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NATIONAL TRANSPORTATION SAFETY COMMITTEE

Aircraft Accident Investigation Report

**PT. ASI Pudjiastuti Aviation
Cessna 208 B Grand Caravan ; PK-VVE
Notnare Village, Distrik Samenage,
Yahukimo, Papua
Republic of Indonesia**

9 September 2011



NATIONAL TRANSPORTATION SAFETY COMMITTEE
MINISTRY OF TRANSPORTATION
REPUBLIC OF INDONESIA
2013

This Final Report was produced by the National Transportation Safety Committee (NTSC), Ministry of Transportation 3rd Floor, Jalan Medan Merdeka Timur No. 5 Jakarta 10110, Indonesia.

The report is based upon the investigation carried out by the NTSC in accordance with Annex 13 to the Convention on International Civil Aviation Organization, the Indonesian Aviation Act (UU No. 1/2009) and Government Regulation (PP No. 3/2001).

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GLOSSARY OF ABBREVIATIONS

AD	: Airworthiness Directive
ADAS	: Automatic Data Acquisition System
AFM	: Airplane Flight Manual
AGL	: Above Ground Level
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
°C	: Degrees Celsius
CAMP	: Continuous Airworthiness Maintenance Program
CASO	: Civil Aviation Safety Officer
CASR	: Civil Aviation Safety Regulation
CPL	: Commercial Pilot License
COM	: Company Operation Manual
CRM	: Cockpit Recourses Management
CSN	: Cycles Since New
DGCA	: Directorate General Civil Aviation
ECTM	: Engine Condition Trend Monitoring
EGT	: Exhaust Gas Temperature
FL	: Flight Level
F/O	: First officer or Copilot
hPa	: Hectopascals
Hr	: Hours
ICAO	: International Civil Aviation Organization
IFR	: Instrument Flight Rules
IIC	: Investigator in Charge
Kg	: Kilogram(s)
Km	: Kilometer(s)
Kt	: Knots (nm/hours)
Mm	: Millimeter(s)
MTOW	: Maximum Take-off Weight
NM	: Nautical mile(s)
KNKT / NTSC	: <i>Komite Nasional Keselamatan Transportasi</i> / National Transportation Safety Committee
OAT	: Outside Air Temperature

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
SCT	:	Scattered
S/N	:	Serial Number
TS/RA	:	Thunderstorm and rain
TSN	:	Time Since New
TT/TD	:	Ambient Temperature/Dew Point
UTC	:	Universal Time Coordinate
VFR	:	Visual Flight Rules
VMC	:	Visual Meteorological Conditions

INTRODUCTION

SYNOPSIS

On 9 September 2011, a Cessna 208B Grand Caravan, registered PK-VVE, was being operated by PT ASI Pudjiastuti Aviation on a non-scheduled cargo flight from Wamena Airport to Kenyam Aerodrome in Papua. The flight was being conducted under the visual flight rules (VFR) and the pilot reported to Air Traffic Control (ATC) that the planned altitude was 9,500 feet. On board the aircraft were two pilots, a manifested load of diesel drums and grocery items, and a non-manifested load of 25 bags of rice weighing 827 lbs (375 Kg).

The aircraft took off from Wamena Runway 15 at 0317 UTC. The last communication between the aircraft and Wamena ATC was at 0323 when the pilot reported over Polimo passing 7,300 feet climbing to 9,500 feet with an Estimated Time of Arrival (ETA) at Kenyam of 0347 UTC.

On 10 September 2011, a Search and Rescue team and local people commenced a rescue operation. Two days later, the SAR team and local people reached the accident site, which was located on the side of the mountain. Both of the persons on board were fatally injured and the aircraft was destroyed.

The aircraft was fitted with a number of devices that recorded various operational and engine parameters. The investigation was able to recover data from each of the devices and develop a sequence of events, based on the recorded data. The data enabled the investigation to develop a number of possible scenarios as follows;

- The handling pilot inadvertently made control inputs during a terrain avoidance maneuver that led to the aircraft entering a stall;
- The aircraft encountered turbulence associated with wind flow over the mountainous terrain during a terrain avoidance maneuver which led to the aircraft entering a stall;
- The handling pilot attempted to minimize the radius of turn during a terrain avoidance maneuver which led to loss of control; or
- The handling pilot lost visual reference due to inadvertent flight into cloud during a terrain avoidance maneuver which led to loss of control.

The following factors contributed to the accident;

- The aircraft was loaded to a weight in excess of the maximum certificated takeoff weight.

- The aircraft climb performance was adversely affected by the aircraft being operated above the certificated maximum takeoff weight.
- The aircraft approached high terrain along the proposed route at an altitude which was below that specified in the operator's route guide.
- The aircraft entered a high rate of descent during a terrain avoidance maneuver.
- Recovery from the abnormal flight path was not achieved before the aircraft collided with terrain.

As a result of the accident and during the investigation, the Directorate General of Civil Aviation performed a special safety audit, and the operator issued and performed safety actions.

1 FACTUAL INFORMATION

1.1 History of the Flight

On 9 September 2011, a Cessna 208B Grand Caravan, registered PK-VVE, was being operated by PT ASI Pudjiastuti Aviation on a non-scheduled cargo flight from Wamena Airport¹ to Kenyam Aerodrome² in Papua (Figure 2). The flight was being conducted under the visual flight rules (VFR) and the pilot reported to Air Traffic Control (ATC) that the planned altitude was 9,500 feet. On board the aircraft were two pilots, a manifested load of diesel drums and grocery items, and a non-manifested load of 25 bags of rice weighing 827 lbs (375 Kg). The investigation was unable to determine which pilot was the handling pilot for the flight.

The aircraft took off from Wamena Runway 15 at 0317 UTC³. At 0323 UTC, the pilot reported over Polimo passing 7,300 feet climbing to 9,500 feet with an Estimated Time of Arrival (ETA) at Kenyam of 0347 UTC.

The last communication between the aircraft and Wamena ATC was at 0323 UTC. Due to the mountainous terrain surrounding Wamena Airport, pilots often are unable to communicate with ATC beyond a few miles from the airport; however, pilots can still communicate with each other on common traffic frequencies.

Sequence of events

The following sequence of events leading up to the accident was determined from information obtained from recordings of radio communication between the pilot and ATC, and data recovered from the operator's Global Position Satellite (GPS) flight tracking system, the aircraft's Engine Condition Trend Monitoring (ECTM) system and Enhanced Ground Proximity Warning System (EGPWS). Further information regarding the recorded data from these systems is provided in the Flight Recorders section and (Appendix A) the aircraft's flight path is displayed in "accident flight track and event of GPS tracking and EGPWS data".

-
- 1 Wamena Airport (WMX/WAJW), Wamena, Papua is referred to as 'Wamena' in this report.
 - 2 Kenyam Aerodrome, Papua is referred to as 'Kenyam' in this report.
 - 3 The 24-hour clock in Universal Time Coordinate (UTC) is used in this report to describe the local time as specific events occurred. Indonesia Eastern Standard Time (*Waktu Indonesia Timur* / WIT) is UTC +9 hours

UTC time	Event	Source
0315	The pilot requested a taxi clearance advising Wamena ATC that the intended destination was Kenyam at a cruising altitude of 9,500 feet with two persons on board.	ATC
0316:49	The aircraft commenced the take-off roll on runway 15 at Wamena.	ECTM GPS tracking
0317:34	The aircraft lifted off at an IAS of 87 knots after a ground roll of 3,232 feet ⁴ .	ECTM
0317	The pilot reported to ATC that the aircraft was airborne at 0317 and a position report would be made at Polimo.	ATC
0318:14	Aircraft established on climb on a track of 145°M. During the climb to 9,538 feet the airspeed remained at about 100 knots with an average rate of climb of about 360 fpm. Altitude: 5,374 feet IAS 96 knots Engine torque: 1,679 ft/lbs Engine Ng: 98.3 % ITT: 730°C	ECTM
0323:12	The aircraft was at the Polimo reporting point. The pilot reported to ATC that the aircraft was over Polimo, passing 7,300 feet climbing to 9,500 feet with an estimated time of arrival (ETA) at Kenyam of 0347 UTC. The aircraft commenced at a right turn onto a heading of 213°M. Altitude: 7,300 feet IAS 100 knots Engine torque: 1,552 ft/lbs Engine Ng: 98.3 % ITT: 720°C	ECTM GPS tracking ATC
0325:02	Altitude: 8,000feet IAS 100 knots Engine torque: 1,570 ft/lbs Engine Ng: 98.2 % ITT: 719°C	ECTM
0327:58	Altitude: 9,000ft IAS 102 knots Engine torque: 1,543 ft/lbs Engine Ng: 98.2 % ITT: 719°C	ECTM
0329:43	Airspeed commenced to decrease over the next 46 seconds from 103 knots to 88 knots and the average rate of climb increased to about 390 fpm. Altitude: 9,538 feet IAS 103 knots Engine torque: 1,522 ft/lbs Engine Ng: 98.2 % ITT: 719°C	ECTM

4 The ground roll was derived from indicated airspeed and time.

UTC time	Event	Source
0330:29	EGPWS recorded data commenced. Aircraft was in a right turn with 4° angle of bank which increased to 29° during the following 6 seconds. Altitude: 9,838 feet IAS 88 knots Engine torque: 1,591 ft/lbs Engine Ng: 98.7 % ITT: 729°C	EGPWS ECTM
0330:30	The engine power commenced to increase. The changes in engine torque, Ng, ITT and fuel flow were consistent with a commanded increase in the selected power setting. Altitude: 9,861 feet IAS 89 knots Engine torque: 1,675 ft/lbs Engine Ng: 99.5 % ITT: 737°C	
0330:31	The aircraft descended from 9,865 feet to 9,728 feet during the following 4 seconds at an average rate of descent of about 2,000 fpm.	EGPWS ECTM
0330:35	Aircraft commenced rolling to the left. The average rate of descent reduced to about zero. Altitude: 9,728 feet IAS 92 knots Engine torque: 1,526 ft/lbs Engine Ng: 99.4 % ITT: 740°C	EGPWS ECTM
0330:40	The aircraft again started to descend while turning left with an angle of bank of 20°. The rate of descent increased to an average rate of 4,400 fpm over the following 9 seconds. Altitude: 9,728 feet IAS 92 knots Engine torque: 1,446 ft/lbs Engine Ng: 99.3 % ITT: 740°C	EGPWS ECTM
0330:43	Engine power started to reduce to about flight idle. The aircraft was continuing in the left turn with an angle of bank of 35°. Altitude: 9,652 feet IAS 91 knots Engine torque: 1,501 ft/lbs Engine Ng: 99.2 % ITT: 740°C	EGPWS ECTM
0330:47	The engine power was at idle with the aircraft continuing in the left turn at an angle of bank of 46°. Altitude: 9,202 feet IAS 104 knots Engine torque: 509 ft/lbs Engine Ng: 66.8 % ITT: 534°C	EGPWS ECTM
0330:49	Activation of EGPWS mode one 'SINK RATE' alert. The aircraft was banked to the left with an angle of bank of 46° and commenced rolling to the right. The rate of descent started to reduce. Altitude: 9,058 feet IAS 122 knots Engine torque: 549 ft/lbs Engine Ng: 63.0 % ITT: 530°C	EGPWS ECTM

UTC time	Event	Source
0330:50	<p>Activation of EGPWS mode one ‘PULL UP’ alert. The aircraft had ceased descending. The left roll was reducing with an angle of bank of 16°. The aircraft track was 127 °M</p> <p>Altitude: 9,045 feet IAS 104 knots</p> <p>Engine torque: 464 ft/lbs Engine Ng: 61.8 % ITT: 534°C</p>	EGPWS ECTM
0330:51	<p>Activation of EGPWS mode one ‘SINK RATE’ alert. The aircraft was rolling through a wings level attitude.</p> <p>Altitude: 9,194 feet IAS 52 knots</p> <p>Engine torque: 193 ft/lbs Engine Ng: 60.7 % ITT: 549°C</p> <p>(This data was most likely affected by the collision with the terrain)</p>	EGPWS ECTM
0330:53	<p>Activation of EGPWS ‘TERRAIN’ caution.</p> <p>End of recorded data.</p>	EGPWS

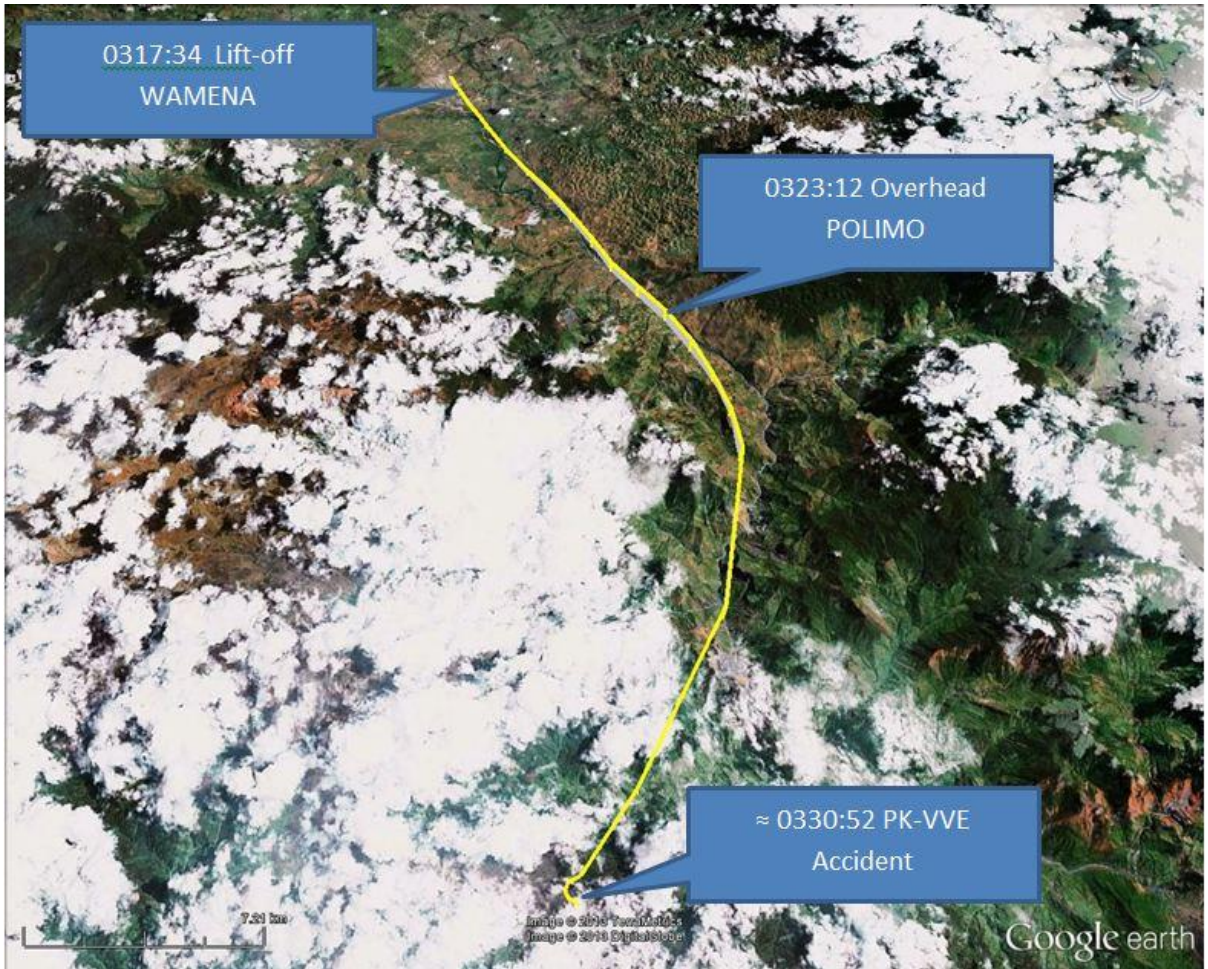


Figure 2: PK-VVE accident flight track and events (Source: GPS tracking and EGPWS data)

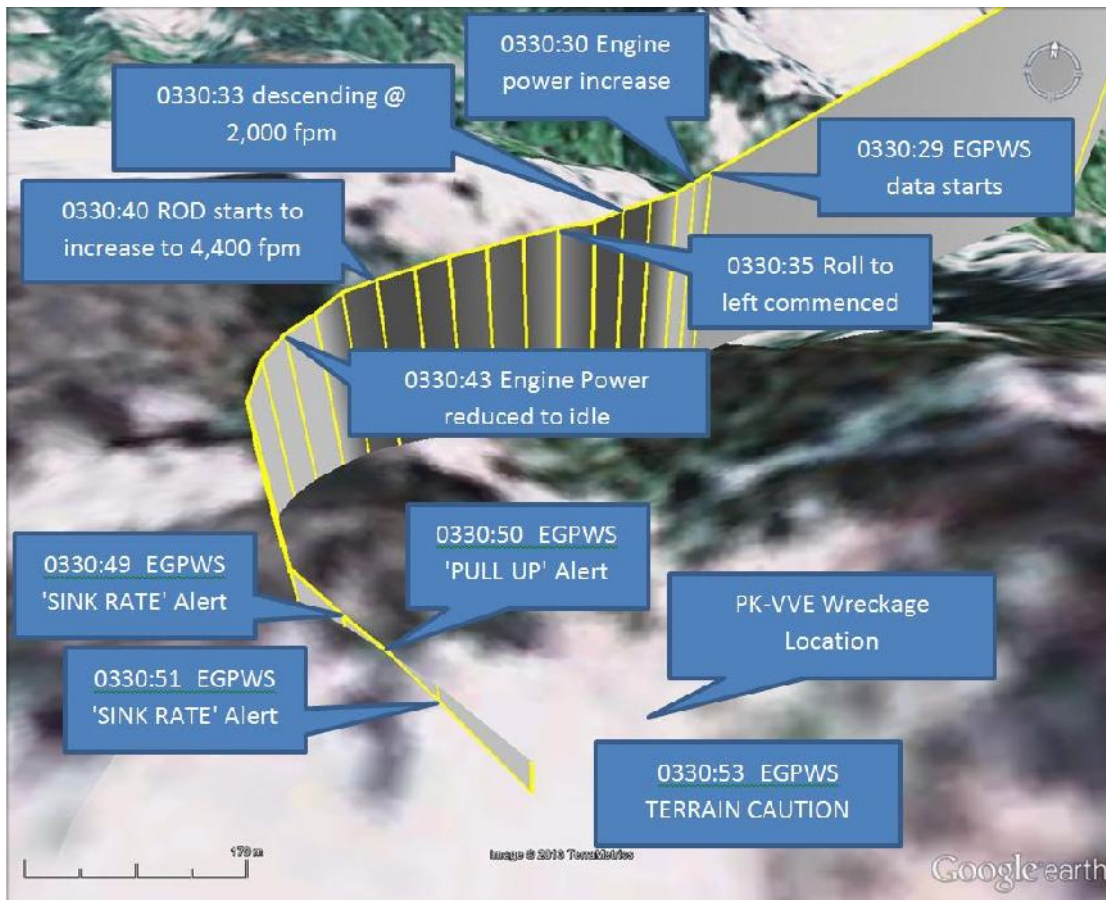


Figure 4: PK-VVE accident flight track and events 0330:29 to end of data (Source: EGPWS and ECTM data)

The Wamena ATC did not have a communications link to Kenyam and a missing aircraft would only be declared when it failed to return to Wamena. At 0530 UTC, The Wamena ATC declared an emergency situation regarding PK-VVE.

Following activation of the company Emergency Response Plan (ERP), at 0628 UTC a Pilatus Porter aircraft operated by PT. ASI Pudjiastuti Aviation, registered PK-BVY, took-off to search for the missing aircraft, and spotted the accident location. Due to the approaching night, no successful search and rescue (SAR) mission to reach the location could be launched.

On 10 September 2011, a Search and Rescue team and local people commenced a rescue operation. Two days later, the SAR team and local people reached the accident site, which was located on the side of the mountain. Both of the persons on board were fatally injured and the aircraft was destroyed. On 14 September 2011, a PT ASI Pudjiastuti Aviation helicopter evacuated the deceased.



Figure 6: Accident location

1.2 Injuries to Persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	2	-	2	-
Serious	-	-	-	-
Minor/None	-	-	-	-
TOTAL	2	-	2	-

1.3 Damage to Aircraft

The aircraft was destroyed.



Figure 7: PK-VVE wreckage

1.4 Other Damage

There was a minor damage to the forest.

1.5 Personnel Information

1.5.1 Pilot in Command

Gender	: Male
Date of birth	: 05 February 1982
Marital status	: Single
Date of joining Company	: 1 November 2009
Nationality	: Australian
Licence	: CPL
Date of issue	: 05 May 2010
Valid to	: 30 November 2011
Aircraft type rating	: Single Engine Land (Cessna 208)
Medical certificate	: Class I
Date of medical	: 16 June 2011

Valid to : 16 December 2011
Last proficiency check : 16 June 2011
Last line check : 30 August 2011
Total hours : 1,546 hours
This make and model : 1,315 hours
Last 90 days : 153 hours 3 minutes
Last 60 days : 107 hours 1 minutes
Last 7 days : 16 hours 7 minutes
Last 24 hours : 2 hours 1 minutes
This flight : 13 minutes

1.5.2 First Officer

Gender : Male
Date of birth : 16 November 1985
Nationality : Slovenska Republika
Marital status : Single
Date of joining Company : 1 June 2011
Licence : CPL
Date of issue : 20 July 2011
Valid to : 30 June 2012
Aircraft type rating : Single Engine Land (Cessna 208)
Medical certificate : Class I
Date of medical : 01 June 2011
Valid to : 01 December 2011
Last proficiency check : 23 June 2011
Total hours : 927 hours 8 minutes
This make and model : 147 hours 8 minutes
Last 90 days : 147 hours 8 minutes
Last 60 days : 146 hours 1 minutes
Last 24 hours : 2 hours 1 minutes
This flight : 13 minutes

1.6 Aircraft Information

1.6.1 General

Aircraft Registration	:	PK-VVE
Country of Manufacturer	:	United States of America
Manufacturer	:	Cessna
Type/ Model	:	Caravan C208B
Serial Number	:	1287
Year of Manufacture	:	2007
Certificate of Airworthiness		
Valid to	:	04 December 2011
Certificate of Registration	:	2439
Valid to	:	04 December 2011
Total flying hours since manufacture	:	3,926 hours
Total cycle since new	:	5,267 cycles

1.6.2 Engines

Engine type	:	Turbo Propeller
Manufacturer	:	Pratt &Whitney Canada
Model	:	PT6A- 114A
Part Number	:	3044000
Serial Number	:	PCE-PC1455
Time Since New (TSN)	:	3,926 hours
Cycle since new	:	5,267 cycles

The engine was detached from the aircraft and a detailed examination was performed on 17-18 April 2012 at Pratt &Whitney Canada Corp. The field report is attached at Appendix D.

The significant findings of the Compressor and Turbine section examination were as follows:

- Compressor 1st, 2nd and 3rd Stage Discs and Blades: The 1st stage compressor blades exhibited light foreign object damage on the leading edges as well as light tip rubbing. The remaining stages were physically unremarkable.
- Compressor 1st, 2nd and 3rd Stage Stators and Shrouds: The stator vanes were intact. The 1st stage shroud showed circular rubbing damage which was consistent with the observed 1st stage compressor blade tip damage.

- Compressor Turbine Shroud: Slight contact scoring was found on all shrouds.
- Compressor Turbine: All blades were in place and were unremarkable except for very light tip rubbing. The disk showed circular scoring on the downstream side of the blade fixings adjacent to the blade platforms. The blade platforms showed similar damage. Light scoring was found on the centre hub, downstream side.

The findings of the engine examination were consistent with the engine operating at a low power setting at the time of impact.

The recorded engine data indicated that the engine operation was consistent with a climb power setting following the departure from Wamena. At 23 seconds before the end of recorded data, the engine power increased. About 10 seconds before the end of the recorded data, the engine power reduced to about the flight idle setting.

The findings of the engine examination and a review of the recorded data did not identify any engine malfunction.

1.6.3 Weight and Balance

A load sheet relating to the flight was not available, however the cargo manifest and supplementary information relating to the cargo, that was prepared on 9 September 2011 were available. The operator reported that the pilot in command used a portable electronic device to calculate the aircraft weight and balance. According to the cargo manifest, the calculated weight of the cargo was 2,555 lbs (1,159 Kg). The operator also advised that additional 827 lbs (375 Kg) of rice was loaded onto the aircraft but was not listed on the cargo manifest (Appendix B).

There were differences between the certificated and estimated weight figures as follows:

- The certificated maximum takeoff weight for a Cessna Caravan incorporating the APE III Payload extender supplemental type certificate (STC), which applied to PK-VVE, was 9,062 lbs (4,110 Kg).
- The takeoff weight, based on the manifested cargo, was estimated by the investigation to be 8,854 lbs (4,016 Kg).
- The takeoff weight, based on the manifested cargo and the additional load of rice was estimated by the investigation to be 9,681 lbs (4,391 Kg) which was 619 lb (281 Kg) above the certificated maximum takeoff weight.
- The aircraft gross weight when operating over high terrain at 0330 was estimated to be 9,591 lb (4,350 Kg).

Centre of gravity

As the aircraft estimated takeoff weight of 9,681 lbs (4,391 Kg) exceeded the certified maximum takeoff weight of 9,062 lbs (4,110 Kg), the aircraft Centre of Gravity (C of G) was outside the certificated C of G envelope. The C of G position, based on witness reports of the cargo loading, was estimated to be about 199.80 inches aft of datum at takeoff and about 199.75 inches at the time of the accident (Appendix D). Operation at these weights and C of G positions would increase the control force necessary to maneuver the aircraft and the nose-up trim required during takeoff and climb.

1.6.4 Aircraft performance

The aircraft performance will be affected by aircraft weight and ambient air temperature. The rate of climb will be reduced however, the takeoff runway length and stall speed will increase, at an increased aircraft weight for a given power setting, airspeed and ambient air temperature.

The climb performance data published in the Pilot's Operating Handbook Supplement showed that the average rate of climb from 5,000 feet to 9,500 feet is 520 fpm at a weight of 9,062 lbs (the highest figure provided in the Supplement) when operating the aircraft at the maximum climb engine torque, maximum rate of climb speed (105 knots) at 20 degrees above ISA temperature. The recorded data showed that, at the calculated take-off weight of 9,681 lbs, the aircraft's average rate of climb from 5,125 ft to 9,538 feet was 360 fpm at an average climb speed of 100 knots.

Based on the ECTM data, the aircraft lifted off at an IAS of 87 knots after a ground roll of 3,232 feet. The normal calculated ground roll at maximum takeoff weight of 9,062 lbs at an altitude of 5,000 feet, and OAT 25° C, would be 2,021 feet with flap setting 30 and 2,322 feet with flap setting 20 (Appendix C)

The aircraft stall speed will increase at a higher aircraft weight and/or angle of bank. Stall speed data published in the Supplement showed that the aircraft stall speed is 63 knots indicated airspeed, at 9,062 lb with flaps up, power idle and 0° angle of bank. This figure increases to 75 knots at 45° angle of bank. These stall speeds would increase by about 2 knots the calculated aircraft weight of about 9,591 lbs when the aircraft was over the high terrain. The recorded data showed that the airspeed decreased to 88 knots at 0330:29 when the aircraft was in a right turn with 4° angle of bank.

1.7 Meteorological Information

The weather report for Wamena issued on 9 September 2011 at 03.00 UTC was as follows:

Surface wind	:	Calm
Visibility	:	12 Km
Weather	:	NOSIG
Cloud base	:	SCT 14,000 feet
Temperature / Dew point	:	25 / 15 ° C
QNH	:	1,009 mbs
QFE	:	836 mbs

The following is a summary of the weather situation as reported by other pilots operating in the area;

- South Gap closed in the morning with high cloud, but improved by midday. Mountain cloud still evident. Polimo clear but Pasema airstrip closed.
- Scattered cloud evident, but South Gap open at 02.00 UTC, overcast north of Kenyam.
- Clouds evident in the lower valley and Silimo area. Strong winds to Ebole.

A review of the recorded data indicated that during the climb to 9,838 feet. the aircraft was encountering a south-easterly wind of about 20 knots. This wind speed could result in turbulence being encountered over mountainous terrain. The wind information was derived from a comparison of true airspeed, groundspeed and track. True airspeed was calculated from ECTM indicated airspeed, pressure altitude, and ambient temperature. Groundspeed and track data was recorded by the flight tracking system.

Figure 5 illustrates the possible weather as described by other pilots on the day of the accident. This is to illustrate that the mountains were visible in Visual Meteorological Conditions.



Figure 10: Possible weather in the accident area

1.8 Aids to Navigation

Not relevant to this accident.

1.9 Communications

Communications between ATC and the pilot were normal with no reported communication difficulties. The last radio contact between ATC and the pilot of PK-VVE was at 03.23 UTC.

1.10 Aerodrome Information

Not relevant to this accident.

1.11 Flight Recorders

The aircraft was not fitted with a flight data recorder or cockpit voice recorder. Neither recorder was required by current Indonesian civil aviation regulations. However, the aircraft was fitted with EGPWS, ECTM and a Blue Sky Network GPS tracking equipment that recorded data during the flight.

The Blue Sky GPS flight tracking system recorded a number of parameters at approximately 34 second intervals, including aircraft time, groundspeed, position and magnetic heading. This data was retrieved from the network web portal by the operator following the accident.

The Pratt and Whitney ECTM system recorded various engine parameters and indicated airspeed and pressure altitude at 0.5 second intervals.

The Honeywell EGPWS recorded a number of parameters, including EGPWS cautions and alerts, aircraft roll angle, altitude, groundspeed, position, track and terrain elevation over a 30 second period when triggered by an EGPWS event (20 seconds before and 10 seconds after the event). This data was recorded at one second intervals.

The recorded data from the three systems was synchronized to a common time datum in the sequence of events. This datum was the flight tracking system GPS time.

The data recorded was analyzed and supported by the Australian Transport Safety Bureau.

1.12 Wreckage and Impact Information

The wreckage was located on the side of a mountain at 9,100 feet elevation and at coordinates S 04° 24' 48.6" E 139° 00' 13.38". The direction of impact was reported to be 124° M.

The wreckage was spread along a line of 124° magnetic over a length of about 200 metres. The initial impact was by the right wing with high trees, separating part of the wing which was found away from the main wreckage. The main wreckage was located about 200 metres from that initial impact point, starting with the right horizontal stabilizer, and then the cargo load, the fuselage, left wing, propeller, engine cowling and left stabilizer. Damage to the propeller blades was consistent with the propeller rotating at low RPM at initial impact. The propeller was reported to have been found with the blades in the feathered position. This was consistent with the propeller assembly separating from the engine during the impact sequence and the blades moving to the feathered position due to the loss of oil pressure and the action of the feathering springs.

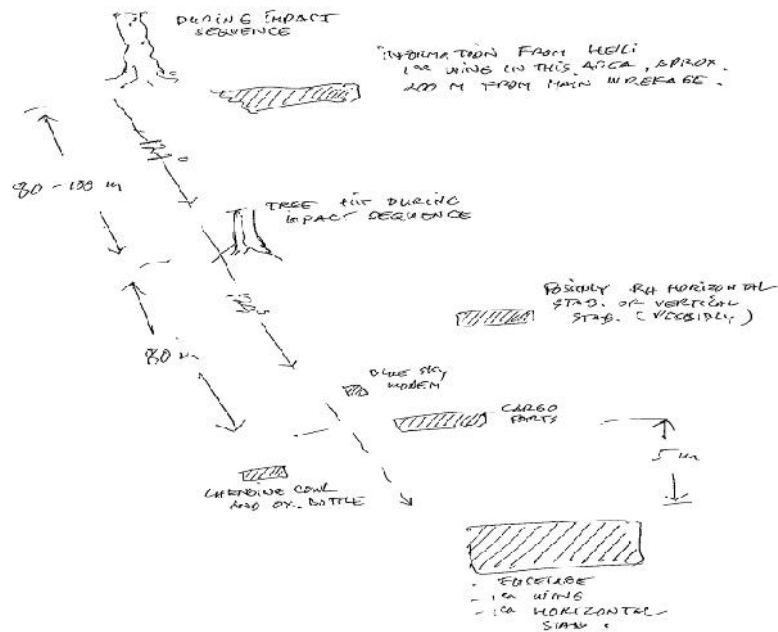


Figure 11: Wreckage distribution (not to scale)



Figure 12: The Reduction Gearbox & Propeller detached from the engine



Figure 13: The left wing



Figure 14: The left horizontal stabilizer



Figure 15: The detached propeller with two blades bent rearward (one blade cut for recovery)



Figure 16: The twisted propeller spinner (one blade cut for recovery)

1.13 Medical and Pathological Information

The two aircraft occupants were fatally injured as result of impact during the accident.

1.14 Fire

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

1.15 Survival Aspects

It was an un-survivable accident.

The aircraft was fitted with an Artex 406 MHz Emergency Locator Transmitter (ELT). The ELT battery had an expiry date of December 2012. The operator reported that the ELT signal was only heard from overhead the accident site.

1.16 Tests and Research

Not relevant for this investigation.

1.17 Organisational and Management Information

Aircraft Owner : PT. ASI Pudjiastuti Aviation

Aircraft Operator : PT. ASI Pudjiastuti Aviation
Jalan Merdeka 312
West Java, Indonesia .

Air Operator Certificate Number: AOC/135-028

The operator reported that with the expansion of the company and increasing demand for pilots, the experience level of pilots operating in Papua had been dropping. Pilots normally spent time flying over flat terrain on company operations before embarking on mountain flying in Papua.

The operator also reported that the Pilot in Command of PK-VVE had flown the Wamena – Kenyam route a few times before, but never using the full Wamena-Kenyam-Wamena GPS route guide as depicted as the yellow track in figure 12.



Figure 17: Accident flight route (green track) and VFR flight route (yellow route)

The operator reported that there was an opinion within the company that Caravan pilots were left to some degree, to their own devices, to analyze the best way to tackle mountain flying. A review of flight tracking data of flights conducted by the pilot in command, including while undergoing training, showed that the pilot flew the more direct route between Wamena and Kenyam. This route was also flown by other company pilots on the day of the accident as shown as green tracks in figure 13. These flights were operated between 11,200 feet and 12,500 feet over the high terrain along the route. The operator's route guide specified that flights over the high terrain enroute from Wamena to Kenyam should be conducted at 11,500 feet and stated that 'IMC climb not below 9000 feet at Polemo'.

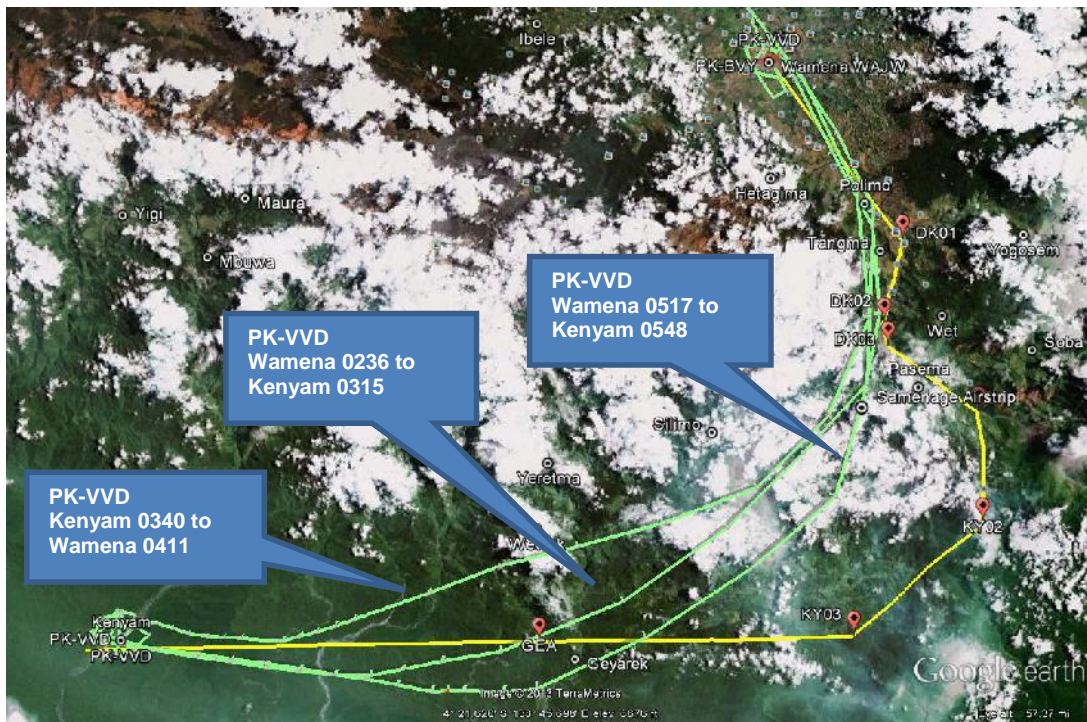


Figure 18: GPS tracks of other flights between Wamena and Kenyam on 9 September 2011

1.18 Additional Information

1.18.1 Maintenance

The aircraft was maintained in accordance with the operator's approved aircraft maintenance program. A review of the available technical logs indicated that the last maintenance conducted was a mini check inspection on the 22 August 2011 at 3892.5 hours.

The maintenance release/return to service statement on the Defect log book form No. ASI-06 contained a discrepancy in regard to the signature block requirement. However, this had no effect on the aircraft maintenance requirement.

1.18.2 Aircraft refuelling

The aircraft was refuelled at Wamena from fuel drums. The use of water finding paste or tablets was not used at Wamena, leading to the possibility of the contamination of fuel with water. However, there was no evidence from the recorded data of any problems associated with the operation of the engine during the flight.

1.19 Useful or Effective Investigation Techniques

The investigation was conducted in accordance with the NTSC approved policies and procedures, and in accordance with the standards and recommended practices of Annex 13 to the Chicago Convention.

2 ANALYSIS

This analysis will discuss the factors associated with the loss of control and subsequent collision with terrain of Cessna Grand Caravan PK-VVE on 9 September 2011. The issues that will be covered include the aircraft maintenance, aircraft refuelling, aircraft loading, and a summary of the development of the accident, based on the recorded data.

2.1 Aircraft maintenance

The aircraft was maintained in accordance with the operator's approved aircraft maintenance program. While the most recent maintenance records were not available for review, the recorded data recovered from the various data sources did not indicate any anomalies with the serviceability of the aircraft during the flight. The investigation considered that there were no maintenance or airworthiness issues related to the development of the accident.

2.2 Aircraft refuelling

There were reported issues related to fuel and the potential for contamination from aviation turbine fuel drum stocks at Wamena Airport and that water detecting paste and tablets were not used to check fuel quality. However, the recorded data indicated that the aircraft engine was operating normally and responding to control inputs throughout the flight. The recorded data indicated normal engine operation and there were no variations in the data that showed evidence of fuel contamination. The investigation considered that the aircraft engine was not affected by the presence of contamination in the fuel leading up to the accident.

2.3 Aircraft loading

The aircraft departed Wamena Airport with an un-manifested 827 lb (375 Kg) load of rice on-board that resulted in the aircraft operating 619 lbs (281 Kg) above the certificated maximum takeoff weight. While the aircraft centre of gravity (C of G) position was outside the C of G envelope, the longitudinal stability of the aircraft did not appear to be adversely affected during normal flight. The effect on controllability while initiating a recovery maneuver could not be determined.

2.4 The accident flight

Following the departure from Wamena Airport, the aircraft was flown along a track toward Kenyam which was consistent with the route used by other company pilots and previously flown by the pilot in command. The additional loading contributed to a reduced rate of climb during the flight which resulted in the aircraft being below 10,000 ft as it approached the high terrain. This altitude was 1,500 ft lower than the altitude specified in the operator's route guide for operations between Wamena and Kenyam, and lower than the altitude flown by other company pilots when operating in the area, including three other flights on the day of the accident which overflew the high terrain between 11,200 and 12,500 ft.

At 0329:43, as the aircraft approached the high terrain at an altitude of 9,538 ft, the airspeed commenced decreasing which was accompanied by the average rate of climb increasing to about 390 fpm. It is probable that the pilots recognized the proximity of the terrain and attempted to improve the aircraft's angle of climb⁹ by decelerating towards the best angle of climb speed of 72 kts. The recorded data showed that 31 seconds after the airspeed started to decrease, the engine power varied with a maximum engine torque of 1,675 ft/lbs being recorded at 0330:30 with changes in the other engine parameters being consistent with a selection of a higher power setting. This is likely to have been associated with the pilot's attempts to improve terrain clearance.

The recorded data then showed the aircraft in a descending right turn for about 6 seconds. The altitude reduced over a period of 4 seconds from 9,865 ft to 9,728 ft at an average rate of descent of about 2,000 fpm. This turn was likely to have been initiated to either avoid cloud or improve terrain clearance. The aircraft subsequently commenced to roll to the left at 0330:35 with the left roll continuing for the following 14 seconds. It was likely that the left turn was initiated to avoid either cloud or terrain.

During the left turn, the angle of bank reached a maximum value of 46° and the aircraft descended from 9,728 ft to 9,045 ft at a high rate of descent. The airspeed also increased from 92 kts to 122 kts during the descent. The engine power was reduced to idle soon after the aircraft commenced descending which was most likely due to the handling pilot attempting to recover from the high descent rate and increasing airspeed. The recorded data indicated that three EGPWS alerts activated during the descent.

The aircraft had stopped descending at 0330:50 and had commenced climbing with a reducing left angle of bank when the recording of all data ceased three

⁹ Angle of climb refers to the gain in altitude in a given distance.

seconds later. At about this time, the data showed that an EGPWS caution was activated.

The investigation considered several scenarios as to why the airspeed and rate of descent increased during the left turn:

- The handling pilot inadvertently made control inputs during a terrain avoidance maneuver that led to the aircraft entering a stall;
- The aircraft encountered turbulence associated with wind flow over the mountainous terrain during a terrain avoidance maneuver which led to the aircraft entering a stall;
- The handling pilot attempted to minimize the radius of turn during a terrain avoidance maneuver which led to loss of control; or
- The handling pilot lost visual reference due to inadvertent flight into cloud during a terrain avoidance maneuver which led to loss of control.

The recorded data indicated that the handling pilot had initiated a recovery maneuver by reducing engine power, reducing the rate of descent and rolling the aircraft towards a wings level attitude. However, the aircraft altitude was insufficient for the handling pilot to successfully complete the recovery maneuver before the aircraft impacted terrain.

Although the aircraft systems recorded a number of flight parameters, aircraft pitch attitude was not recorded. Accordingly, the investigation was unable to determine which of the above scenarios was most likely.



3 CONCLUSIONS

3.1 Findings

- The aircraft was airworthy prior the accident and there was no evidence of system malfunction during the flight.
- The crew had valid licenses and medical certificates.
- The aircraft was loaded with an un-manifested load of rice, weighing 827 lbs (375 kg) resulting in the aircraft operating at 619 lb (281 Kg) above the certificated maximum takeoff weight.
- The aircraft was operated outside the centre of gravity envelope.
- The aircraft climb performance was adversely affected by the aircraft being operated above the certificated maximum takeoff weight.

3.2 Other findings

- It was reported that water detector paste and tablets were not used at Wamena to test drum fuel for contamination.

3.3 Factors

Factors that contributed to the accident are as follows:

- a. The aircraft was loaded to a weight in excess of the maximum certificated takeoff weight.
- b. The aircraft climb performance was adversely affected by the aircraft being operated above the certificated maximum takeoff weight.
- c. The aircraft approached high terrain along the proposed route at an altitude which was below that specified in the operator's route guide.
- d. The aircraft entered a high rate of descent during a terrain avoidance maneuver.
- e. Recovery from the abnormal flight path was not achieved before the aircraft collided with terrain.

4 SAFETY ACTIONS

During the investigation process prior to the release of this Final Report, the National Transportation Safety Committee had been advised of Safety Actions taken by the following parties:

4.1 Directorate General of Civil Aviation

The Directorate Airworthiness & Aircraft Operation of the DGCA advised that they conducted a special audit on PT. ASI Pujjiastuti referred to in DKUPPU letter No. 2047/ DKUPPU/STD/V/2012

4.2 PT ASI Pudjiastuti Aviation

PT ASI Pudjiastuti Aviation advised that they took the following safety actions as a result of this accident:

- All Papua flights to be flown as per the route guide designated and approved routes and altitudes. No deviations from these tracks to be made unless there is an immediate danger to the safety of the flight. Any track deviation requires a safety report. This is to be reviewed within 3 months.

This has been re-trained to all crew in Papua and has been followed without exception. Following the mountain training in February 2012, crews are now more able to properly assess alternate routes and safe flying in any mountain environment, providing an even better alternative to a rigid route system. Supervision performs by occasional checks by blue sky flight following system.

- Immediate review of the route guide and assessment of all routes to check continued suitability. Minimum climb check heights to be added in.
- The PT ASI Pudjiastuti Aviation Papua Route Guide has been re-assessed and re-issued with changes to routes and altitudes. New maps have been created and issued.
- The weight and balance documentation requirements had been improved, that all Ground Crew, PT ASI Pudjiastuti Aviation or otherwise to use aircraft loading sheet or similar. All flights to complete weight and balance sheet prior to departure to be compiled by one crew member and cross-checked by the other. Blue copies to be left at base.
- Blue Sky monitoring procedures to be evaluated. Improve training at Pangandaran Flight Following and ensure communication process is clear.
- The flight following department has now been integrated into the OCC (Operations Control Center) and is led by a more senior manager. Training and improvements to the interface with ERP (Emergency Response Plan)

and the operations in each base have been implemented. Recent incidents have shown a marked improvement in reaction times following problems with aircraft.

- Establish a mountain training course with an external provider for all Papua Captains.

In February 2012, 1 week of training was held with MCCALL MOUNTAIN/CANYON FLIGHT TRAINING. 3 highly qualified mountain training instructors came to Papua and trained all current captains, and provided new training methods and insight (also used to improve the training program / manual, recommendation 4). Another week was spent training in Kalimantan with the pilot group there. In total, over 60 PT ASI Pudjiastuti Aviation pilots participated directly in this training. Follow up training with the same company has been completed.

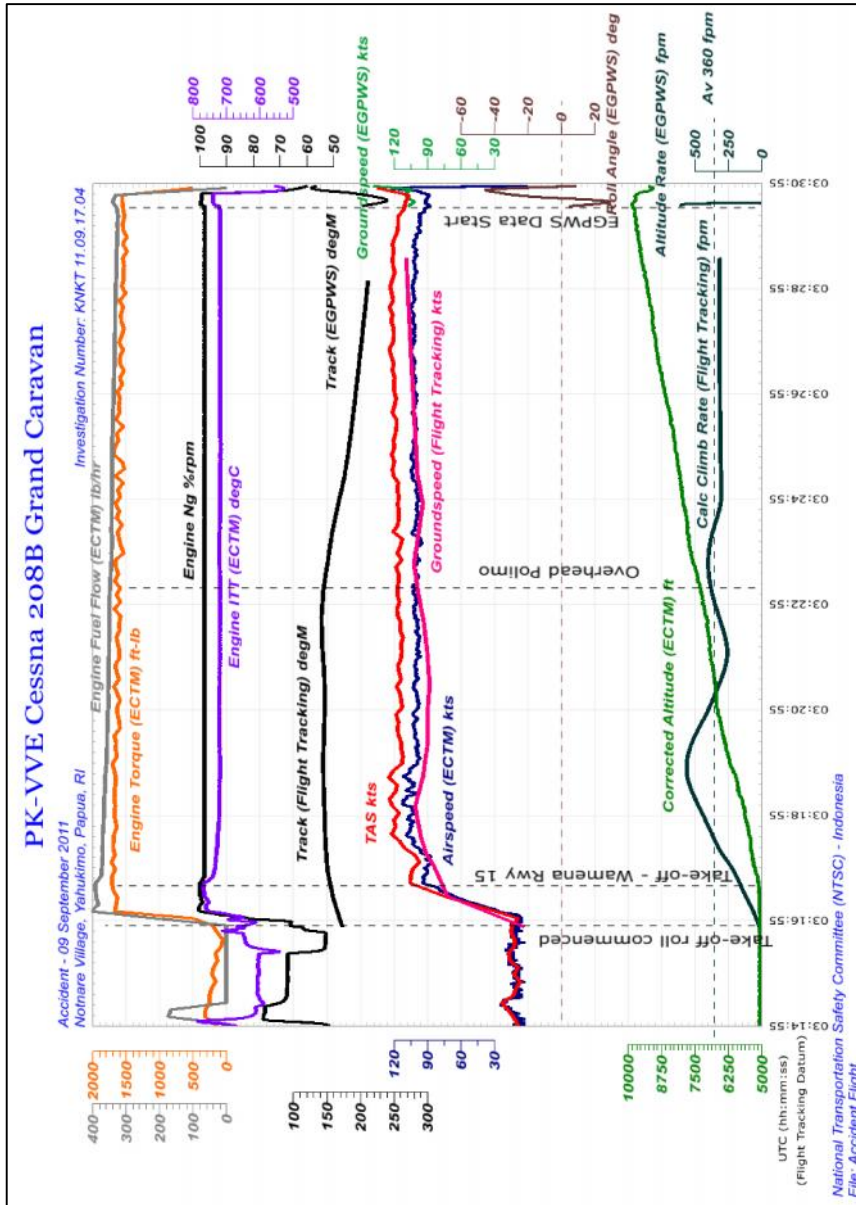
- Cargo/Baggage loadings to be sealed once the Pilot has ensured loading is correct, the pilots are now in constant attendance from beginning of loading to dispatch, ensuring correct load and no possibility of fraudulent / intentional overloading.
- The current loading configurations to be evaluated and improved, event it was not a factor in the accident outcome, it was determined that the tie-down (cargo securing) procedure for heavy loads did not sufficiently secure the load. Changes have been made and all loads are now secured to satisfy the requirements of the POH for the Caravan.
- Fuel water detector had been use at all of the line operations.
- The Maintenance Release and Return to Service had been revised in accordance with the Civil Aviation Safety Regulation.

5 SAFETY RECOMMENDATIONS

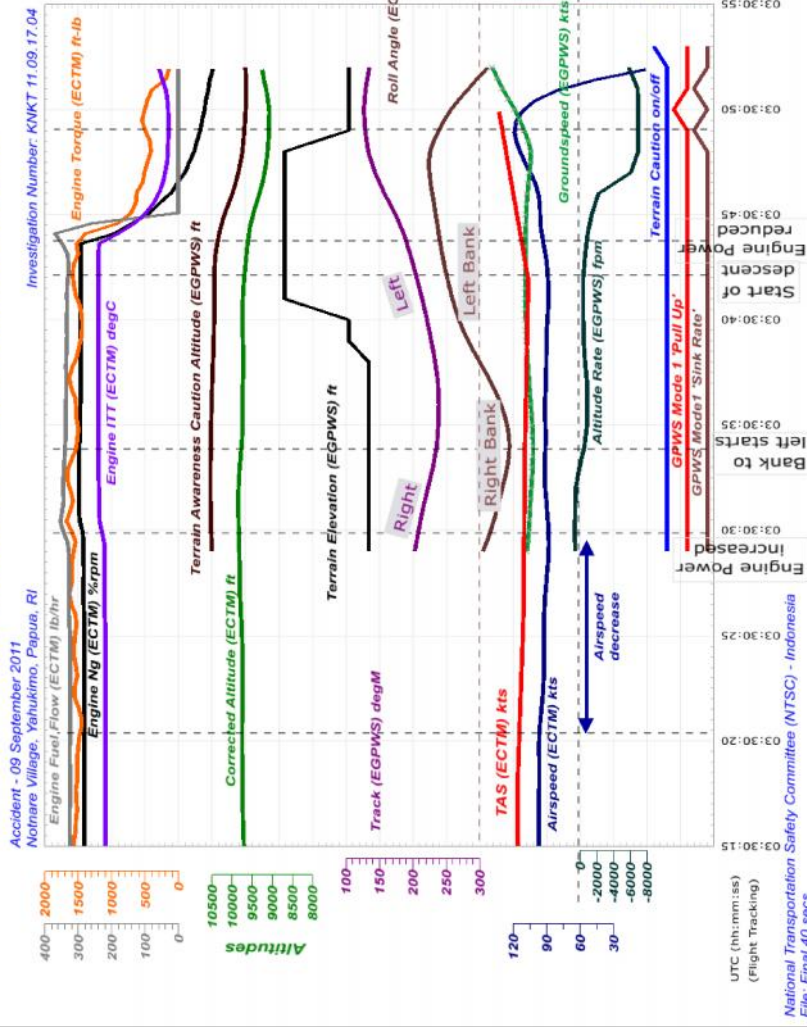
As a result of the safety actions taken by the relevant parties to the investigation, there are no safety recommendations contained in this report.

6 APPENDICES

Appendices A: Recorded Data Relevant Parameters

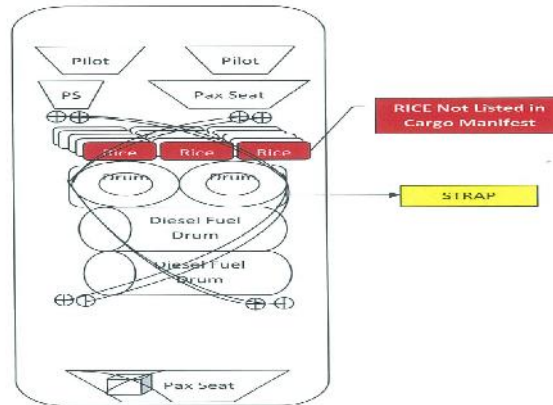


PK-VVE Cessna 208B Grand Caravan



Appendices B: cargo Diagram PK-VVE before accident

CARGO DIAGRAM VVE BEFORE ACCIDENT



Note:

CABIN:
 DRUM WEIGHT (184Kg, 189Kg, 187Kg, 182Kg) Total = 742 Kg

CARGO POT:
 (BOX 5 Ø/@10 Kg, 5 Ø @9 Kg, 5 Ø/@10 Kg, 1 Ø/@20 Kg, 5 Ø/@12 Kg, 1 Ø/@4 Kg, 20 Ø/@3 Kg, 2 Ø/@10 Kg, 3 Ø/@11 Kg, 3 Ø/@32 Kg, 2 Ø/@15.5 Kg) Total = 417 Kg

TOTAL CARGO LISTED IN MANIFEST :
 (742 Kg + 417 Kg) = 1.159 Kg

CARGO NOT LISTED IN MANIFEST:
 (RICE 25 Ø /@15 Kg) Total = 375 Kg

TOTAL LOAD PK VVE ACTUAL:
(1.159 Kg + 375 Kg) = 1.534 Kg

Source: Based on interview with Ongen Crew

PA-YVE

SIAM - KENYAMA

Received 9 Sept 11

PAVE
7 000

744

SOLAR

184 + 107 + 107
182

744 (744)

CHARGES

RAWN EXPENSE	5 4 (10)	50
" SPINT	5 4 (19)	45
" POCHE	5 4 (110)	525
" KATON	2 4 (100)	20
" SAKUS	5 4 (110)	60
" KOPING	1 4 (4)	4
" SAMPURAN	20 4 (4)	80
200 MORGAN PUNY	2 4	32
+ cement		
RAWN COMPURAN	2 4	32
" "	2 4	32
" "	2 4	31

417

417
1159

Appendices C: The normal calculated ground roll at maximum takeoff weight of 9,062 lbs at an altitude of 5,000 feet, and OAT 25° C.

Flap setting 20°

Altitude	20C		25C		28.8C		30C	
	Grd Roll	50ft clearance	Grd Roll	50ft clearance	Grd Roll	50ft clearance	Grd Roll	50ft clearance
4000	2057	3654	2124	3774	2159	3836	2191	3894
6000	2357	4181	2520	4531	2605	4712	2683	4880
5000	2207	3918	2322	4152	2332	4274	2437	4387

Interpolated from POH
Used by NTSC
More accurate for ECTM OAT

Actual temp = 25C
Corr alt = 5,000ft

Reference
Page

POH Supplement for Cessna Caravan 208B (675SHP) Equipped with AeroAcoustics Aircraft Payload Extender STOL System
7

Flap setting 30°

Altitude	20C		25C		28.8C		30C	
	Grd Roll	50ft clearance	Grd Roll	50ft clearance	Grd Roll	50ft clearance	Grd Roll	50ft clearance
4000	1825	2820	1875	2878	1901	2907	1925	2935
6000	2050	3105	2168	3340	2229	3462	2285	3575
5000	1938	2963	2021	3109	2065	3185	2105	3255

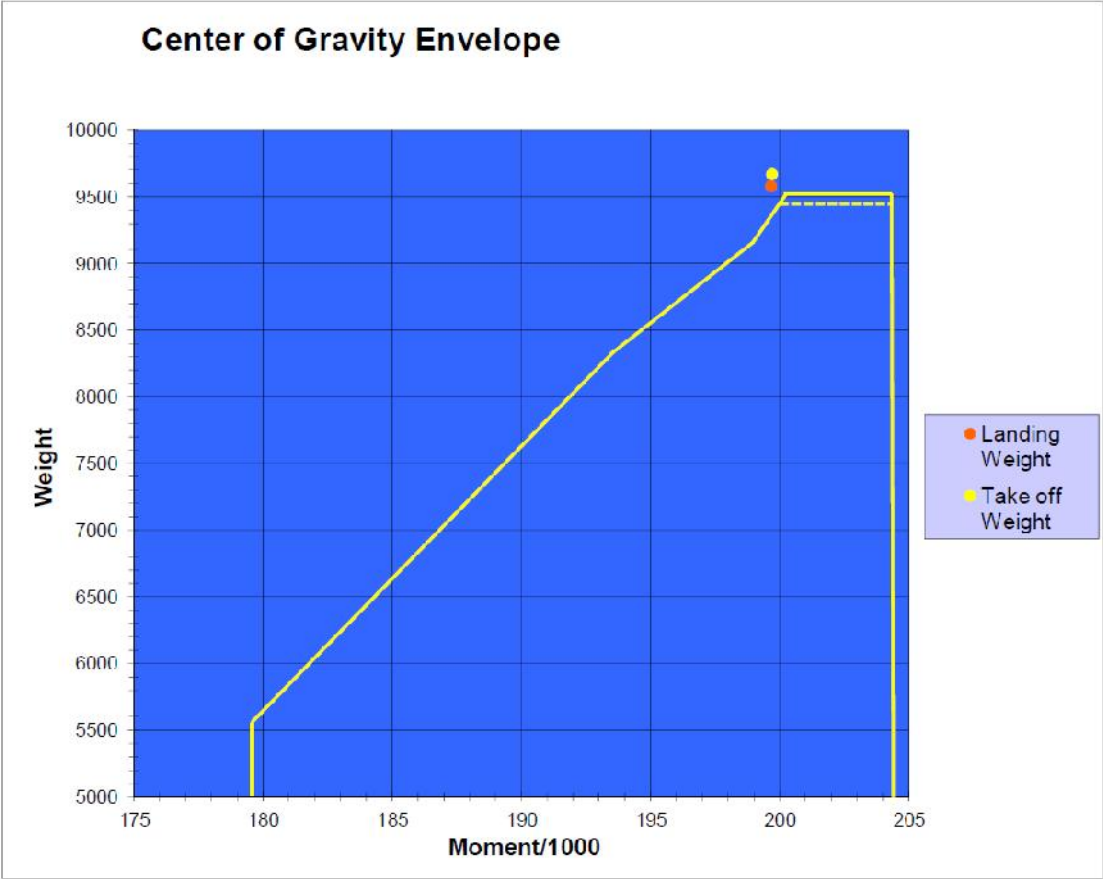
Interpolated from POH
Used by NTSC
More accurate for ECTM OAT

Actual temp = 28.8C
Corr alt = 5,000ft

Reference
Page

POH Supplement for Cessna Caravan 208B (675SHP) Equipped with AeroAcoustics Aircraft Payload Extender STOL System
12

Appendices D: Centre of gravity envelope



Appendices D: Pratt & Whitney Report



FACTUAL NOTES, ENGINE TEARDOWN INVESTIGATION IN SUPPORT OF ACCIDENT INVESTIGATION OF A CESSNA 208B CARAVAN, PK-VVE PERFORMED FOR NATIONAL TRANSPORTATION SAFETY COMMITTEE OF INDONESIA.

P&WC Ref. File No: 11-111

1. INVESTIGATION PARTICIPANTS

The powerplant investigation was performed on April 17-18, 2012 at Pratt & Whitney Canada Corp., St-Hubert, QC. The following individuals participated in the investigation as representatives of their respective organisations:

Paul Frechette	Investigator Transportation Safety Board of Canada
David Barnard	Accessories Technical Support Pratt & Whitney Canada Corp.
Marc Gratton	Air Safety Investigator Pratt & Whitney Canada Corp.

2. LEFT HAND ENGINE HISTORY

PT6A-114A S/N PC1455

Hours Since New: 3,925.2

Cycles Since New: 5,197

Hours Since Overhaul: Unk

Cycles Since Overhaul: Unk

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	ECCN or USML (ITAR) #	
	P-ECCN or P-USML (Non US Origin)	P9E991

3. ENGINE EXAMINATION

All positional references are in relation to view from aft looking forward. Upstream and downstream references are in relation to gas path flow from the compressor inlet to exhaust.

3.1 External Condition

3.1.1 External Cases

Reduction Gearbox (RGB): The RGB front housing was fractured in front of "A" flange. It was not sent with the engine.

Exhaust Duct: Impact damage was present on the exhaust stack extension and its bolting flange was partially torn off. Flange "A" was deformed from impact.

Gas Generator Case: Compressive impact damage was present adjacent to "C" flange between the 6 and 9 o'clock position. A large impact dent was located at the 3 o'clock position in the fuel nozzle plane. Compressive deformation of the compressor housing was also noted.

Accessory Gearbox (AGB): The AGB housing was intact.

3.1.2 Power Control and Reversing Linkage

All components were bent from impact and the control rod to the fuel control was fractured.

3.1.3 Pneumatic Lines

Compressor Discharge Air (P3): The line from the gas generator to the P3 housing was secured. The insulation was partially ripped however pressurising with shop air revealed no leaks.

Power Turbine Control (Py): The portion of the line between the fuel control and gas generator case fire wall was available for review. The insulation was damaged however pressurising with shop air showed no leaks. The remainder of the line was not available for review.

3.1.4 Chip Detectors and Filters

Reduction Gearbox Chip Detector: Clean

Oil Filter: Clean

Fuel Filter: Not available for review.

3.2 Disassembly Observations

The front RGB housing, propeller shaft and 2nd stage reduction gears were not sent with the remainder of the engine and therefore they were not available for review. The compressor was generally dirty. A significant amount of environmental dirt, soil and wood chips was found on the front portion of the engine especially inside the gearbox. The power turbine rotor was seized. The compressor could be moved however there was no rotation possible.

3.2.1 Compressor Section

Compressor 1st, 2nd and 3rd Stage Discs and Blades: The 1st stage compressor blades exhibited light foreign object damage on the leading edges as well as light tip rubbing. The remaining stages were physically unremarkable.

Compressor 1st, 2nd and 3rd Stage Stators and Shrouds: The stator vanes were intact. The 1st stage shroud showed circular rubbing damage which was consistent with the observed 1st stage compressor blade tip damage.

Compressor 1st, 2nd and 3rd Stage Spacers: Unremarkable.

Centrifugal Impeller: Light rubbing damage was found on all blades at the exducer.

Centrifugal Impeller Shroud: Corresponding rubbing damage was noted on the inner portion of the shroud.

Front Stub Shaft: Unremarkable.

No. 1 Bearing and Airseals: The bearing showed light corrosion but no evidence of other damages. The airseal was unremarkable.

No. 2 Bearing and Airseals: Light corrosion was observed on the rollers but no evidence of other distress was noted. The airseal was unremarkable.

3.2.2 Combustion Section

Combustion Chamber Liner: The liner was deformed from impact damage at the 3 o'clock position. There was no burning or excessive soot observed inside the chamber and normal flame patterns were observed.

Large Exit Duct: The duct outer rim was structurally deformed in areas consistent with the damage found on the liner. There was no evidence of heat related damage.

Small Exit Duct: Unremarkable.

3.2.3 Turbine Section

Compressor Turbine Guide Vane Ring: Unremarkable.

Compressor Turbine Shroud: Slight contact scoring was found on all shrouds.

Compressor Turbine: All blades were in place and were unremarkable except for very light tip rubbing. The disk showed circular scoring on the downstream side of the blade fixings adjacent to the blade platforms. The blade platforms showed similar damage. Light scoring was found on the centre hub, downstream side.

ITT Probes, Busbar, and Harness: Unremarkable.

Power Turbine Housing: Unremarkable.

Power Turbine Guide Vane Ring and Interstage Baffle: The vane ring was dirty and sooted but showed no structural damage.

Power Turbine Shroud: Moderate rubbing damage was noted on the knife edges.

Power Turbine: All blades were in place and showed moderate tip rubbing. The upstream side of the edges of the blade platform and the shroud leading edge tips showed slight scoring. The disk was unremarkable.

Power Turbine Shaft and Shaft Housing: The housing was externally dirty with soot. The No. 3 & 4 bearings could not be rotated due to corrosion.

3.2.4 Reduction Gearbox

Rear Housing: The mounting flange rim was fractured. The remainder of the housing was dirty but structurally intact.

1st Stage Sun gear: The visible portion through the planet gears was unremarkable.

1st Stage Planet Gear Carrier: The carrier was covered in environmental dirt but there was no evidence of pre impact damage.

1st Stage Planet Gears: The gears were covered in environmental dirt but there was no evidence of pre impact damage.

1st Stage Ring Gear: Dirty but otherwise unremarkable.

Torque Meter: Not available for review.

2nd Stage Sun Gear and Flex Coupling: Dirty but no evidence of pre-impact damage was noted.

2nd Stage Planet Gear Carrier: Not available for review.

2nd Stage Planet Gears: Not available for review.

2nd Stage Ring Gear: Not available for review.

No. 5 Bearing: Not available for review.

Propeller Shaft: Not available for review.

Nos. 6 and 7 Bearings: Not available for review.

Forward Housing: The housing was fractured at "A" flange and not available for review.

3.2.5 Accessory Gearbox

The AGB could not be rotated prior to disassembly. Disassembly revealed significant corrosion on the bearing lands of most gears. The bearing showed corresponding corrosion. This corrosion prevented free movement of the gears and bearings. Examination of the gear teeth showed no evidence of pre-impact anomalies.

3.3 Controls and Accessories Evaluation

3.3.1 Ignition System

Exciter Box: not available for review.

Ignition Leads: Not available for review.

Ignition Plugs: Unremarkable.

3.3.2 Fuel System

Fuel Heater: The heat exchanger as well as the inlet and outlet ports were fractured and not available for review. The thermal element housing had remained attached to the engine. Testing of the thermal element showed it responded well to temperature changes.

Fuel Pump: The pump was in unremarkable physical condition. Testing showed seal leakage however, this did not affect its operation.

Fuel Control Unit: Only the portion of the drive body containing the flyweights was available for review. The flyweights and bearing were free to run.

Flow Divider: Testing showed it would not open to secondary; disassemble revealed corrosion on the piston.

Fuel Nozzles: The nozzles were dirty, which affected the flow patterns and flows during testing.

3.3.3 Air System:

Compressor Bleed Valve: Dirt was present on the valve seat and piston which contributed to leakage when tested. Cleaning of this debris and subsequent re-testing of the BOV revealed that it operated normally.

3.3.4 Oil System:

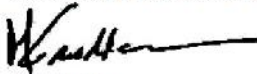
Propeller Governor: Not available for review.

Overspeed Governor: Not available for review.

5. CLOSING:

These factual notes are based upon observations made on April 17 & 18, 2012, and may be altered or corrected on the basis of further information.

PRATT & WHITNEY CANADA CORP.



Marc Gratton
Service Investigation
20 April 2012