ACCIDENT INVESTIGATION REPORT

ON

9N-AJU Cessna Grand Caravan (Charter Flight)

OPERATED BY

MAKALU AIR AT EKLABHUJ KHARKA, SOUTH OF SIMIKOT AIRPORT DISTRICT, NEPAL

ON 16th MAY 2018

SUBMITTED BY

AIRCRAFT ACCIDENT INVESTIGATION COMMISSION

TO

THE GOVERNMENT OF NEPAL

MINISTRY OF CULTURE, TOURISM AND CIVIL AVIATION

December, 2019 (Poush, 2076 B.S.)

FOREWORD

This report on the accident of 9N-AJU, Cessna Grand Caravan (Charter flight) operated by Makalu Air, Nepal is based on the investigation carried out by the Accident Investigation Commission constituted by the Government of Nepal on 16th May 2018 (2nd Jestha 2075 B.S.) as per the provision of the Aircraft Accident Investigation Regulation 2014 (2071 B.S.) and article-26 of Chicago Convention.

The main objective of the investigation is to find out the cause of the accident and suggest recommendations to prevent the recurrence of such kind of accident in the future. Thus, it is not the function of the Commission to apportion blame or determine civil or criminal liability since neither the investigation nor the reporting process has been undertaken for that purpose.

The Commission adopted standard methodology and resources in compiling this report including technical information on the aircraft, relevant documents, existing rules and regulations, crash site examination, meteorological reports, and direct interviews with other flight crew, witnesses & other concerned personnel.

The commission conducted detail study and analysis of all available information, evidences, records, and documents and took references of several previous reports prepared by different air accident investigation bodies/commissions.

Composition of Commission:

1. Mr. Tri Ratna Manandhar (Former DG CAAN) ----- Chairman
2. Sr. Engineer Upendra Lal Shrestha (Buddha Air) --------- Member
3. Sr. Captain Gopal Singh Bist (Nepal Airlines) ---------- Member
4. Joint Secretary Buddhi Sagar Lamichhane (MoCTCA)-- Member Secretary

Experts to the Commission:

1. Dr. Rajeev Deo (Aero Medical Expert)
2. Er. Yogesh Aryal. (MoCTCA)

Note:

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ACKNOWLEDGEMENTS

The Commission would like to thank to the Government of Nepal, Prat & Whitney, TSB Canada and all those who spared out their valuable time and suggestions in course of investigation to prepare this report.

Abbreviations and Definitions

AD	Airworthiness Directives
AGL	Above Ground Level
AIG	Aircraft Accident and Incident Investigation
AMSL	Above Mean Sea Level
AMT	Aircraft Maintenance Technician
ARP	Aerodrome Reference Point
ATF	Aviation Turbine Fuel
ATC	Air Traffic Controller
ATPL	Airline Transport Pilot License
ATZ	Aerodrome Traffic Zone
AUW	All up weight
B. S.	Bikram Sambat
C of A	Certificate of Airworthiness
CAAN	Civil Aviation Authority of Nepal
CFIT	Controlled Flight Into Terrain
CG	Center of Gravity
CPL	Commercial Pilot License
CTR	Control Zone
CVR	Cockpit Voice Recorder
DCP	Designated Check Pilot
DI	Daily Inspection
ELT	Emergency Locator Transmitter
ECTM	Engine Condition Trend Monitoring
F/O	First Officer
FAA	Federal Aviation Administration
FDR	Flight Data Recorder
FG	Fog
FOM	Flight Operation Manual
FOR	Flight Operation Requirements
GPWS	Ground Proximity Warning System
HF	High Frequency
HSI	Horizontal Situation Indicator
IFR	Instrument Flight Rules
IP	Instructor Pilot
ITT	Inter Turbine Temperature
Kg	Kilogram
KHz	Kilo Hertz
Kts	Knots
Lbs	Pounds
LCD	Liquid Crystal Display
LH	Left Hand
LST	Local Standard Time

MEL	Minimum Equipment List
METAR	Meteorological Report
MHz	Mega Hertz
MoCTCA	Ministry of Culture, Tourism and Civil Aviation
MSA	Minimum Safe Altitude
Mtr	Meter
N/A	Not Applicable
NAC	Nepal Airlines Corporation
NM	Nautical Mile
NTSB	National Transportation Safety Board
OAT	Outside Air Temperature
OM	Operations Manual
PI	Preflight Inspection
PIC	Pilot in Command
POH	Pilot„s Operating Handbook
PPC	Pilot Proficiency Check
QNH	Pressure Setting to Indicate Elevation
RH	Right Hand
RTOW	Regulated Take-Off Weight
SB	Service Bulletin
SOP	Standard Operating Procedure
TAWS	Terrain Awareness and Warning Systems
TLP	Technical Log Page
TSB	Transportation Safety Board of Canada
UTC	Universal Coordinated Time
VFR	Visual Flight Rules
VHF	Very High Frequency
WX	Weather

Definitions

Aircraft Engine: An engine that is used or intended to be used for propelling aircraft. It includes turbo superchargers, appurtenances, and accessories necessary for its functioning, but does not include propellers.

Airframe: The fuselage, booms, nacelles, cowlings, fairings, airfoil surfaces (including rotors but excluding propellers and rotating airfoils of engines), and landing gear of an aircraft and their accessories and controls.

Airplane: An engine-driven fixed-wing aircraft heavier than air, that is supported in flight by the dynamic reaction of the air against its wings.

Approved: Unless used with reference to another person, means approved by the Administrator.

Approved Design Data: Applicable design data that has been granted an approval (for example: type certificate, supplemental type certificate, technical standard order authorization, parts manufacturer approval, or equivalent) by the relevant civil aviation authority.

Authorized Instructor: A person who holds a valid ground instructor certificate or a person who holds a current flight instructor certificate issued by CAAN.

Authorized Representative: Any individual within an organizational delegation that is authorized in the procedure manual to make findings of compliance, and determinations of conformity and/or airworthiness on behalf of the CAAN.

Airworthy: An aircraft that meets its type design and is in a condition for safe operation.

Crew Decision Making: Decision making is the cognitive process of selecting a course of action from among multiple alternatives. The decision-making process produces a choice of action or an opinion that determines the decision maker's behavior and therefore has a profound influence on task performance.

Crew Member: A person assigned to perform duty in an aircraft during flight time.

Crew Resource Management: Crew resource management or Cockpit Resource Management (CRM) is a set of training procedures for use in environments where human error can have devastating effects. Used primarily for improving air safety, CRM focuses on interpersonal communication, leadership, and decision making in the cockpit.

Delegated Function: For DERs, a delegated function applies to the technical areas involved in determining compliance with applicable airworthiness regulations.

Exception: A case in which a rule, general principle, etc., does not apply.

Exemption: Approval to be freed from current regulations in NCAR.

Export: When a product or article is found to be airworthy, meets the special conditions of the importing country/jurisdiction, and is transferred from one civil aviation authority (CAA) regulatory authority to another CAA‟s regulatory authority.

Flight crew Member: A pilot, flight engineer, or flight navigator assigned to duty in an aircraft during flight time.

Human Factors: Human factors is the discipline concerned with optimizing the relationships between people and their activities through the systematic application of the human sciences, integrated within the framework of system engineering.

Load factor: The ratio of a specified load to the total weight of the aircraft. The specified load is expressed in terms of any of the following: aerodynamic forces, inertia forces, or ground or water reactions.

Maintenance: Inspection, overhaul, repair, preservation, and the replacement of parts, but excludes preventive maintenance.

Operate: With respect to aircraft, means use, cause to use or authorize to use aircraft, for air navigation including the piloting of aircraft, with or without the right of legal control (as owner, lessee, or otherwise).

Over Confidence: The overconfidence effect is a well-established bias in which a person's subjective confidence in his or her judgments is reliably greater than the objective accuracy of those judgments, especially when confidence is relatively high.

Preventive Maintenance: Simple or minor preservation operations and the replacement of small standard parts not involving complex assembly operations.

Propeller: A device for propelling an aircraft that has blades on an engine-driven shaft and that, when rotated, produces by its action on the air, a thrust approximately perpendicular to its plane of rotation. It includes control components normally supplied by its manufacturer, but does not include main and auxiliary rotors or rotating airfoils of engines.

Statement of Compliance: A statement of compliance (SOC) is a signed statement made by the aircraft manufacturer stating that the aircraft (specific by serial number) was designed, manufactured, and is supported with a monitoring and correction of safety-of-flight within a continued airworthiness system, in accordance with the appropriate consensus standards.

Situational Awareness: Situational Awareness (S.A.) means having a mental picture of the existing inter-relationship of location, flight conditions, configuration and energy state of your aircraft as well as any other factors that could be about to affect its safety such as proximate terrain, obstructions, airspace reservations and weather systems.

Skill-Based Behaviors: Behaviors that rely on stored routines or motor programs that has been learned and can be repeated without conscious thought.

Spatial Disorientation: Spatial disorientation, spatial unawareness is the inability of a person to correctly determine his/her body position in space. When a pilot does not know in flight where his or her body is in relation to the surface of the Earth, the pilot has spatial disorientation (S.D.)

SYNOPSIS

On 16 May 2018, a Cessna Grand Caravan, 9N-AJU with its MSN: 208B-0770, owned and operated by Makalu Air, bound to SIMIKOT from SURKHET, met an accident at an altitude of 12800 at EKLABHUJ KHARKA, about 7.7 NM South East of Simikot Airport. The charter flight was operated under Visual Flight Rules (VFR), carrying 1170 kg cargo with 2 flight crews and no passenger. The aircraft was left of normal track hit south face of the steep ridge and flipped over the northern side of the ridge killing both pilots. The aircraft was completely destroyed upon impact.

That morning (16 May, 2018), 9N-AJU was second aircraft to depart at 0027 UTC from Surkhet for Simikot,. At the time of departure Simikot ceiling and visibility reported to be okay and wind was light and variable.

In the morning HF frequency in the Region was reported to be affected by ionosphere disturbances making it difficult to communicate. Duty ATS Officer of Surkhet Tower reported that the departure message was transmitted blind due to disturbances in HF frequency and telephone line was also not working. As a result, Simikot Tower was unaware of the departure and the position of the ill-fated aircraft.

There was PIREP from the aircrafts departed from Nepalgunj and Surkhet. VHF communication between those aircrafts and ill-fated aircraft was recorded in the automatic recording system of the Nepalgunj Tower. Last contact with the aircraft with Nepalgunj Tower was 0044, reporting its position as West of Virgin pass maintaining 11000 ft.

One of the Dornier Do-228 (9N-AKE) which departed from Nepalgunj was checking west of Virgin Pass at the time the ill-fated 9N-AJU was leaving Surkhet Valley. 9N-AKE advised 9N-AJU – "weather at high level is not possible, probably low altitude may be good, provided you are not too late". Accident aircraft did acknowledge but in contrary found to have maintained a higher altitude from west of Virgin pass to all the way to Simikot pass.

Ill-fated aircraft was left of the track and was approximately over “W” pass. It is likely that the aircraft could not maintain VMC and continued same heading in IMC. The actual flight path required immediate right turn for appreciable time and then initiate left turn to follow Karnali river till it reaches base for runway 28. 9N-AJU was continuously getting en route weather from preceding traffics in that sector. She was acknowledging them but it was surprising to note that there was no corrective action initiated by 9N-AJU. "

9N-AJU crossed Simikot pass from west of the normal crossing point and the spot where it made initial impact with windward side (South) of the ridge was at an altitude of 12800 on climbing attitude. At the point of initial impact propeller was found on the ground detached from its hub with propeller spinner missing and all three blades were in its fine blade pitch position. Since slope of the impact site is steep, only belly of the aircraft was touching

windward side whereas whole of fuselage found smashed and destroyed on the leeward side (opposite side of the ridge) of the peak.

No sign of fire was found at the crash site. Local shepherds who reached the accident site immediately after the crash also reported no fire. Cabin and cockpit found badly smashed with bodies of crew found close to the main fuselage. On board cargo was found to be scattered about 200 meters up and down of the crash site.

The airplane was not equipped, and was not required to be equipped, with a cockpit voice recorder (CVR) or flight data recorder (FDR). ELT was not activated on impact.

After receiving information of missing aircraft, RCC was activated at 0158 UTC. Despite the cloudy weather, helicopters were mobilized immediately from Simikot and search operation was intensified. Crash site was spotted by the villagers and the search helicopter could locate the crash site at 0438 UTC. Immediately the helicopter with rescue team reached the crash site.

Location of the crash site was the Bahun Khark, 7.7 NM SE of Simikot Airport, coordinate: 29^0 50"38.4" N $081^0$50"34.8" E

Pursuant to Civil Aviation (Accident Investigation) rules 2071 B.S., the Government of Nepal constituted a four members Accident Investigation Commission on 16th May 2018 (2nd Jestha 2075 B.S.) to investigate the fatal accident. The Investigation Commission was mandated to determine the facts, conditions and circumstances pertaining to the accident and make necessary recommendations to preclude a recurrence and enhance aviation safety in future. The Commission commenced its investigation task formally on 17th May 2018.

On the basis of the available information from the VHF communication record of the Nepalgunj Tower, interview with the pilots of the preceding flights, interview with the local shepherds and other concerned personnel, study of the related documents and records, the Commission concluded that the most probable cause of this accident was to continue the flight despite unfavorable weather conditions resulting inadvertent flight into instrument meteorological conditions and there by deviating from the normal track due to loss of situational awareness that aggravated the spatial disorientation leading to CFIT accident.

Contributing factors

1. Possible effect of hypoxia due to flight for prolonged period in high altitude without oxygen supplement.
2. Ineffective safety management of the company which prevented the organization from identifying and correcting latent deficiencies in risk management and inadequacies in pilot training.

The Commission has made twelve safety recommendations to the concerned agencies for the further enhancement of aviation safety and to prevent such accidents in future.

This report is submitted to the Government of Nepal, Ministry of Culture, Tourism and Civil Aviation on December 20, 2018.

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1. FACTUAL INFORMATION

1.1 History of the Flight

As per the flight plan filed half an hour before the departure, the aircraft's Estimated Off-block Time was 00:45 UTC. Flight rules: VFR. Intended cruising speed 140 knots, intended altitude 11000 ft and via Direct Track. The first and second alternate aerodromes were Bajura and Nepalgunj respectively and estimated elapsed time was 45 minutes with the fuel (endurance) of 2 hours and 45 minute.

Ceiling and visibility of the destination and alternate airports were reported to be Okay. After receiving necessary weather briefing, flight crews were ready to start for Simikot. Based on the information from the Flight Progress Strip of the Surkhet Tower, 9N AJU started engine at 00:23, taxied at 00:25 for runway 20 and airborne at 0027. The aircraft reported 5 miles from Surkhet at 00:33 and was changed over to en route.

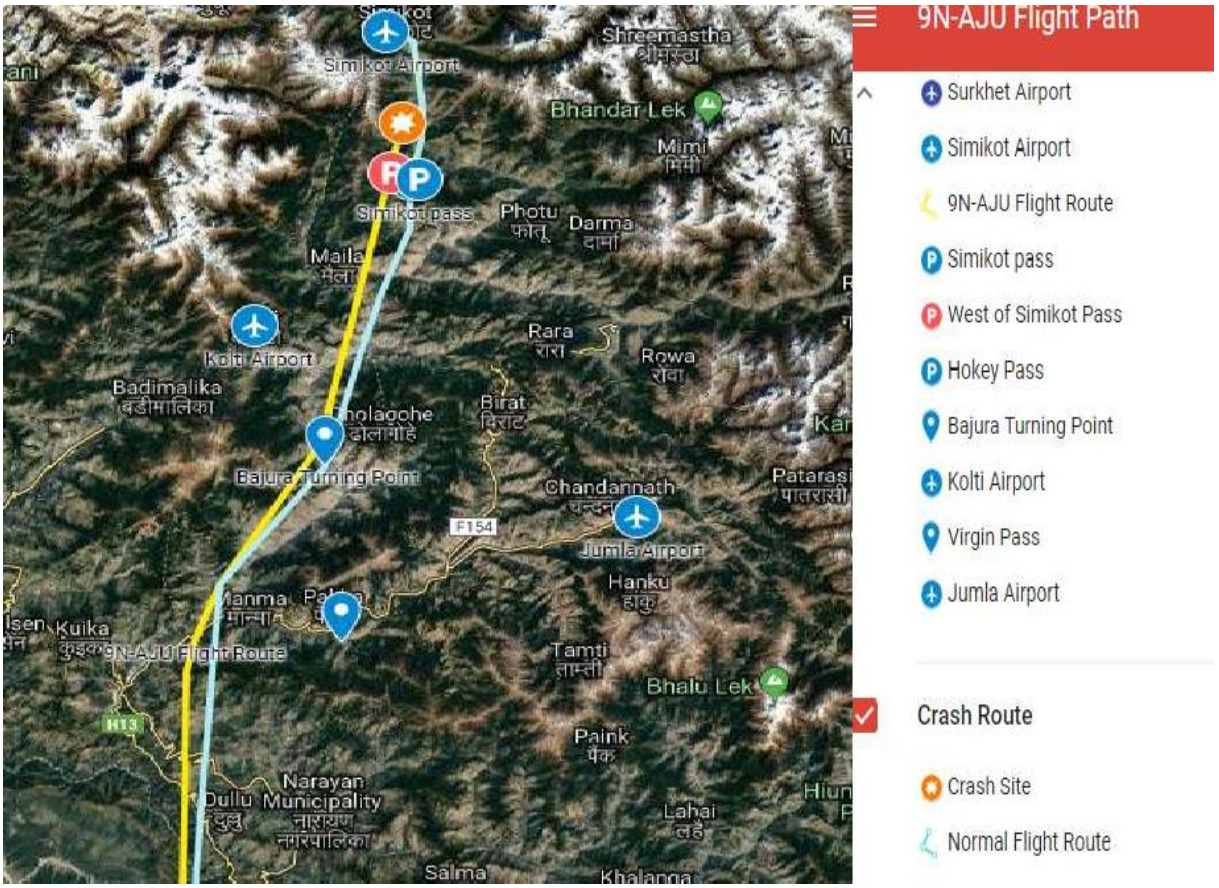
VHF communication recorded at Nepalgunj Tower showed - at 00:34 9N-AJU was leaving Surkhet valley and climbing through 6100 ft, estimated arrival time Simikot at 01:10. Another traffic 9N AKE Dornier from Nepalgunj to Simikot which had reported West West of Virgin Pass at 00:36 maintaining 12500 ft informed 9N AJU about high cloud in the route and advised to follow river track provided they were not too late.

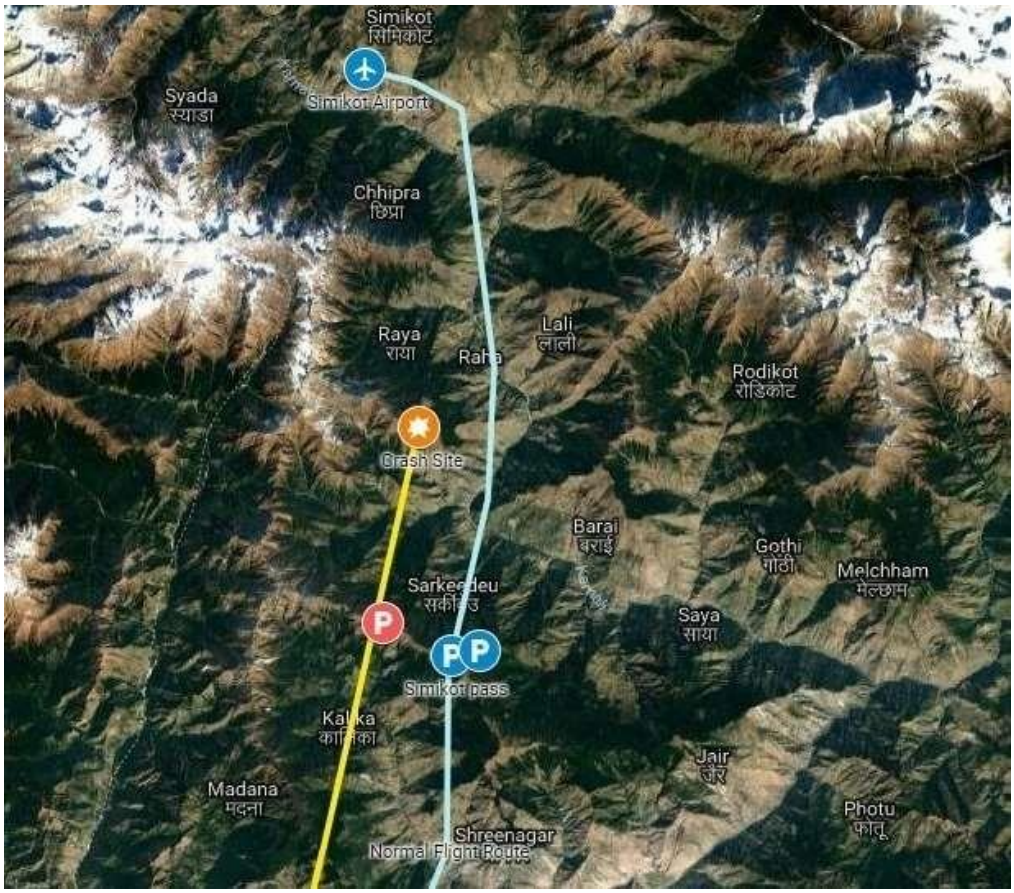
Another Cessna Caravan of Makalu Air 9N AJT which had departed Surkhet at 00:22 for Simikot also had passed on en route weather to 9N AJU at 00:41 warning that there was scary bumping 10 miles out of West of Virgin. The last contact with 9N AJU with Nepalgunj Tower was at 00:44 reported West of Virgin maintaining 11000 ft.

In an investigative enquiry with the PIC of another Dornier 9N AHB who had departed Nepalgunj at 0045 for Simikot reported that it had overtaken 9N AJU around East abeam Bajura. As 9N AJU was maintaining 12000, 9N AHB (overtaking aircraft) climbed to 12500 ft, PIC informed the Commission in his written statement. Estimated time of crossing was around 0109 UTC.

The accident aircraft did not establish communication with Bajura Tower and Simikot Tower.

Projected Flight Path





1.2 Injuries to Persons

Two pilots onboard the aircraft died in the accident.

1.3 Damage to Aircraft

Aircraft was completely destroyed due to the impact.

1.4 Other Damages

There was no third party damage.

1.5 Personnel Information

1.5.1 Pilot-in Command (PIC)

Date of Birth:	28 Nov 1964
Gender:	Male
Type of License issued:	ATPL No. 247
CAAN License Validity:	31 Aug 2018
Aircraft Rating:	Do-228/Ce208B
Instructor Ratings:	Nil
Previous accident/incident:	Crashed Do228 while making approach at Simikot on 1 June 2013
Medical Certificate Type and Validity:	Class I / 31 Aug 2018
Limitation/ Restriction:	Shall wear correcting lens and carry a spare set of spectacles while exercising privilege.
Aviation Language Proficiency: & validity:	Level 5 / 27 Feb 2018
Last Recurrent on type:	18/19 Dec 2017
Last CRM date:	12 Sept 2017
Last DGR training:	2nd May 2017
Instrument Recurrent	NA
Simulator training:	NA
Initial Type training Ce-208B:	18th Sept 2017
Release as P1 on Ce-208B:	15 Oct 2017
First Employer (FE):	NECON AIR& was flying Ce-208/HS-748

Reason for leaving:	Got medical problem and Medical board declared him unfit for piloting in the year 2000.
Second Employer (SE):	SITA Air, was flying Do-228.
Reason for leaving (SE):	Crashed Do228 while making approach at Simikot on 1 June 2013 He resigned from the company.
Joined Nepal Airlines:	2014 Sept 28
Joined Simrik Airlines:	19 Apr 2017
Joined Makalu Air:	2nd July 2017
Designated Flight Safety Manager:	7th July 2017
Makalu Air indoctrination Training:	23 Aug 2017

In-service training/courses:

Emergency evacuation training:	Nil
Simulator Training:	NA
Dangerous Goods Regulation Training:	2nd May 2017
Route Check:	Nil
Pilot Proficiency:	7 Sept 2017(At the time of P1 Check ride)
Refresher ground training Ce-208B:	15-20 July 2017
PPC:	7 Sept 2017 (At the time of P1 Check ride)
Monsoon Briefing:	Not recorded
CRM training:	12 Sept 2017

Flight Experience:

Total hours flown:	Not available
Total hours on Ce-208B type:	414:25 Hours
Total hours on type Do-228:	Not available
Flight hours in 12 months:	414:25 Hours
Flight hours in 3 months:	160:41 Hours
Flight hours in 30 days:	74:25 Hours
Flight hours in 7 days:	28:10 Hours

PIC arrived SURKHET base on 12th May 2018 to replace another crew. He was scheduled to return to Kathmandu on 17 May 2018. The Captain started his professional flying career in 1996 as a F/O of HS-748/Ce-208 in the then NECON AIR. He had medical problem in 1999

and declared medically unfit for flying. He then went through treatment and medication for almost ten years.

In 2009 he was declared fit to fly by the Medical Board and joined Buddha Air to fly B1900D. But soon after some time he joined SITA Air and got type rating for Do-228. In the SITA Air he got upgrading to Captain after completing FAA ATPL, he was issued CAAN ATPL with its Number ATPL-247(A).

He continued to work with SITA Air till he met accident in Simikot on 1 June 2013. After the accident he resigned SITA Air. After changing many companies in between he ultimately landed with Makalu Air, managed and owned by the previous team of SITA Air itself.

After required ground classes and training on Ce-208B he got endorsement in his license on 18 Sept 2017. Since Makalu Air is short of instructor pilots, Capt. T.M. Lama the only Nepali Instructor pilot did his training, Check ride and line clearance. On 15 Oct 2017 after completing minimum required flying hours with instructor pilot (after completing 50 hours) he was given clearance to fly with Copilots. However, unfortunately the PIC met accident exactly after 7 months i.e. on 16 May, 2018.

1.5.2 Co-pilot

Date of Birth:	10 Jan 1988
Gender:	Male
Type of License and Issued by:	CPL-443
CAA-N License Validity:	30 Sept 2018
Aircraft Rating:	Do-228/Ce208B
Instructor Ratings:	Nil
Previous accident/incident:	Nil
Medical Certificate Type and Validity:	Class I / 31 Aug 2018
Limitation/ Restriction:	Glasses
Aviation Language Proficiency & validity:	Level 5 / 08 Sept 2019
Last Recurrent on type	07 Sept 2017
Last CRM date:	12 Sept 2017
Last DGR training:	29 Aug 2017
Instrument Recurrent	NA
Simulator training:	NA
Initial Type training Ce-208B:	18th Sept 2017
Release as P1 on Ce-208B:	07 Sept 2017
First Employer (FE):	SITA AIR Do-228
Reason for leaving (FE):	Purchased Makalu Air
Second Employer (SE):	Makalu Air
Designated Corporate Safety	

Manager:	08th Mar 2018
Makalu Air indoctrination	
Training:	Nil

In-service training/courses:

Emergency evacuation training:	Nil
Simulator Training:	NA
Dangerous Goods Regulation Training:	28 Aug 2017
Route Check:	Nil
Pilot Proficiency:	7 Sept 2017(At the time of P1 Check ride)
Refresher ground training Ce-208B:	Sept 2017
PPC:	7 Sept 2017(At the time of P1 Check ride)
Monsoon Briefing:	Not recorded
CRM training:	12 Sept 2017

Flight Experience:

Total hours flown:	Not available
Total hours on Ce-208B type:	461:02Hours
Flight hours in 12 months:	461:02Hours
Flight hours in 3 months:	244:57Hours
Flight hours in 30 days:	110:54Hours
Flight hours in 7 days:	25:59 Hours
Flight hours in 24 Hours:	4:05 Hours

As per other captains in the company he was very much academic and smart flyer. After purchasing Makalu Air he became Managing Director of the Company on 15th June 2017 and soon after he showed interest in active flying. On 02nd July he was appointed as a copilot in the company. As per the CAAN‟s guidelines and regulatory requirement he had been designated as Corporate Safety Manager on 8th Mar 2018. He had Academic Qualification Bachelor of Science (B.SC). Prior to that he did A level. He completed Basic flying training from USA. He was short by 100 hours to Captaincy for the Ce-208B.

1.5.3 Air Traffic Services Personnel

Surkhet, Simikot and Bajura are the AFIS stations. Each stations were manned by one ATS Officer appropriately trained for AFIS Service. Nepalgunj is the Regional Hub Airport and air traffic control service is provided within the control airspace. Two ATC Officers were on duty at the time of crash at the Nepalgunj Airport.

1.6 Aircraft Information

1.6.1 General

The Cessna Grand Caravan Ce-208B is a Single engine, turbo-prop, non-pressurized, non-retractable landing gear airplane certified for day/night flight in VFR and IFR conditions. The structure is an all-metal, high-wing monoplane with a tail plane. The aircraft is equipped with one Pratt & Whitney PT6A-114 with 675 SHP turbine engine with 3-bladed Hartzell/McCauley Propellers.

Cessna Grand Caravan has maximum Ramp weight of 8785 pounds (3984 Kg) whereas the maximum Takeoff weight is 8750 pounds (3968.9 Kg). This single engine aircraft has maximum landing weight 8500 pounds (3853.5 Kg). The aircraft wing tanks can accommodate maximum fuel of 2224 pounds (1009 Kg) of useable fuel. The aircraft has basic empty weight of 5188.1 pounds.

This aircraft can cruise at maximum speed of 186 Kts. Maximum range of this aircraft is 1070 nautical miles (1982 Kms) ground roll for takeoff and ground roll for landing at sea level is 1160 feet and 715 feet respectively. Maximum operating altitude for this aircraft is 25000 feet AMSL. Whereas maximum limit speed for this aircraft is 175 kts. with stalling speed very low 61 Kts. The aircraft is fitted with dual control and two pilot‟s seats in the cockpit. This MSN :208B-0770 (9N-AJU) was fitted with analogue instrument panel

1.6.2 Aircraft

Model:	208B-0770
Manufacturer:	Cessna Aircraft Company, USA
Type Certificate Number:	A37E
Category:	utility aircraft
Registration:	9N-AJU
Operator:	Makalu Air Pvt. Ltd, Kathmandu. Owner:
Serial No:	208B-0770
Date of Manufacture:	1999
Validity of C of A:	
Maximum Take-off Mass:	8750 pounds (3969 Kg)
Maximum Landing Mass:	8500 pounds (3856 Kg)
Total Airframe Hours:	(TTSN) 15757:38 hours
Total Number of Landings:	(TCSN 31540 Cycles

1.6.3 Engine

Manufacturer - Pratt & Whitney Canada Type:	PT6A-114
Type Certificate Number -	E4EA
Engine position:	Front
Serial No:	PCE-PC19396
Installed Date:	6 October 2017
Time Since New (TTSN):	18382:40 Hours
Total Cycle Since New (TCSN):	16994 Cycles
Time since Overhaul(TSO):	177:44 hours
Total Cycles since Overhaul (CSO):	316 Cycles

1.6.4 Propeller

Manufacturer:	Hartzell Propeller Inc/McCauly.
Type:	HC-B3TN-3AF
Type Certificate Number:	P15EA
Propeller position:	Front
Serial No:	BUA25699
Installed Date:	20 December 2017
Total Time Since New (TTSN)	4801:20 hours
Total Cycle Since New (TCSN):	Not maintained
Time since Overhaul:	651:20535:49 hours

1.6.5 Aircraft Maintenance History

Last DI Carried out on: 15th May 2018
100 Hour Inspection Card No: 0A: 8th April 2018 @ 15719:02 Hours

Last C of A Check Flight Carried out: 10th November 2017
Schedule Checks carried out during last years as per CAAN Approved Maintenance Program

Card No: 01	12 Monthly Inspection	5-Oct-17
Card No: 06	200 Hours or 12 Monthly	6-Oct-17
Card No: 07	400 Hours or 12 Monthly	7-Oct-17
Card No: 09	800 Hours or 12 Monthly	6-Oct-17
Card No:11	1600 Hours or 24 Monthly	6-Oct-17
Card No: 19	5000 Cycles Inspection	18-Mar-18
Card No: 20	12 Monthly Inspection	6-Oct-17
Card No: 21	24 Monthly Inspection	31-Dec-17
Deceleration Check IAW PWC SB 1784R1		8-Apr-18

Other Major Maintenance:

Engine Change: 6th October 2017
Propeller Change: 20th December 2017 [3rd January 2018]
MLG Assemblies Change: 5th April 2018
Whole Aircraft Painting: 6th November 2017

1.6.6 Aircraft Weight and Balance

Last aircraft weighing: 6 November 2017 (after whole aircraft painting)

- Basic Empty Weight: 52031 lbs (2360 kg)
- Index(I): 475.95

Calculated New Weight & Balance after removal of Stone Guards from Landing Gears

- Basic Empty Weight: 5188.3 lbs
- Index (I): 497.772

The load & Trim Sheet of the accident flight had mentioned Basic Empty Weight as 5000 lbs with passenger seat removed and Take off weight for that flight was 8684 lbs.

1.7 Meteorological Information

Meteorological Forecasting Division, Department of Hydrology & Meteorology had provided weather conditions over Mid-Western Nepal around the time of the accident. Detail is on Appendix

1.7.1 Weather Analysis of Weather News International (WNI) Japan

Two weather cameras were installed at Simikot Tower by WNI Japan through which on line weather can be accessed from Kathmandu and Japan and any other station provided the password is available. But one of the cameras was unserviceable.

On Commission's request WNI Japan provided the Weather Analysis Report of the region. Detail is on Appendix.

1.7.2 Significant weather disturbance towards North India :

A significant weather disturbance towards North India and over Nepal, few days before the accident was noteworthy. On 13 May evening in between 2000 LT to 2030 LT, several air traffic from India deviated to Nepal due to severe weather. Perhaps that was pre-monsoon effects.

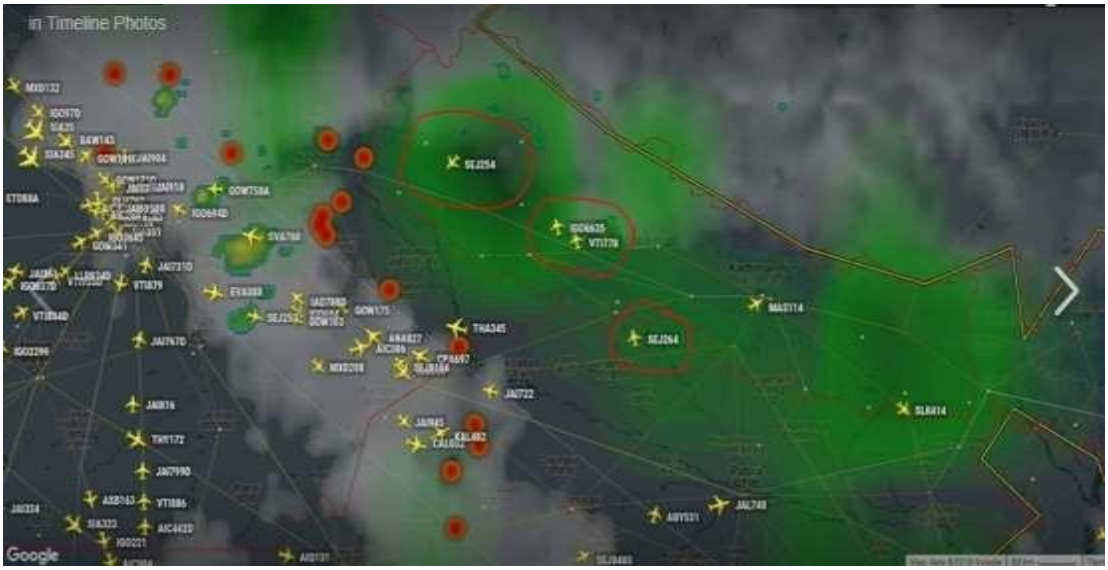


Fig: Air traffic scenario of 13 May evening. Several air traffic deviated to Nepal due weather.

1.7.3 Weather at Departure Aerodrome: Surkhet

0013 UTC: 360/0 10 km FEW 040 SCT 060/080

1.7.4 Weather at Destination Aerodrome: Simikot

0024 UTC: L/V 10 km FEW005 FEW010 BKN070

1.7.5 Weather at Alternate Aerodrome

Bajura: 0113 UTC: W/03 10 km FEW 005/15
Nepalgunj: Ceiling and Visibility OK

1.7.6 En route weather as per other pilots: Weather was cloudy and marginal.

1.8 Aids to Navigation

1.8.1 Ground Based Navigation

Surkhet, Simikot and Bajura airfields are AFIS stations and not facilitated with any ground based navigation aid. The airspace is categorized as G Airspace. Only VFR flights are permitted.

1.8.2 Aircraft Navigation Aids

The accident aircraft was equipped with GPS KLN 94.

1.9 Communication

Surkhet, Bajura and Simikot are uncontrolled airports which provide AFIS (Aeronautical Flight Information Service) to all air traffics. They are equipped with VHF radio for ground to air communication and HF for ground to ground communication on 5805.5 KHz along with landline telephone services. Surkhet and Nepalgunj Tower are additionally equipped with AMHS (Automatic Message Handling System) which can exchange messages with Kathmandu, Biratnagar, Bhairahawa, Dhangadhi, Simara and Lukla. HF communication was reported to be disturbed by ionosphere disturbance in the morning and landline telephone was also not working at the time of the accident. Transcript of VHF Communication of accident aircraft with Nepalgunj Tower and other en route aircrafts was recorded in automatic recording system of Nepalgunj Tower. Recorded VHF communication had provided important information about en route weather to Simikot. Transcript of VHF communication is on Appendix G.

1.10 Aerodrome Information

1.10.1 Departure Aerodrome-Surkhet

Surkhet Airport is the leading airport from where regular passenger and cargo flights are operated to various STOL airfields of Karnali region like Bajura, Dolpa, Simikot, Rara, Jumla. Main operating airlines are Makalu Air, Sita Air,Tara Air and Summit Air.

Aerodrome Location Indicator:	**VNSK**
Name:	**Surkhet Airport**
ARP Coordinates:	**28°35′09″N 081°38′09″E**
Elevation:	**2400 ft (732 m)**
Runway Designation:	**02/20 Runway**
Dimension:	**1255 m x 30 m**
Runway Surface:	**Asphalt**
Approach Lights:	**NIL**

VASIS /PAPI:	**PAPI**
Runway Lights:	**NIL**
Take off/ Landing:	**20/02 respectively**
Radio Navigation Aid:	**None**
Types of Traffic Permitted:	**VFR**
ATS service:	**AFIS , Alerting Service**
Meteorological Information Provided:	**METAR**
Refueling Facility:	**Available**
Communication Facilities:	**VHF on 122.5 MHZ, HF on 5805.5 KHZ, AMHS**

1.10.2 Destination Aerodrome-SIMIKOT

Aerodrome Location Indicator:	**VNST**
Name:	**SIMIKOT Airport**
ARP Coordinates:	**295816N/0814908E**
Elevation:	**2971 m./9747 ft.**
Runway Designation:	**10/28**
Runway Dimension:	**650 m x 20 m**
Runway Surface:	**Asphalt Concrete**
Take off/ Landing:	**10/28 Respectively**
Operating Hours:	**Operation hour is up to 0645 UTC. After 0645 airport will be opened on request.**
Radio Navigation Aid:	**NIL**
Types of Traffic Permitted:	**VFR**
Service:	**AFIS, Alerting service.**
RFF:	**Not Available (Portable Fire extinguishers provided)**
	Communication Facility:
	i. VHF (122.5 MHz),
	ii.HF (5805.5 KHz)
Refueling Facility:	**Not Available**.
PAPI/APAPI Light:	**Not available**

1.10.3 Alternate Aerodrome- Nepalgunj

Aerodrome Location Indicator:	**VNNG**
Name:	**NEPALGUNJ**
ARP Coordinates:	**28 6 5.42 N/081 40 3.14 E**
Elevation:	**105 m/344 ft.**
Runway Designation:	**08/26**
Runway Dimension:	**1500 x 30 m**
Runway Surface:	**Bitumen**
Approach & Runway Lighting:	**Available**
Take off/ Landing:	**Both Runway**
Radio Navigation Aid:	**VOR/DME**

Types of Traffic Permitted:	**IFR/VFR**
ATS service:	**ATC service within NEPALGUNJ control Zone on 118.3 MHz**
Meteorological Information Provided:	**METAR**
Refueling Facility:	**Available**
RFF:	**Category V**
Communication Facilities:	**VHF on 118.3 MHZ, HF on 5805.5 KHZ, AMHS.**

1.11 Flight Data Recorder

1.11.1 CVR: Not installed in the aircraft.

1.11.2 FDR: Not installed.

1.11.3 Additional source of Recorded Information

The only useful recorded information was the ATC/Pilot VHF Communication recorded in the Automatic VHF Recording System of Nepalgunj Tower. This recorded information provided the important information about the en route weather during the time of crash.

1.12 Wreckage and Impact Information

The aircraft was found with single fuselage section with the severely damaged nose section and forward cabin section resting on its right hand side at approximately 150 meter below the first impact point beyond other side of the hill. Both wing assemblies were lying at the point of the second impact which was almost 100 meter below the first impact point. The instrument panels were completely damaged by the force of the impact. All the cowlings and the fairing were in the damaged condition. Based on the data collected during the site visit of crash site by the commission; the following observations were made:

i. The propeller was separated from the engine at the point of first impact and found stuck with its propeller blades in fine position. The aircraft belly pod was damaged and scattered at the windward side of the impact point.

ii. The point of first impact was approximately 10 meters below the ridge from where it was flipped over other side of the ridge due to the impact force. See photo

iii. The measurements of the wreckage scattered area was about 250 meters long by 50 meters wide, with the wreckage aligned on a heading of flight path but on the other side of the impact point.

iv. The propeller and the nose section of the fuselage hit the ground first and then flipped over the other side of the ridge, landed at about 100 meter beyond other side of the ridge where its engine and wings assemblies were detached. The remaining part of the fuselage came to rest about 150 meters from the first impact point. (Refer Figure of crash site location Appendix)

Second Impact Place and LH Wing Assembly was detached here

RH Wing Assembly and detached engine assembly

Crushed Main Fuselage / empennage

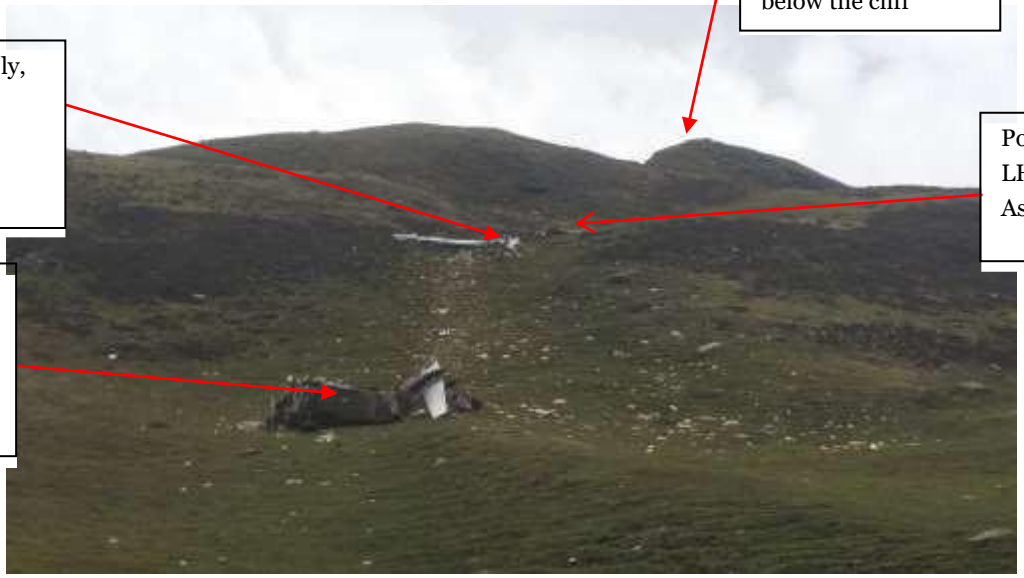
The place of First Impact where the detached propeller assembly was lying and part of belly pod scattered downside

First Impact at other side of the peak about 10 meters below the cliff

RH Wing Assembly, Engine Assembly and Crushed Instrument Panel

Position of LH Wing Assembly

Aircraft Fuselage with completely damaged Nose and FWD Cabin Section




Main Fuselage
RH Wing Assembly
LH Wing Assembly
Location of Second Impact
Propeller Assembly


First Impact

Detached Propeller Assembly

1.13 Medical and Pathological Information

1.13.1 Medical History of PIC

PIC was diagnosed with Neurocysticercosis (NCC) of brain in the year 2000 and then onward stopped flying. He was under medication till 2008. He applied for pilot licence again in August 2008. He was evaluated in detail by Civil Aviation Medical Board (CAMB) and cleared him for flying status. After 2010 he was never reevaluated for his history of NCC in any of the subsequent medical examination

1.13.2 Postmortem Report of PIC

Postmortem examination of PIC was conducted in Department of Forensic Medicine, IOM. The report suggested BLUNT FORCE INJURIES TO THE HEAD, CHEST, ABDOMEN AND SPINE as likely cause of death. Detail postmortem report of External Examination and Internal examination of PIC is attached in APPENDIX H

Blood sample was tested by Gas Chromatography/Mass Spectrometry (GC/MS) for common drugs including Amphetamines, Barbiturates, Benzodiazepines, Cannabis, Cocaine, and Opiates. The sample was negative for all the drugs analyzed.

Blood sample was also tested for ethyl alcohol by Head space-Gas Chromatography (HS-GC). The sample was negative for ethyl alcohol.

1.13.3 Postmortem Report of FO

Postmortem examination of the First Officer was conducted in Department of Forensic Medicine, IOM. The report suggested BLUNT FORCE INJURIES TO THE HEAD, CHEST, ABDOMEN AND SPINE as likely cause of death. Detail postmortem report is attached in APPENDIX I

Blood sample was tested by Gas Chromatography/Mass Spectrometry (GC/MS) for common drugs including Amphetamines, Barbiturates, Benzodiazepines, Cannabis, Cocaine, and Opiates. The sample was negative for all the drugs analyzed. Blood sample was also tested for ethyl alcohol by Head space-Gas Chromatography (HS-GC). The sample was negative for ethyl alcohol.

1.14 Survival Aspect

The accident was not survivable. The severe impact of the collision with the terrain led to the immediate death of both the cockpit crew.

1.15 Tests and Research

Engine of the crashed aircraft was collected from the crash site and shipped to Prat & Whitney (the manufacturer) for the investigation. Engine Investigation was conducted in the presence of Mr. Earl Chapman from the Transport Safety Board of Canada, who was assigned to act on behalf of the Investigation Commission.

The Report of Engine Investigation:

As per the preliminary report from the Pratt & Whitney, Canada, the engine does not show any evidence that could have precluded normal operation prior to impact. All gears and bearings were found in good condition and there was no evidence of compressor or turbine blade fracture. Some evidence of rotation on both the compressor and power turbine rotors at impact; rubbing marks were found on turbine disks and blades as well as all of the compressor components.

The amount of rotational signatures, however, is limited mainly due to the absence of significant structural deformation on the engine main housings and cases.

1.16 Human Factor

There were errors like misjudgment of weather phenomena and also violations of VFR Rules. Those errors and violations resulted in unsafe situations. Investigators are unable to determine whether such unsafe situation was developed by adverse weather conditions or as a result of the complacency created by the effect of hypoxia. There was also a possibility of psychological pressure to flight crews to continue their flight in spite of adverse weather conditions as other flights were going to complete their mission.

1.17 Organization and Management Information

1.17.1 MAKALU Air Pvt. Ltd.

According to the Operations Specifications issued by CAAN, Makalu Air is an operator authorized to operate commercial air transport service with non-schedule, charter and cargo flights by Cessna 208B aircraft within the territory of Nepal. At the time of accident, Makalu Air operated 3 Cessna 208B airplanes. Operational base of Makalu Air is Surkhet Airport, and having their Head Quarter at Kathmandu. All flights were planned and released from the Surkhet. Deceased First Officer of Makalu Air was the promoter as well as the Managing Director of the airline. Accountable Manager is the General Manager of the company. Most of the destinations served by Makalu Air were STOL airfields having no IFR operations.

1.17.2 Chain of Command

As per the Operations Manual of the company the General Manager is designated as the Accountable Manager. He has the total power of authority in the whole organizational set up. However in matters related with the flight operations, power of authority is delegated to Flight Operations Director. No Chief pilot has been designated. Deceased PIC of the accident aircraft was also designated as the Safety Manager. Operation Manual has specified the qualification of a Safety Manager to have at least 2 years' experience in the managerial work and must have undertaken a Flight Safety or Safety Management System Course. Deceased First Officer was the Managing Director of the company. He was also assigned the responsibility of the Corporate Safety Manager. Role of the Managing Director is not specified in the Operation Manual. However, it has been mentioned that the Corporate Safety Manager is the responsible person for monitoring the safety of the entire activities of the company which will be looked after by the Managing Director by interfacing with the Flight Safety Manager and the Quality Manager of the company. Operation Manual has specified the qualification of a Corporate Safety Manager as having a license in any aviation license or 10 years' experience in air transportation and must have worked in a managerial position for at least five years. Besides he also must have undertaken Safety Management Related course.

1.17.3 Flight Duty Time and rest

Makalu Air„s Operations Manual Part-A (provided to the Commission) has the following provision regarding Flight Duty Time Limitation: The maximum flight duty period in any period of 24 hours for pilots engaged in two-pilots operations shall be 13 hours of which not more than 10 hours for operations by aeroplane. The minimum rest period between two consecutive duty periods shall be 9 hours and if the preceding flight duty period was 11 hours or more, it shall not be less than 10 hours. Any period between two consecutive flight duty periods which is spent at a place where there is no facility for prone rest shall not qualify as a rest period. This differs with the regulatory requirement as provisioned in Flight Operations Requirement (FOR) of CAAN which reads as follows:

For STOL Operations: The flight duty period in any period of 24 hours for pilots engaged in two pilots operations shall be 10 hours of which not more than 8 hours of operations by airplane.

A day before the accident (on 15 May), the same crew set had their last flight landed Surkhet at 0555. So crew had a sufficient rest period of over 18 hours i.e. well within the flight and duty time limitations.

1.17.4 Pilot Training, Procedures and Guidance

Makalu Air has developed and designed Training Manual as per the Flight Operations Requirements (FOR) of Civil Aviation Authority of Nepal incorporating it in the Operation Manual Part D. The Manual is developed so as to provide required trainings to Makalu Air operations staffs, as spelled out in FOR to perform their assigned duties. The training include required initial ground and flight training including training relating to abnormal and emergency procedures.

The Operations Director is made responsible to ensure required training for all crew members and maintaining their records. Review of Makalu Air's Training Requirement is dealt in part 2 Analysis.

1.17.5 Oversight of Flight Operations

The CAAN approved Operations Manual (OM) of Makalu Air defines the procedures for the operations of aircraft in accordance with requirement prescribed by CAAN.

- *Audits*

It was observed that in-house audits were carried out on a regular basis.

Flight Operations

Due to the limited numbers of senior pilots, line pilots themselves are occupying the senior management posts of Operations Department.

Makalu Air has not established Flight Tracking System to monitor the progress and whereabouts of their flight

1.17.6 Accident / Incident Records

The accident aircraft 9N AJU was previously in ownership of Goma Air. It was sold by Goma Air to Makalu Air. While in the ownership of Goma Air this aircraft had met accident in Simikot Airport.

The Makalu Air's another Ce208B had crash landed in Humla, Karnali river on return leg from Simikot to Surkhet in 2017 June . Aircraft had engine failure. Two cockpit crew on board the flight could survive by jumping out of the cockpit into the river. The aircraft was still missing as it was flowed away by the river current. Contributory factors of the crash was reported to be inadequate adherence to SMS by Makalu Air, negligence in ECTM analysis, manipulation of TLP entries in regards to engine performance and Test/Local flights conducted by unauthorized pilots.

1.17.7 Status of SMS

Makalu Air has implemented Safety Management System (SMS). Lack of training especially to the managerial level, lack of data mainly due to the poor reporting culture, the absence of hazard identification and risk management in the regular basis had resulted in an ineffective safety management system of the Company. There was no adequate effort in the evaluation of cockpit crew by monitoring the pilots' behavior, adherence to SOP, and performance of individual pilots.

1.17.8 Operating Procedures

Makalu Air is permitted to operate only VFR flights. VFR flights can be operated only when following weather minima is met.

Table 7: Weather Requirement for VFR flights

	Airspace Class C	Airspace Class G	
Distance from cloud		Above 900 m (3000 ft.) AMSL or above 300 m (1000 ft) terrain whichever is the higher	At and below 900 m (3000 ft) AMSL or 300 M (1000 ft) above terrain whichever is higher
	1500 m horizontally 300 m (1000 ft.) vertically	1500 m horizontally 300 m (1000 ft.) vertically	Clear of cloud and in sight of the surface
Flight Visibility	8 km at and above 3050 m (10000 ft) AMSL 5 km below 3050 m (10000 ft) AMSL	8 km at and above 3050 (10000 ft.) AMSL 5 km below 3050 m (10000 ft) AMSL	5 km

1.17.9 Civil Aviation Authority of Nepal

Civil Aviation Authority of Nepal is the service provider as well as the regulating authority of aviation industry of the country. As a service provider CAAN operates and manages the airports and provides the air navigation services. As a regulator safety oversight is the responsibility of the CAAN. CAAN is also responsible for establishment and provision of search and rescue services within Nepalese territory in coordination with other agencies to ensure that assistance is rendered to persons in distress. Such services shall be provided on a 24-hour basis. Rescue Coordination Centre is setup at TIA, Kathmandu.

1.17.10 Ministry of Culture, Tourism and Civil Aviation (MoCTCA)

The Ministry is responsible for all civil aircraft operation under CAAN (Civil Aviation Authority of Nepal). Investigation of aircraft accident is the responsibility of the Ministry. It may set up an independent Accident Investigation Commission for carrying out the investigation of such accident and submit the report thereof.

1.17.11 Department of Hydrology and Meteorology (DHM)

The Department of Hydrology and Meteorology is the meteorological authority of Nepal that forecasts, analyses and disseminates weather report for aeronautical purpose. The meteorological service is provided as per ICAO requirement and guidelines.

1.17.12 Nepal Oil Corporation (NOC)

Nepal Oil Corporation Limited is a state-owned trading enterprise of Nepal to deal with the import, transportation, storage and distribution of various petroleum products in the country. NOC is the sole supplier of ATF for the air transportation service of the country. Sukhet NOC Depot has an established Quality Control Procedure of ATF. However, there is no procedure to keep fuel sample during refueling. Aircraft was refueled a day before the accident.

1.18 Search and Rescue (SAR) Operations

The SAR within Kathmandu FIR is organized by CAAN in collaboration with other governmental agencies. The SAR operation for 9N-AJU was activated once the communication between Simikot and Surkhet on HF was established and realized that 9N AJU was overdue. As the position of the aircraft could not be located from all the possible means, helicopters were activated for search and RCC was activated. As ELT signal of the ill fated aircraft did not activate, the search helicopters could not locate the crashed aircraft. It was only about two and half hours after the crash, the search helicopters could locate the crash site, based on the information provided by the local shepherds to the Simikot Tower.

Two local shepherds who reached the accident site immediately after the crash found two pilots already dead. One of the shepherds was carrying the cell phone. He called several persons he knows including emergency number 100 to inform about the crash. But due to the antennae coverage it took a considerable period for him by the time a local political figure could be contacted. Then search helicopters were informed of the location of the crash site through Simikot Tower. Shepherds also signaled the helicopters for the safe landing site.

1.18.1 Chronology of Search and Rescue

00:27	9N AJU departed Surkhet for Simikot , ETA 0110. Departure time was transmitted blind by Surkhet Tower as HF frequency was not readable and telephone was out of service.
01:25	Simikot and Surkhet were in contact on HF. Passed on departure of 9N AJT departed Simikot 0124 for Surkhet.
01:31	Surkhet provided departure of 9N AJU to Simikot.
01:47	Simikot informed Surkhet and Nepalgunj no contact with 9N AJU.
01:49	Realized 9N AJU was overdue and missing.
0158	RCC activated.
02:17	9N ALD departed Simikot for SAR
02:25	9N AJH D228 departed Simikot for Nepalgunj requested to look around the route for missing 9N AJU .
02:52	9N AHB departed Simikot for Nepalgunj also requested to search around the route for missing aircraft.
03:15	Nepalgunj Police informed Nepalgunj Tower crash site found. Location DhulaChaur, 4 hours walking distance NE of Bajura. Details not received.
03:19	RAN 33 departed VNKT for SAR.

03:27	Bhairahawa Tower received information that crews are safe and aircraft is at boarder of Bajura East of Simikot.
03:38	Information passed to IMCC Banglore.
03:44	9N ALD is on ground DhulaChaur for refueling.
04:10	9N AKB departed Simikot for SAR.
04:38	9N AKB located crash site. Location Bahun Khark
04:48	9N AKB landed at crash site 7.7 NM SE of Simikot Airport. Wreckage found. Aircraft hit at 12800 feet and broken into 3 pieces. Both crews passed away.

i.

1.18.2 Emergency Locator Transmitter (ELT)

ELT was not activated upon impact.

2 ANALYSIS

2.1 Introduction

Analysis of the accident was performed on the basis of available information. Discussions were held among the members and experts, especially on the possibility of the human factors, weather factors, technical factors, violation of regulations, conditions of crash site, possible effect of hypoxia and other likely causes.

The accident aircraft was not equipped, and was not required to be equipped, with a CVR and FDR. Aircraft was also not equipped with any real-time aircraft tracking device. There was no survival and no eye witness of the actual crash. So the investigators were not able to obtain exact information about the accident aircraft's position or altitude and not been able to develop an exact flight path. The retrieval of information from another potential source of data, the on board GPS (KLN94) memory chip, was also not possible as that was not crash-resistant and damaged upon impact. Investigators lacked information about the dynamic aspects of the weather the flight crew faced, visual cues of deteriorating weather, and how the flight crew reacted to the developing situation and worked with each other. In course of investigative enquiry with other pilots who had communicated with the accident aircraft while flying along the same route informed that the First Officer was communicating on RT. From that it could be guessed that Pilot-in Command was the "Pilot Flying" and First Officer was the "Pilot Monitoring". Under those circumstances, the commission adopted following approaches to determine the situation and probable cause of the accident.

2.2 Methodology

a) Interviews and discussions with the concerned pilots, officials and individuals.
b) Study and analysis of communication of the pilots of crashed aircraft with other pilots along the route.
b) Study and analysis of the crash site.
c) Examination and assessment of wreckages, related photographs and videos.
d) Study of the prevailing weather report received from different sources.
e) Study of technical documents related to the maintenance and operational history of the aircraft.
f) Study of personal files and details of the deceased flight crews.
g) Review of the CAAN regulations/requirements regarding flight operations.
h) Study of the autopsy report of the deceased flight crews.

2.2.1 VHF Communication

VHF Communication recorded on 118.3 Mhz of Nepalgunj Tower's Automatic VHF Recording revealed the following information: After leaving Surkhet valley at 0034 UTC, 9N AJU reported its position to Nepalgunj Tower. The accident aircraft had communication with other traffic on the same route proceeding to the same destination - Simikot. 9N AKE Dornier

which was from Nepalgunj when approaching West of Virgin Pass at 0036 UTC maintaining 12500 ft informed the accident aircraft that there was high cloud towards West of Virgin pass and advised to follow river track. Three minutes after that 9N AKE again informed 9N AJU - high level is not possible and advised to proceed from the low level provided they were not too late. In response, they replied - they will decide on reaching the spot. Another aircraft of the same Company 9N AJT which departed 5 minutes ahead of 9N AJU, informed 9N AJU at 0041 UTC that there was scary bumping 10 miles ahead of West of Virgin pass. The last contact of accident aircraft with Nepalgunj Tower was at 0044 when 9N AJU reported West of Virgin pass maintaining 11000 ft.

Above communication clearly indicate that the en route weather was not favorable. Pilots exhibited poor decision-making when they chose to continue and attempt visual flight rules flight in adverse weather conditions and can be guessed that led to an inadvertent IMC encounter. Conducting the flight under IMC definitely presented high risks. Furthermore, aircraft GPS terrain data was not updated. After the aircraft encountered IMC, the pilot became spatially disoriented and while climbing attitude hit the steep ridge. It was surprising to note that in spite of the information about deteriorating weather provided by the preceding traffics why the pilots were so motivated to accomplish the mission. The investigation identified that the Makalu Air lacked organizational policies and procedures to ensure that operational risk was appropriately assessed and managed both before and during the flight.

As per the ATS Officer on duty at Bajura Tower during the accident 9N AJU aircraft did not call Bajura Tower and Bajura also did not initiated call.

2.2.2 Enquiry with concerned pilots

In course of the investigation, the commission interviewed with all three pilots who had completed their flights to Simikot that morning. Among them, information from the PIC of Dornier 9N AHB which departed Nepalgunj at 0045 for Simikot (ETA 0121) had overtaken 9N AJU East Abeam Bajura approximately at time 0110 UTC was not recorded in Nepalgunj VHF. As 9N AJU was maintaining 12000 ft. 9N AHB climbed to 12500 ft., the pilot said. A significant point to be noted here is 9N AJU which departed Surkhet at 0027 and her ETA Simikot was 0112 was still around Bajura at time 0110 UTC, approximately 43 minutes after departure. As Simikot was still about 36 NM away from Bajura the accident aircraft could have been circling for more than 10 minutes in an attempt to penetrate the weather.

2.2.3 Weather Factors

It was quite evident that Prevailing Weather Report at the time of the crash obtained from different sources was not favorable. Interview with local shepherds grazing their sheep during crash had also verified that. In absence of authentic data source, it is difficult to understand why three other flights had successfully completed their mission going and returning back from the same route while the fourth one (9N AJU) had to meet the unfortunate accident. The weather pattern over mountainous terrain was very unpredictable, changing every minute.

That was evident from the weather advisory passed by 9N AKE, DO228 at time 0041 UTC - high level would not be possible, maintain low level provided they were not too late. At Simikot Pass all aircraft reported their position to Simikot Tower and started descent but 9N-AJU didn"t contact or tried to relay through other aircraft their position to Simikot. That might be because pilots were unaware of their position and the terrain ahead. They entered the cloud and got disoriented of the position losing the situational awareness.

2.2.4 Human Factor

2.2.4.1 Pilot In Command (PIC)

PIC started his professional flying career in 1996 as a F/O of HS-748/Ce-208 in NECON AIR. In the year 2000, he was diagnosed with Neurocysticercosis (NCC) of brain and stopped flying. It was reported that he was under medication till 2008 in close coordination with the Civil Aviation Medical Board. He applied for pilot licence again in August 2008. He was evaluated in detail by Civil Aviation Medical Board (CAMB) and cleared him for flying status. It was also found that he did not mention about his past medical history in self-declaration form during medical exams in 2010 and beyond. Subsequently he was never reevaluated for his history of NCC in any of the subsequent medical examination.

He joined Buddha Air for B1900D after medical clearance but soon after some time he left Buddha Air to join SITA Air and got type rating for Do-228. In the SITA Air he was upgraded to Captain after completing FAA ATPL. He was issued CAAN ATPL license. As the PIC of a Dornier flight, he had a crash in Simikot Airport on 1st June 2013. Aircraft was severely damaged however there was no fatality. After the crash, he left Sita Air and joined Nepal Airlines Corporation (NAC) on September 28, 2014.

In Nepal Airlines, he was selected for type training in Y12. However, after completion of all formalities to go to Harbin (China) for type training, he refused to go to China for an unknown reason. Then he was prepared for type training in Twin-otter in NAC. But again on the day of type exam, he left the examination hall without attempting the exam. He was out of flying from June 2013 to Sept 2017.

He left NAC and joined Simrik Air on 19 April 2017. However, shortly afterwards, on 2nd June 2017, he again joined Makalu Air leaving Simrik. After required ground classes and training on Ce-208B he got endorsement in his license on 18 Sept 2017. On 15 Oct 2017 after completing minimum required flying hours with instructor pilot he was cleared to fly with Copilots. Exactly 7 months after he obtained P1 rating in Ce-208, he met this unfortunate fatal accident.

He was found to be presbyopic in his medical exam in 2016 and was prescribed glasses. His last medical examination was done in August 2017, where he was again prescribed glasses for presbyopia. He however did not mention anything about his past medical history even in his last medical.

The career and jobs that PIC attained suggested that he was not a settled person and was not satisfied in any one place. He kept on changing his jobs and was never really settled. The accident he had in September 2013 seemed to have severely impacted his career and his thought process. He exhibited unstable nature and gave impression that he was not confident in whatever he was trying to do. There were many occasion when he backed out from last moment in professional front. It seemed that he had suffered from Post-Traumatic Stress Disorder (PTSD), though he was never evaluated by specialist regarding this symptom.

As PIC did not declare his preexisting medical condition and past history in annual medical examination, authorities did not evaluate PIC in detail about any neurological and psychological issues. He was also not evaluated regarding his stress after his previous accident before being made fit to fly again.

PIC was a non smoker and social drinker. He had no addictions to drugs. The blood samples were also negative for any substance abuse. He had adequate rest at home prior to this flight with official rest period of 18 hours. His flight duties did not suggest any cumulative fatigue and work load was managed well by the company.

2.2.4.2 First Officer (FO)

First Officer received his initial medical licence on August 2013. He completed Basic flying training from USA. After possessing Makalu Air he became Managing Director of the Company on 15th June 2017 and soon after he showed interest in active flying so on 02nd July he was appointed as a copilot in the company. As per the CAAN‟s guidelines and regulatory requirement he had been designated as Corporate Safety Manager on 8th Mar 2018. FO was prescribed glasses during his medical in 2016 and was under this limitation. His last medical was done on 4th September, 2017 and was valid till August 2018.

FO was sincere, efficient and hard working person. He was very focused in his career. He was really looking forward to becoming Captain and had around 100 hours of flying left to be eligible to be Captain. He used to discuss about becoming Captain with his friends and family quite often and this seemed his immediate short term goal. He seemed fairly satisfied with his job and was looking forward to long career ahead. He was married less than a year ago, and had no child yet. His father is chairman of the company he was flying.

First Officer was a social drinker and a smoker. He had no addictions to drugs. The blood samples were also negative for any substance abuse. He had adequate rest at home prior to this flight with official rest period of 18 hours. His flight duties did not suggest any cumulative fatigue and work load was managed well by the company.

2.2.5 Effect of Hypoxia

When 9N AHB DO228 had overtaken 9N AJU at 0110 UTC abeam Bajura. 9N AJU was maintaining 12000 feet. Distance from Bajura to crash site is almost 18 NM. Aircraft hit the sloppy terrain at 12800 feet. That indicated 9N AJU was above 12500 for a considerable period of time. Moreover, accident aircraft was getting the information from other traffic that the high level is not favorable. 9N AJU just acknowledged but did not comply with the advice of preceding traffic. The Preliminary Investigation Team who reached the accident site after the crash found the oxygen mask unused. That produced a doubt that perhaps the flight crews were affected by hypoxia, a feeling of wellbeing and overconfidence caused by lack of oxygen.

2.2.5.1 Oxygen Supply

As per CAAN Flight Operations Requirement para 4.3.9.1 (b) A flight to be operated at flight altitudes at which the atmospheric pressure in personnel compartments will be less than 700 hPa shall not be commenced unless sufficient stored breathing oxygen is carried to supply: the crew and passengers for any period that the atmospheric pressure in compartments occupied by them will be less than 620 hPa i.e. at 13000 feet.

Hypoxia or deficiency of oxygen occurs when the oxygen available is not sufficient to meet the needs of the tissues. Hypoxia is the most often experienced physiological hazard at high altitude. While the crew may not entirely succumb to the effects of hypoxia, their awareness and judgment can be affected in various degrees. In aviation, the greatest risk of hypoxia occurs with the fall in ambient pressure due to ascent to altitude. The brain tissues are most sensitive to lack of oxygen and the effects are similar to those of alcohol. The rate of onset of symptoms greatly depends on the altitude to which an individual is exposed and, to a lesser extent, on his own metabolism and physical wellbeing.

2.2.6 Flight Tracking

Makalu Air has no mechanism for monitoring the progress of their flight. In absence of a proper Flight Following mechanism and in the meantime lack of communication between airports due to the problem in the HF frequency, it took a considerable time for the concerned to understand about the missing aircraft. Later, only at time 0147 when HF communication was established between Surkhet and Simikot, it was realized that 9N AJU was missing. So exact time of crash could not be determined.

2.2.7 Human Factors Analysis and Classification System (HFACS)

The commission examined in-depth humanoid aspect of this accident based on the guidelines of HFACS framework to determine the primary factor or casual factor of this accident. A systematic analysis of the accident and interactions with concerned personnel of different

aviation organizations revealed some underlying problems of human factor associated with this accident as tabulated below.

Table : HFACS

PARAMETER	EVIDENCE	SOURCE	EFFECT	OTHER INFORMATION
1) Unsafe Acts				
Decision to continue in adverse weather condition	VHF recording	Causal/ Contributory	Significant effect in this accident	Risk taking
Skill Base error of Crew	PIC's long gap in flying and no training in case of inadvertent entry into IMC	Log Book records	Circumstantial	
Perceptual error	Loss of situational awareness	Casual	Causal	Spatial disorientation
Routine Violation	VFR Rules/Oxygen requirement	FOR/ Interview with other crews	Contributory	Usual practice
Lack of Risk Assessment and mitigation	Casually followed departure of previous flight	contributory	Contributory	Usual practice
2**) Preconditions for Unsafe Acts**				
Loss of Situational awareness	Spatial disorientation	Casual	Causal	Significant effect in this accident
Complacency	Oxygen was not used in high altitude	Oxygen Mask found unused	Possible effect of hypoxia	
GPS map data not current	Found on enquiry	On enquiry	circumstantial	
Mission not in accordance with rules/ regulations	VFR flight was continued in spite of deteriorating weather condition	ATC VHF Recording	Circumstantial	Usual practice
Failed to provide skill based training on simulator	Inadvertent entry into IMC	Training reports/ CAAN Requirement	Inability to take remedial action to exit from IMC	
3) Unsafe				

Supervision				
Lack of effective oversight by CAAN	Crew taking risk to complete flight in marginal weather condition	ATC VHF Recordings/ Interviews	Contributory	-No reliable HF communicatio n -ECTM
Lack of effective oversight by Operator	Failed to identify unsafe acts	Interviews/ recordings	Circumstantial	-Entering IMC in VFR flight -ECTM
Lack of flight tracking mechanism of the operator	observation	Took long time to locate crash site	Circumstantial	
4) Organizational Influences				
Lack of effective training for crew	Skilled based training on Simulator	Training record	Contributory	
Operational Tempo	Get-There-anyway. Other colleagues are going to complete their mission.	Interview Accident / incident records	Circumstantial	A psychologica l aspect of competitiven ess.
Lack of risk management	Lack of proper risk assessment before conducting the flight, Ineffective voluntary reporting system resulting to poor SMS	Safety Oversight Inspection Report	Circumstantial	
Non-functional ELT	No ELT transmission	ELT recovered at crash site	Took longer time to locate the crash site	
Inadequate ATS surveillance	Unreliable HF communication	Tower log books	None	

2.2.8 Engine Trend Monitoring System

2.2.8.1 FOR 5.4.2 states all single-engine turbine-powered aeroplanes engaged in commercial operations shall have an engine trend monitoring system, and those aeroplanes for which the individual Certificate of Airworthiness is first issued on or after 01 January 2005 shall have an automatic trend monitoring system.

2.2.8.2 Makalu Air's previous accident Investigation Team had showed their serious concern on negligence in ECTM analysis.

2.2.8.3 ECTM Program of Makalu Air:

2.2.8.3.1 Makalu Air has got the enrollment with CAMP for ECTM Trend monitoring and the ECTM trend graph are printed. But there are no ECTM Trend Analysis Report indicating the health status of the respective engines. There are no CAMP Recommendations available for the required maintenance if any for the respective engine and no information of maintenance activities taken which affect the ECTM trend. However, the Commission could find one email from CAMP regarding the entry of erroneous data in ECTM. There are high chances of such erroneous data entry in ECTM because of the data are being collected manually during the stabilized cruise flight.

2.2.8.3.2 The aircraft does not require to have FDR hence it does not have FDAU (Flight Data Acquisition Unit) which is required to collect all required data (engine parameters and other aircraft flight data) automatically with one push button switch (Event Record).

2.2.8.4 Other issues regarding Engine Health Monitoring:

2.2.8.4.1 Trend Monitoring of ITT Margin: The engine power assurance checks are being conducted every 100 hours to ensure that the engine parameters are within the required performance. But the trends of ITT margins are not being monitored which could be one of the handy information regarding the condition of engine.

2.2.8.4.2 Filter Patch Test as recommended by Engine Manufacturer PWC is not being practiced.

2.2.8.4.3 Monitoring of Oil Consumption: This is being monitored as an event wise in case of the engine oil top up requires significantly more and frequently. But it requires to have monitoring the oil consumption in flight hours average for certain period.

2.2.9 Training Factors

The Commission tried to collect and correlate, Makalu Air‟s past accident/incident records and explored the CAAN directives and advisories circulars issued to enhance the flight safety. The Commission conducted detail study of the training aspects and clearance process of the pilots. After several interactions with the pilots and other officials of the Makalu Air, the Commission concluded that the corrective actions initiated by the company was not adequate. Following are some of the lacking in training part noted by the Commission:

1. Once a pilot is designated as an instructor, there is no provision of periodic validation of their instructorship.

2. Despite two instructor pilots (IP) were available in the company, Makalu Air could not provide justifiable answer to the question why only one IP was found to be involved for training/check ride and clearance purpose. No Route Checks and Recurrent Trainings were found to be provided to any cockpit crew in the company.

3. **CFIT-Avoidance training:** In the Operation Manual, Part A, Makalu Air has recognized CFIT as the major cause for the hull loss in the Nepal's context. To address this issue though no separate CFIT-Avoidance Training is provided, the airline is conducting monsoon briefing to their operations staff every year.

4. **Inadvertent entry into IMC** Operation Manual, Part-A, emphasize the pilots to operate their flight remaining strictly within VFR minima. However, a clear cut guidance or procedure in case of inadvertent entry into IMC is not available.

5. **Simulator and Emergency Training:** Airline has not realized the need of scenario based simulator training to its pilots as it operate only VFR flights. This is also not within regulatory requirement. Moreover, company is also not providing regular emergency training to their flight crews. This is an apparent deficiency in training requirement. In absence of appropriate training pilots when unintentionally enter into IMC may not be able to handle safely at all time.

6. **CRM Training** Initial and recurrent CRM training is provided to its pilots by Makalu Air. According to the training material, a major focus of CRM training is to optimize communication among crew members and promote the flow of information for better decision making. The CRM includes "the coordinated efforts of all those involved in company operations to insure the safe completion of the flight; this includes: the pilot, mechanic, flight coordinator, ramp personnel etc." The CRM included the PIC‟s authority and the responsibilities for copilots, which included monitoring the captain, reporting concerns, learning from the captain, supporting and respecting the leader and the importance of teamwork. Makalu Air‟s general subjects module contained information about crew duties, but none of the training materials discussed about the inadvertent entry into IMC.

3 CONCLUSION

3.1 Findings

1. Both pilots were certified and qualified in accordance with the existing Nepalese aviation regulations to fly in visual meteorological conditions (but not in IMC). Both the pilots were in normal health condition and were certified as fit to fly.
2. The crew had adequate rest and the duty times within the prescribed guidelines.
3. The aircraft was maintained as per the existing rules and regulation. Pre-impact failure and other mechanical malfunctions were also not found.
4. There was no evidence of engine failure before impact.
5. There was no evidence of failure of aircraft's flight control, system, structures or power plant prior to the impact.
6. The crash site indicates no likelihood of lightning strike and icing. Besides no sign of unlawful interferences or explosives were observed.
7. Cargo loading for the accident flight was routine; no cargo loading anomalies were observed. There was no bulky cargo which might shift the CG of the aircraft and the airplane was operating within prescribed center of gravity limits as per load sheet and trim sheet.
8. Deficiencies in the last audit report of the Makalu Air's Safety Management System showed its poor implementation status.
9. As there was no communication between Simikot and Surkhet Airport, Simikot Tower was not aware of the departure and position of the accident aircraft.
10. On reaching Simikot pass, pilots usually provide position report to Simikot. The accident aircraft did not call Simikot even on reaching Simikot pass. So it could be assumed that the aircraft was lost and not sure of its position.
11. First Officer was handling the RT communication. So it can be assumed that PIC was PF and the First Officer was PM.
12. There was no sign of cross control of the flight.
13. En-route weather was not favorable. However, other three flights had completed their mission. This might have exerted psychological pressure to the accident aircraft to complete the mission in spite of the adverse conditions.
14. Aircraft was flying above 12500 for a considerable period and cockpit crew were not using oxygen.
15. In FOR, there is a clear provision for the renewal of Instructor pilot rated in multi engine STOL aeroplane but it does not reflect the provision for the renewal process for single engine aeroplane instructor.
16. Pilot had no scenario based simulator training in inadvertent instrument meteorological conditions and Emergency Training.
17. Although it is unlikely that the use of flight-tracking systems would have resulted in a different outcome in this case, the use of such systems, which provide real-time information regarding the accident aircraft, could shorten search times.

18. PIC was never evaluated for his previous medical condition of neurocysticercosis after recertification in 2009. PIC was also not evaluated for any evidence of post-traumatic stress disorder after initial crash in 2013 before recertifying.
19. PIC did not declare about his past medical history in the self-declaration page of medical examination form in subsequent medical examination
20. ELT was found at the accident site but the distress signal was not activated.
21. A crash-resistant CVR and FDR capable of capturing cockpit audio and images of the instrument panel and pilot‟s forward view would have benefitted the accident investigation by providing definite information on the cause of the accident. In absence of CVR and FDR, it was not possible to find out the final cockpit environment, communication between two pilots and the definite flight path of the aircraft.

3.2 Probable Cause

The Commission determines the most probable cause of this accident was to continue the flight despite unfavorable weather conditions resulting inadvertent flight into instrument meteorological conditions and there by deviating from the normal track due to loss of situational awareness that aggravated the spatial disorientation leading to CFIT accident.

3.3 Contributing factors

3.3.1 Possible effect of hypoxia due to flight for prolonged period in high altitude without oxygen supplement.

3.3.2 Ineffective safety management of the company which prevented the organization from identifying and correcting latent deficiencies in risk management and inadequacies in pilot training.

4 RECOMMENDATION

To the CAAN

1. Review the effectiveness of current training programs for single engine pilots and develop and publish best practices for such trainings.

2. Develop criteria for scenario-based training, including the use of flight training simulators, for pilots, to include inadvertent flight into instrument meteorological conditions and hazards unique to high altitude STOL operations that includes strategies for recognizing, avoiding, and safely escaping the conditions.

3. For any types of commercial operations by fixed wing aircraft, a pilot having recurrent training with IFR currency only be permitted to act as PIC.

4. Review/ specify a definite qualifications and training requirements for instructor pilots (IP). IP be strictly evaluated before being designated and also ensure their renewal at regular interval.

5. Evaluate the effectiveness of the essential management posts assigned to the cockpit crews as an add-on responsibility. Ensure that the operators do not compromise on the required qualifications and experiences for such posts.

6. Existing problem on HF Frequency and online weather camera installed at Simikot Airport be rectified at the earliest.

7. Develop an appropriate mechanism to deal with the post-accident trauma stress management for individuals involved in critical accident or incident and if necessary circulate necessary guidelines to airline operators.

To Makalu Air

1. Adopt an Effective Engine Health Monitoring Program which shall include the proper analysis of ECTM and have Periodic ECTM Analysis Report with the Engine Status. It should also carry out proper monitoring of Engine Oil Consumption, Filter Patch Test as recommended by engine manufacturer (PWC) in their maintenance manual and closely monitoring of Engine ITT Margin.

2. Conduct scenario-based training for pilots, to include inadvertent flight into instrument meteorological conditions and hazards unique to high altitude STOL operations.

3. Introduce a real time tracking of the aircraft in flight to enable continuous monitoring of the aircraft in flight.

4. Review and further strengthen the effective implementation of SMS process especially in the areas of improved reporting system, hazard identification and risk management and mitigation.

5. Ensure that the provisions of FOR including Use of oxygen is exactly complied by the pilots

To MoCTCA

As recommended by previous accident investigation commissions MoCTCA should establish an independent and effective aircraft accident investigation mechanism for the effective investigations and also for the continuous monitoring of the implementation and compliance-status of remedial safety measures.