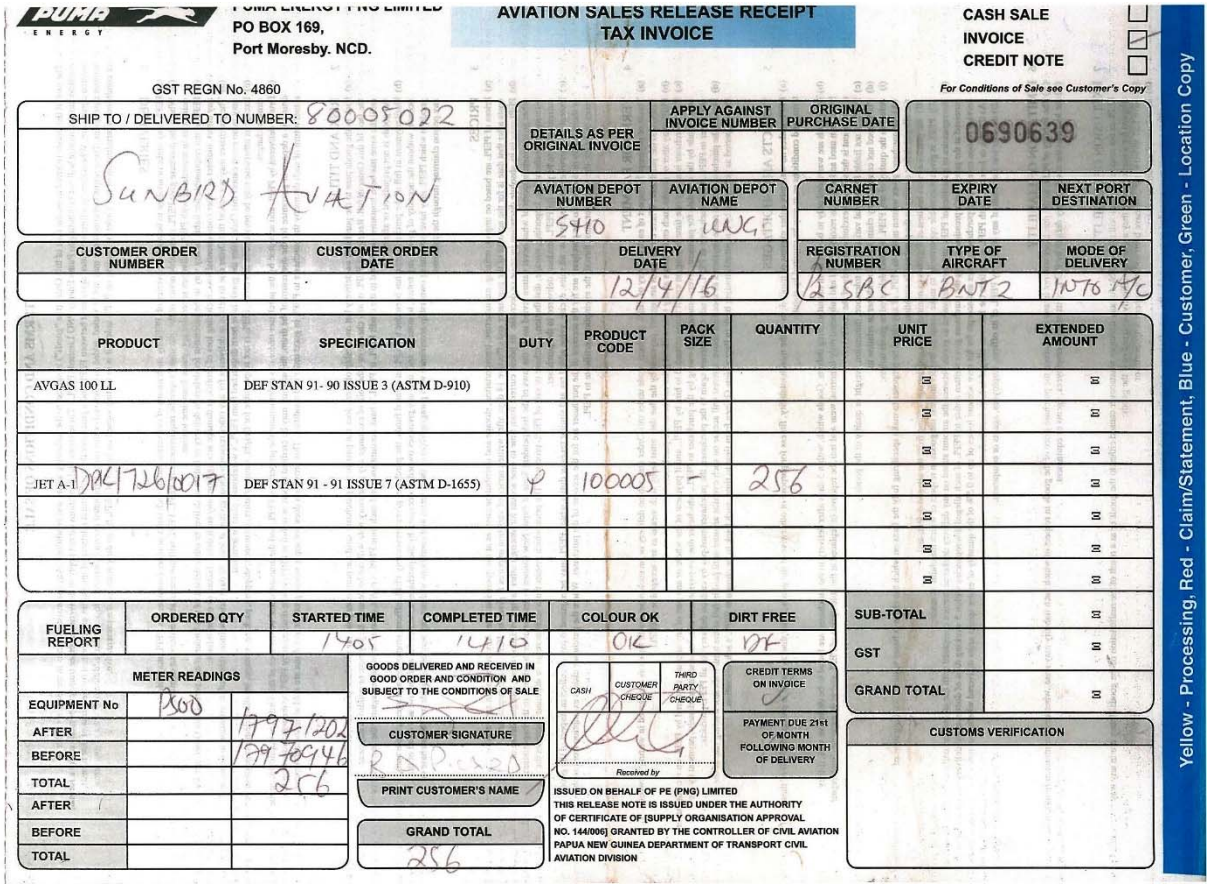
5.1.5 Centre of Gravity envelope for SBC

Max Allowable weight (3175kg, 7000lb). Stall speed at 6239.2lbs is **43kts**. Aft Limit is **26.4in.** The aircraft was well within its weight limits, but distribution was the main factor. The CG after reweigh was 28in, already out of the envelope. The previous CG was **23.22in**. The basic empty weight (BEW) was found to be the same**, 1848kg (4065.6lbs)**.



5.2 Appendix 2: Fuel information

5.2.1 Aviation Sales Release Receipt Tax Invoice (No. 0690639)



PUMA ENERGY

PUMA ENERGY PNG LIMITED
PO BOX 169,
Port Moresby. NCD.

AVIATION SALES RELEASE RECEIPT
TAX INVOICE

CASH SALE ☐
INVOICE ☑
CREDIT NOTE ☐

GST REGN No. 4860

For Conditions of Sale see Customer's Copy

SHIP TO / DELIVERED TO NUMBER: 80005022	DETAILS AS PER ORIGINAL INVOICE	APPLY AGAINST INVOICE NUMBER	ORIGINAL PURCHASE DATE	0690639
SUNBIRD AVIATION				

AVIATION DEPOT NUMBER	AVIATION DEPOT NAME	CARNET NUMBER	EXPIRY DATE	NEXT PORT DESTINATION
5410	WNG			

CUSTOMER ORDER NUMBER	CUSTOMER ORDER DATE	DELIVERY DATE	REGISTRATION NUMBER	TYPE OF AIRCRAFT	MODE OF DELIVERY
		12/4/16	P2-SBC	BNT2	INTO A/C

PRODUCT	SPECIFICATION	DUTY	PRODUCT CODE	PACK SIZE	QUANTITY	UNIT PRICE	EXTENDED AMOUNT
AVGAS 100 LL	DEF STAN 91- 90 ISSUE 3 (ASTM D-910)						
JET A-1 DPC/126/0017	DEF STAN 91 - 91 ISSUE 7 (ASTM D-1655)	P	100005	-	256		

FUELING REPORT	ORDERED QTY	STARTED TIME	COMPLETED TIME	COLOUR OK	DIRT FREE
		1405	1410	OK	DF

SUB-TOTAL	
GST	
GRAND TOTAL	

METER READINGS

EQUIPMENT No	1500	
AFTER		1797202
BEFORE		1796946
TOTAL		256
AFTER		
BEFORE		
TOTAL		

GOODS DELIVERED AND RECEIVED IN GOOD ORDER AND CONDITION AND SUBJECT TO THE CONDITIONS OF SALE

CUSTOMER SIGNATURE

PRINT CUSTOMER'S NAME

GRAND TOTAL 256

CASH | CUSTOMER CHEQUE | THIRD PARTY CHEQUE

Received by

CREDIT TERMS ON INVOICE ✓

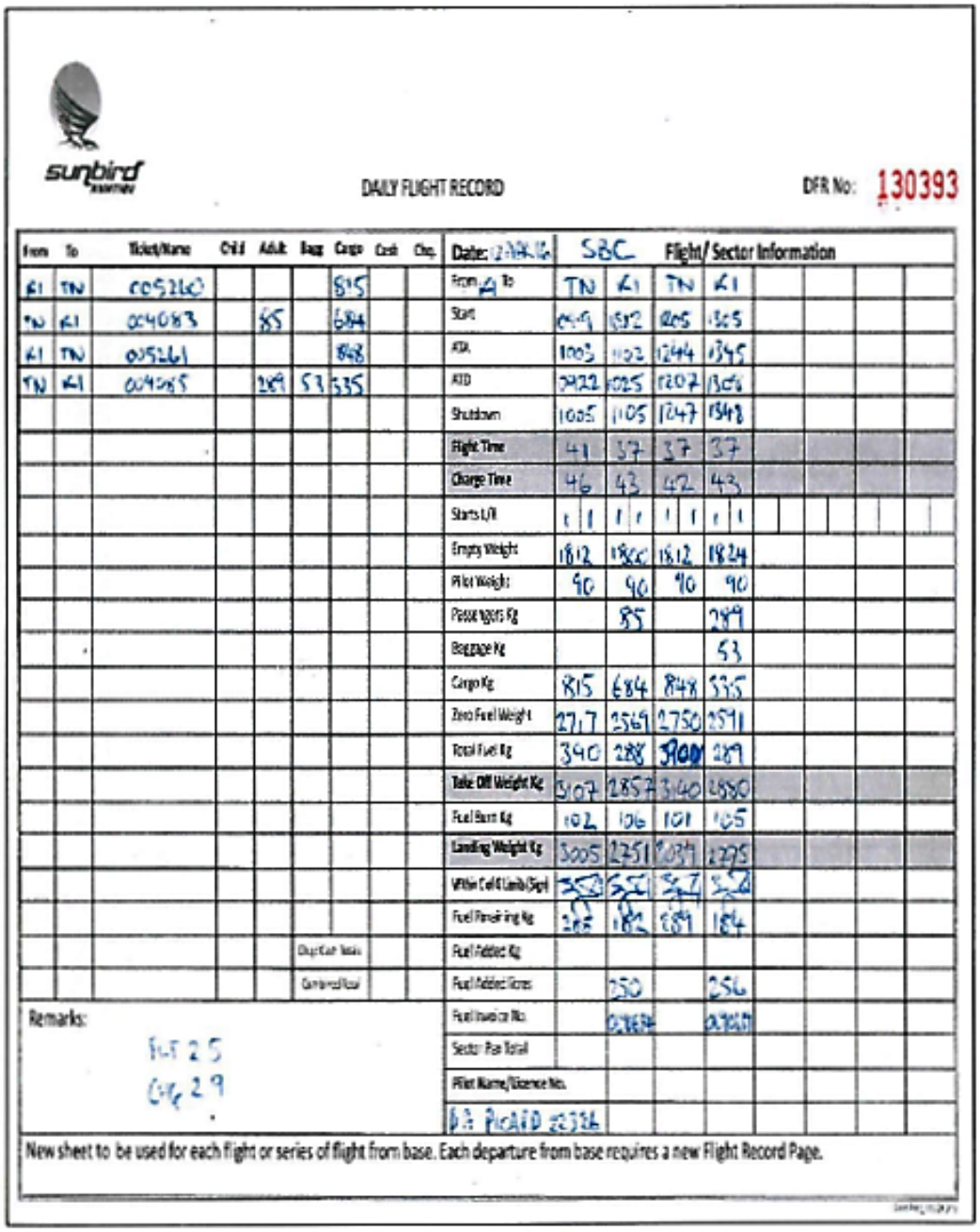
PAYMENT DUE 21st OF MONTH FOLLOWING MONTH OF DELIVERY

CUSTOMS VERIFICATION

ISSUED ON BEHALF OF PE (PNG) LIMITED
THIS RELEASE NOTE IS ISSUED UNDER THE AUTHORITY OF CERTIFICATE OF [SUPPLY ORGANISATION APPROVAL NO. 144/006] GRANTED BY THE CONTROLLER OF CIVIL AVIATION PAPUA NEW GUINEA DEPARTMENT OF TRANSPORT CIVIL AVIATION DIVISION

Yellow - Processing, Red - Claim/Statement, Blue - Customer, Green - Location Copy

5.2.2 Daily Flight Record (No.130393)



sunbird

DAILY FLIGHT RECORD

DFR No: 130393

From	To	Ticket/Name	Child	Adult	Bags	Cargo	Cash	Chq.
KI	TN	005260				815		
TN	KI	004083		85		684		
KI	TN	005261				848		
TN	KI	004085		289	53	535		

Date: [illegible] SBC Flight/Sector Information

From/To	TN	KI	TN	KI
Start	0949	1512	1205	1505
ATA	1003	1102	1244	1345
ATD	1022	1025	1207	1308
Shutdown	1105	1105	1247	1348
Flight Time	41	37	37	37
Charge Time	46	43	42	43
Starts L/R	1 1	1 1	1 1	1 1
Empty Weight	1812	1866	1812	1824
Pilot Weight	90	90	90	90
Passengers Kg		85		289
Baggage Kg				53
Cargo Kg	815	684	848	535
Zero Fuel Weight	2717	2569	2750	2791
Total Fuel Kg	340	288	3900	289
Take Off Weight Kg	3107	2857	3140	2880
Fuel Burn Kg	102	106	101	105
Landing Weight Kg	3005	2751	2039	2775
Within Cof G Limits (Sign)	[illegible]	[illegible]	[illegible]	[illegible]
Fuel Remaining Kg	265	182	189	184
Fuel Added Kg				
Fuel Added Litres		250		256
Fuel Invoice No.		[illegible]		[illegible]
Sector Pax Total				
Pilot Name/Licence No.				
[illegible]				

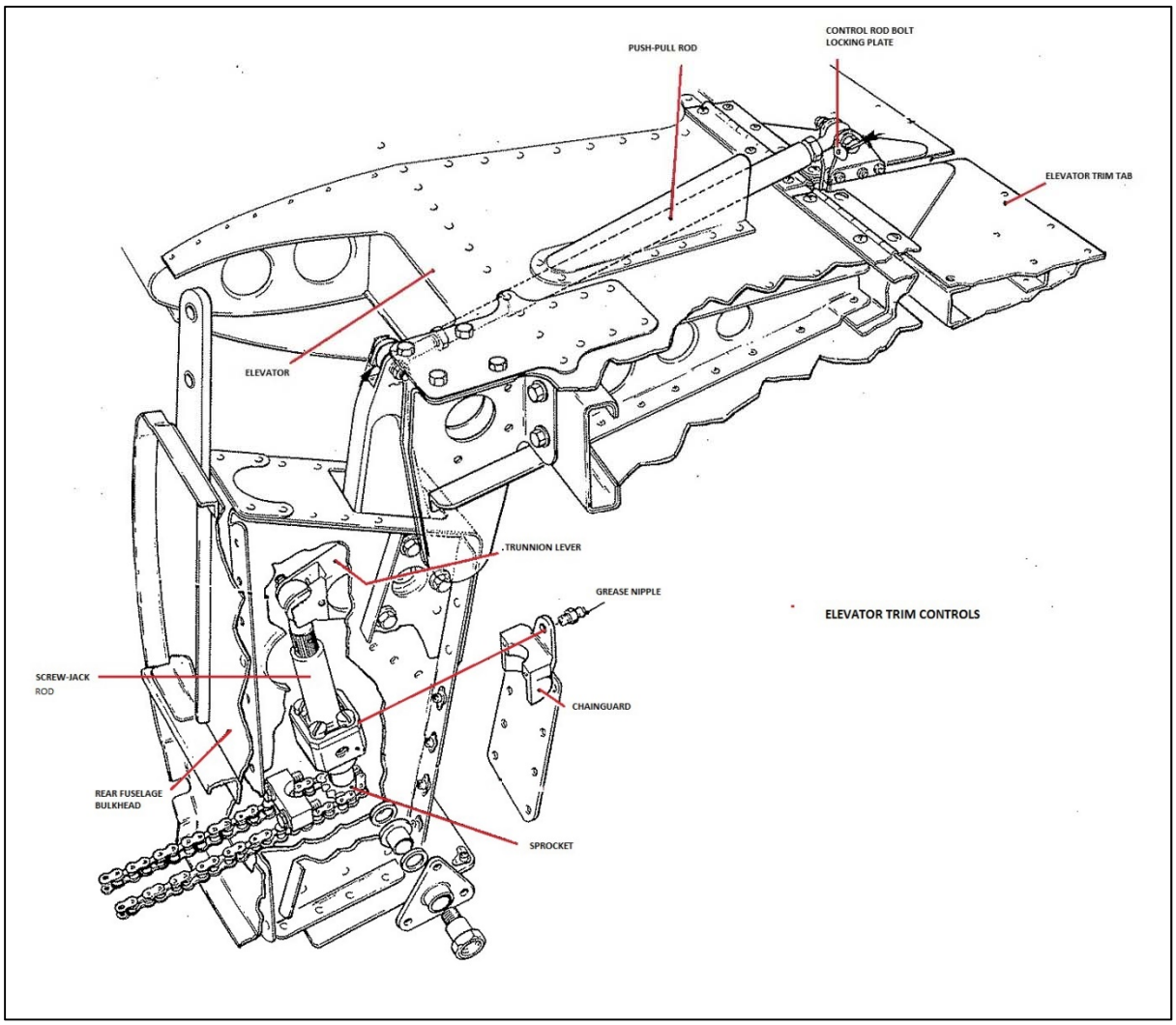
Remarks:

FLT 25
CK 29

New sheet to be used for each flight or series of flight from base. Each departure from base requires a new Flight Record Page.

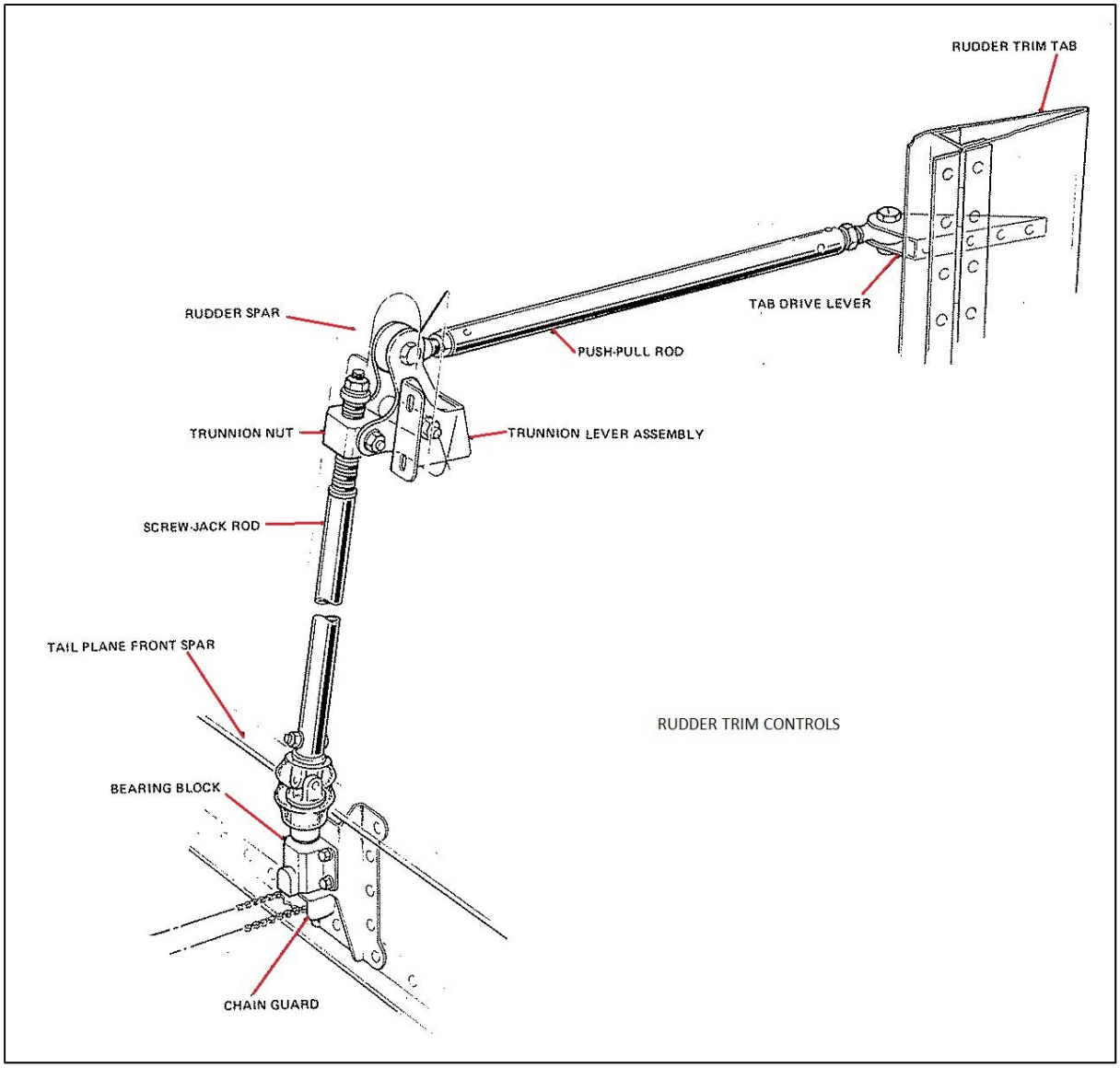
5.3 Appendix 3: Elevator and Rudder trim

5.3.1 Elevator trim controls



Source: Britten Norman

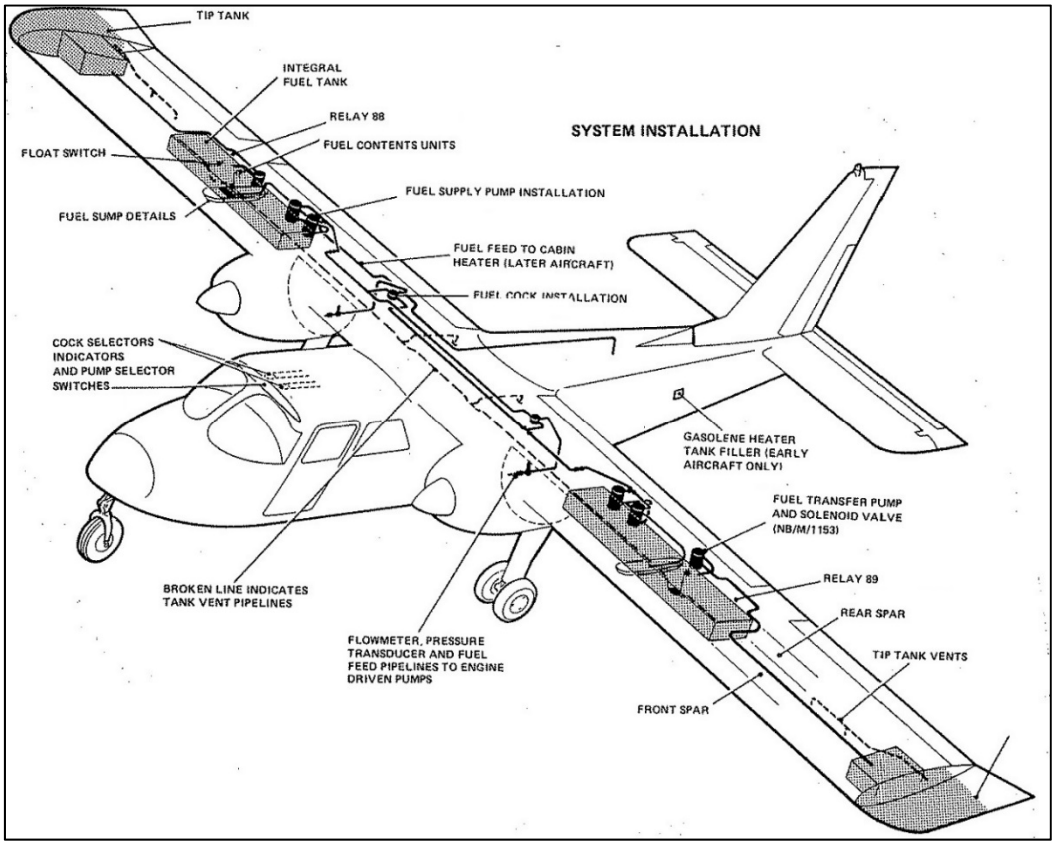
5.3.2 Rudder trim controls



Source: Britten Norman

5.4 Appendix 4: BN-2T Airframe fuel system

5.4.1 BN-2T airframe fuel system diagram



Source: Britten Norman

5.4.2 BN-2T Fuel system schematic

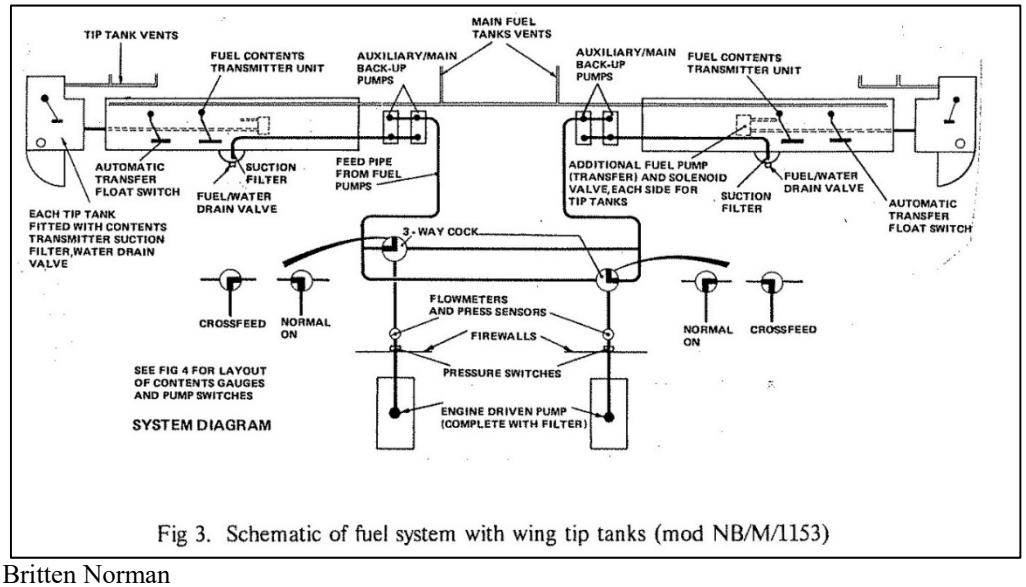
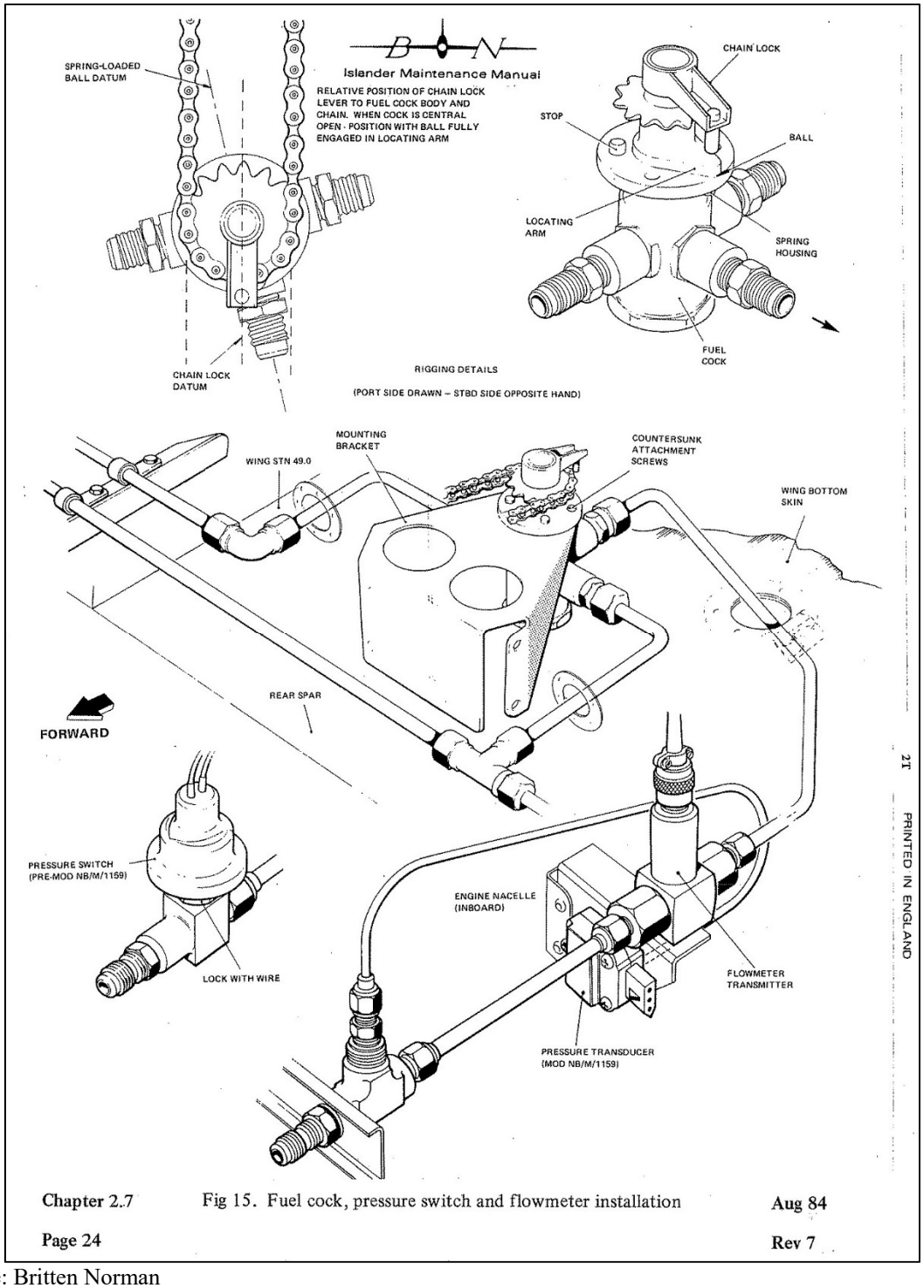


Fig 3. Schematic of fuel system with wing tip tanks (mod NB/M/1153)

Source: Britten Norman

5.4.3 BN-2T Fuel cock system



Source: Britten Norman

5.5 Appendix 5: Engine ConditionTrend Monitor

BN2T ECTM – RECORDING SHEET – Rego: P2- SBC S/N SBC08

		At start			Cruise Record once per day if flown, ideally at 8000ft and an established power setting. Record after engine has stabilised and no engine control adjustment for 5 mins. *Pay particular attention to record exactly what is indicated.* ***DON'T ROUND OFF!***											
Date	Eng	Ext pwr Y / N	Bus Vdc	Start TOT	IOAT	Press Alt	IAS	Tq	TOT	N2	N1	Fuel Flow	Oil Temp	Oil Px.	Elec Load	Remarks
11 FEB 16	L/H	N	24.5	820	+10	A105	111	680	700	1700	95.0	180	70	120	2.0	
	R/H			680				700	650	1200	95.0	150	90	120	2.0	
12 FEB 16	L/H	N	24.4	790	+8	A116	110	590	720	1700	97.0	185	70	120	1.8	
	R/H			660				630	670	1700	96.0	150	90	120	2.5	
17 FEB 16	L/H	N	24.5	790	+16	A065	116	680	675	1700	94.0	185	70	125	1.0	
	R/H			680				680	625	1700	93.0	150	90	125	1.0	
1 Mar 16	L/H	N	25.5	800	+18	A073	123	630	675	1700	94.1	160	70	130	1.0	
	R/H			690				710	650	1700	94.0	190	90	125	1.0	
17 MAR 16	L/H	N	25.4	780	+17	A085	132	780	720	1700	97.5	175	70	130	1.0	
	R/H			720				760	665	1700	96.0	175	90	125	1.1	
18 MAR 16	L/H	N	25.5	810	+16	A083	122	600	660	1700	92.5	150	70	130	1.0	
	R/H			740				600	610	1200	92.0	150	90	125	1.0	
19 MAR 16	L/H	N	25.2	750	+14	A092	121	590	660	1700	92.5	150	70	130	1.0	
	R/H			700				600	610	1700	92.0	215*	90	125	1.0	
22 MAR 16	L/H	N	25.0	850	+12°	A110	119	620	680	1700	94.0	150	70	130	1.6	
	R/H			720				680	650	1700	95.0	-	90	120	1.0	
24 MAR 16	L/H	N	25.0	915	+12°	A110	117	640	700	1700	95.0	160	70	130	1.0	
	R/H			790				610	650	1700	94.5	150	90	120	1.0	
06 APR 16	L/H	N	25.0	740	+15°	A075	126	700	680	1700	94.0	170	70	130	1.0	
	R/H			670				700	635	1700	94.0	166	90	120	1.0	
07 APR 16	L/H	N	25.0	780	+14°	A095	126	760	720	1700	96.0	180	70	130	1.0	
	R/H			690				760	670	1700	96.0	160	90	120	1.0	
08 APR 16	L/H	N	25.0	780	+12°	A105	127	630	720	1700	96.5	175	70	130	1.0	
	R/H			680				620	670	1700	96.0	160	90	120	1.0	

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BN2T ECTM – RECORDING SHEET – Rego: P2- SBC S/N SBC08

		At start			Cruise Record once per day if flown, <u>ideally at 8000ft</u> and an established power setting. Record after engine has stabilised and no engine control adjustment for 5 mins. *Pay particular attention to record exactly what is indicated.* ***<u>DON'T ROUND OFF!</u>***											
Date	Eng	Ext pwr Y / N	Bus Vdc	Start TOT	IOAT	Press Alt	IAS	Tq	TOT	N2	N1	Fuel Flow	Oil Temp	Oil Px.	Elec Load	Remarks
12 APR 16	L/H	N	25	720	+13	A105	121	680	700	1700	95.5	170	70	130	1.0	
	R/H			695				690	650	1700	95.0	160	90	120	1.0	
	L/H															
	R/H															
	L/H															
	R/H															
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	L/H															
	R/H															

5.6 Appendix 6: P2-SBC Transcript and flight strips

5.6.1 ATS recorded information transcript

SBC TAPE TRANSCRIPT DEPARTURE OUT OF OKSAPMIN AND ARRIVAL KIUNGA

Time	From	To	Transcript	Remarks
03:57:09				Transmissions unreadable due lot of background hash. Aircraft probably calling Moresby.
03:57:13	Moresby	SBC	Sierra Bravo Charlie Moresby go ahead.	Sector 2 operator.
03:57:16				Transmissions going on but unreadable.
03:57:35	Moresby	SBC	Sierra Bravo Charlie Moresby say again POB.	Sector 2 operator.
03:57:38				Transmissions unreadable.
03:57:46	Moresby	SBC	Sierra Bravo Charlie Mor Moresby say again all.	Sector 9.
03:57:50				Transmissions unreadable.
03:58:03				End of transmissions heard, "Kiunga at"
03:58:07	Moresby	SBC	Sierra Bravo Charlie roger on climb one zero thousand.	Sector 9.
03:58:20	Moresby Sector 9	Moresby Sector 2	Departed 56 on climb one zero thousand tracking 222 9 POB, estimate Kiunga 28	Sector 9 operator passing departure to Sector 2 operator.
04:31:51	Moresby	SBC	Sierra Bravo Charlie, confirm cancelling SAR?	The transmissions were accompanied by a lot of hash. Sector 2.
04:31:56	SBC	Moresby	Sierra Bravo Charlie circuit area Kiunga cancel SAR.	
04:31:58	Moresby	SBC	Sierra Bravo Charlie Kiunga SAR watch terminated.	Sector 2
04:32:04	SBC	Moresby	Sierra Bravo Charlie.	

This is the time SBC cancelled SAR at Kiunga. 04:31

Note:

Sector 2 operator takes care of flights in the Western Province areas.

Sector 9 operator takes care of flights in the New Guinea Islands areas. Sector 9 operator assisting due to poor transmissions in Sector 2 airspace.

5.6.2 ATS Flight strip