FINAL
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KOMITE NASIONAL KESELAMATAN TRANSPORTASI

Runway Excursion Investigation Report

PT. Adventist Aviation Indonesia
Kodiak-100; PK-SDF
Doyo Baru Airstrip, Papua
Republic of Indonesia
09 April 2014

KOMITE NASIONAL KESELAMATAN TRANSPORTASI
REPUBLIC OF INDONESIA
2015

This Final report was produced by the Komite Nasional Keselamatan Transportasi (KNKT), 3rd Floor Transportation Building, Jalan Medan Merdeka Timur No. 5 Jakarta 10110, INDONESIA.

The report is based upon the investigation carried out by the KNKT 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. 62/2013).

The final report consists of factual information collected until the final report published. This report includes analysis and conclusion.

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ABBREVIATIONS AND DEFINITIONS

AAI	:	Adventist Aviation Indonesia
AOC	:	Air Operator Certificated
AIM	:	Airplane Information Manual
ASD	:	Accelerate Stop Distance
ATPL	:	Air Transport Pilot License
BLDC	:	Brushless Direct Current
CASR	:	Civil Aviation Safety Regulation
CCTV	:	Close Circuit Television
CT	:	Compressor Turbine
DOB	:	Doyo Baru
DGCA	:	Directorate General Civil Aviation
EPL	:	Emergency Power Lever
FAA	:	Federation Administration Aviation
ft	:	feet
ICAO	:	International Civil Aviation Organization
IIC	:	Investigator in Charge
Km	:	Kilometer(s)
KNKT / NTSC	:	*Komite Nasional Keselamatan Transportasi* / National Transportation Safety Committee
Kts	:	Knot (s)
NM	:	Nautical mile(s)
POH	:	Pilot Operating Handbook
PPL	:	Private Pilot License
PT	:	Power Turbine
QFE	:	Height above airport elevation (or runway threshold elevation) based on local station pressure
QNH	:	Height above mean sea level based on local station pressure
RSUD	:	Rumah Sakit Umum Daerah/ local hospital
SOP	:	Standard Operating Procedure
USA	:	United States of America
UTC	:	Universal Time Coordinate
VFR	:	Visual Flight Rule
VOR	:	Very high frequency Omnidirectional Range
WIT	:	W*aktu Indonesia Timur* / Eastern Indonesian Standard Time

INTRODUCTION

SYNOPSIS

A Kodiak-100 aircraft, registered PK-SDF, on 9 April 2014 was being operated by PT. Adventist Aviation Indonesia as non-schedule flight from Doyo Baru Airstrip with intended destination of Ninia Airstrip, Papua. On board in this flight were 7 persons consist of one pilot and six passengers.

This flight was the fourth flights for the pilot. The flight time to Ninia was estimated of 1 hour and was planned at cruising altitude of 10,000 feet and the fuel on board were sufficient for 4 hours flight time.

At 0024 UTC, the pilot received clearance for takeoff.

At 0027 UTC, Sentani Tower controller has not received reports from the PK-SDF pilot and tried to call but was not responded.

At 0030 UTC, The Chief Section of Sentani Tower Air Navigation obtained information that the aircraft had experienced an accident during takeoff at Doyo Baru.

The aircraft failed to lift off and impacted to several objects prior to stop at 30 meters from the end of the runway. The nose section damage after consumed by post impact fire.

Two occupants including the pilot were fatally injured and five other occupants seriously injured. All occupants were taken to Yowari Hospital (Rumah Sakit Umum Daerah – RSUD Yowari).

The investigation concluded that the contributing factors of this occurrence was due to the aircraft was not in the correct takeoff configuration which required wing flap 20° while the flap was found on position of 6° during impact. The investigation concluded that the flap was selected during the takeoff roll when the pilot realized that the aircraft did not airborn on the position where normally became airborne. The pilot also operated the Emergency Power Lever intended to add more engine power. The corrective actions to recover the situation by selection of emergency power lever and flap were not proper for particular condition.

At the time of issuing this Final Report, the Komite Nasional Keselamatan Transportasi has been informed safety action of the Adventist Aviation Indonesia by installing a CCTV to monitor pilot and aircraft behavior on takeoff.

As result of this investigation, the KNKT issued several safety recommendations to address the safety issues identified in this final report, which is related to flight operation procedures and airport firefighting equipment and system to the PT. Adventist Aviation Indonesia, Doyo Baru Airport authority and Directorate General of Civil Aviation.

1 FACTUAL INFORMATION

1.1 History of the Flight

A Kodiak-100 aircraft, registered PK-SDF, on 9 April 2014 was being operated by PT. Adventist Aviation Indonesia as non-schedule flight from Doyo Baru Airstrip with intended destination of Ninia Airstrip, Papua. On board in this flight were 7 persons consist of one pilot and six passengers.

This flight was the fourth flights for the pilot who has performed flights from Doyo Baru (DOB) – Puldamat (PUL) at 2138-2228 UTC; Puldamat (PUL) –Soya (SOY) at 2243-2247 UTC; Soya (SOY) – Doyo Baru (DOB) at 2256-2344 UTC.

The flight time to destination was estimated of 1 hour with cruising altitude of 10,000 feet and the fuel on board were sufficient for 4 hours flight time.

Doyo Baru Airstrip located at approximately 10 NM North West of Sentani Airport (WAJJ). Air traffic movement to and from Doyo Baru Airstrip was controlled by Sentani Tower controller.

At 0015 UTC, the pilot contacted to Sentani Tower controller, requested for start engine and clearance to fly to Ninia. The requests were approved and to report when ready for departure.

At 0021 UTC, the pilot reported to the Sentani Tower controller ready for departure from Doyo Baru Airstrip. The Sentani Tower Controller instructed the pilot to hold to wait an aircraft took off from Sentani Airport.

At 0024 UTC, the pilot received clearance for takeoff with additional traffic information and to report after airborne.

At 0027 UTC, Sentani Tower controller has not received reports from the PK-SDF pilot and tried to call but was not responded. After several observations toward Doyo Baru area and did not see PK-SDF aircraft, The Sentani Tower controller reported to the Chief Section of Sentani Tower Air Navigation.

At 0030 UTC, The Chief Section of Sentani Tower Air Navigation clarified the condition of PK-SDF aircraft to one of Indonesian Adventist Aviation pilot in Doyo Baru and obtained information that the aircraft had experienced in accident during takeoff at Doyo Baru.

An engineer after received the information went to the accident site and saw appearance of white smoke came out from the side of the river which was known as the accident aircraft located. After arrived at the accident site the engineer saw the Adventist's staffs and local people tried to extinguish the fire on the aircraft engine by throwing some water and used two fire extinguishers while some people moved the passengers from the wreckage.

Two occupants including the pilot were fatally injured and five other passengers were seriously injured. All occupants were taken to Yowari Hospital (*Rumah Sakit Umum Daerah* – RSUD Yowari).

Map Courtesy of Google Earth

Figure 1: Airport layout and the accident site

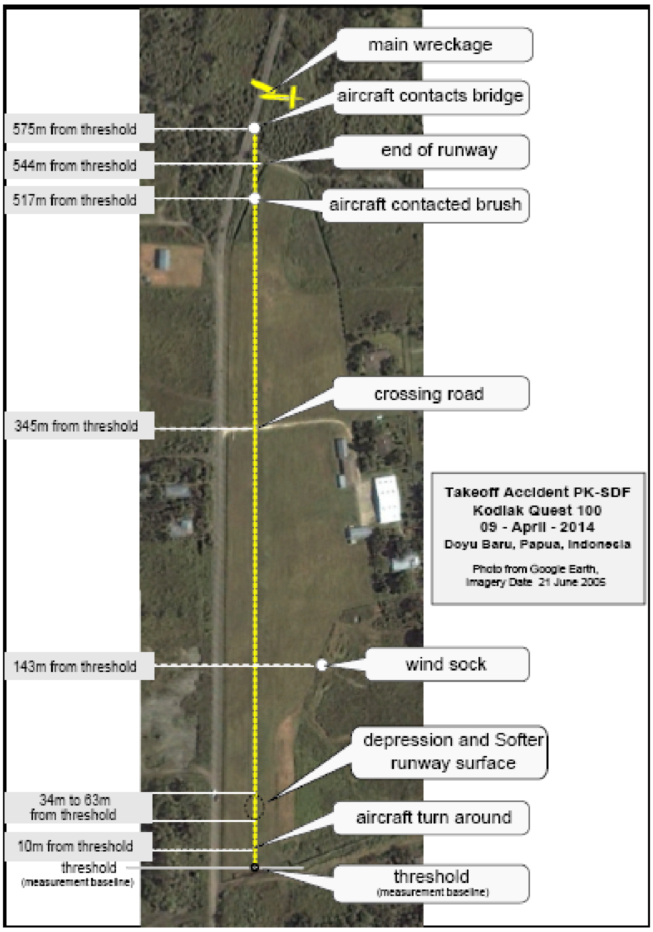


Figure 2: Illustration of takeoff track and significant marks superimposed to Google earth

1.2 Injuries to Persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	1	1	2	-
Serious	-	5	5	-
Minor/None	-	-	-	N/A
TOTAL	1	6	7	-

The pilot was American citizen and the other occupants were Indonesian.

1.3 Damage to Aircraft

The aircraft was substantially damage. The nose section consumed by post impact fire. The landing gear and the wing were detached from the main wreckage. The passengers cabin relatively intact.

Figure 3: Aircraft main wreckage

1.4 Other Damage

There was no other damage to property and/or the environment.

1.5 Personnel Information (Pilot)

Gender	:	Male
Age	:	63 years
Nationality	:	USA
Marital status	:	Married
Date of joining company	:	1992
License	:	PPL (Indonesia)
	:	ATPL (FAA)
Aircraft type rating	:	C-185, PC-6 porter, K-100 Kodiak
Medical certificate	:	Second Class
Last of medical	:	14 March 2014
Validity	:	21 September 2014
Medical limitation	:	Holder shall wear lensesthat correct for distant vision and posses glasses that correct for near vision

Flying hours experience

Total hours	:	25,530 hours
Total on type	:	1,752 Hours 04 Minutes
Last 90 days	:	204 hours
Last 60 days	:	105 hours
Last 24 hours	:	07 Hours 04 minutes
This flight	:	02 hours 04 minutes

The pilot moved to Papua, Indonesia on August 1992 and lived in Doyo Baru closed to the airport. His first mission in Papua started with two Cessna 185 aircrafts and one Super Cub aircraft. The pilot had accumulated more than 14500 hours spend in Papua Indonesia. The pilot flew Kodiak 100 since end of 2011 and most of the flying conducted in Papua Indonesia Aircraft Information.

1.6 Aircraft Information

1.6.1 General

Registration Mark	:	**PK-SDF**
Manufacturer	:	Quest Aircraft
State of Manufacturer	:	USA
Type/ Model	:	Quest Kodiak 100
Serial Number	:	100-049
Year of manufacture	:	2011

Certificate of Airworthiness		
Issued	:	09 August 2013
Validity	:	08 August 2014
Category	:	Normal
Limitations	:	None
Certificate of Registration		
Number	:	2936
Issued	:	09 August 2011
Validity	:	08 August 2014
Time Since New	:	1,752.2 hours
Cycles Since New	:	2,211 cycles
Last routine maintenance Check	:	100 hours inspection at 1,699 hours and 2,131 cycles on 28 February 2014

1.6.2 Engines

Manufacturer	:	Pratt & Whitney
Type/Model	:	PTGA-34
Serial Number engine	:	PCE-RB0521
▪ Time Since New	:	1,752.2 hours
▪ Cycles Since New	:	2,211

1.6.3 Propellers

Manufacturer	:	Hartzell
Type/Model	:	HC-B3TN-3DY
Serial Number	:	BUA-31288
▪ Time Since New	:	1,341.6

There was no pilot report related to engine over-temperature or malfunction on the previous flights.

1.6.4 Weight and Balance

The Airplane Information Manual (AIM) the aircraft limitation:

Maximum Ramp Weight	:	7,305 lbs
Maximum Take-off Weight	:	7,255 lbs
Maximum Landing Weight	:	6,690 lbs
Maximum Zero Fuel Weight	:	6,490 lbs

The aircraft weight and balance data stated that the aircraft Basic Empty Weight was 4226 lbs. The total weight of passenger and cargo carried were 764 kg or 1683 lbs. Fuel on board was 1180 lbs which was sufficient for 4 hours flight (320 pounds per hour). Take-off weight calculation assuming pilot weight of 200 lbs:

Basic Empty Weight	:	4,226 lbs
Passenger and cargo	:	1,683 lbs
Fuel on board	:	1,180 lbs
Crew	:	200 lbs
The taxi weight	:	7,289 lbs

WT (LB)	Press Alt (FT)	0°C		10°C		20°C		30°C		40°C	
		Ground Roll (FT)	Total Feet to Clear 50' OBS	Ground Roll (FT)	Total Feet to Clear 50' OBS	Ground Roll (FT)	Total Feet to Clear 50' OBS	Ground Roll (FT)	Total Feet to Clear 50' OBS	Ground Roll (FT)	Total Feet to Clear 50' OBS
	S.L.	852	1353	906	1429	961	1506	1097	1720	1275	2002
	1000	899	1412	956	1491	1040	1615	1197	1860	1396	2173
	2000	950	1473	1010	1556	1135	1747	1308	2015	1526	2355
	3000	1003	1538	1085	1655	1241	1893	1433	2187	1673	2559
	4000	1061	1607	1187	1795	1358	2052	1568	2372	1833	2779
	5000	1148	1722	1300	1948	1485	2223	1714	2569	2007	3015
7255	6000	1260	1872	1423	2113	1625	2410	1879	2790	2210	3292
	7000	1379	2032	1559	2292	1782	2619	2065	3040	2440	3603
	8000	1513	2208	1713	2496	1960	2856	2273	3315	2684	3927
	9000	1663	2404	1886	2723	2158	3115	2500	3614	2943	4266
	10000	1826	2615	2072	2964	2375	3397	2757	3949	—	—
	11000	2010	2852	2290	3246	2619	3712	3056	4337	—	—
	12000	2215	3113	2527	3548	2893	4063	3377	4750	—	—

Table 1: Table of takeoff distance required for take-off weight of 7255 lbs taken from POH Chapter 5-28 Performance

The interpolation for take-off distance assumed airport elevation at 350 feet, wing flaps 20° and surface temperature at 28 °C based on the table the required ground roll would be 1,102 feet or 336 m and to clear obstacle at 50 feet would be 1816 feet or 553 m.

1.7 Meteorological Information

Doyo Baru airport situated 5 km from Sentani Airport and the weather condition relatively similar to Sentani Airport. The weather report from Sentani Airport, issued 9 April 2014 as follows:

	0000 UTC	0100 UTC	0200 UTC	0300 UTC
Wind	280/12 knots	270/11 knot	280/09 knot	280/12 knot
Visibility	8 km	8 km	10 km	10 km
Weather	Slight rain	Slight rain	Nil	Nil
Cloud	SCT 010	SCT 010	FEW 010	FEW 013
TT/TD	27 / 23	27 / 23	28 / 24	29 / 22
QNH (mb/in Hg)	85	81	80	69
QFE (mb/in Hg)	1008	1008	1008	1007

1.8 Aids to Navigation

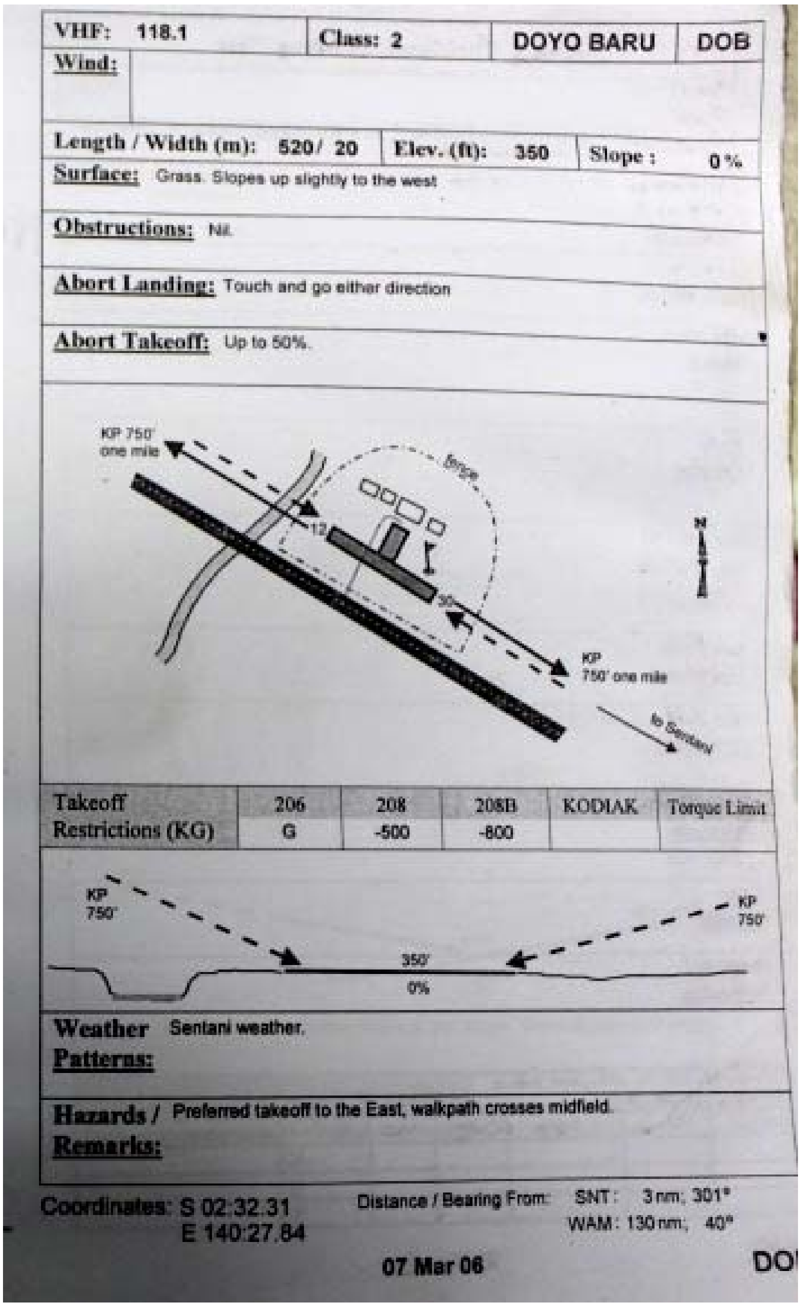
Ground-based navigation aids and on board navigation aids were serviceable and considered not a factor in this occurrence.

1.9 Communications

All communications between ATS and the crew were good and considered not related to the occurrence.

1.10 Aerodrome Information

Airport Name	:	Doyo Baru
Airport Identification	:	DOB
Airport Operator	:	Adventist Aviation Indonesia
Coordinate	:	S 02:32.31, E140:27.84
Elevation	:	350 ft
Runway Direction	:	12- 30
Runway Length	:	520 m
Runway Width	:	20 m
Surface	:	Grass



VHF: 118.1 | Class: 2 | DOYO BARU | DOB

Wind:

Length / Width (m): 520/ 20 | Elev. (ft): 350 | Slope : 0 %

Surface: Grass. Slopes up slightly to the west

Obstructions: Nil.

Abort Landing: Touch and go either direction

Abort Takeoff: Up to 50%.

Takeoff Restrictions (KG)	206	208	208B	KODIAK	Torque Limit
	G	-500	-800		

Weather Patterns: Sentani weather.

Hazards / Remarks: Preferred takeoff to the East, walkpath crosses midfield.

Coordinates: S 02:32.31
E 140:27.84

Distance / Bearing From: SNT: 3 nm; 301°
WAM: 130 nm; 40°

07 Mar 06

DO

Figure 4: Doyo Baru Aerodrome chart

1.11 Flight Recorders

The aircraft was not equipped with flight recorder nor was it required by existing Indonesia regulation.

1.12 Wreckage and Impact Information

1.12.1 Impact information

The flight path after takeoff of the aircraft hit small trees that were trimmed short by propeller of the end of the runway and the spot on the bridge were the main impact had occurred, completed with the pilots door still logged in the spot on the bridge. It was apparent that the left wing had directly struck part of the bridge also as the entire center section of the left wing was lying back from the bridge separated from join tip and wing root if it had directly impacted a bridge pillar or something, wrapped and bounced backward off of it. The main wheel lying in the grass with part of the strut attached to it.

The emergency power lever was un-stowed in the control column and partially (not fully) activated.

The flaps were at least partially activated an examination of the flap jack screws would be the primary determining factor as to where the flap were at the time of the impact.

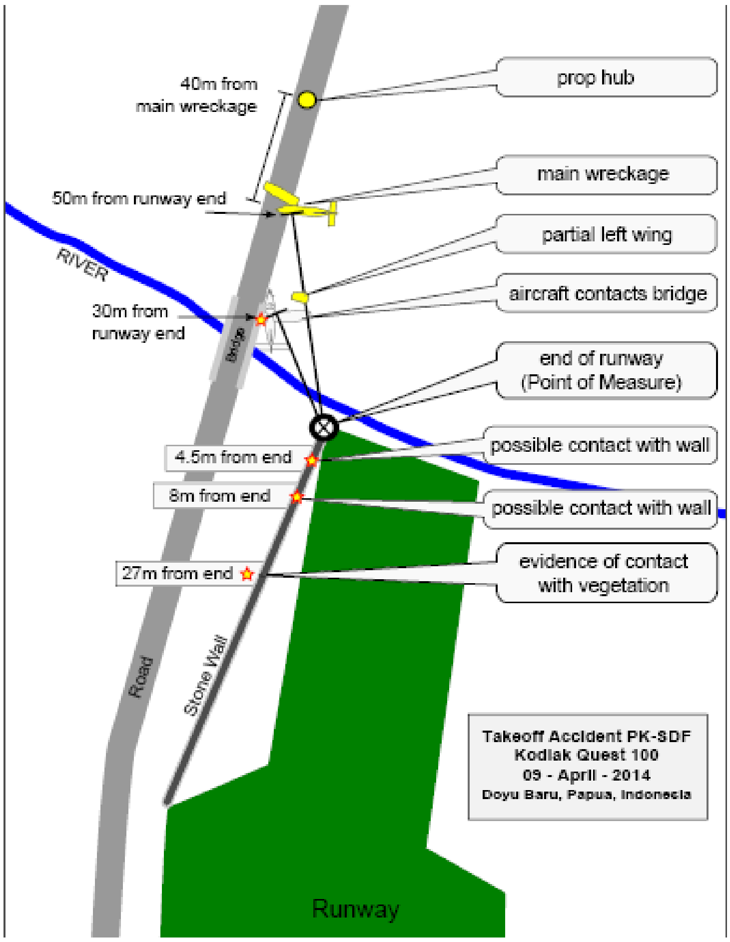


Figure 5: The illustration of impact marks found and aircraft final position

1.12.2 Wreckage information

Examination on the wreckage found several evidences as follows;

1. Elevator trim stuck at up position.

   Refer to the Airplane Information Manual (Document No. AM901.201), stated that the elevator trim will automatically move to up position when the flap in-transit to down position and elevator trim will automatically move to down if the flap in-transit to up position. The range of automatic elevator trim movement is the flap in position between 5 and 35.

2. The wing flap selector was on position 35(full down).
3. The Emergency Power Lever and power lever on full forward position.

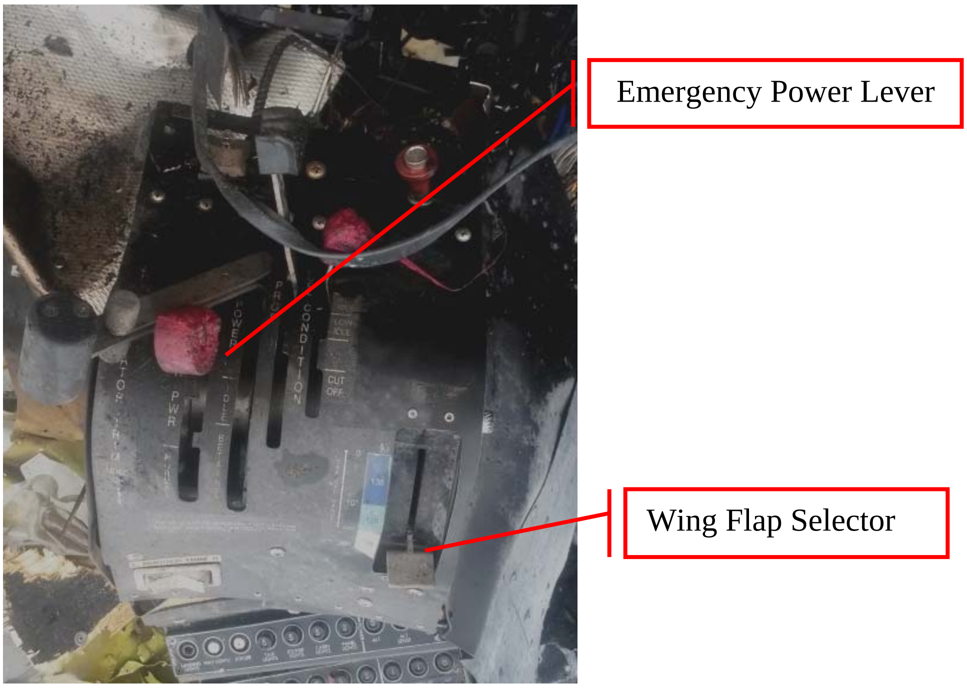


Figure 6: Pedestal found after accident showed the position of wing flap selector and emergency power lever

4. Left control yoke bent.

   Refer to the Kodiak manufacturer information, the gust lock (flight control lock) of the Kodiak aircraft 100 is conducted by inserting the pin into a hole on the yoke (gust lock housing).When the gust lock is engaged the elevator is on neutral position.

   The wreckage indicated that the distance of the gust lock pin and the gust lock housing separated approximately 15 cm. The yoke was found bent. This condition indicated that the gust lock has been disengaged and the yoke has been pulled backward to move the elevator.

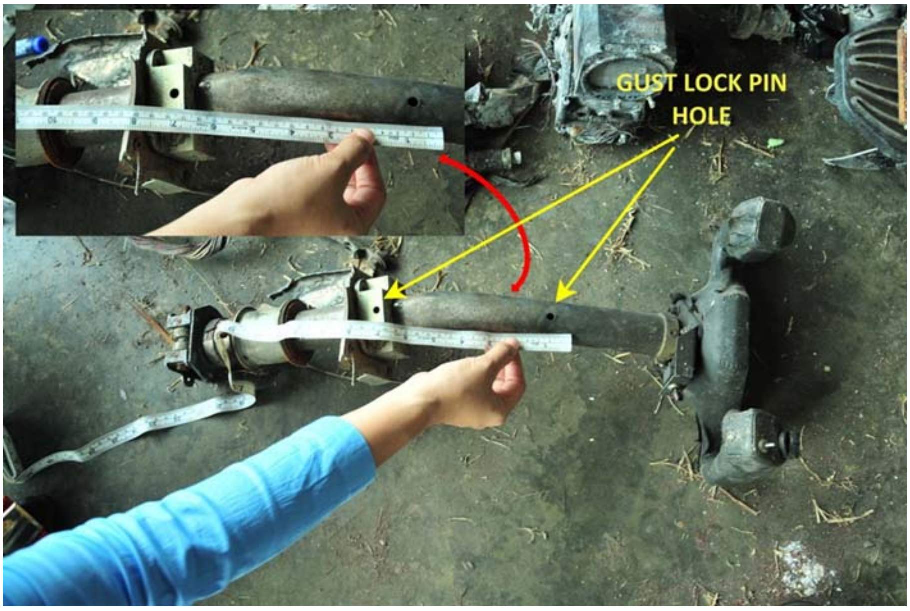


Figure 7: gust lock pin hole

5. Flaps physically did not extend.

Figure 8: Wing flap physically did not extend

6. Flap screw jack

   There were four screw-jacks of the wing flaps, two screw jacks for each wing. One screw jack was found broken presumably at the time of impact. The measurements of screw jack extensions (distance from the “flat plane” to the center of the “eye”). The extensions of three screw jacks were found similar.

The manufacturer provided table for the cross reference of flap angle and the distance either from the actuator pivot to the flap horn ("eye"). The detail stated in the following table:

No.	Screw jack	Distance from Flap Horn ("eye") to Spar Mount Plate (mm)
1	Left outer	145.1
2	Left inner	Broken on the screw and could not be measured
3	Right inner	144.4
4	Right outer	144.7

Table 2: Screw jack extension found on the wreckage

The measurement of the 3 flap screw jacks were relatively equal and it was highly possible that the Left inner screw jack might have the equal distance.

This can be concluded that there was no flap asymmetry.

Figure 9: The left inner and outer wing flap screw jacks

Figure 10: Measurement of the wing flap screw jack

1.13 Medical and Pathological Information

The pathological information performed at local Hospital at Jayapura at 12 April 2014, reported that the cause of the fatality for the pilot was hard impact on the right neck and jaw.

Pathological Examination found alcohol on the urine and gastric (stomach) equal to 40mg% or more. No drug was found.

40mg% alcohol found in post-mortem consider low figure and could not be determined the source from alcohol consumption or production of post-mortem.

1.14 Fire

Figure 11: Post impact fire

There was post impact fire on the area of aircraft engine.

1.15 Survival Aspects

The forward section of the aircraft heavily damaged as result of impact and post impact fire. The Captain seat was detached and the copilot seat was still intact. The main passenger compartment was relatively intact.

The fire extinguished by two bottles of fire extinguisher and assisted by local people by throwing water to the engine.

All occupants were evacuated by local people.

The fire truck of the Kabupaten Jayapura arrived later assisted the emergency response.

Figure 12: Local people carried water to extinguish the fire

1.16 Tests and Research

No tests or research was required to be conducted as a result of this occurrence.

1.17 Organisational and Management Information

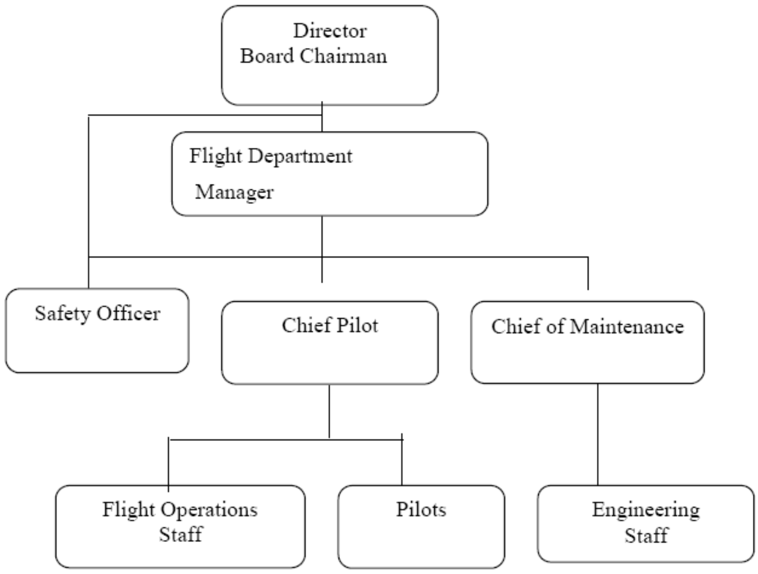
1.17.1 Organisation

ADVENTIS AVIATION INDONESIA
ORGANIZATION STRUCTURE

1.1 Organizational Structure

The following is the organizational structure of Adventist Aviation.

Flight Department Organizational Structure



The organization structure consists of the unit and person responsibility to the operation, maintenance and financial aspect at Adventist Aviation Indonesia, which is operate under CASR part 91 General Aviation.

The pilot of the accident aircraft was the leader of the Director Board Chairman and assisted by Flight Department Manager, Chief Pilot and Chief of Maintenance.

The Flight Department Manager is accountable for overall operation of the Flight Department and safe flight operations and that flight department safety management goals are met.

The Chief Pilot is accountable for the professional standards of the flight crews under his/her authority and that the operations and training safety management goals are met.

The Chief of Maintenance is accountable for ensuring that all aircraft are maintained in accordance with regulatory requirements and that all maintenance related safety management goals are met.

1.17.2 Operational Oversight Program

Most of the operation over sighting conducted by the Adventist Aviation Indonesia chief pilot, the operational over sight included all the area such as, flight document, pilot and flight performance, maintenance activities and record. In Adventist Aviation Indonesia, it was done by the accident pilot.

1.17.3 Drug & Alcohol Program

AAI PERSONNEL AND PASSENGER HEALTH PRECAUTIONS (Chapter 7, Operation Manual)

7.1. Use of Alcohol and Other Psychoactive Substances

It is extremely important that all persons involved in aviation activities not be impaired in any manner. Therefore, flight department personnel shall not at any time be under the influence of any psychoactive substance that might in any way limit their ability to perform their duties in a safe and effective manner.

Aircraft crew and maintenance personnel shall not consume any alcoholic beverage within eight hours and no excessive consumption within 12 hours prior to reporting for duty and shall not use any drug or medication that may impair the person's ability to perform their duties.

1.18 Additional Information

1.18.1 Witness statements

Maintenance Specialists

A maintenance specialist who worked at another company and knew the pilot well, stated as follows:

Having flown a fair amount in the Kodiak, I was very surprised by the result as the Kodiak is not known as a poor takeoff performer. I immediately thought he must have been way overloaded, or had an engine problem. The EPL being un-stowed was not too significant in my mind because that could have been a last ditch desperate effort to get some more engine power wondering if it wasn't making full power.

Something significant that was brought to my attention later in the day was the no flap takeoff performance is noticeably longer than with the typical 20 degrees of flaps on takeoff. Also I heard our organization has tested Kodiak performance out of Doyo Baru, and since we have a policy that liftoff must be attained in 75 percent of the airstrip, we had to limit our load to ¾ load to achieve that. If a full load was being carried, or even perhaps a bit over loaded accidentally, and the pilot forgot the flaps and did a no flap takeoff, that combination could combine for the failure to climb out that was seen.

My last conversation with the pilot who perished in the accident was about a week ago. He came into our hangar and was inquiring about the new gross weight increase that was being approved. He was mentioning the price of the paperwork was more than he expected or that we said we had to pay for ours. I was busy working so I didn't talk to him long about that but I just told him our chief of maintenance could probably tell him all about it. He also told me a fair amount about the new batteries he was trying in his Kodiak that were supposed to be less expensive and last longer.

After we left the crash and went to the Adventist hangar to talk with some of the staff there, somebody there let us know (I don't remember exactly but I think it was 750) kilos were on board. I believe a copy of that load manifest was obtained.

Another pilot statement

A pilot who knew the pilot well and had experienced to fly together with the pilot stated that the pilot forgot to select the flap prior to takeoff several times.

Management personnel statement

The management personnel, one the Director Board Management sub-ordinate, stated that the pilot of the accident flight, who also the Director Board Management, also took control of the all management decision in relation to aircraft operation and maintenance. Most of his sub-ordinate did not have the full management control of their responsibilities.

Security statement

There was a road cross the Doyo Baru airstrip to provide access to the local people. Security guard stands by the cross road to prevent vehicle movement during aircraft movement. The security personnel stated that:

Normally a Kodiak 100 aircraft while takeoff at Doyo Baru airstrip would be airborne, after passing the cross road. This accident flight, he saw that the aircraft did not lift off after passing cross road and suspected that something might have happened.

1.18.2 Aircraft procedure

Pilot Operating Handbook, Chapter 4 page 4.28

Prior to takeoff, move the fuel condition lever forward to the HIGH IDLE position. Leave the fuel condition level in this position until after landing. The HIGH IDLE gas generator speeds allow for faster engine acceleration when adding power from an idle condition.

Takeoff Wing Flap Setting **(Pilot Operating Handbook, Chapter 4 page 4.29)**

A flap setting of 20° is recommended for all takeoffs unless a strong crosswind is present, in which case 10° of flap may be preferred. The use of 20° of flap is recommended due to the decreased takeoff roll, lower liftoff speed and a decrease in the total distance to clear obstacles (compared to using 10° of flaps).

A flap setting of greater than 20° is not recommended for takeoff use, due to the increased drag with the flaps deflected to 35°.

Short Field Takeoff

If obstacles dictate the use of a steep climb angle after liftoff, accelerate to and climb out at 73 KIAS with 20° of flaps. The takeoff performance data outlined in "Section 5" of this manual based on this speed and configuration.

After clearing the obstacles, and reaching a safe operating altitude, the flap gradually retracted as the airplane accelerates to the normal climb-out speed.

Minimum ground roll (soft field) takeoffs are accomplished by using 20° of flaps, lifting the nose wheel of the ground as soon as practical, and lifting off of the ground in the a slightly tail low altitude. Once the airplane is airborne, the nose should be lowered and the airplane accelerated in ground effect to a safe climb speed.

1.18.3 Rejected Take-Off

As simple method in determining the distance of rejected take-off for an aircraft such as in this example is Kodiak -100.

<u>Investigation calculations:</u>

V0 = speed of the aircraft when the pilot decide to RTO = 65 knot = 33.44 m/sec (in this aircraft can be assumed as VR).

t = specified time required action = 4 – 6 seconds

w = the aircraft taxy weight = 7289 lbs = 3306.23 kg

- Thrust reverser is not used
- Braking action is not define
- Runway friction is not define

The momentum of the aircraft is

$p = m \,.\, v$

$p = 3306.23 \times 33.44$

$p = 110560.33$ kg m/sec

The force required to move the aircraft in 6 sec is

$\Delta F = \Delta p : \Delta t$

$\Delta F = 110560.33 : 6$

$\Delta F = 18426.72$ N

The kinetic energy to move the aircraft with the speed of 33.44 m/sec is

$Ek = \frac{1}{2}\, m\, v^2$ (Joule)

$$Ek = 0.5 \times 3306.23 \times 33.44^2$$

$$Ek = 1848568.74 \text{ Joule}$$

The energy is also can be represented by the force required to move object in specific distance or

$$W = \Delta Ek = F.s \text{ (Joule)}$$

Converting the energy to move the aircraft with existing kinetic energy (Ek) with the change of momentum Δp within 6 seconds, therefore the distance traveled of the aircraft is

$$W = F \times s$$

$$s = 1848568.74 : 18426.72$$

$$s = 100.32 \text{ m}$$

(This calculation is not include the braking action and thrust reverse).

1.18.4 Take off Performance Table

The takeoff performance table available in the Airplane Information Manual (AIM) was based on flap 20° configuration. There was no takeoff performance for flap 0 and 10° configuration. The KNKT requested several data to the aircraft manufacturer.

The aircraft manufacturer stated:

Since no flight test data exists for the specific takeoff conditions requested, estimations of the takeoff performance were generated using a physics-based takeoff simulation. This simulation was validated by comparing the dry pavement results for sea level conditions at a takeoff weight of 7255 lb, and temperatures of 15° C and 30° C to the numbers published in the KODIAK® flight manual for aircraft with an external cargo compartment. The simulation was then run at the desired conditions with the desired flap settings. The following table contains the requested data:

T/O Wt (lb)	Flaps (deg)	Press Alt (ft)	Temp (°C)	Headwind (kts)	Ground Roll (ft)
7389	10	499	28	0	1626
7389	10	499	28	5	1438
7389	10	499	28	10	1262
7389	0	499	28	0	2154
7389	0	499	28	5	1936
7389	0	499	28	10	1726

Table 3: Estimated Grass Field Takeoff Ground Roll

The POH did not describe the required Accelerate Stop Distance (ASD) or the required distance in case the take-off is rejected.

The investigation examined the probable result if the pilot had rejected the takeoff at the VR (at maximum Rotation Speed) at approximately 65 knots.

Based on calculation stated on the chapter 1.6.4 of this report, it can be determined the required ground roll and distance to clear obstacle at 50 feet. The interpolation of the table for the existing takeoff condition (temperature 28°C and aerodrome elevation 350 ft) found that, the required ground roll would be 1102 feet or 336 m and to reach at 50 feet clear obstacle would be 1816 feet or 553 m.

Based on the calculation of the assumed conditions, the investigation predicted the distance required for the aircraft to accelerate to VR (65 knots) would be approximately 336 m or 1102 feet. The predicted distance for the aircraft to stop from 65 knot speed would be approximately 100 m (see calculation on 1.18.3).

The Accelerate Stop Distance or the total distance for the aircraft from stand still position to accelerate to 65 knot and to stop from that point in case of the takeoff was rejected, was predicted 336m + 100m = 436 m.

1.18.5 Emergency Power Lever

The descriptions related to the Emergency Power Lever (EPL) refer to Pilot Operation Handbook Chapter 7, page 7-77, stated as follows:

The emergency power lever is connected , through linkages, to the manual override lever on the fuel control unit and allows manual governing of the engine fuel flow should a malfunction occur in the fuel control unit's pneumatic governing system.

When the engine operating, a failure of an control unit pneumatic governing signal input will result in the fuel flow decreasing to minimum idle (approximately 48% NG at sea level and increasing with altitude). The emergency power lever allows restoration of engine power in the event of such a failure. NORMAL and MAX positions are provided for the emergency power lever. The NORMAL position is used for all normal engine operations when the fuel control unit is functioning normally and engine power is selected through the power lever. The range from NORMAL to MAX governs engine power and is used when a malfunction has occurred in the pneumatic governing system of the fuel control unit and the power lever ineffective. A mechanical stop in the lever slot requires that the emergency power lever be moved to the left to clear the stop before it can be moved forward, out of the normal (full aft) position, and into the override positions.

CAUTION: The emergency power lever/ manual override system is considered an emergency system and should only be used in the event of a fuel control unit governing malfunction. When attempting a normal start, ensure the emergency power lever is in the NORMAL (full aft) position; otherwise, an over-temperature (hot-start) condition may result.

CAUTION: when the fuel control manual override system is in use, engine response may be more rapid compared to using the normal power lever. Additional care should be taken during engine acceleration to avoid exceeding the engine limitations

NOTE: when using the emergency power lever, 100 % power may not be obtainable

NOTE: The **EMER PWR LVR** annunciator will illuminate whenever the lever is not stowed in its NORMAL position. This precaution is provided to prevent starting the engine with the emergency power lever inadvertently placed in any positions other than NORMAL.

1.18.6 The flaps mechanism

There were four screw-jacks of the wing flaps, two screw jacks for each wing. Screw jack uses to extend and retract wing flap surface. The wing flap system equipped asymmetry protection system. The asymmetry sensors are installed on both outboard flap actuators. Whenever wing flap asymmetry reaches 0.20 inches, the flap movement will be stopped by the pop out Brushless Direct Current (BLDC)[1] circuit breaker and must be reset by the maintenance personnel on ground.

Refer to the table provided by the manufacturer, the following table contain information of the cross reference of flap angle, the length of flap screw jack extension and wing flap travel time.

Flap Angle	Distance from Flap Horn ("eye") to Spar Mount Plate	
	Inches	Centimeters
0	4.041	10.26
3	5.786	14.70
7	8.152	20.71
10	9.602	24.39
20	11.973	30.41
30 (rigging point)	13.356	35.92
35	13.851	35.18

Table 4: Wing flap operation table

[1] Brushless Direct Current (BLDC) is a type of motor which is used to drive the flap motor in Kodiak 100

Flap Angle	Transit Time (seconds)
0 – 10	6.8
10 – 20	2.9
20 – 35	2.2
0 – 35	11.8
35 – 0	11.9

Table 5: Wing flap transit time

1.18.7 Metalurgy examination of the engine part

The objectives of the metalurgy inspection are to observe the conditions of the parts, leading to factual data to support the analysis of the accident investigation.

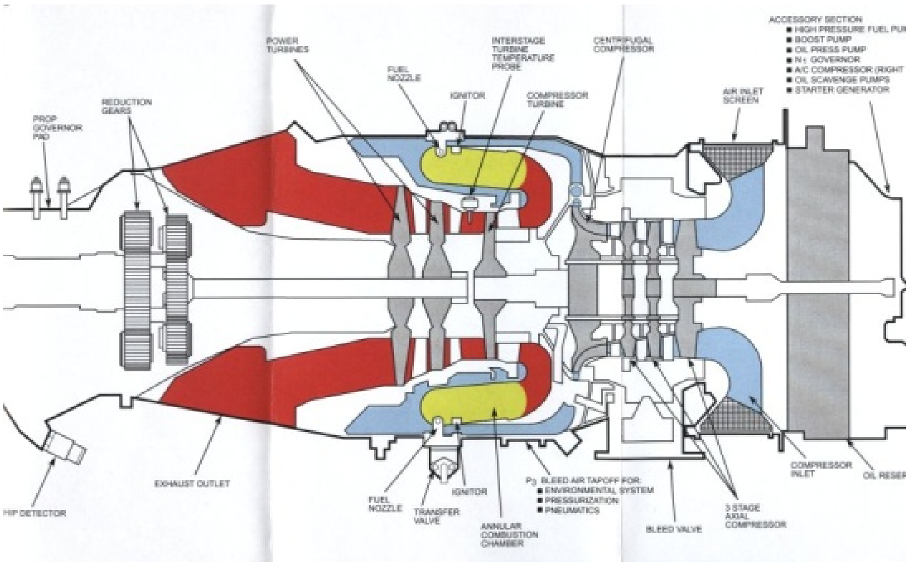


Figure 13: Diagram of the engine

1. Observation on Engine Parts

- **Power Turbine vane casing**

  Metal deposits were found on the Power Turbine (PT) vane casing. The origin of metal deposits was from the molten parts of the compressor turbine (CT) blades which were located up-stream.

- **Compressor Turbine (CT)**

  All blades of the compressor turbine (CT) were found broken (Fig.14). Coating materials near the broken surface peeled off.

Figure 14: Broken blades of the compressor turbine

The broken surfaces of the CT blades orientated in the tangential place, or almost at right angle to the radial direction. It indicated that the centrifugal stresses on the CT blades had exceeded the strength due to over temperature operation. To observe the thermal damage of the blades, a metallographic examination was performed.

- **Power Turbine:**

  All blades of the power turbine were broken with deformation. (Figure.15)

Figure 15: Broken and deformed PT blades

The damages indicated that the PT blades were impacted by other parts.

2. Metallographic Observation Data:

- **Power Turbine blades**

A series of micrographs were taken from the blade root to near the broken location (shown on Fig.16).

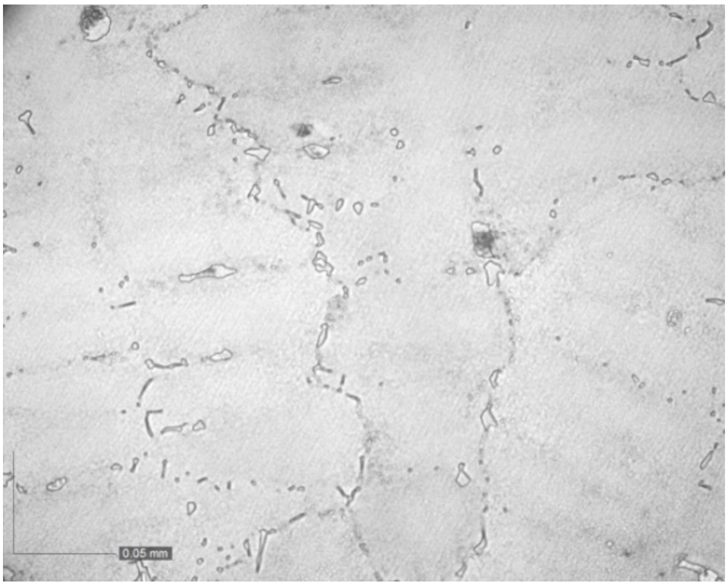


Figure 16: Microstructure at a distance from the root

The microstructure was similar to the one at the blade root.

Remarks on the power turbine micrographs:

The microstructures of the PT blade are quite similar from the root to the broken edge. The damages were due to impacts with metallic CT blade debris, as well as impacts with the PT vane casing at the time of aircraft impact.

- **Compressor Turbine blades:**

The metallographic samples of the broken Compressor Turbine (CT) blades are shown in figure 17.

A series of micrographs were taken from the blade root moving to the broken edge.

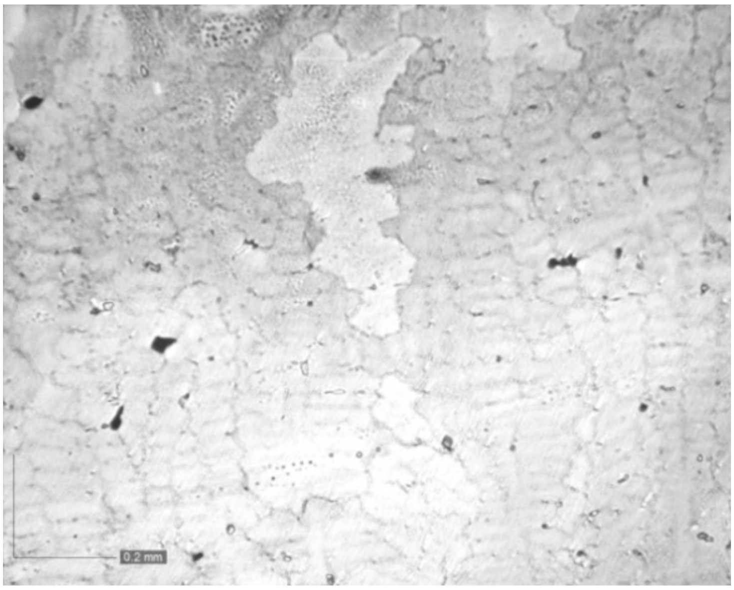


Figure 17: Relative intact microstructure near the CT blade root

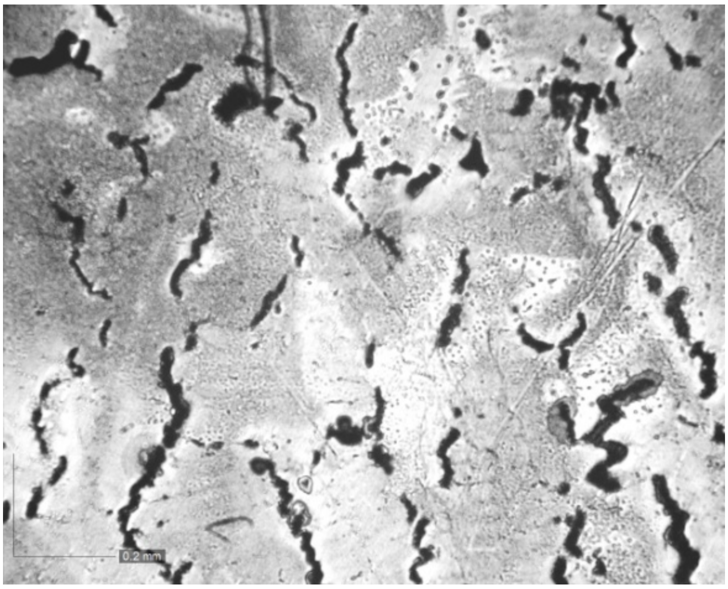


Figure 18: Grain boundaries melted down and cracked approximately in the tangential plane

Remarks on the compressor turbine micrographs:

Molten grain boundaries were found near the broken edge. It shows that the CT blade damages were due to over temperature. The microstructure at the root was still intact, showing no melted grain boundary. Nearing the broken edge, more grain boundaries were melted. It shows that the over-temperature was excessive and occurred at short time (in seconds).

1.18.8 Flap transit time

The flap transit time based on the KODIAK® report is as follows:

Flap Angle Transition (degrees)	Transit Time (seconds)
0 - 10	6.8
10 - 20	2.9
20 - 35	2.2
0 - 35	11.8
35 - 0	11.9

Table 6: Table flaps transit time

1.19 Useful or Effective Investigation Techniques

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

2 ANALYSIS

The analysis part of this Final Report will discuss the relevant issues resulting in the runway excursion involving a KODIAK-100 aircraft, registered PK-SDF, as non-schedule flight at Doyo Baru Airstrip on 9 April 2014.

The investigation determined that there were no issues with the aircraft and all systems were operating normally. The analysis will therefore focus on the following issues:

1. Failure for takeoff.
2. Engine overheats.
3. Human performance.
4. Alternative decision for rejected takeoff.

2.1 Failure for Takeoff

The aircraft failed to airborne during takeoff runway 30 and impacted to terrain on the takeoff area. It indicated by several impact marks found on the runway extension and stopped at 30 meters from the end of the runway. The probability of failure to airborne might due to over load or insufficient lift produce by the wings.

2.1.1 Load analysis

The evaluation on the takeoff weight described in chapter 1.6.4 of this report showed that the aircraft was takeoff on maximum certified takeoff weight. It can be concluded that the overload was not issue of the failure to airborne.

2.1.2 Lift analysis

The other possibility of failure for takeoff was insufficient lift produced by the wing.

The examination of the wing flap screw jack found that 3 of 4 screw jacks travel relatively equal of 14.5 cm. There was no asymmetrical flap condition suspected. The measurement on a serviceable aircraft found that 14.5 cm extension of wing flap screw jack was equal to the wing flap extension of 5° or 6°.

The Pilot Operating Handbook, Chapter 4 page 4.29 on title Takeoff Wing Flap Setting stated:

A flap setting of 20° is recommended for all takeoff unless a strong crosswind is present, in which case 10° of flap may be preferred. The use of 20° of flap is recommended due to the decreased takeoff roll, lower liftoff speed and a decrease in the total distance to clear obstacles (compared to using 10° of flaps).

A flap setting of greater than 20° is not recommended for takeoff use, due to the increased drag with the flaps deflected to 35°.

The Pilot Operating Handbook did not state takeoff performance with flap less than 10°. The data provided by KODIAK® for takeoff with configuration of wing flap 0 or 10° for the existing temperature, elevation and takeoff weight with variation of wind condition stated:

T/O Wt (lb)	Flaps (deg)	Press Alt (ft)	Temp (°C)	Headwind (kts)	Ground Roll (ft)
7389	10	499	28	0	1626
7389	10	499	28	5	1438
7389	10	499	28	10	1262
7389	0	499	28	0	2154
7389	0	499	28	5	1936
7389	0	499	28	10	1726
Based on the data above can be interpolated to determine the required ground roll with head wind 7 knots					
7389	10	499	28	7	1350
7389	0	499	28	7	1831
Based on the interpolated data above can be interpolated to determine the required ground roll with head wind 7 knots for flap 5° configuration.					
7389	5	499	28	7	1590

The existing conditions during takeoff were; temperature 28°C, head wind component was 7 knots, wing flap 5° and runway length 520 m (1706 feet).

Interpolation of takeoff performance calculation based on the existing condition concluded that required ground roll was 1590 feet. This calculation was assumed the takeoff was on flap 5° configuration from the initial takeoff roll.

Other evidence found on the accident site was the flap lever selector on full down position. This can be predicted that during the impact, the flap was travelling toward full down position it indicated by the BLDC did not popped out.

The information provided by KODIAK® stated that the travel time of the wing flap from 0 to 10° was 6.8 seconds. There was no information the travel time of the wing flap from 0 to 5°. It can be assumed that the travel time was approximately 4 seconds, therefore it can be predicted that the flap was selected approximately 4 seconds prior to the impact.

The takeoff performance of the KODIAK-100 refer to the Pilot Operation Handbook stated that the rotation speed was 60 knot and the 50 foot obstacle speed was 73 knot for takeoff with 20° flap configuration. During the accident the flap was less than 20° hence the speed might be greater than 73 knot.

Assumed that the aircraft speed was 75 knot and flaps travel time from 0 to 5° was 4 seconds, the position of initial flap selection was at 155 meter prior to impact point. Refer to the data that the first impact point was 30 meter from the end of the runway; hence the initial wing flap selection was approximately 125 meter before the end of the runway or at 419 meter (1375 feet) from the beginning runway (runway length based on the measurement stated on the figure 2 of this report).

The interpolation of data based on the existing condition found that takeoff ground roll required for takeoff with flap 0 was 1831 feet and 1590 feet for takeoff with 5°. The aircraft might have been airborne if the flap was selected to 5° since the runway length was 1706 feet. The other evidence predicted that the flap was selected approximately 419 meters (1375 feet) from the beginning runway.

This can be concluded that the failure for airborne was due to delay on the wing flap selection up to approximately 1375 feet from the beginning runway.

2.1.3 Alternative decision for rejected takeoff

The POH did not describe the required Accelerate Stop Distance (ASD) or the required distance in case the take-off was rejected.

The investigation examined the probable result if the pilot rejected the takeoff at the VR (at maximum Rotation Speed) at approximately 65 knots.

Based on which table, in can be determined the ground roll and distance to clear obstacle at 50 feet. The interpolation of the table for the existing takeoff condition it found that, the required ground roll would be 336 m or 1102 feet and to reach at 50 feet clear obstacle would be 553 m or 1816 feet.

As described in 1.18.6 using a simple method of rejected take-off calculation, the distance if the take-off rejected at VR speed would be approximately 100 m.

Therefore the total stop distance in case the alternative decision was selected by the pilot will be 336 m (ground roll) plus 100 m resulted 436 m or it was similar to the remaining runway length available of 84 m, which the aircraft will still on the runway.

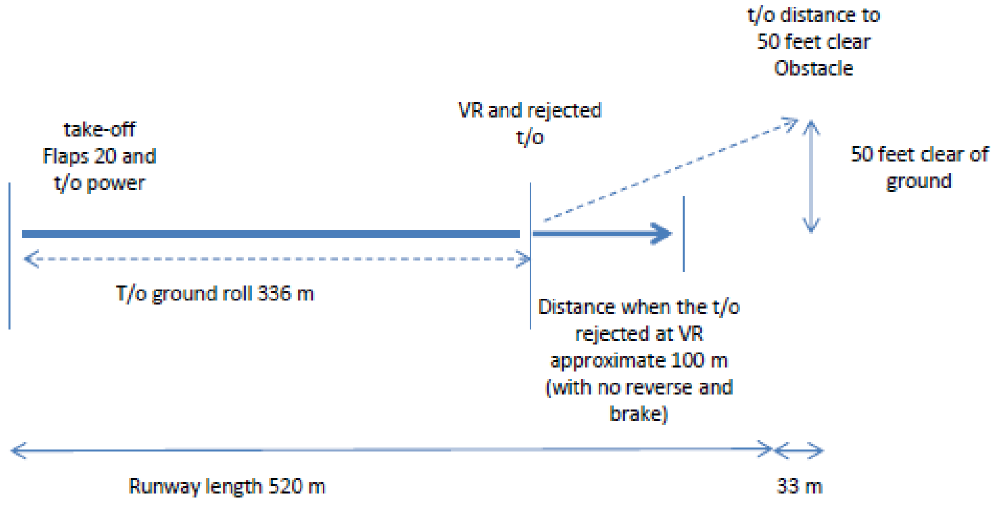


Figure 19: RTO and T/O illustration refer to the performance calculation.

Based on the calculation of the assumed conditions, the investigation predicted the distance required for the aircraft to accelerate to VR (65 knots) would be approximately 336 m or 1102 feet. The predicted distance for the aircraft to stop from 65 knot speed would be approximately 100 m. The Accelerate Stop Distance (ASD) required or the total distance for the aircraft from stand still position to accelerate to 65 knot and to stop from that point in the case the takeoff was rejected, the predicted ASD required will be 336 m + 100 m = 436 m. Assumed that additional effort such as wheel brake and thrust reverser application, the ASD required would be reduced.

2.2 Engine overheat

The examination of the engine found Compressor Turbine (CT) blades damage. The damage of the CT blades was caused by exceeded the strength due to over temperature operation. A metallographic examination was performed and concluded that the over-temperature was excessive and occurred at short time.

There was no pilot report related to engine over-temperature or malfunction on the previous flights.

On the accident site found the Emergency Power Lever (EPL) was on full forward position. The significant descriptions of the Emergency Power Lever (EPL) in the Pilot Operation Handbook are as follows:

The emergency power lever is provided for the manual override lever on the fuel control unit and allows manual governing of the engine fuel flow should a malfunction occur in the fuel control unit's pneumatic governing system.

CAUTION: The emergency power lever/ manual override system is considered an emergency system and should only be used in the event of a fuel control unit governing malfunction. When attempting a normal start, ensure the emergency power lever is in the NORMAL (full aft) position; otherwise, an over-temperature (hot-start) condition may result.

This can be concluded that the EPL is provided as a backup system in case of failure on fuel control unit. The operation of EPL when the fuel control unit functioning normally will provide additional fuel to the engine and may become excessive fuel leads to engine over-temperature.

On takeoff, the fuel supply to the engine is provided by fuel control unit which selected through power lever in almost maximum to produce sufficient power for takeoff. Operation of EPL during takeoff power operation may cause an over-temperature condition.

The findings of no engine malfunction reported from the previous flights, the Emergency Power Lever found on full forward position and metallographic examination concluded that the over-temperature was excessive and occurred at short time this might due to the EPL was selected during the takeoff roll.

The pilot decision to select the EPL during the takeoff roll might due to the pilot assessment that the aircraft did not airborne normally. The operation of EPL intended to provide additional engine power. The pilot also selected the wing flap lever to full down position intended to increase the wing lift. These actions were intended to make the aircraft airborne immediately.

It can be concluded that the engine overheat was due to the operation of EPL during the takeoff roll which intended to provide additional power to make the aircraft airborne immediately.

2.3 Human Performance

The pilot had 1.752 flight hours on Kodiak-100 and total more than 25 thousand hours flight experience. The pilot had been employed by PT. Adventist Aviation Indonesia, and had routine duty for non-schedule flights from Doyo Baru to several airports in Papua. The pilot was an American and lived in Doyo Baru and had lived in Papua for more than 22 years.

Observation on the pilot documents found that the pilot conducted the class two medical examination on 14 March 2014 and valid until 21 September 2014.

Refers to the personal information stated above, the investigation believed that the pilots was medically fit and had sufficient familiarization time and experience for such airport as well as to fly the aircraft.

The Pilot Operating Handbook, Chapter 4 stated that the wing flap shall be selected at the beginning of the take-off runway. The analysis 2.1 predicted that the wing flap was selected at approximately 419 meters from the beginning runway, it equivalent with 101 m remaining runway length available. Therefore the operation analysis concluded that the take-off flap selection was not according to the POH.

Engine analysis on 2.2 indicated that the Emergency Power Lever found on full forward position and metallographic examination concluded that the over-temperature was excessive and occurred at short time indicated that the EPL (Emergency Power Lever) was selected during the takeoff roll, which according the POH the selection of EPL allowed only if the Fuel Control Unit malfunctions.

The two analysis stated above suggest that the pilot might have realized that the aircraft unable to lift off after passed the point where the aircraft normally lift off, where according to the witness statement was approximately passed the cross road. The statement of a pilot who knew the pilot well, and had experienced fly together with the pilot stated that the pilot forgot to select the flap prior to takeoff several times.

The review of the management revealed that the pilot who was also the Director of Board Management took control of the all management decision in relation to aircraft operation and maintenance. This might have affected the pilot workload of management task and flying the aircraft. This condition where all management decision was controlled by the Director of Board Management might also affect to the Chief Pilot or the Flight Department Manager unable to oversight the professional standards of the pilot in order to maintain the safe operation.

The delay of flap selection might indicate the pilot forgotten to select the flap prior to takeoff.

3 CONCLUSIONS

3.1 Findings

1. The aircraft was airworthy prior to this occurrence and was operated under a correct weight and balance envelope.
2. The pilot had valid Indonesia PPL and American ATP Licenses and class one medical certificates and had 1.752 flight hours on Kodiak-100 and total more than 25 thousand hours flight experience.
3. The aircraft failed to airborne and impacted with several objects prior to stop at 30 meters from the end of runway.
4. Two occupants including the pilot were fatally injured and five other occupants seriously injured.
5. The aircraft was substantially damage. The nose section was damaged after consumed by post impact fire. The landing gear and the wing were detached from the main wreckage. The passenger cabin relatively intact
6. The conditions during takeoff were; temperature 28°C, head wind component 7 knots.
7. Wreckage examination found, the wing flap selector was on position 35 (full down), 3 flap screw jacks extended relatively equal at 14.5 cm, flaps physically did not extend, and the Emergency Power Lever and power lever on full forward position.
8. The extension of the wing flap screw jack of 14.5 cm equal to the wing flap position at 5° or 6° position and no asymmetry.
9. The Kodiak 100 on takeoff at Doyo Baru airstrip normally lift off after passing the cross road which did not occurred on this accident flight.
10. The data calculation based on the existing condition found that the aircraft might have been airborne if the flap was selected to 5° since the beginning takeoff roll with available runway length.
11. There was post impact fire and was extinguished by two bottles of fire extinguisher and assisted by local people by throwing water to the engine.
12. Pathological examination found alcohol on the urine and gastric equal to 40mg%, which could not be determined the source from alcohol consumption or production of post-mortem. No drug was found.
13. The examination of the engine found Compressor Turbine (CT) blades damage caused by exceeded the strength due to excessive over temperature operation and occurred at short time (seconds).

14. Investigation concluded that the failure for airborne was due to delay on the wing flap selection up to approximately 1375 feet from the beginning runway.
15. The operation of Emergency Power Lever (EPL) during the takeoff roll might due to the pilot assessment that the aircraft did not airborne normally and pilot intended to add more engine power.

3.2 Contributing Factors[2]

1. The failure to airborne was due to the aircraft was not in correct takeoff configuration which required wing flap 20° while the flap was found at approximately 6° position during impact.
2. The actions to recover the situation by selection of emergency power and flap were not proper for particular condition.

2 "Contributing Factors" is defined as events that might cause the occurrence. In the case that the event did not occur then the accident might not happen or result in a less severe occurrence.

4 SAFETY ACTION

At the time of issuing this final investigation report, the Komite Nasional Keselamatan Transportasi (KNKT) has been informed safety actions as result from this accident.

4.1 PT. Adventist Aviation Indonesia

The Adventist Aviation Indonesia has performed several safety actions as follows:

1. Installed a Close Circuit Television (CCTV) near the Doyo Baru runway to monitor the aircraft and pilot behavior on takeoff.
2. Improve runway condition to prevent standing water during and after raining;
3. Stop all activities and movement of people or vehicle prior aircraft takeoff and landing including closed the cross road and make new access on the east side.
4. Restrict pilot to fly if he/she feel unfit (stress/problem);
5. Controlling the aircraft operation and loading unloading process by restrict unauthorized personnel.
6. Routine meeting (twice a month) to discuss the improvement for all pilot, mechanic, ground handling and administrative staff.
7. Direct observation by the head of Adventist Aviation Indonesia (AAI) of South Asia Pacific Division, the head of uni-conference east area and the head of local board AAI Papua and will conduct regular meeting 3 times a year to discuss all operation system.

4.2 Directorate General of Civil Aviation (DGCA)

The Directorate General Civil Aviation (DGCA) informed KNKT refer to DGCA letter number 252/DKUPPU/DIR/1/2015 dated 27 January 2015 that The DGCA will review the effectiveness of operator’s Take off checklist procedure including proper implementation of recommendations chapter 5.1 and 5.2.

5 SAFETY RECOMMENDATIONS

The investigation identified safety issues contributed to this occurrence was associated with the operational procedures related to wing flaps selection and improper corrective action while on takeoff-roll.

The recommendations issued in this final report are based on the safety issues as described on findings and analysis chapter. Some of the findings which was clearly known and classified as hazards did not analyse in this report, however the operators shall consider that the condition might possibly and need to be extended to other pilots and related operators for the future of overall safety improvement.

Concerning to the safety issues identified in this investigation, the Komite Nasional Keselamatan Transportasi issued several safety recommendations intended for the safety improvement and addressed to;

5.1 PT. Adventist Aviation Indonesia

To review specifically of the effectiveness of the implementation of Before Takeoff Check List procedure and might be extended to the implementation of overall company procedures.

5.2 Doyo Baru Airport Authority

The investigation did not find any evidence that there was sufficient firefighting and system involved at the crash site in time. As such the KNKT recommends, the Doyo Baru airport authority shall review the current availability and adequacy of firefighting equipment and system as part of the airport emergency response plan according to the type of aircraft operates.

5.3 Directorate General of Civil Aviation (DGCA)

Refer to the ICAO Annex 19 sub chapter 7, that the DGCA shall implement documented surveillance processes, by defining and planning inspections, audits, and monitoring activities on a continuous basis.

Therefore the KNKT recommends to proactively oversight to ensure that the recommendations issued in this final report were implemented correctly by the addressee and other related operators.