



**KOMITE NASIONAL KESELAMATAN TRANSPORTASI
REPUBLIC OF INDONESIA**

FINAL

KNKT.16.09.27.04

Aircraft Accident Investigation Report

**PT. Trigana Air Services
Boeing 737-300F; PK-YSY
Wamena Airport, Papua
Republic of Indonesia
13 September 2016**

2020

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

The report is based upon the initial 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).

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Jakarta, 9 July 2020

**KOMITE NASIONAL
KESELAMATAN TRANSPORTASI
CHAIRMAN**



SOERJANTO TJAHJONO

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ABBREVIATIONS AND DEFINITIONS

AFE	:	Above Field Elevation
ATC	:	Air Traffic Control
ATPL	:	Airline Transport Pilot License
ATS	:	Air Traffic Services
BMKG	:	<i>Badan Meteorologi Klimatologi dan Geofisika</i> (Bureau of Meteorology, Climatology and Geophysics)
C of A	:	Certificate of Airworthiness
C of R	:	Certificate of Registration
CASR	:	Civil Aviation Safety Regulation
CPL	:	Commercial Pilot License
CVR	:	Cockpit Voice Recorder
EGPWS	:	Enhanced Ground Proximity Warning System
FCTM	:	Flight Crew Training Manual
FCOM	:	Flight Crew Operating Manual
FDR	:	Flight Data Recorder
FL	:	Flight Level
FMA	:	Flight Mode Annunciator
FOO	:	Flight Operation Officer
g	:	Gravitational Force
kg	:	Kilogram
km	:	Kilometer
KNKT	:	<i>Komite Nasional Keselamatan Transportasi</i>
lbs	:	Libra (ancient Roman unit) Identical standard of mass to the pound
LDW	:	Landing weight
MAC	:	Mean Aerodynamic Chord
MCT	:	Maximum Continuous Thrust
Nm	:	Nautical Mile
NNC	:	Non-Normal Checklist
PBN	:	Performance Based Navigation
PF	:	Pilot Flying
PIC	:	Pilot in Command
PM	:	Pilot Monitoring
RNAV	:	Area Navigation
RPM	:	Revolutions Per Minutes
SIC	:	Second in Command
TOW	:	Takeoff weight

UTC : Universal Time Coordinated
VASI : Visual Approach Slope Indicator
VFR : Visual Flight Rules
VMC : Visual Meteorological Condition

SYNOPSIS

On 13 September 2016, a Boeing 737-300 Freighter, registered PK-YSY was being operated by PT. Trigana Air Service on a scheduled cargo flight from Sentani Airport, Jayapura (WAJJ) to Wamena Airport, Wamena (WAVV), Papua, Indonesia. On board the aircraft were two pilots and one Flight Operation Officer (FOO) as a loadmaster. The flight carried 14,913 kg of cargo.

The aircraft cruised at altitude 18,000 feet and prior to descend, the pilot observed the weather within the criteria of Visual Meteorological Condition (VMC). The pilots able to identify the other Trigana flight from Sentani to Wamena in front of them.

The aircraft make orbit in point X which located at 8 Nm from runway 15 to provide separation with the aircraft ahead. The aircraft was on sequence number three for landing.

The aircraft ahead safely landed and made the pilot confidence that safe landing would be able to be made on the existing weather condition.

About 2,000 feet above airport elevation, the descend approach continued while the weather did not meet the visual minima. The pilot reduced the rate of descend twice during the descend approach.

About 1,000 feet above airport elevation, the PM informed to the PF that runway was not in sight and advised to go around. About 500 feet above airport elevation, the PF was able to see the runway and increased the rate of descend. The pilot noticed that the Enhanced Ground Proximity Warning System (EGPWS) aural warning "SINK RATE" active.

The aircraft touched down approximately 125 meters from the beginning runway 15 with vertical acceleration of 3.25 g, the aircraft speed 137 knots, pitch 7° up and roll to the left 5°. The calculation of FDR data showed that the rate of descend prior to touch down was 2,300 feet/minute which was greater than the requirement described on the CASR Part 25.473

Several indications of weather below the visual approach minima, un-stabilized approach, the PM suggestion to go around, EGPWS warning, and absence of landing clearance did not make the pilot decided to go around. The pilot was sure that he could land the aircraft as the previous flight landed safely.

The investigation concluded that the contributing factors to the accident was refer to the previous aircraft that was landed safely, the pilot confidence that a safe landing could be made and disregarding several conditions required for go around

Following the accident, the aircraft operator had taken several safety actions. The Komite Nasional Keselamatan Transportasi (KNKT) acknowledged the safety actions taken by the aircraft operator and considered relevant to prevent similar occurrence. However, KNKT identify other safety issues required to be considered and issued safety recommendations to aircraft operator.

1 FACTUAL INFORMATION

1.1 History of the Flight

On 13 September 2016, a Boeing 737-300 Freighter, registered PK-YSY was being operated by PT. Trigana Air Service on a scheduled cargo flight from Sentani Airport, Jayapura (WAJJ) to Wamena Airport¹, Wamena (WAVV), Papua, Indonesia.

Approximately 2130 UTC², during the flight preparation, the pilot received weather information which stated that on the right base runway 15 of Wamena Airport, on the area of Mount Pikei, low cloud was observed with the cloud base was increasing from 200 to 1000 feet and the visibility was 3 km.

At 2145 UTC, the aircraft departed Sentani Airport with flight number IL 7321 and cruised at altitude 18,000 feet. On board the aircraft was two pilots and one Flight Operation Officer (FOO) acted as loadmaster. The aircraft carried 14,913 kg of cargo. The Pilot in Command (PIC) acted as Pilot Flying (PF) while the Second in Command (SIC) acted as Pilot Monitoring (PM). There was no reported or recorded aircraft system abnormality during the flight until the time of occurrence.

After passing point MALIO, the aircraft started to descend. The pilot observed the weather met the criteria of Visual Meteorological Condition (VMC). The pilots able to identify another Trigana flight from Sentani to Wamena in front of them. While passing altitude 13,500 feet, approximately over PASS VALLEY, the Wamena Tower controller instructed the pilot to report position over JIWIKA.

When the aircraft position was over point JIWIKA, the Wamena Tower controller informed to the pilot that the flight was on sequence number three for landing and instructed the pilot to make orbit over point X, which located at 8 Nm from runway 15.

The pilot made two orbits over Point X to make adequate separation with the aircraft ahead prior to received approach clearance. About 7,000 feet (about 2,000 feet above airport elevation), the pilot could not identify visual checkpoint mount PIKEI and attempted to identify a church which was a check point of right base runway 15. The pilot felt that the aircraft position was on right side of runway centerline.

About 6,200 feet (about 1,000 feet above airport elevation), the PF reduced the rate of descend and continued the approach. The PM informed to the PF that runway was not in sight and advised to go around. The PF was confident that the aircraft could be landed safely as the aircraft ahead had landed.

Approximately 5,600 feet altitude (about 500 feet above airport elevation) and about 2 Nm from runway threshold the PF was able to see the runway and increased the rate of descend. The pilot noticed that the Enhanced Ground Proximity Warning System (EGPWS) aural warning "SINK RATE" active and the PF reduced the rate of descend. While the aircraft passing threshold, the pilot felt the aircraft sunk and touched down at approximately 125 meters from the beginning runway 15. The

¹ Wamena Airport (WAWW) Papua, Indonesia will be named Wamena for the purpose of this report.

² The 24-hours clock in Universal Time Coordinated (UTC) is used in this report to describe the local time as specific events occurred. Local time is UTC+9 hours.

Flight Data Recorder recorded the vertical acceleration was 3.25 g on touchdown at 2230 UTC.

Both of main landings gear collapsed. The left main landing gear detached and found on runway. The engine and lower fuselage contacted to the runway surface. The aircraft veer to the right and stopped approximately 1,890 meters from the beginning of the runway 15.

No one was injured on this occurrence and the aircraft had substantially damage. Both pilots and the load master evacuated the aircraft via the forward left main cargo door used a rope.



Figure 1: The aircraft final position

1.2 Injuries to Persons

Injuries	Flight crew	Other Crew	Total in Aircraft	Others
Fatal	-	-	-	-
Serious	-	-	-	-
Minor/None	2	1	3	-
TOTAL	2	1	3	-

1.3 Damage to Aircraft

The aircraft was substantially damaged, mostly on the lower part of the fuselage that contacted to the runway after both main landing gears failure. The detail of the damages was as follow:

- Both of main landing gears collapsed with the left main landing gear including the landing gear strut detached and the right main landing gear strut broken;
- Nose wheel broken;
- Tire number 2 blown out;

- Both inner flaps broken;
- Left engine cowling detached;
- Leading edge of right horizontal stabilizer dent and the lower skin of right horizontal stabilizer perforated;
- Aft lower fuselage scratched;
- Left wing to fuselage fairing torn.



Figure 2: Damage on the nose wheel



Figure 3: Damage on the lower fuselage



Figure 4: Damage on the left engine

1.4 Other Damage

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

1.5 Personnel Information

1.5.1 Pilot in Command

Gender	:	Male
Age	:	59 years
Nationality	:	Indonesian
Marital status	:	Married
Date of joining company	:	1 March 2013
License	:	ATPL
Date of issue	:	9 March 1983
Aircraft type rating	:	Boeing 737-300/400/500
Instrument rating validity	:	31 March 2017
Medical certificate	:	First Class
Last of medical	:	1 June 2016
Validity	:	31 December 2016
Medical limitation	:	Holder shall possess glass that correct for near vision
Last line check	:	23 April 2016
Last proficiency check	:	10 March 2016

Flying experience

Total hours	:	23,823 hours 5 minutes
Total on type	:	9,627 hours 35 minutes
Last 90 days	:	262 hours 25 minutes
Last 60 days	:	196 hours 55 minutes
Last 24 hours	:	2 hours 27 minutes
This flight	:	46 minutes

The PIC training record on 2016 was as follows:

1. Recurrent Training performed on 9 March 2016 in simulator it was remark as SB (Satisfactory with Briefing) on two items:
 - On assessment item of “TCAS/ EGPWS/ Windshear”; the remark was during TCAS maneuver the auto-throttle (A/T) did not disengage and recommended to review Non-normal Maneuver on item Traffic Advisory / Resolution Advisory (TA/RA) command
 - On assessment item of “In event emergencies: Evacuation”, the remark was to review on ground evacuation procedure in the FCTM.
2. Proficiency check performed on 10 March 2016 in simulator;
 - On assessment item of “miss approach”, the remark was that during miss

approach two engines did not follow flap retraction on acceleration height. It was recommended to review FCOM volume 1 on missed approach procedure section.

- On assessment item of “stall”, the remark was at first attempt forgot the speed brake, second attempt OK. It was recommended to review stall recovery refer to NNC Manual.
3. Line Check performed on 23 April 2016 with route from Jayapura to Wamena, the instructor remark was on assessment item of “General Piloting” on point 3.3: “Navigation and critical point”, it was remarked to review Procedure Visual Guidance Wamena.

1.5.2 Second in Command

Gender	: Male
Age	: 22 years
Nationality	: Indonesian
Marital status	: Single
Date of joining company	: 2 February 2015
License	: CPL
Date of issue	: 18 October 2014
Aircraft type rating	: Boeing 737-300/400/500
Instrument rating validity	: 30 June 2015
Medical certificate	: First Class
Last of medical	: 2 May 2016
Validity	: 30 November 2016
Medical limitation	: None
Last line check	: 3 March 2016
Last proficiency check	: 24 June 2016

Flying experience

Total hours	: 650 hours 51 minutes
Total on type	: 480 hours 51 minutes
Last 90 days	: 248 hours 17 minutes
Last 60 days	: 144 hours 26 minutes
Last 24 hours	: 2 hours 20 minutes
This flight	: 46 minutes

The SIC training record on 2016 were as follows:

1. Line training performed on 3 March 2016 on route from Jayapura to Wamena the remarks were as follows:
 - On the assessment item of “Landing”, it was recommended to review profile landing on FCTM
 - On the assessment item of “company regulation and procedure”, it was

recommended to review company regulations and procedures.

2. Recurrent training performed on 23 June 2016 in simulator the remarks were as follows:
 - On the assessment item of “Pre-flight Start malfunction”, the remark was forgot to select engine start switch manually to cut off at 46% N1 RPM and was recommended to review FCOM Vol 1;
 - On the assessment item of “Instrument approach and final approach”, it was remarked not monitor FMA during ILS approach, while did not capture the ILS path, flew parallel with the ILS path and recommended to review FMA reading.
 - On the assessment item of “On ground evacuation”, it was recommended to review FCTM.
3. Proficiency check performed on 24 June 2016 in simulator the remarks were as follows:
 - On the assessment item of “Engine starting”, the remark while acted as PM, did not monitor when the engine start switch not automatically cut out at 46% N1 RPM (FCOM Vol 1);
 - On the assessment item of “Rejected take off” while acted as PM was remark wrong in identifying malfunction it was recommended to review the malfunction after aircraft stop.
 - On the assessment item of “Take Off engine failure after V1”, while acted as PM did not set MCT and recommended to review how to set MCT on FMC. While acted as PF, remarked did not monitor heading on FMA and recommended to review one engine failure after V1 procedure.

1.6 Aircraft Information

1.6.1 General

Registration Mark	: PK-YSY
Manufacturer	: Boeing Company
Country of Manufacturer	: United State of America
Type/Model	: Boeing 737-300F
Serial Number	: 23597
Year of Manufacture	: 1986
Certificate of Airworthiness	
Issued	: 2 October 2015
Validity	: 1 October 2016
Category	: Transport
Limitations	: None
Certificate of Registration	

Number : 2972
 Issued : 26 September 2015
 Validity : 25 September 2016
 Time Since New : 59,420 hours 57 minutes
 Cycles Since New : 48,637 cycles
 Last Major Check : 10 October 2014
 Last Minor Check : 4 September 2016

1.6.2 Engines

Manufacturer : General Electric
 Type/Model : CFM 56-3
 Serial Number-1 engine : 720864

- Time Since New : 68,808 hours 56 minutes
- Cycles Since New : 48,842 cycles

 Serial Number-2 engine : 722296

- Time Since New : 42,197 hours 19 minutes
- Cycles Since New : 29,807 cycles

1.6.3 Landing gears

Manufacturer : Boeing Company
 Serial Number Left : MC04595P2331
 Main Landing Gear

- Cycles Since New : 40,272 cycles

 Serial Number Right : MC04596P2331
 Main Landing Gear

- Cycles Since New : 40,272 cycles

 Serial Number Nose : T5042P2331
 Landing Gear

- Cycles Since New : 40,272 cycles

1.6.4 Weight and balance

According to the weight and balance sheet, the aircraft takeoff weight (TOW) was 54,193 kg (119,658 lbs) with Mean Aerodynamic Chord (MAC) on takeoff was 17% carried total cargo of 14,913 kg and under load was 223 kg. The aircraft landing weight (LDW) was 52,566 kg (116,108 lbs). According to these data, the aircraft was operating within the weight and balance envelope.

1.7 Meteorological Information

Weather reports of Wamena Airport, issued on 13 September 2016, were as follows:

	2130 UTC	2200 UTC	2230 UTC
--	----------	----------	----------

Wind (°/knot)	110 / 2	350 / 3	010 / 3
Visibility (km)	3	2	3
Weather	BR (MIST ³)	BR (MIST)	BR (MIST)
Cloud	BKN ⁴ 200 feet	BKN 400 feet	BKN 100 feet
Temperature / Dew point (°C)	16 / 16	16 / 16	16 / 16
QNH ⁵ (hPa/in Hg)	1,009/29.79	1,010/29.82	1,010/29.82
QFE ⁶ (hPa /in Hg)	837/24.71	837/24.71	837/24.71

According to the observation of meteorological personnel, the weather surrounding the Wamena Airport at 2200 UTC was haze and the visibility was 2,000 meters

The weather observed by *Badan Meteorologi Klimatologi dan Geofisika* (BMKG – Bureau of Meteorology, Climatology and Geophysics) on the day of the accident at 2100 UTC and 2300 UTC on Wamena area was haze.

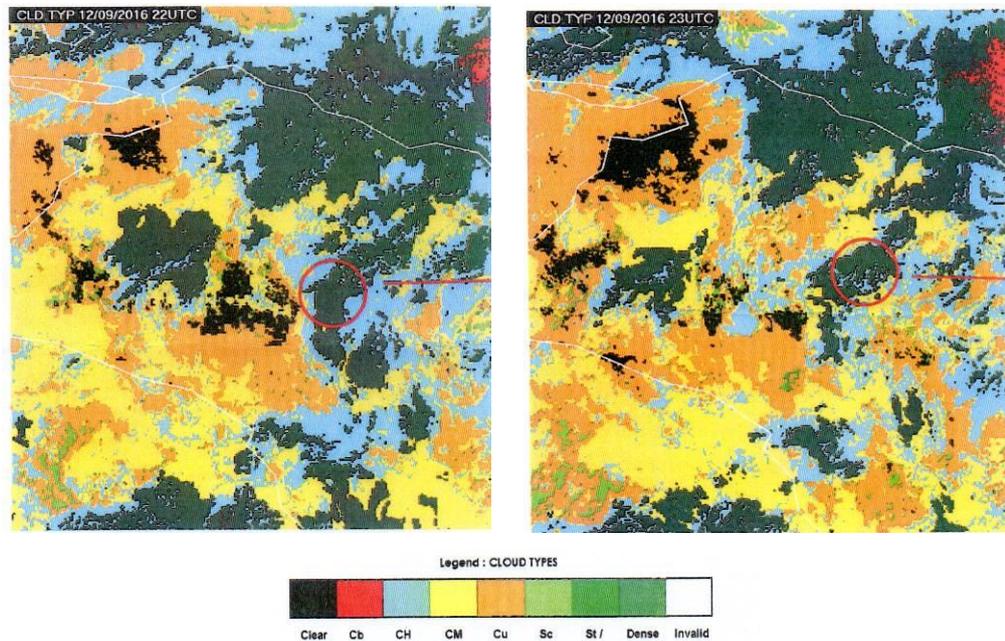


Figure 5: Satellite weather images at the accident site (red circle)

-
- 3 BR (mist): reported when visibility is at least 1,000 meters but not more than 5,000 meters
 - 4 BKN (Broken): Cloud amount is assessed in total which is the estimated total apparent area of the sky covered with cloud. The international unit for reporting cloud amount for Broken (BKN) is when the clouds cover more than half (5/8 up to 7/8) area of the sky.
 - 5 QNH is an aeronautical code indicating the atmospheric pressure adjusted to mean sea level. It is a pressure setting used by pilots, air traffic control (ATC), and low frequency weather beacons to refer to the barometric setting which, when set on an aircraft's altimeter, will cause the altimeter to read altitude above mean sea level within a certain defined region.
 - 6 QFE is an aeronautical code indicating the atmospheric pressure adjusted to airport elevation. It is a pressure setting refer to the barometric setting which, when set on an aircraft's altimeter, will cause the altimeter to read altitude certain airport elevation and will indicate zero when the aircraft is on the ground.

1.8 Aids to Navigation

Wamena Airport equipped with a Non-Directional Beacon (NDB) which was serviceable at the time of occurrence. Visual ground navigation aid available such as Visual Approach Slope Indicator (VASI) and several runway lights that were unserviceable at the time of occurrence.

No instrument approach procedure available for both runways. The aircraft operator provided visual guidance for pilots as shown in the figure below.

WAMENA

WMX / WAJW

1-1

Effective date : 03 July 2013

Visual Guidance

TERMINAL AREA CHART

Boeing 737-300



Figure 6: Operator Visual Guidance, terminal area chart

WAMENA

WMX / WAJW

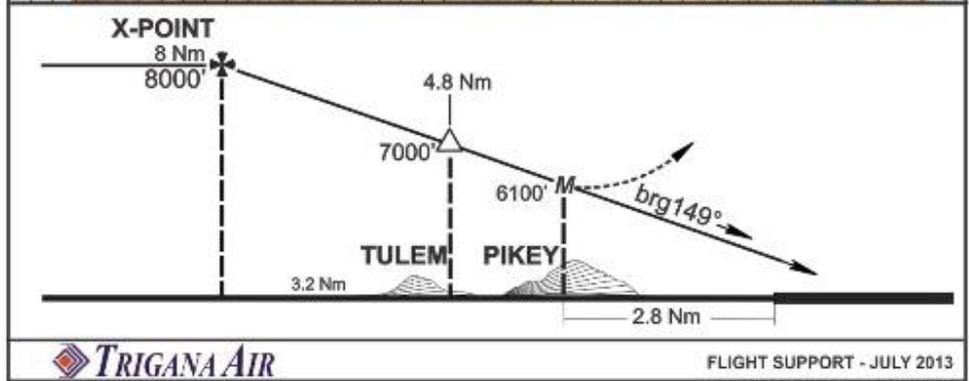
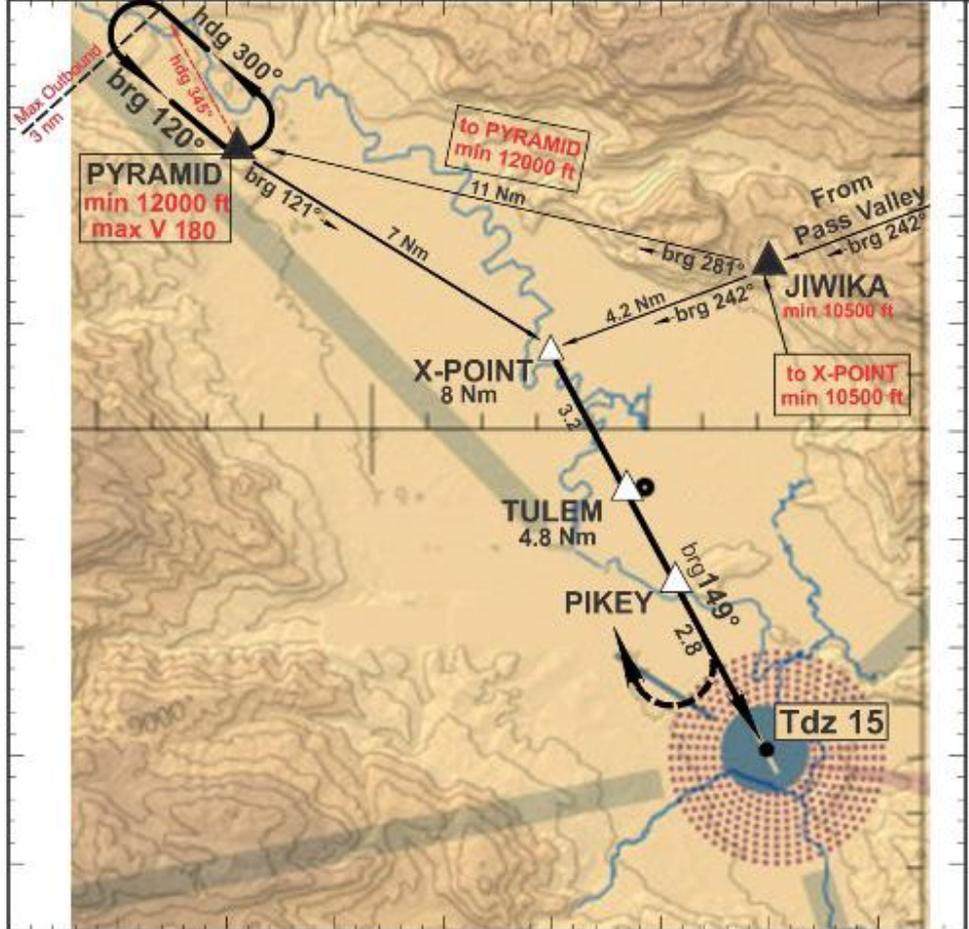
2-1
Effective date : 03 July 2013

Visual Guidance

Approach Rwy 15

Boieng 737-300

Jayapura App : 119.1 MHz	Wamena Tower: 120.0 MHz ADF : ZW 222	AD ELEV 5084 ft Height related to MSL	
Missed Approach : Climb STRAIGHT AHEAD then IMMEDIATE RIGHT TURN to heading 330° proceed to PYRAMID at 12000 ft, or as instructed by ATC.		TRANS LEVEL ALT : FL 160 / 18000'	



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Figure 7: Operator Visual Guidance, approach chart runway 15

1.9 Communications

Communication between Air Traffic Services (ATS) and the pilot was normal as recorded on ground based automatic voice recording equipment and Cockpit Voice Recorder (CVR) for the duration of the flight. The quality of the recorded transmissions was good. The communication excerpt will be discussed on the chapter Cockpit Voice Recorder in this report.

1.10 Aerodrome Information

Airport Name	: Wamena
Airport identification	: WAVV (WMX)
Airport operator	: Directorate General Civil Aviation
Coordinate	: 04° 05'89" S; 138°57'17" E
Elevation	: 5,084 feet
Runway direction	: 15 – 33
Runway length	: 2,175 meters
Runway width	: 30 meters
Surface	: Asphalt

No refueling facility available.

1.11 Flight Recorders

1.11.1 Flight Data Recorder

The aircraft was equipped with a Fairchild F1000 Flight Data Recorder (FDR) with part number S703-1000-00 and serial number 00343. Following the accident, the recorder was transported to KNKT recorder facility for data downloading process.

The Fairchild F1000 FDR with serial number S703-1000-00 capable to record up to 32 parameters, while the aircraft had about 300 parameters ready to be recorded. The FDR data download retrieved 20 recorded parameters which contained 52 flights including the accident flight. Latitude and longitude were not recorded. Investigation utilized five parameters consisted of airspeed, heading, roll, pitch and yaw to determine the flight path of the flight. The flight path is shown on the following figure.

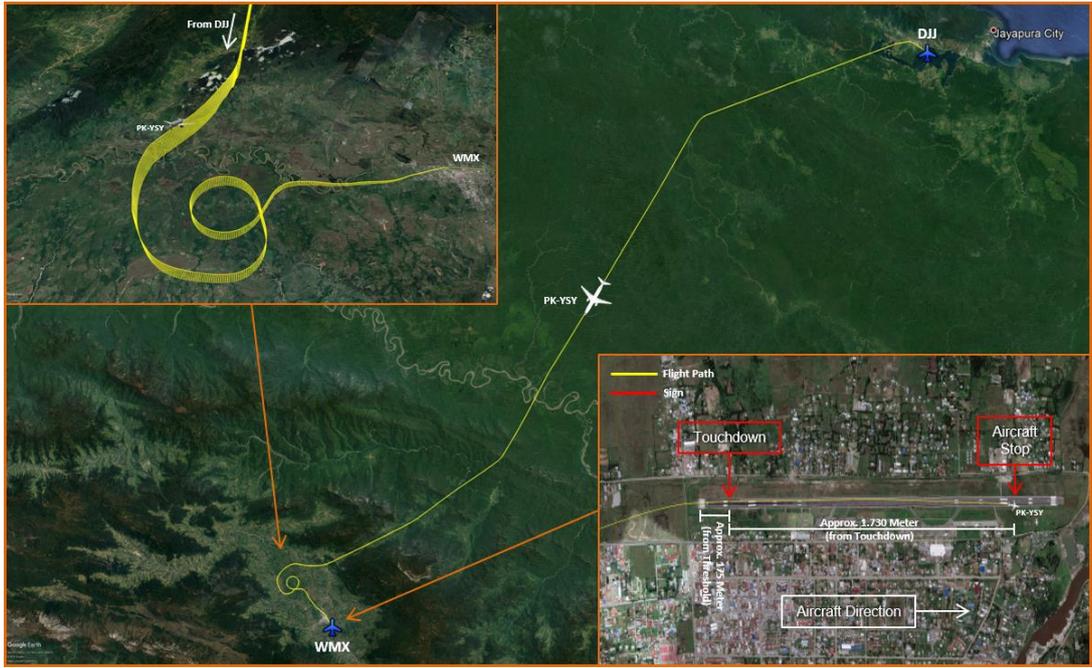


Figure 8: The aircraft flight path

The recorded parameters are shown on the following figure:

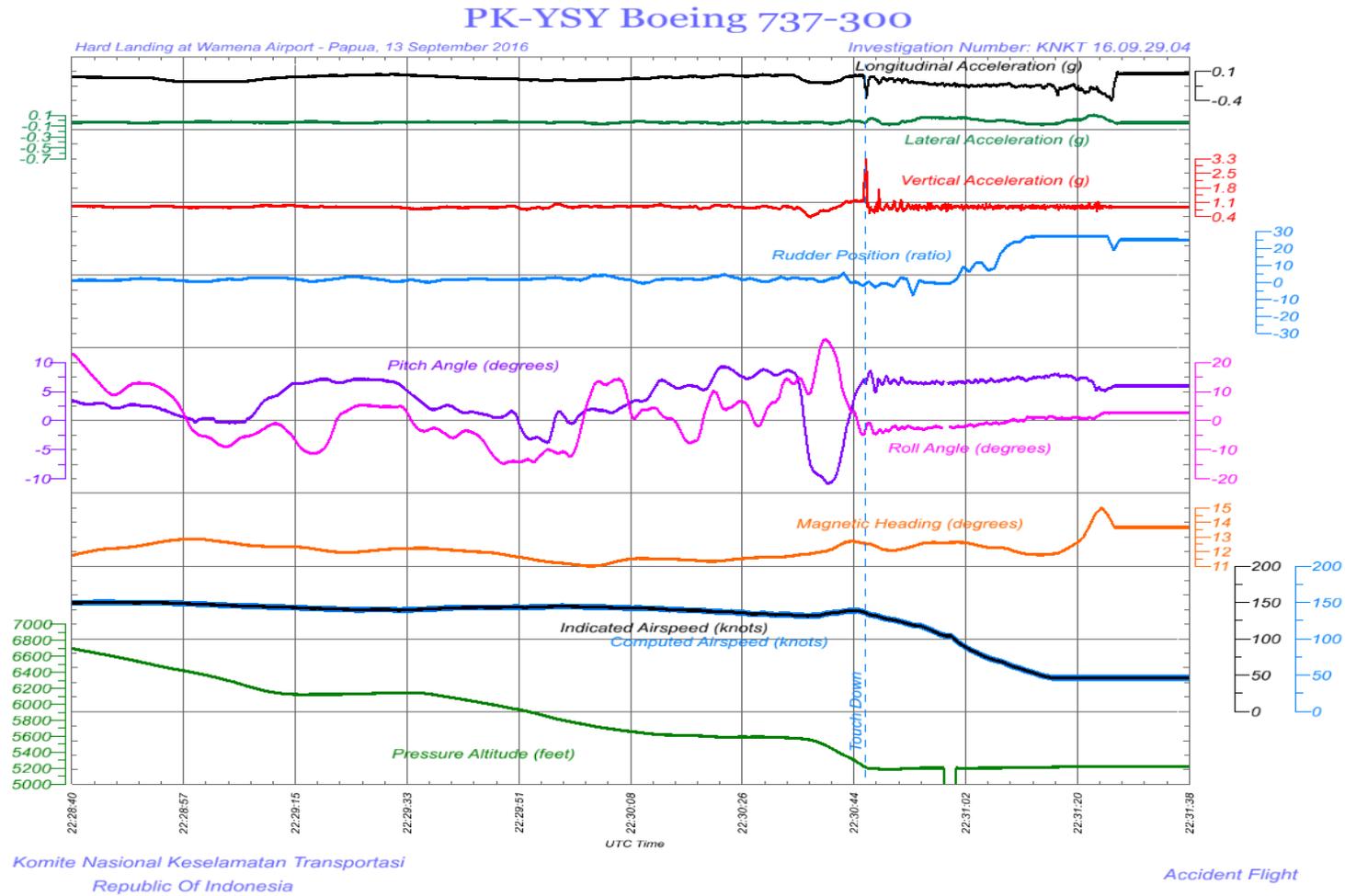


Figure 9: FDR parameters on approach and landing

Significant events recorded on the FDR are as follow:

- The data started with the information of the aircraft on descend with the rate of descend about 1,500 feet/minute and at 22:29:16 UTC the aircraft altitude maintained about 6,200 feet for about 18 seconds, afterward descend with the average rate of 900 feet/minute.
- At 22:30:14 UTC until 22:30:35 UTC, the rate of descend decreasing and the aircraft altitude maintain at about 5,600 feet.
- At 22:30:38 UTC, the aircraft started to descend from 5,600 feet, the pitch down reached 11° and changed to pitch up 8°, the rate of descend recorded up to 3,200 feet, roll angle up to 28° to the right and the aircraft speed increased from 132 knots up to 139 knots.
- At 22:30:46 UTC, the aircraft touched down with vertical acceleration 3.25 g, the aircraft speed 137 knots, the rate of descend was about 2,300 feet/minute, pitch 7° up and roll to the left 5°. The calculation of FDR data showed that the rate of descend prior to touch down was 3,200 feet/minute.

1.11.2 Cockpit Voice Recorder

The aircraft was fitted with Cockpit Voice Recorder (CVR) manufactured by L3 Communication, with part number 2100-1020-00 and serial number 000103498. The CVR recorded 2 hours of good quality recording.

The excerpt of the CVR data is as follow:

Time (UTC)	voice	Description
22:09:36	PM	The PM reported to Jayapura controller that the flight position was 37 Nm to waypoint MALIO.
22:14:34	PM	The PM stated the value of QNH was 1010 mbs and declared the approach checklist has been completed.
22:14:44	PM	The pilot broadcast message that the flight was in bound to Wamena and estimated time of arrival was 2223 UTC.
22:15:22	PF	The PF stated that he would follow GPS track.
22:17:29	PM	The PM contacted Wamena Tower controller, and informed that the position was over Pass Valley, on descend passing 13,000 feet and estimated time of arrival Wamena would be 2225 UTC.
22:17:41	TWR	The messages acknowledged, and Wamena Tower controller informed that the runway in use was runway 15, and the wind was calm, QNH 1010, temperature 16°C. The pilot was advised to report when position over waypoint JIWIKA
22:18:07	PF	The PF instructed to select flap to 5 position, landing gear down and continued by flap 30 position.

Time (UTC)	voice	Description
22:20:01	PM	The PM mentioned to the PF that another aircraft was 2,000 below
22:20:45	PM	The PM reported to the Wamena Tower controller that they would follow the traffic ahead.
22:20:53	PF	The PF stated that they would hold at that position.
22:21:21	PM	Mentioned to PF that the traffic ahead took the final too far, up to 13 miles.
22:21:23	PF	The PF agreed to the PM statement and added that it wasted fuel.
22:23:16	PM	The PM reported position over X point at altitude 9,500 feet and confirming whether they would approach after the aircraft ahead.
22:23:23	TWR	Wamena Tower controller advised to the pilot to hold at present position to provide separation with the aircraft ahead.
22:23:31	PF	The pilots acknowledged and initiated to make orbit.
22:24:17	Other	The pilot of another flight reported runway insight and was approved to land
22:24:42	TWR	Wamena Tower controller advised the pilot to make another orbit.
22:26:19	TWR	The Wamena Tower controller advised the PK-YSY pilot that after orbit completed, clear for approach runway 15 and to report when runway insight
22:27:12	PM	The PM reported that the orbit has been completed and leaving X point
22:27:22	PF	The PF stated to PM that the FMC message appeared 'using reserve fuel'
22:27:55	PM	The PM stated that something on the left (investigation could not determine) was not visible.
22:28:10	PF	The PF stated that he would fly direct to PIKEI
22:28:50	PF	Requested to select flap to 40 position
22:28:52	PM	Read the Final Landing checklist
22:28:55	PF	The PF Stated that he could see the bottom of something. (investigation could not determine)
22:29:28	PM	The PM stated to the PF that the aircraft was too high
22:29:29	PF	The PF stated that the condition was acceptable and it was better too high than too low.
22:29:30		Sound similar of auto pilot disengaged warning
22:29:45	PM	The PM stated that the runway was on the left.
22:29:47	EGPWS	Altitude callout 'ONE THOUSAND'
22:30:06	PF	The PF stated that the church was in sight
22:30:11	other	A pilot of another aircraft stated on the radio that only bottom part of the Pikei was open.
22:30:11	EGPWS	Altitude callout 'FIVE HUNDRED'
22:30:15	Other	On the radio a pilot of another aircraft added that

Time (UTC)	voice	Description
		according to the information before 7 o'clock it was open, when they were about to arrive it was close.
22:30:21	PF	PF instructed to the PM to check whether the runway has in sight
22:30:24	PM	The PM informed to the PF that they were on position one mile away.
22:30:29	PM	The PM advised to the PF for go around
22:30:34.496	PM	The PM advised to the PF that they were too far.
22:30:41.523	EGPWS	Warning 'SINK RATE'
22:30:42.891	EGPWS	Warning 'PULL UP'
22:30:44.498	PM	The PM informed to the Wamena Tower controller that the runway was in sight
22:30:45.213	GPWS	Warning 'PULL UP'
22:30:46.055		Impact sound similar to touchdown
22:30:46.909		Long beep sound similar to landing gear warning
22:31:19	TWR	The controller advised to all pilot on the ground to shut down the engine.
22:31:45	Other	Another pilot of an aircraft on the ground requested to make 180 back to the parking stand and 180 turn on the runway
22:31:53	TWR	The Wamena Tower controller informed that possibly debris on runway and advised to shut down the engine at present position.
22:32:13	PM	Stated that stand by power selected to battery position
22:32:18	PM	[Unintelligible] mode selector manual
22:32:19	PF	The PF stated that he advanced the throttle but the power did not increase.
22:32:38	PF	The PF stated that he pulled but it was stuck.
22:32:42	PM	The PM asked whether the door should be opened.
22:32:45	PF	Approved to open the door
22:32:48	PF	Instructed not to pull
22:32:49		End of recording

1.12 Wreckage and Impact Information

The investigation found the tire marks of left main landing gear on the runway at approximately 125 meters from the runway threshold, followed by the tire mark of the right main landing gear. Following these marks, a white paint between two purple paint scratch marks which afterward changed to metal scratch marks found along the aircraft trajectory.



Figure 10: The left main landing gear found on the left side of the white paint scratch mark

Observation on the runway found paint and metal scratches marks on the touch down zone area of runway 15 and continued to the last aircraft position. The aircraft stopped at approximately 1,890 meters from the beginning of the runway 15.



Figure 11: Marks of paint and metal scratches found on the runway

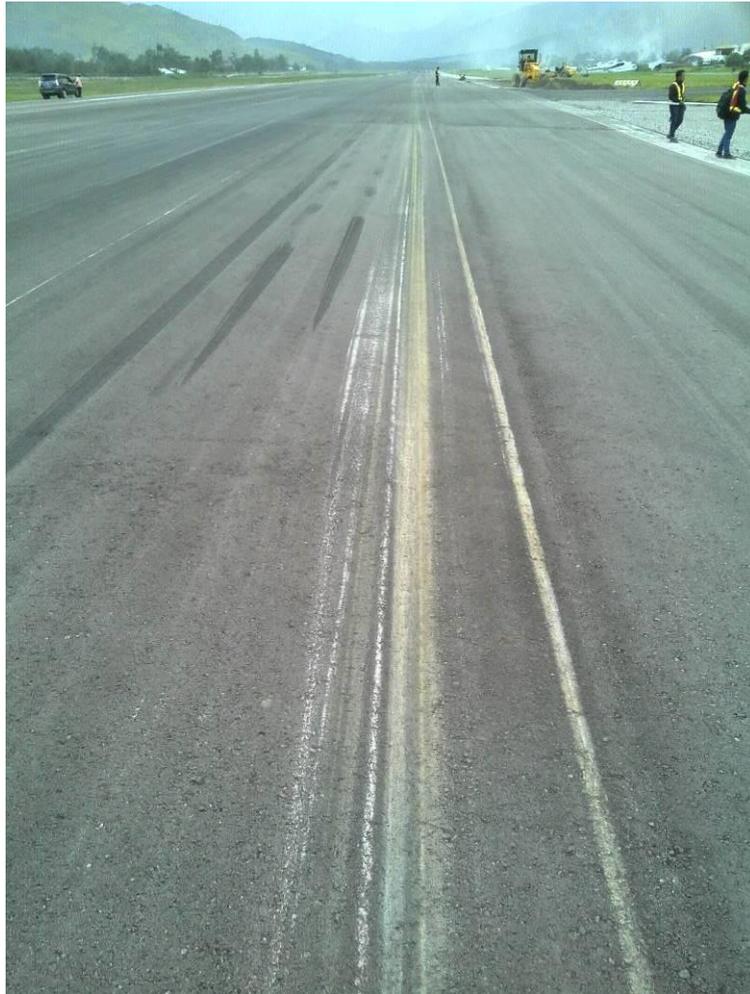


Figure 12: The metal scratch marks along the aircraft trajectory

1.13 Medical and Pathological Information

No medical or pathological investigations were conducted as a result of this occurrence.

1.14 Fire

There was no evidence of fire.

1.15 Survival Aspects

All occupants safely evacuated from the aircraft using escape rope.

1.16 Tests and Research

The broken left main landing gear strut was examined by KNKT metallurgist to determine the mode of failure. The examination did not find any sign of fatigue or any other condition that may degraded the strength of the landing gear strut.

The examination on the broken part found that the surface was at 45° cut, is a common characteristic of a ductile fracture under axial tensile loading.



Figure 13: the broken surface of the left main landing gear strut

1.17 Organizational and Management Information

1.17.1 PT. Trigana Air Service

Aircraft Owner and Operator : PT. Trigana Air Service

Address : Komplek Puri Sentra Niaga. Jl. Wiraloka Blok D
68-70 Kalimalang, Jakarta 13620

Certificate Number : AOC 121 - 006

PT. Trigana Air Services serves domestic routes for both passenger and cargo flight, the operator operates 13 aircraft consist of three ATR 42-300, two ATR 72-202, three DHC6-300, four Boeing B737-300 and one B737-400.

The operator conducted cargo flight from Jayapura to Wamena with average four flights per day utilizing Boeing 737-300F aircraft.

1.17.1.1 Company Operation Manual

5.1.2. BASIC VFR

5.1.2.1. BASIC VFR WEATHER MINIMUMS (CASR 91.155)

Except as provided in this paragraph and under Special VFR (see Section Special VFR Weather Min.), no pilot may operate an aircraft under VFR when the flight visibility is less, or at a distance from clouds that is less, than that prescribed for the corresponding altitude in the following table:

Airspace	Flight Altitude	Visibility	Distance/ Clouds
Class A		Not Applicable	Not Applicable
Class B		3 Statute miles (4.8 km)	Clear of Clouds
Class C			500 feet below 1000 feet above 2000 feet horizontal
Class D			
Class E	Less than 10,000' msl	5 Statute miles (8km)	1000 feet below 1000 feet above 1 statute miles (1.6 km) horizontal
	Greater or equal than 10,000' msl		
Class G	Less than or equal to 1,200' agl (regardless of msl altitude)	1 statute mile (1.6 km)	Clear of clouds
	Greater than 1,200 ' agl but less than 10,000' msl		500 feet below 1000 feet above 2000 feet horizontal
	Greater than 1,200 ' agl and greater than or equal to 10,000' msl	5 statute miles (8km)	1000 feet below 1000 feet above 1 statute miles (1.6 km) horizontal

5.1.2.2. EXCEPTIONS TO BASIC VFR WEATHER MINIMUMS (CASR 91.155)

Notwithstanding the provisions of Sub-section, the following operations may be conducted outside of controlled airspace below 1,200 feet above the surface:

- a. When the visibility is less than 3 miles but not less than 1 mile during night hours, an airplane may be operated clear of clouds if operated in an airport traffic pattern within one-half mile of the runway.
- b. Except under Special VFR, no pilot may operate an aircraft, under VFR, within a control zone beneath the ceiling when the ceiling is less than 1,000 feet.
- c. Except under Special VFR no pilot may take off or land the aircraft, or enter the traffic pattern of an airport, under VFR within a control zone :
 1. Unless ground visibility at that airport is at least 3 statute miles; or
 2. If ground visibility is not reported at that airport, unless flights visibility

during landing or take off, or while operating in the traffic pattern, are at least 3 statute miles.

- d. *For the purpose of this section, an aircraft operating at the base altitude of a class E airspace area is considered to be within the airspace directly below that area.*

1.17.1.2 Flight Crew Training Manual (FCTM)

The FCTM chapter 5.4 described the Stabilized Approach Recommendations as follows:

Maintaining a stable speed, descent rate, and vertical/lateral flight path in landing configuration is commonly referred to as the stabilized approach concept.

Any significant deviation from planned flight path, airspeed, or descent rate should be announced. The decision to execute a go-around is not an indication of poor performance.

Note: Do not attempt to land from an unstable approach.

Recommended Elements of a Stabilized Approach

The following recommendations are consistent with criteria developed by the Flight Safety Foundation.

All approaches should be stabilized by 1,000 feet AFE in instrument meteorological conditions (IMC) and by 500 feet AFE in visual meteorological conditions (VMC). An approach is considered stabilized when all of the following criteria are met:

- the airplane is on the correct flight path*
- only small changes in heading and pitch are required to maintain the correct flight path*
- the airplane should be at approach speed. Deviations of +10 knots to – 5 knots are acceptable if the airspeed is trending toward approach speed*
- the airplane is in the correct landing configuration*
- sink rate is no greater than 1,000 fpm; if an approach requires a sink rate greater than 1,000 fpm, a special briefing should be conducted*
- thrust setting is appropriate for the airplane configuration*
- all briefings and checklists have been conducted.*

Specific types of approaches are stabilized if they also fulfill the following:

- ILS approaches should be flown within one dot of the glide slope and localizer, or within the expanded localizer scale (as installed)*
- during a circling approach, wings should be level on final when the airplane reaches 300 feet AFE.*

Unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilized approach require a special briefing.

Note: An approach that becomes un-stabilized below 1,000 feet AFE in IMC or below 500 feet AFE in VMC requires an immediate go-around.

These conditions should be maintained throughout the rest of the approach for it to be considered a stabilized approach. If the above criteria cannot be established and maintained until approaching the flare, initiate a go-around.

At 100 feet HAT for all visual approaches, the airplane should be positioned so the flight deck is within, and tracking to remain within, the lateral confines of the runway edges extended.

As the airplane crosses the runway threshold it should be:

- stabilized on approach airspeed to within + 10 knots until arresting descent rate at flare*
- on a stabilized flight path using normal maneuvering*
- positioned to make a normal landing in the touchdown zone (the first 3,000 feet or first third of the runway, whichever is less).*

Initiate a go-around if the above criteria cannot be maintained.

1.17.2 Basic VFR weather Minimums

Refer to CASR Part 91 amendment 4 issued on December 2014, the basic VFR weather minimums were as follows:

CASR 91. 155 Basic VFR weather Minimums

- (c) No person may operate an aircraft beneath the ceiling under VFR within the lateral boundaries of controlled airspace designated to the surface for an airport when the ceiling is less than 1,000 feet.*
- (d) No person may take off or land an aircraft, or enter the traffic pattern of an airport, under VFR, within the lateral boundaries of the surface areas of Class B, Class C, Class D, or Class E airspace designated for an airport*
 - (1) Unless ground visibility at that airport is at least 3 statute miles (4.8 km); or*
 - (2) If ground visibility is not reported at that airport, unless flight visibility during landing or takeoff, or while operating in the traffic pattern is at least 3 statute miles (4.8 km).*
- (e) For the purpose of this section, an aircraft operating at the base altitude of a Class E airspace area is considered to be within the airspace directly below that area.*

1.17.3 FDR requirement

121.343 Flight Recorders

No certificate holder may operate a transport category airplane unless it is equipped with an approved flight recorder, as required by CASR Part 91.

91.231 Flight Recorders

- (a) No person may conduct any operation of aircraft unless that aircraft complies with any applicable flight data recorder and cockpit voice recorder requirements. However, the person may_*
 - (1) Ferry an aircraft with an inoperative flight data recorder or cockpit voice recorder from a place where repair or replacement cannot be made to a place where they can be made;*

- (2) *Continue a flight as originally planned, if the flight data recorder or cockpit voice recorder becomes inoperative after the aircraft has taken off;*
 - (3) *All airplanes of a maximum certificated take-off mass of over 27,000 kg for which the individual certificate of airworthiness is first issued on or after 1 January 1989 shall be equipped with a Type I FDR.*
 - (4) *All airplanes of a maximum certificated take-off mass of over 5,700 kg, up to and including 27,000 kg, for which the individual certificate of airworthiness is first issued on or after 1 January 1989, shall be equipped with a Type II FDR.*
- (b) *All airplanes which are required to record pilot input and/or control surface position of primary controls (pitch, roll, yaw) for which a type certificate is first issued on or after 1 January 2016 and which are required to be fitted with an FDR shall record those parameters at a maximum sampling and recording interval of 0.125 seconds.*
- (c) *No person may operate a helicopter unless it is equipped with a flight data recorder:*
 - (1) *All helicopters of a maximum certificated take-off mass of over 3,180 kg for which the individual certificate of airworthiness is first issued on or after 1 January 2016 shall be equipped with a Type IVA FDR.*
 - (2) *All helicopters of a maximum certificated take-off mass of over 7,000 kg, or having a passenger seating configuration of more than nineteen, for which the individual certificate of airworthiness is first issued on or after 1 January 1989 shall be equipped with a Type IV FDR.*
- (d) *The use of the following recorders shall be discontinued:*
 - (1) *Engraving metal foil FDRs.*
 - (2) *Analogue FDRs using frequency modulation (FM).*
 - (3) *Photographic film FDRs.*
 - (4) *Magnetic tape FDRs by 1 January 2016.*
- (e) *Types I, IA, and II FDRs shall be capable of retaining the information recorded during at least the last 25 hours of their operation.*
 - (f) *Types IV, IVA and V FDRs shall be capable of retaining the information recorded during at least the last ten hours of their operation.*

1.17.4 Landing gear requirements

CASR Part 25: Airworthiness standard for transport category airplane stated:

25.473 Landing Load Conditions and Assumptions

- (a) *For the landing conditions specified in § 25.479 to § 25.485 the airplane is assumed to contact the ground—*
 - (1) *In the attitudes defined in § 25.479 and § 25.481;*
 - (2) *With a limit descent velocity of 10 fps at the design landing weight (the*

*maximum weight for landing conditions at maximum descent velocity);
and*

- (3) *With a limit descent velocity of 6 fps at the design take-off weight (the maximum weight for landing conditions at a reduced descent velocity).*
- (4) *The prescribed descent velocities may be modified if it is shown that the airplane has design features that make it impossible to develop these velocities.*

1.18 Additional Information

The investigation utilized amateur video footage made by a ground personnel on the apron of Wamena Airport which recorded the aircraft on final until landing. On the foreground of the video was a B 737 200 that was holding on taxiway.

Significant screen shoots of the video are as follows:



Figure 14: At video time 00:01, the aircraft was not clearly visible



Figure 15: At video time 00:04, the aircraft begin to visible



Figure 16: At video time 00:06, the aircraft was rolling to the right and pitching down



Figure 17: At video time 00:20, the aircraft was on landing roll and main landing gear had collapsed

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 investigation did not find any evidence of aircraft serviceability contributed to the accident. The analysis of this report will discuss the relevant issues resulting in the abnormal runway contact. Therefore, the analysis will discuss topics on:

1. Failure of the landing gears;
2. Decision to continue landing.

2.1 Failure of the landing gears

The Flight Data Recorder (FDR) data showed that during approach the aircraft descend with rate of about 1,500 feet/minute and at altitude about 6,200 feet or at about 1,000 feet above ground level (AGL), the altitude was maintained for about 18 seconds. Thereafter, the aircraft descend with average rate of about 900 feet/minute. The Cockpit Voice Recorder (CVR) data showed that after the GPWS altitude callout 'one thousand' the PF able to see the church, however the pilot had not seen the runway.

The pilot decision to maintain the altitude likely due to the weather condition that made the pilot did not have visual references. After the pilot saw the church, the descend approach continued.

The approach descend once again was stopped, and the aircraft maintained at about 5,600 feet or about 400 feet AGL for about 21 seconds. The CVR data showed that after the EGPWS altitude callout 'five hundred', the PF instructed the PM to check the runway. This showed that up to this point, the pilot had not seen the runway. The PM replied that they were one mile away which probably refer to the runway threshold and advised for go around and also mentioned that they were too far. The stop descend might had made the aircraft deviated from the approach profile and became above the correct glide path.

At 22:30:41 UTC, the CVR recorded EGPWS warning SINK RATE which indicates that the aircraft was on excessive descent rate. The FDR showed the attitude recorded pitch down to 11°, the calculated rate of descend reached up to 3,200 feet/minute, the aircraft rolled to the right up to 28° and the speed increased by 7 knots. The video footage showed the aircraft attitude was rolling and pitching down. The CVR recorded EGPWS warning 'PULL UP'. During this time, the PM reported to the tower controller, that the runway was in sight. Five seconds after the EGPWS warning 'SINK RATE' the aircraft touched down.

The rate of descend was recorded up to 3,200 feet/minute while normal approach landing rate of descend for approach was between 700 to 800 feet/minute. This excessive rate of descend indicated that when the pilot able to see the runway, the aircraft was too high for approach and require excessive sink rate to reach the touch down point.

The aircraft touched down with vertical acceleration 3.25 g, the aircraft speed 137 knots, pitch 7° up and roll to the left 5°. The calculation of FDR data showed that the rate of descend prior to touch down was 2,300 feet/minute.

The CVR recorded the pilot statement of the power levers were advanced but the power did not increase. The advancing power levers might be the pilot attempt to

reduce the rate of descend by pitch up and advanced power. The aircraft pitch changed from 11° down to 7° up reduced the rate of descend from 3,200 feet/minute to 2,300 feet/minute on touchdown. The CASR Part 25.473 requires the landing gear able to support a landing with the rate of descend 10 feet/second (600 feet/minute). The aircraft landed with the rate of descend of 2,300 feet/minute was greater than the requirement.

The pilot stated that the power levers were advanced to recover the sink rate but the engine power did not increase, this might be caused by the delay of the engine to accelerate. The FDR did not record the engine parameters therefore, the throttle movement and the change of power could not be determined. These pilot actions indicated that the recovery to the condition was not in timely manner.

The aircraft touched down with recorded vertical acceleration was 3.25 g and roll 5° to the left. The impact force was received mainly by the left main landing gear. The excessive vertical acceleration created significant force to the left main landing gear combined with the side force which not aligned with the normal landing direction resulted in the collapse of the left main landing gear.

Excessive sink rate resulted in touched down with high vertical acceleration and led to the failure of the main landing gears.

2.2 Crew coordination and decision making

The instrument approach procedure was not available for Wamena Airport and the approach and landing shall be performed under Visual Flight Rules (VFR). The visual navigation aids such as Visual Approach Slope Indicator (VASI) and several runway lights were unserviceable at the time of occurrence.

According to the CASR Part 91, the weather minima for approach in VFR was visibility of 4.8 km and ceiling 1,000 feet.

During the flight preparation, the pilot received weather information of Wamena Airport which stated on the right base runway 15 of Wamena Airport, on the area known as mount PIKEI, low cloud was observed with the cloud base was increasing from 200 to 1000 feet and the visibility was 3 km.

The weather report of Wamena Airport between 2130 – 2230 UTC indicated that the visibility between 2 to 3 km and the cloud base (ceiling) between 100 to 400 feet. The weather information showed that the weather condition did not meet the minima for VFR flight. The pilot decision to depart to Wamena Airport might be caused by the assumption that the weather would improve at the time of arrival.

During descend, the Wamena Tower controller informed that the wind was calm, QNH 1010, temperature 16°C. The weather information did not contain the information of ceiling and visibility which required by the crew to determine the weather minima for approach.

After completed holding and approved for approach, there were several conversations between pilots, indicated that the weather was not suitable for approach. It was indicated by some visual reference points that were not visible. The PF also stated that the flight would direct to PIKEI. The other pilot of aircraft ahead of the accident aircraft stated that only the bottom of Mount Pikei was open. This indicated that the ceiling was low and the visibility was limited. Based on the FDR

data and the video footage, it was estimated that the pilot able to see the runway about 400 feet AGL.

The Visual Approach Guidance for Runway 15 Wamena Airport, published by the aircraft operator, showed that if at 6,100 feet, at 2.8 Nm from runway or about point PIKEI, a safe landing cannot be made, the aircraft should go around.

During the approach, when the aircraft was about 1,000 feet AGL, the PM reminded the PF that the approach was too high. The PM also suggested the PF to go around and followed by the statement that they were too far. None of PM advice were taken by the PF. The suggestions was not seriously considered by the PF was caused by the successful landing of previous aircraft.

After the pilot able to see the runway, the descend approach was continued and the calculated rate of descend was 3,200 feet/minute. The excessive rate of descend contrary to the stabilized approach criteria and triggered the EGPWS warning of SINKRATE and PULL UP to active.

The PM reported to tower controller that the runway was in sight and two seconds after the aircraft touched down. Landing clearance had not been issued by the tower controller.

The reminder and suggestion of the PM were not taken by the PF indicated lack of crew coordination and resulted in the flight continued the approach landing under the un-stabilized approach condition and the weather that was not suitable for landing.

While PK-YSY aircraft on holding, another aircraft was successfully landing on existing weather condition. The success of another flight landing on the existing weather condition had made the pilot confidence that the aircraft could be landed safely.

Several indications of weather below the visual approach minima, un-stabilized approach, the PM suggestion to go around, EGPWS warning, and absence of landing clearance did not make the pilot decided to go around. The pilot was confidence that safe landing could be made as the previous flight landed safely.

3 CONCLUSION

3.1 Findings⁷

According to factual information gathered during the investigation, the findings were listed as follows:

1. The aircraft was airworthy prior to the occurrence and was operated within the weight and balance envelope. There was no report or record of the aircraft system abnormality during the flight from take-off until the time of the occurrence.
2. All crew had valid licenses and medical certificates.
3. Fifteen minutes before departure, the pilot received weather information of Wamena which was stated that on the right base runway 15, low cloud was observed with the cloud base was increasing from 200 to 1000 feet and the visibility was 3 km.
4. The FDR installed capable to record up to 32 FDR parameters and the aircraft has 300 parameters ready to record. The FDR data retrieved 20 parameters recorded on the FDR.
5. During descend, the Wamena Tower controller informed weather information, however the information did not include the information of ceiling and visibility which required by the crew to determine the weather minima for approach.
6. The visibility of Wamena airport reported by BMKG at the time of the occurrence was 3 km. According to the CASR 91, the weather minima for approach in VFR was visibility of 4.8 km and ceiling 1,000 feet.
7. No available instrument approach procedure for Wamena Airport. The aircraft operator issued Visual Approach Guidance for Runway 15 Wamena Airport, which requires to go around at 6,100 feet, at 2.8 Nm from runway or about point Pikey, when a safe landing cannot be made.
8. During the descend approach, there were several pilot discussions related to some visual reference points that were not visible. This indicated that the weather was not suitable for approach under VFR.
9. The descend approach was stopped when the aircraft altitude about 400 feet AGL for about 21 seconds. The pilots had not seen the runway and the PM advised for go around.
10. The reminder and suggestion of the PM were not taken by the PF indicated lack of crew coordination and resulted in the flight continued the approach landing under the unstabilized approach condition and the weather that was not suitable for landing.
11. After the pilot able to see the runway, the pilot flew the aircraft toward the runway. The FDR recorded pitch down up to 11°, the calculated rate of descend reached up to 3,200 feet/minute, the aircraft rolled to the right up to 28° and the speed increased by 7 knots while the CVR recorded EGPWS warning SINK RATE which indicates that the aircraft

⁷ Findings are statements of all significant conditions, events or circumstances in the accident sequence. The findings are significant steps in the accident sequence, but they are not always causal, or indicate deficiencies. Some findings point out the conditions that pre-existed the accident sequence, but they are usually essential to the understanding of the occurrence, usually in chronological order.

was on excessive descent rate and PULL UP. The video footage showed the aircraft attitude was rolling and pitching down. The aircraft touched down 5 seconds after the EGPWS warning 'SINK RATE'.

12. The PM reported to the tower controller, that the runway was insight and the aircraft landed prior to the tower controller issued landing clearance.
13. While PK-YSY aircraft on holding, another aircraft was successfully landing on existing weather condition. The success of another flight landing on the existing weather condition had made the pilot convinced that the aircraft could be landed safely.
14. Several indications of weather below the visual approach minima, un-stabilized approach, the PM suggestion to go around, EGPWS warning, and absence of landing clearance did not make the pilot decided to go around. The pilot was confidence that he could land the aircraft as the previous flight was able to land safely.
15. The aircraft touched down approximately 125 meters from the beginning runway 15 with vertical acceleration of 3.25 g, the aircraft speed 137 knots, pitch 7° up and roll to the left 5°. The calculation of FDR data showed that the rate of descend prior to touch down was 2,300 feet/minute. The aircraft landed with the rate of descend of 2,300 feet/minute was greater than the requirement described on the CASR Part 25.473.
16. Excessive sink rate resulted in touched down with high vertical acceleration and led to the failure of the main landing gears.

3.2 Contributing Factors

Refer to the previous aircraft that was landed safely, the pilot confidence that a safe landing could be made and disregarding several conditions required for go around.

4 SAFETY ACTION

At the time of issuing this preliminary report, the Komite Nasional Keselamatan Transportasi (KNKT) had been informed of safety actions taken by Trigana Air Services resulting from this occurrence.

4.1 PT. Trigana Air

After the occurrence, the management issued safety action were as follows:

1. Issued Notice to Pilot Number 12/OPS-NPB/IX/2016:
 - a. Before flying to Wamena, the pilot should update the weather information and the minimum for dispatch were visibility 5 Km and ceiling 1,000 feet Above Ground Level (AGL). The dispatcher shall not dispatch a flight when the weather is below minima.
 - b. Reemphasize go around when the stabilized approach criteria do not achieve.
2. Implemented Flight Data Analysis (FDA) and assigned AERING as FDA provider.
3. Improved hazard reporting, including assigning personnel to observe daily operation and to report for any deviation to standard.
4. Improve the monitoring of cargo weight to ensure the correct weight and balance.

4.2 Directorate General of Civil Aviation.

1. Issued letter number AU.402/4/22/DRJU.DKPPU.2016 dated 29 September 2016 subjected to safety circular related weather condition and stabilized approach.
2. Issued letter number SE 24 year 2016 dated 9 October 2016 subjected to aircraft accident prevention in Papua and other mountainous area.
3. Issued letter number SE 28 year 2016 dated 30 December 2016 subjected to adherence to Standar Operational procedure flight preparation.
4. Issued letter number SE 7 year 2017 dated 31 May 2017 subjected to increase awareness in order to aircraft accident and serious incident prevention during landing.
5. Develop a Staff Instruction number SI 8900-6.1 related to aircraft inspection as guidance to use C of A checklist inspection DGCA Form 21-40 dated 11 October 2017 to ensure the minimum FDR parameter recorded during C of A inspection.
6. Issued letter number SE 003 year 2018 dated 26 January 2018 subjected to areas of safety concern for Indonesian Civil Aviation in 2018.
7. Issued letter number SE.005/DKPPU/2018 dated 28 January 2018 subjected to Internal instruction to verify the application by airlines of safety circular SE 003-

2018.

8. Deliver and communicate improving aviation safety awareness on 15 August 2019 to the Aircraft Operator and Pilot School.

5 SAFETY RECOMMENDATIONS

The Komite Nasional Keselamatan Transportasi (KNKT) acknowledged the safety actions taken by the aircraft operator and considered relevant to prevent similar occurrence. However, KNKT identify other safety issues required to be considered and issued safety recommendations.

5.1 PT. Trigana Air Services

- **04.O-2020-27-01**

During approach descend about 400 feet AGL and the pilot did not see the runway, the PM reminded to the PF that they were too far and suggested to go around. The reminder and suggestion of the PM were not taken by the PF indicated lack of crew coordination and resulted in the flight continued the approach landing under the un-stabilized approach condition and the weather that was not suitable for landing. KNKT recommends to provide training for pilots to improve crew coordination.

- **04.O-2020-27-02**

The data download of the FDR installed on PK-YSY aircraft retrieved 20 parameters recorded on the FDR. The limited parameters recorded on the FDR contributed to FDA analysis and investigation purposes. KNKT recommends to ensure that all FDR installed are capable to record sufficient data as required by the regulation.

6 APPENDICES

6.1 Appendix E of CASR 91

December 2014

CASR 91 Amdt. 4

APPENDIX E - AIRPLANE FLIGHT RECORDER SPECIFICATIONS

Crash protected flight recorders comprise four systems: a flight data recorder (FDR), a cockpit voice recorder (CVR), an airborne image recorder (AIR) and a data link recorder (DLR). Lightweight flight recorders comprise four systems, an aircraft data recording system (ADRS), a cockpit audio recording system (CARS), an airborne image recording system (AIRS) and a data link recording system (DLRS).

1. General requirements

- a. Nonejectable flight recorder containers shall:
 - (1) be painted a distinctive orange or yellow colour;
 - (2) carry reflective material to facilitate their location; and
 - (3) have securely attached an automatically activated underwater locating device operating at a frequency of 37.5 kilohertz (kHz). At the earliest practical date, but not later than 1 January 2018, this device shall operate for a minimum of ninety days.
- b. The flight recorder systems shall be installed so that:
 - (1) the probability of damage to the recordings is minimized;
 - (2) they receive electrical power from a bus that provides the maximum reliability for operation of the flight recorder systems without jeopardizing service to essential or emergency loads;
 - (3) there is an aural or visual means for pre-flight checking that the flight recorder systems are operating properly; and
 - (4) if the flight recorder systems have a bulk erasure device, the installation shall be designed to prevent operation of the device during flight time or crash impact.
- c. The flight recorder systems, when tested by methods approved by DGCA, shall be demonstrated to be suitable for the environmental extremes over which they are designed to operate.
- d. Means shall be provided for an accurate time correlation between the flight recorder systems recordings.

2. Flight Data Recorder (FDR)

- a. The flight data recorder shall start to record prior to the airplane moving under its own power and record continuously until the termination of the flight when the airplane is no longer capable of moving under its own power.
- b. Parameters to be recorded

- (1) Flight data recorders shall be classified as Type I, Type IA, Type II and Type IIA depending upon the number of parameters to be recorded and the duration required for retention of the recorded information.
- (2) The parameters that satisfy the requirements for FDRs are listed in the paragraphs below. The number of parameters to be recorded shall depend on airplane complexity. The parameters without an asterisk (*) are mandatory parameters which shall be recorded regardless of airplane complexity. In addition, the parameters designated by an asterisk (*) shall be recorded if an information data source for the parameter is used by airplane systems or the flight crew to operate the airplane. However, other parameters may be substituted with due regard to the airplane type and the characteristics of the recording equipment.
 - (a) The following parameters shall satisfy the requirements for flight path and speed:
 - i. Pressure altitude
 - ii. Indicated airspeed or calibrated airspeed
 - iii. Air-ground status and each landing gear air-ground sensor when practicable
 - iv. Total or outside air temperature
 - v. Heading (primary flight crew reference)
 - vi. Normal acceleration
 - vii. Lateral acceleration
 - viii. Longitudinal acceleration (body axis)
 - ix. Time or relative time count
 - x. Navigation data*: drift angle, wind speed, wind direction, latitude/longitude
 - xi. Groundspeed*
 - xii. Radio altitude*
 - (b) The following parameters shall satisfy the requirements for attitude:
 - i. Pitch attitude
 - ii. Roll attitude
 - iii. Yaw or sideslip angle*
 - iv. Angle of attack*
 - (c) The following parameters shall satisfy the requirements for engine power:
 - i. Engine thrust/power: propulsive thrust/power on each engine, cockpit thrust/power lever position
 - ii. Thrust reverse status*
 - iii. Engine thrust command*
 - iv. Engine thrust target*
 - v. Engine bleed valve position*

- vi. Additional engine parameters*: EPR, N1, indicated vibration level, N2, EGT, TLA, fuel flow, fuel cut-off lever position, N3
- (d) The following parameters shall satisfy the requirements for configuration:
- i. Pitch trim surface position
 - ii. Flaps*: trailing edge flap position, cockpit control selection
 - iii. Slats*: leading edge flap (slat) position, cockpit control selection
 - iv. Landing gear*: landing gear, gear selector position
 - v. Yaw trim surface position*
 - vi. Roll trim surface position*
 - vii. Cockpit trim control input position pitch*
 - viii. Cockpit trim control input position roll*
 - ix. Cockpit trim control input position yaw*
 - x. Ground spoiler and speed brake*: Ground spoiler position, ground spoiler selection, speed brake position, speed brake selection
 - xi. De-icing and/or anti-icing systems selection*
 - xii. Hydraulic pressure (each system)*
 - xiii. Fuel quantity in CG trim tank *
 - xiv. AC electrical bus status*
 - xv. DC electrical bus status*
 - xvi. APU bleed valve position*
 - xvii. Computed centre of gravity*
- (e) The following parameters shall satisfy the requirements for operation:
- i. Warnings
 - ii. Primary flight control surface and primary flight control pilot input: pitch axis, roll axis, yaw axis
 - iii. Marker beacon passage
 - iv. Each navigation receiver frequency selection
 - v. Manual radio transmission keying and CVR/FDR synchronization reference
 - vi. Autopilot/autothrottle/AFCS mode and engagement status*
 - vii. Selected barometric setting*: pilot, first officer
 - viii. Selected altitude (all pilot selectable modes of operation)*
 - ix. Selected speed (all pilot selectable modes of operation)*
 - x. Selected Mach (all pilot selectable modes of operation)*
 - xi. Selected vertical speed (all pilot selectable modes of operation)*
 - xii. Selected heading (all pilot selectable modes of operation)*
 - xiii. Selected flight path (all pilot selectable modes of operation)*: course/DSTRK, path angle
 - xiv. Selected decision height*
 - xv. EFIS display format*: pilot, first officer

- xvi. Multi-function/engine/alerts display format*
 - xvii. GPWS/TAWS/GCAS status*: selection of terrain display mode including pop-up display status, terrain alerts, both cautions and warnings, and advisories, on/off switch position
 - xviii. Low pressure warning*: hydraulic pressure, pneumatic pressure
 - xix. Computer failure*
 - xx. Loss of cabin pressure*
 - xxi. TCAS/ACAS (traffic alert and collision avoidance system/airborne collision avoidance system)*
 - xxii. Ice detection*
 - xxiii. Engine warning each engine vibration*
 - xxiv. Engine warning each engine over temperature*
 - xxv. Engine warning each engine oil pressure low*
 - xxvi. Engine warning each engine over speed*
 - xxvii. Wind shear warning*
 - xxviii. Operational stall protection, stick shaker and pusher activation*
 - xxix. All cockpit flight control input forces*: control wheel, control column, rudder pedal cockpit input forces
 - xxx. Vertical deviation*: ILS glide path, MLS elevation, GNSS approach path
 - xxxi. Horizontal deviation*: ILS localizer, MLS azimuth, GNSS approach path
 - xxxii. DME 1 and 2 distances*
 - xxxiii. Primary navigation system reference*: GNSS, INS, VOR/DME, MLS, Loran C, ILS
 - xxxiv. Brakes*: left and right brake pressure, left and right brake pedal position
 - xxxv. Date*
 - xxxvi. Event marker*
 - xxxvii. Head up display in use*
 - xxxviii. Para visual display on*
- (f) Type IA FDR. This FDR shall be capable of recording, as appropriate to the airplane, at least the 78 parameters in Table E.
- (g) Type I FDR. This FDR shall be capable of recording, as appropriate to the airplane, at least the first 32 parameters in Table E.
- (h) Types II FDR. These FDR shall be capable of recording, as appropriate to the airplane, at least the first 15 parameters in Table E.
- (i) The parameters that satisfy the requirements for flight path and speed as displayed to the pilot(s) are listed below. The parameters without an (*) are mandatory parameters which shall be recorded. In addition, the parameters designated by an (*)

shall be recorded if an information source for the parameter is displayed to the pilot and is practicable to record:

- i. Pressure altitude
- ii. Indicated airspeed or calibrated airspeed
- iii. Heading (primary flight crew reference)
- iv. Pitch attitude
- v. Roll attitude
- vi. Engine thrust/power
- vii. Landing-gear status*
- viii. Total or outside air temperature*
- ix. Time*
- x. Navigation data*: drift angle, wind speed, wind direction, latitude/longitude
- xi. Radio altitude*

c. Additional information

- (1) A Type IIA FDR, in addition to a 30-minute recording duration, shall retain sufficient information from the preceding take-off for calibration purposes.
- (2) The measurement range, recording interval and accuracy of parameters on installed equipment shall be verified by methods approved by the appropriate certificating authority.
- (3) Documentation concerning parameter allocation, conversion equations, periodic calibration and other serviceability/maintenance information shall be maintained by the operator. The documentation shall be sufficient to ensure that accident investigation authorities have the necessary information to read out the data in engineering units.

3. Cockpit Voice Recorder (CVR) and Cockpit Audio Recording System (CARS)

a. Signals to be recorded

The CVR and CARS shall start to record prior to the aeroplane moving under its own power and record continuously until the termination of the flight when the aeroplane is no longer capable of moving under its own power. In addition, depending on the availability of electrical power, the CVR and CARS shall start to record as early as possible during the cockpit checks prior to engine start at the beginning of the flight until the cockpit checks immediately following engine shutdown at the end of the flight.

- (1) The CVR shall record on four separate channels, or more, at least the following:
 - (a) voice communication transmitted from or received in the aeroplane by radio;
 - (b) aural environment on the flight deck;

6.2 Notice to Pilot

 NOTICE TO PILOT	
N O M O R	: 12 / OPS-NPB / IX / 2016
EFFECTIVE DATE	: 13 SEPTEMBER 2016
ATTENTION	: ALL PILOT BOEING 737 CL
SUBJECT	: INCIDENT PK-YSY AT WMX
CC	: - OPERATION DIRECTOR - OPERATION MANAGER - SAFETY DIRECTOR - SAFETY MANAGER - FLOPS

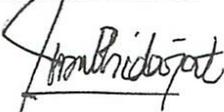
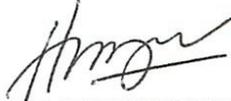
Mengacu kepada kejadian Serious Incident PK-YSY di Bandara Wamena pada hari Selasa, tanggal 13 sep 2016, saat mendarat yang mengakibatkan kerusakan pada pesawat dan kerugian terhadap perusahaan. Dengan ini diingatkan kembali kepada rekan-rekan pilot B737 CL Trigana Air agar tidak melakukan kesalahan yang sama.

Di instruksikan kepada seluruh Pilot B737-CL :

1. Pilot yang akan terbang ke Wamena harus Update Weather wamena (Minimum Visibility 5 km dan Minimum Ceiling 1000 ft AGL)
2. Apabila terjadi Unstabilized Approach jangan ragu-ragu melakukan **Go-Around. Ref FCTM 5.4 (Stabilized Approach)**

Demikian Notice to Pilot ini dibuat agar dapat dilaksanakan sebaik mungkin, terima kasih atas perhatian dan kerjasamanya.

SELAMAT BERTUGAS DAN *SAFE FLIGHT*

ISSUED BY CHIEF PILOT B 737 CL  (CAPT. IWAN B. HIDAJAT)	ACKNOWLEDGE BY OPERATION MANAGER  (CAPT. HARGUMAWAN)
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6.3 Direct Involves Parties Comments to draft final report

6.3.1 Indonesia DGCA

Reference Chapter, Page, paragraph	Original Text	Proposed Amendment	Reason for Proposed Change	KNKT Response
ABBREVIATIONS AND DEFINITIONS (halaman 1)	EGPWS: Ground Proximity Warning System	add text enhanced to EGPWS abbreviation into Enhanced Ground Proximity Warning System	not complete	accepted
1. FACTUAL INFORMATION (sub chapter 1.5.1, page 4)	Recurrent Training performed on 9 March 2016 in simulator it was remark as SB (Standard with Briefing) on two items:	Terminology SB change to satisfied with briefing		Accepted
1. FACTUAL INFORMATION (sub chapter 1.5.1, page 4)	On assessment item of “TCAS/ EGPWS/ Windshear”; the remark was during TCAS maneuver the auto-throttle (A/T) did not disengage and recommended to review Non-normal Checklist on item	On assessment item of “TCAS/ EGPWS/ Windshear”; the remark was during TCAS maneuver the auto-throttle (A/T) did not disengage and recommended to review Non-normal Maneuver on item Traffic Advisory / Resolution Advisory (TA/RA) command in QRH B737	conform with QRH B737-300	accepted

	Traffic Advisory / Resolution Advisory (TA/RA) command			
1. FACTUAL INFORMATION (sub chapter 1.17.1, halaman 20)	Address : Komplek Puri Sentra Niaga. Jl. Wiraloka Blok D 60-61 Kalimalang, Jakarta 13620	Address : Komplek Puri Sentra Niaga. Jl. Wiraloka Blok D 68-70 Kalimalang, Jakarta 13620	Consistent with AOC issued by DGCA	Accepted
4. SAFETY ACTION	At the time of issuing this report, the Komite Nasional Keselamatan Transportasi had not been informed of any safety actions taken by related parties resulting from this occurrence.	<p>Added several safety actions taken by DGCA after the occurrence</p> <ol style="list-style-type: none"> 1. Issued letter number AU.402/4/22/DRJU.DKPPU.2016 dated 29 September 2016 subjected to safety circular related weather condition and stabilized approach. 2. Issued letter number SE 24 year 2016 dated 9 October 2016 subjected to aircraft accident prevention in Papua and other mountainous area. 3. Issued letter number SE 28 year 2016 dated 30 December 2016 subjected to adherence to Standar Operational procedure flight preparation. 4. Issued letter number SE 7 year 	DGCA had been develop SI 8900-6.1 and several safety circular related to aviation safety since 2016 and had been delivered to the aircraft operator.	Accepted

		<p>2017 dated 31 May 2017 subjected to increase awareness in order to aircraft accident and serious incident prevention during landing.</p> <p>5. Develop a Staff Instruction number SI 8900-6.1 related to aircraft inspection as guidance to use C of A checklist inspection DGCA Form 21-40 dated 11 October 2017 to ensure the minimum FDR parameter recorded during C of A inspection.</p> <p>6. Issued letter number SE 003 year 2018 dated 26 January 2018 subjected to areas of safety concern for Indonesian Civil Aviation in 2018.</p> <p>7. Issued letter number SE.005/DKPPU/2018 dated 28 January 2018 subjected to Internal instruction to verify the application by airlines of safety circular SE 003-2018</p> <p>8. Deliver/Communicate improving aviation safety awareness on 15 August 2019 to the Aircraft Operator dan Pilot School.</p>		
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<p>5. SAFETY RECOMMENDATION S (subchapter 5.2, halaman 33)</p>	<p>5.2 DGCA</p> <p>The data download of the FDR installed on PK-YSY aircraft retrieved 20 parameters recorded on the FDR while CASR required more parameters to be recorded. The limited parameter was not identified during the issuance of Certificate of Airworthiness. KNKT recommends to improve oversight process to ensure that all FDR installed are capable to record sufficient data as required by the regulation</p>	<p>Suggest to deleted this recommendation</p>	<p>DGCA had been develop Staff Instruction number SI 8900-6.1 related to aircraft inspection as guidance to use C of A checklist inspection DGCA Form 21-40 dated 11 October 2017 to ensure the minimum FDR parameter recorded during C of A inspection.</p>	<p>Accepted</p>
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6.3.2 PT. Trigana Air

No	Reference Chapter, Page, paragraph	Original Text	Proposed Amendment	Reason for Proposed Change	KNKT Response
1	Chapter 1.2	passengers	Change text passenger to FOO/Load Master or other crew	to improve clarity	accepted
2	Chapter 1.17.1	two ATR 72-212A	two ATR72-202	Conform with OPSPEC Trigana Air D85 Feb.2016	accepted
3	Chapter 4 paragraph 2	<p>After the occurrence, the management issued Notice to Pilot Number 12/OPSNPB/IX/2016 were as follow:</p> <ol style="list-style-type: none"> 1. Before flying to Wamena, the pilot should update the weather information and the minimum for dispatch were visibility 5 Km and ceiling 1,500 feet Above Ground Level (AGL). The dispatcher shall not dispatch a flight when the weather is below minima. 2. Reemphasize go around when the stabilized approach criteria do not achieve. 3. Implemented Flight Data Analysis (FDA) and assigned AERING as FDA provider. 4. Improved hazard reporting, including assigning personnel 	<p>After the occurrence, the management issued safety action were as follows:</p> <ol style="list-style-type: none"> 1. Notice to Pilot Number 12/OPSNPB/IX/2016: <ol style="list-style-type: none"> a. Before flying to Wamena, the pilot should update the weather information and the minimum for dispatch were visibility 5 Km and ceiling 1,000 feet Above Ground Level (AGL). The dispatcher shall not dispatch a flight when the weather is below minima. b. Reemphasize go around when the stabilized approach criteria do not achieve. 2. Implemented Flight Data Analysis (FDA) and assigned AERING as FDA provider. 3. Improved hazard reporting, including assigning personnel to 	Conform with Notice to Pilot number 12/OPSNPB/IX/2016	accepted

		<p>to observe daily operation and to report for any deviation to standard.</p> <p>5. Improve the monitoring of cargo weight to ensure the correct weight and balance.</p>	<p>observe daily operation and to report for any deviation to standard.</p> <p>4. Improve the monitoring of cargo weight to ensure the correct weight and balance.</p>		
4	Chapter 5.1	<p>The data download of the FDR installed on PK-YSY aircraft retrieved 20 parameters recorded on the FDR while CASR required more parameters to be recorded. The limited parameters recorded on the FDR contributed to FDA analysis and investigation purposes. KNKT recommends to ensure that all FDR installed are capable to record sufficient data as required by the regulation.</p>	<p>The data download of the FDR installed on PK-YSY aircraft retrieved 20 parameters recorded on the FDR while CASR required more parameters to be recorded. The limited parameters recorded on the FDR contributed to FDA analysis and investigation purposes. KNKT recommends to ensure that all FDR installed are capable to record sufficient data as required by the regulation.</p>	REF. CASR 91.233 and CASR 91 Appendix E	rejected
5	Chapter 5.2	<p>The data download of the FDR installed on PK-YSY aircraft retrieved 20 parameters recorded on the FDR while CASR required more parameters to be recorded. The limited parameters recorded on the FDR contributed to FDA analysis and investigation purposes. KNKT recommends to ensure that all FDR installed are capable to record sufficient data as required by the regulation.</p>	<p>The data download of the FDR installed on PK-YSY aircraft retrieved 20 parameters recorded on the FDR while CASR required more parameters to be recorded. The limited parameters recorded on the FDR contributed to FDA analysis and investigation purposes. KNKT recommends to ensure that all FDR installed are capable to record sufficient data as required by the regulation.</p>	REF. CASR 91.233 and CASR 91 Appendix E	rejected

6.3.3 National Transportation Safety Board

No	Reference Chapter, Page, paragraph	Original Text	Proposed Amendment	Reason for Proposed Change	KNKT Response
1	Chapter 1.1 History of the Flight (page 1, third paragraph)	<p><i>At 2145 UTC, the aircraft departed Sentani Airport with flight number IL 7321 and cruised at altitude 18,000 feet. On board the aircraft was two pilots and one Flight Operation Officer (FOO) acted as loadmaster. The aircraft carried 14,913 kg of cargo. The Pilot in Command (PIC) acted as Pilot Flying (PF) while the Second in Command (SIC) acted as Pilot Monitoring (PM). There was no reported or recorded aircraft system abnormality during the flight until the time of occurrence</i></p>	<p><i>At 2145 UTC, the aircraft departed Sentani Airport with flight number IL 7321 and cruised at altitude 18,000 feet. On board the aircraft was two pilots and one Flight Operation Officer (FOO) acted as loadmaster. The aircraft carried 14,913 kg of cargo. The Pilot in Command (PIC) acted as Pilot Flying (PF) while the Second in Command (SIC) acted as Pilot Monitoring (PM). <u>Except for damage that resulted from the accident</u>, there was no reported or recorded aircraft system abnormality during the flight. until the time of occurrence</i></p>	<p>To clarify there were no aircraft system anomalies noted, other than damage that resulted from the accident.</p>	<p>Rejected. Reason: Back to context, it is history of flight, damage resulted from the accident is the outcome from the accident.</p>
2	1.3 Damage to Aircraft (pages 2 and 3)		<p><i>Boeing noted the detail of damages listed in this section of the report does not have bullet items associated with Figure 2, titled <i>Damage to nose wheel</i>.</i></p>		<p>accepted</p>
3	1.16 Test and Research (page 20, second paragraph of section)	<p>The examination on the broken part found that the surface was at 45° cut, which indicated that the mode</p>	<p><i>The examination on the broken part found that the surface was at 45° cut, which indicated that the mode of failure was due to torsional force <u>is a</u></i></p>	<p>Based on the image shown in Figure 13, titled <i>the broken surface of the left</i></p>	

		of failure was due to torsional force.	<u>common characteristic of a ductile fracture under axial tensile loading.</u>	main landing gear strut, Boeing believes the failure was a ductile fracture resulting from tensile loading. Our experience has shown fractures on tubular parts due to high torsional loading tend to spiral around the circumference in a helical direction	
4	3.1 Findings (page 30, first item)	<i>The aircraft was airworthy prior to the occurrence and was operated within the weight and balance envelope. There was no report or record of the aircraft system abnormality during the flight from take-off until the time of the occurrence.</i>	<i><u>The aircraft was airworthy prior to the occurrence and was operated within the weight and balance envelope. Except for damage that resulted from the accident, there was no report or record of the aircraft system abnormality during the flight. from take-off until the time of the occurrence.</u></i>	To clarify there were no aircraft system anomalies noted, other than damage that resulted from the accident.	rejected

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