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**NATIONAL
TRANSPORTATION
SAFETY
COMMITTEE**

AIRCRAFT ACCIDENT REPORT

Manunggal Air

Kamov K-32 Helicopter RA-31029

Wamena, Irian Jaya

11 June 1999



NATIONAL TRANSPORTATION SAFETY COMMITTEE
DEPARTMENT OF COMMUNICATIONS
REPUBLIC OF INDONESIA
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GLOSSARY OF ABBREVIATIONS

| | |
|--------------|--|
| AD | Airworthiness Directives |
| AGL | Above Ground Level |
| AMSL | Above Mean Sea Level |
| AOC | Air Operator Certificate |
| ATC | Air Traffic Control |
| ATPL | Air Transport Pilot License |
| CPL | Commercial Pilot License |
| CSN | Cycles Since New |
| CVR | Cockpit Voice Recorder |
| DGAC | Directorate General of Air Communications |
| DME | Distance Measuring Equipment |
| F/O | first officer |
| FDR | Flight Data Recorder |
| hrs | time (24 hour clock) |
| IFR | Instrument Flight Rules |
| IIC | Investigator-In-Charge |
| ILS | Instrument Landing System |
| kg | kilogram(s) |
| km | kilometre(s) |
| kts | knots (nm/hour) |
| mm | millimetre(s) |
| MTOW | Maximum Take-Off Weight |
| nm | nautical mile(s) |
| NTSC | National Transportation Safety Committee |
| °C | degrees Celcius |
| PIC | Pilot-In-Command |
| QFE | Height above airport elevation (or runway threshold elevation) based on local station pressure |
| QNH | Altitude above mean sea level based on local station pressure |
| RPM | Revolutions Per Minute |
| S/N | Serial number |
| TS/RA | thunder strom and rain |
| TSN | Time Since New |
| TT/TD | ambient temperature/dew point |
| UTC | Universal Time Co-ordinated |
| VFR | Visual Flight Rules |
| VMC | Visual Meteorological Conditions |

SYNOPSIS

The helicopter, with flight number II and internal cargo type of operation, departed from Wamena airport at 8.10 WIT (local time) with destination Mulia. The typical flight path in the area was flying through the mountain's opening or valleys to avoid the clouds. The aircraft last contact is at 08.15 LT with the Jayapura info. The weather report on the airport upon take-off is VFR permissible.

The investigation team consists of AAIC (Aircraft Accident Investigation Commission), with accredited representatives from Manunggal (operator), Trigana (AOC holder), Avialift (the aircraft owner), and Russian Interstate Aviation Committee. The team was supported by:

1. Government of Wamena.
2. Regional office of the DOC.
3. Military district 1702.
4. Wamena Airport operator.
5. Ministry of Communication of Irian Jaya province.

1 FACTUAL INFORMATIONS

1.1 History of Flight

The helicopter departed from Wamena airport at 8.10 WIT (local time) with destination Mulia. The estimated flight time was estimated 35-40 minutes. On-board the aircraft were 3 Russian crews and 1 Indonesian crew (loadmaster), 2 Indonesian passengers, and 3,000 kg of rice being carried internally. The aircraft carried fuel for 2 hours flying. The aircraft failed to reach Mulia. The last contact was at 08.20 LT to Wamena tower. It reported that RA-31029 established contact with Jayapura info and leaving Wamena frequency. The typical flight path in the area is flying through the mountain's opening or valley to avoid the clouds. The place of the crash is a valley with altitude of 9,200 ft and surrounded with high terrain of 12,000 ft. In front of the flight path was a mountain/an obstacle with approximately 10,200 ft elevation. The helicopter entered the area with approximate heading of $\pm 280^{\circ}$. From the last contact with Jayapura info, the crew told that the helicopter tried to maintain 10,000 feet altitude. The helicopter heading of the crash site was approximately $\pm 130^{\circ}$.

The coordinate of the impact site is 03.48.43 S/138.30.72 E.

1.2 Injuries to Persons

| Injuries | Crew | Passengers | Others | TOTAL |
|-------------|------|------------|--------|-------|
| Fatal | - | 1 | - | 1 |
| Serious | - | 2 | - | 2 |
| Minor/ None | 3 | - | - | 3 |
| TOTAL | 3 | 3 | - | 6 |

1.3 Damage to Aircraft

The front right leg of the second pilot's canopy was broken in the upper part. The airframe has smooth concavity on the entire airframe surface along frame #4A. Two right longitudinal stringers were broken along tail lower part of the right pilot door (near frame #6).

The cargo cabin ceiling was deflected downward along frame # 7-9. The cargo cabin floor has the same deflection directed upward between frames #4 and #7.

The right part of the airframe was severely crimped along frame # 7-9. The upper longitudinal and sidelong stringer was deflected in this area.

The rotor blades have multiple fracture across blade's spars, and parts of the blades were dispersed around the helicopter.

Tail beam was separated from the helicopter body along the frame # 20. The tail collars and rudder were torn on the surface.

The engine air inlets have large indents along the circuit. Input distributor and blade wheels have multiple dints. The input ducts were clogged with leaf and branches.

The filling nozzle and pipeline of the right fuel tank #1 were broken.

The airframe was broken along the frame #20. The helicopter tail section was separated from the body and lying beside the helicopter.

Tail collars and rudders were torn on the surface.

1.3.1 Steering System

Cyclic pitch lever was located at the standard place in vertical random position. The right collective pitch lever head was in random position (30 degrees upward); the left handle was broken at the horizontal walking beam. All connecting rods of longitudinal, lateral, and directional steering system were screwed. Some of them were deflected and damaged.

Rudder section of the vertical stabilizer was broken along the frame #20 (in airframe breakage point).

All connecting rods of the main rotor mast were twisted.

1.3.2 Landing Gear

The landing gears were completely sunk in the ground; visual assessment was impossible.

1.3.3 Fuel System

The filling nozzle and pipeline of right fuel tank #1 were broken. Indications of kerosene leakage from the fuel system on the ground have not been discovered.

1.3.4 Gear Box

The gearbox has no visual damages. The magnetic tap was open; oil was missing.

1.3.5 Main Rotor Mast

The flap stoppers and lead-lag hinges were broken.

1.3.6 Engines

Engine inlet and compressor blades have multiple dents. The input ducts were clogged with leaves and branches.

Oil drain valves were open; oil was missing.

1.3.7 Radio and Electrical Equipment

Batteries, electric modules, devices, indicators have no visual damages.

1.4 Other Damage

Some trees around the impact area were cut by the main rotor.

1.5 Personnel Information

1.5.1 Cockpit Crew

1.5.1.1 Pilot-in-Command

| | | |
|-----------------------------|---|------------------------------------|
| Gender | : | Male |
| Date of birth | : | 31 August 1956 |
| Nationality | : | Russian |
| Marital status | : | Married |
| License | : | Airline (helicopter) pilot license |
| Type rating | : | Kamov 32-C |
| Date of last medical | : | 24 April 1998 |
| FLIGHT TIME | | |
| Total time | : | ± 6,520 hours |

This make & model : 2,712 hours
Last 90 Days : 99 hours
Last 72 Days : 31 hours
Last 24 Hours : 1.40 hours
This flight : 30 minutes

1.5.1.2 First Officer

Gender : Male
Date of birth : 27 January 1948
Nationality : Russian
License : Airline (helicopter) pilot License
Type rating : Kamov 32-C
Date of last medical : 12 February 1999
Total time : ± 14,345 hours
This make & model : 2,712 hours
Last 90 Days : 93 hours
Last 72 Days : 31 hours
Last 24 Hours : 1.40 hours
This flight : 30 minutes

1.6 Aircraft Information

1.6.1 Aircraft Data

Registration Mark : RA-31029
Manufacturer : Kumartau
Country of Manufacturer : Russia
Type/ Model : Helicopter Counter Rotating Kamov 32C
Serial Number : 6104
Date of manufacture :
Certificate of airworthiness :
Issued : 20 June 1999
Certificate of registration :
Issued : 8 April 1998
Category :
Crew (Cockpit/Cabin) : 3
Pax seats : 16
Airframe hours : 2,209.09 hours

Last Major Inspection : 04 June 1998
 Hours since last inspection : 23.47 hours

1.6.2 Engine Data

Engine Type : TV3-117
 Manufacturer : ISOTOV
 Type/ Model : TV3 117BK
 Serial Number #1 : 7087871003098

- TSN : 1327.48 hrs
- Time Since Inspection : 20.45 hrs
- Time Since Overhaul : 177.73 hrs

Serial Number #2 : 7083711100005

- TSN : 234.82 hrs
- Time Since Inspection : 20.45 hrs
- Time Since Overhaul : New

1.6.3 Weight and Balance

| | |
|------------------------|-----------|
| Empty weight | 6,495 kg |
| Oil, lubricants | 90 kg |
| Fuel (1,800 liters) | 1,440 kg |
| Crew (3 persons) | 240 kg |
| Passengers (3 persons) | 240 kg |
| Service cargo | 150 kg |
| Payload cargo | 3,000 kg |
| <hr/> | |
| TOTAL | 11,655 Kg |

1.7 Meteorological Information

There are no data available for the en-route. The only meteorological data available is the one from Wamena weather station.

Wind : Calm
 Visibility : 10 km
 Weather : Haze
 Cloud : 5 F cm - 300 (ft)

| | | |
|-------|---|---------------------------------------|
| TT/TD | : | 18 ⁰ C / 15 ⁰ C |
| QNH | : | 1011.1 ins |
| QFE | : | 838,0 ins |

1.8 Aids to Navigation

The helicopter integrated navigation system is composed of:

1. Airborne radio equipment of automatic short - range radio navigation and landing system A-340-CB-BOPT
2. Compass system GREBEN-2
3. Doppler navigation π BCC-32
4. Airspeed transmitter π BC-21
5. Automatic direction finder APK-19

1.9 Communications

The communication facilities provided on the helicopter include the following equipment:

1. Intercommunication and switching equipment n-510
2. High-frequency radio set YARDO - 1X1 ;
3. Main and backup VHF radio set BALKAN -5 ;
4. Recorder MC-61M

The equipment control elements are arranged on the overhead and central consoles, on the additional instrument board and cyclic pitch control stick.

1.10 Aerodrome Information

Last take off from :

| | | |
|-------------------------------|---|---------------------------------------|
| Airport Name | : | Wamena |
| Airport Identification | : | WAJW |
| Airport Operator | : | Angkasa Pura |
| Runway Direction | : | 154 ⁰ and 334 ⁰ |
| Runway Length | : | 1,500 m |
| Runway Width | : | 30 m |

1.11 Flight Recorders

1.11.1 Flight Data Recorder

The flight data recorder BYP - 1 - 2B is designed for recording and collecting flight data and for their storage in case of flight accident.

The time of continuous operation is 15 hours. The time of data storage in the protected recorder unit (3BH) is (50-10) h.

The time of readiness for operation after engagement is not in excess of 3 min at an ambient air temperature from +60 °C to -40 °C and 15 min at a temperature from 40 °C to minus 60 °C.

The data recorder is powered from the source of the 27-V DC. It comprises of:

1. Flight data collector unit BCnH-4 ;
2. Control panel HY-25 ;
3. Protected recorder unit 3BH-1 ;
4. Transmitter and matching devices.

The magnetic flight data recorder recorded the flight parameter and discrete commands. The number of recorded parameters is up to 25, of recorded discrete command up to 48.

The serial of the FDR is 70347 and pin number is BUR-1.

1.11.2 Cockpit Voice Recorder

The serial number of the CVR is 990735 and the pin number is P-503.

1.12 Wreckage and Impact Information

The helicopter was lying on a sloping surface of mountain among the residuals of trees cut off (by local and army) after the helicopter crash. The cut-off trees were about 60 ft height. The helicopter was lying horizontally along the longitudinal section in the direction of approximately 120 degrees and slightly tilted to the right along the lateral section. The altitude of the accident site is 9,000 feet above sea level.

1.13 Medical and Pathological Information

| CREW AND PASSENGER | MEDICAL STATUS |
|--------------------|------------------------|
| Pilot 1 (PIC) | Chest injury |
| Pilot 2 (F/O) | Chest and leg injury |
| Flight Engineer | Leg injury |
| Load Master | Died (after evacuated) |
| Passenger 1 | Backbone injury |
| Passenger 2 | Backbone injury |

1.14 Fire

There are no sign of pre or post impact fire on the aircraft.

1.15 Survival Aspects

See 1.13

1.16 Test and Research

Test and research done were :

- Captain pilot flight report/interview
- Flight officer flight report/interview
- Flight engineer flight report/interview
- Ground engineer report /interview :
 - Avionics engineer interview
 - Mechanical & structural engineer
- The interview with Trigana & Manunggal management
- FDR and CVR readout

1.17 Organizational and Management Information

| | |
|--------------------------|---|
| Aircraft Owner | : Vladivostok Air |
| Address | : Avialift Vladivostok Airport, 41 Portovaya Street 692800 Rusia |
| Aircraft Operator | : PT Manunggal Air |

The parties involved in the operation were PT Trigana, Avialift, and PT Manunggal. PT Manunggal was listed as the operator. However, since it does not hold an AOC as helicopter operator, PT Manunggal hired PT Trigana, which is a helicopter AOC holder to join the operation. It should be noted that PT Trigana did not have "rating" for Kamov helicopter. Avialift was the aircraft owner, which subleased the aircraft and its crew to PT Manunggal.

Only two contracts existed. Those are between PT Manunggal and Avialift, and between PT Trigana and PT Manunggal. There were no contract that bounds PT Trigana and Avialift.

The contracts mentioned that Avialift was responsible for quality control (the technical aspects of the operation), while PT Manunggal and PT Trigana were responsible for monitoring and supervising the operation, in addition for PT Manunggal being responsible for logistic of the operation. The contract also mentioned that the operation would be done according to Avialift and PT Trigana BOM.

1.18 Other Information

None.

2 ANALYSIS

2.1 Engineering

2.1.1 Wreckage analysis

The fuselage was crushed by the weight of its engine and gearbox during the impact. Some parts of the fuselage were buckled and the cockpit windows were shattered due to large deflection. The heavier buckling mode occurred on the right side of the helicopter. This indicates that the direction of the crash may not be perpendicular to the ground. Instead it was tilting a little bit to the right.

The damages on the rotor blades show that the blades were damaged by excessive static loading in the direction from leading edge to trailing edge. Some of the blades were pulled back on their drag hinges. These and the broken flap stopper indicate that the blades still rotated upon impact and hit another object.

The tail was broken in the cantilever bending type damage. This indicates the damage happened upon impact. The connecting rods to the vertical tail moveable back section were broken. The surface torn of the tail collars and rudders are likely due to hit with the surrounding trees upon impact.

The fact that the engine inlet (input ducts) were clogged with leaf and branches show that the engines were still running during impact.

2.1.2 Cockpit indicators

1. Airspeed (horizontal speed) indicator pointed to 13 km/hr. Radio altimeter showed number of 13 (m?) or beyond the range. The artificial horizon shows 30° bank angle; however another artificial horizon shows a lot less banking.
2. The altimeter's short needle pointed to 9.6 while the long needle pointed to 6.6. Vertical Speed Indicator shows 0 m/s. The Ground Speed Indicator pointed to number of 5. This indicates that the impact happened at relatively slow speed.
3. The engine & rotor RPM indicate 0 rotation. The turbine gas temperature shows number of 650° C on both engines. The engine 1 and engine 2 oil pressure & Temperature indicate 0 pressure and -50° C temperature. These indicate that the pilot had time to shut down the engine after impact.
4. The fuel indicators show that the R/H tank has more fuel (indicated 70) than the L/H tank (indicated 10). The difference is due to the leak in the L/H fuel tank caused by impact.
5. The oil pressure on main gearbox is indicated zero. The indicator was set to zero as the engines were shut down.
6. The fuel valves are opened for both engines, and the throttle is pulled backward.

2.1.3 Impact Site Analysis

By the time investigators arrived to the location, some of the trees around the aircraft have been cut down to give access to the Search And Rescue Team to evacuate the survivors. Only little sign of the surrounding trees that clearly indicate they were damaged by the impact of aircraft fell onto them or they were hit by rotating blades. The fact that the wreckage was distributed only at small area (radius of 10 m) indicates that the aircraft fell almost straight down.

2.2 Operations

2.2.1 Weight and Balance Analysis

Since the limit weight for internal load is 3,500 kg and the weight of the cargo during the flight is 3,000 kg, therefore, during the flight, the cargo weight is within the prescribed limit.

The helicopter take-off weight was 11,655 kg, based on the data presented in paragraph 1.6.3.

According to the information from Kamov Helicopter Enterprise (ref. No. 03-90/1919 dated 09/10/99), KA-32 RA-31029 helicopter was produced as KA-32 C-type (designed for use on board of vessels). This type has several differences as compared to KA-32 T-type (empty weight - 6,495 kg): it has higher empty weight (7,010 kg), no dust-protective devices, and different radar-set. However, according to the request of the operator, Vladivostok Air, the following equipment was dismantled from the helicopter:

| | | |
|-----|---|--------|
| (1) | Units C55, 1C58, 1C571, control panel GPK-52 and sensor with brackets | 45 kg |
| (2) | Ballonets | 210 kg |
| (3) | Hoisting and rescue equipment | 138 kg |
| (4) | External Sling | 90 kg |
| (5) | Heating ducks in cockpit and cargo compartment | 25 kg |
| (6) | Electric cables and main rotor current collector | 10 kg |
| (7) | De-icing system liquid | 15 kg |
| (8) | Life raft PCN 25/30 around frames 9-11 | 90 kg |

According to the above equipment layout, the helicopter's empty weight totaled 6,495 kg, trimming \pm 79 millimeters ahead of main rotor rotation line, total take-off weight (including fuel weight of 1,440 kg) totaled 11,665 kg.

The take-off weight of KA-32 helicopter is limited to 11,000 kg by the applicable Flight Manual based on landing gears endurance. In spite of engine power surplus, exceeding of take-off weight in these circumstances is strictly prohibited. Increased min rotor thrust computed by nomographs can be used only when transportation on external sling is performed (the prohibition is set due to limited landing gear endurance).

Thus, during flight preparation procedure a deviation from maximum take-off weight requirements specified in Helicopter Flight Manual occurred, nevertheless it could not affect the flight performance.

2.2.2 FDR Analysis

The helicopter took off from the landing pad at 23.09.47 UTC. The helicopter was hovering for approximately 10 seconds at altitude of 8 meters and simultaneously turning rightwards of the take-off course 330° to the flight course 315° with brief fixation at the course 145°. This was done to evaluate serviceability of helicopter units and systems. The action was sufficient for experienced pilot to evaluate operational condition of helicopter systems and check helicopter loading factor and trimming.

Even though the flight was the second flight on the day and having the same load factor and fuel quantity, formally, this flight fails to have registered hovering, which is a violation of Chapter 7, article 7.7, paragraph 7.77 of Aircraft Piloting Instruction CA-85. Determining the balancing value of pitch angle (for estimation of trimming) or estimating the trimming by position of steering systems was impossible (KA-32 Flight Manual, Chapter "Limitations").

To climb, propeller pitch was increased to 15° and engine power to 99.7-99.9%. This decreased the main rotor rotation speed from 89% to 88%, which is within the permissible range according to the Flight Manual. At the same time the crew increased the rightward roll to the maximum of 19°, decreased tangage angle to 10° (within 30 seconds) with subsequent smooth increase to 0°.

The first stage of speed and altitude increase started at 21.10.00 UTC. Propeller pitch started decreased after this stage to reached 11.8-11.9° at 23.10.52 UTC and remained stable afterwards. The position of propeller pitch handle set the turbo-compressor (N1) rotation to 95-95.6% that is approximately the same as the II-type cruising speed (KA-32 Flight Manual, paragraph 8.1.2). Main rotor rotation speed remained stable at 91.5%.

The vertical speed was 8 m/sec in the beginning of aircraft climb, then decreased to 3 m/sec and remained stable until the altitude of 2,750 meters. When altitude of 3,000 meters was reached, the recording of altitude stopped, which most possibly occurred because the crew turned off the radio altimeter. The switching off of the radio altimeter was an improper action since aircraft altitude above ground level data is a necessary additional information for the crew during flights in mountainous regions.

The airspeed cannot be obtained from BUR1-2B data due to malfunctioning on the recording channel. The completion of 2,750 meters climb concurred with aircraft position past the control point Pyramid (point of mandatory report to aircraft dispatcher), which was confirmed by flight course changing. Distance of this control point from the airport was approximately 30 km, time from take-off (23.10.00) to the moment of passing the Pyramid point (at 23.22.30 recorded at the aircraft left roll) is 748 seconds thereby determining the average flight speed as 140-150 km/hour. According to the conclusions of investigation commission and general weather patterns, the wind in the flight region was minor from which it can be assumed that airspeed is close to the actual. Taking into consideration the altitude (1,650 - 2,750 m), the airspeed was 120-130 km/hr, which is within the permissible range for climbing.

The aircraft trimming was 170-210 mm ahead of main rotor rotating axis, which corresponds to the medium range and complies with KA-32 Flight Manual requirements.

At 2,750 m altitude angle of roll and pitch angle were close to the equilibrium. Longitudinal steering deviation was 1.9° that corresponds to steering stick movement of 75 mm. When aircraft trimming was in the medium range (approx. 170-210 mm) the corresponding value of aircraft speed is 130-170 km/hr. Flight course at the altitude of 2,750 m was about 305-310°.

From 23.22.30 to 23.30.10 the flight continues at the average altitude of 2,750 m. Altitude deviation was ±15-25 m which was within the permissible range especially if the crew changes flight course. The turn was made with little roll from 307° to 290° direction. This decision was made to change the course to the left (to the south) from 295° to the one with better weather conditions.

From 23.30.10 the crew started climbing because there was a mountain pass of 3,100 m (10,400 ft). Safe altitude above the mountain was 3,700 m (12,100 ft), according to the report of the PIC. Plot 1a (altitude) shows change in barometrical altitude during the aircraft climb. Until 23.35.45 climbing was done with constant propeller pitch of 11.5°, main rotor rotation speed was 91.5%, turbo-compressor rotation speed was gradually increasing during the climb at the rate of 0.5% within 5 minutes (N21 & N22 plot 1a). The climbing was done by an increase in tangage angle, which is confirmed by equal change in pitch angle (pitch angle at plot 1a).

It was calculated that the aircraft speed decreased from 110 km/hr at 23.34.00 to 85-90 km/hr at 23.35.45 (when the rotor rotating speed and accordingly the engine power was increased), that was the result of increase in the pitch angle during climbing (resulting a braking effect). To reach the same climbing performance/rate at lower speed, KA-32 would need significantly higher engine power. In order to get the same climb performance at 80-90 km/hr speed as it is at speed of 130-150 km/hr, the power need to be increases by 15-25%.

Here, the vertical speed margin was less than 5 m/sec for aircraft of any weight at 85-90 km/hr. Therefore, the crew made the mistake in choosing appropriate climbing mode to reach the safe altitude over the mountain. The mode performed resulted in braking (reducing aircraft speed), which resulted in increase in required engine power.

At 23.35.45 the crew increased propeller pitch to 12.5° and then at 23.36.20 to 15.3° . By these actions, the crew increased engine power to the nominal (96% and 97% of turbo-compressors) and decreased propeller rotation speed to 91%. The pitch angle simultaneously decreased to -5° to ensure increase in aircraft speed. However, from 23.35.30 the crew continued spiral climb, which undertook, at first, a 12° left-bank turn (from 270° to 180° flight course) and then a 27° right-bank turn from 180° to 40° flight course. The most possible reason for such deep bank was the crew's belated decision to make a necessary turn. Altitude over and distance to the obstacle was small and further decreased by wrong decision to make left-bank turn. It is to be noted that the bank angle of more than 20° is prohibited at altitudes over 1,000 meters.

During aircraft bank the vertical speed decreased by 1.1 m/sec. At 23.36.40 the aircraft most probably came into the descending air current (downdraft), which is indirectly confirmed by the sharp increase in propeller pitch up to 19° . This caused the engine power to increase to the upper take-off limit of 99%; main rotor rotation speed decreased to the minimum limit of 83%. The main rotor thrust must have decreased due to stalling at the root sections of main rotor blades, which inevitably occurs at these large pitch angles. [According to the Expert at Meteorological Research Center of Russian Federation (ref. No 5/16 dated 09/09/1999), the vertical speed of air in compensatory descending air currents could reach 5 m/sec in lower atmosphere above the crash site]

2.2.3 Flight Technique

Interpretation from PIC report and interview

1. The PIC as the pilot flying had never flown over the area before. Vladivostok Air SOP stated that a route check should be performed prior to flying over mountainous area with maximum load. Therefore, the flight crew did not comply with the company's SOP.
2. In spite of the fact that the accident flight was the second flight of the day and having the same load factor and fuel quantity, the flight crew should perform hovering for estimation of cyclic trimming as stated on Chapter 7, article 7.7, paragraph 7.77 of Aircraft Piloting Instruction CA-85. Although this did not contribute significantly to the accident, the flight crew's failure to perform such procedure is a violation of the flight procedure.
3. The climbing mode chosen, which initiated by reducing forward speed, resulted in increase of required engine power for the same climb performance. The most optimum forward climbing performance can be reached at horizontal speed of 130-150 km/h. By decelerating to speed of 80-90 km/h, the required engine power increases 15-25%, which was not available for such altitude and load configuration.
4. It is probable that the crew decision to make turn was too late that they were forced to make deep bank to avoid obstacle. Bank angle of more than 20° is prohibited at altitudes over 1,000 meters, as it made the A/C lose its much needed lift.
5. The PIC 's attempt to recover from loss of rotor RPM by quick "down and up" movement on collective lever was probably not a suitable action for this condition.

Such action would only remedy normal blade stall. However, if the blades stalled due to autopilot reaction to downdraft, this action will not remedy the stall. The proper action to recover from downdraft is by nose down and moving away from the ridge. However, at the time, the height from the ground was too low since the crew was forced to avoid cloud to maintain VFR.

2.3 Organizational / Management

1. The parties involved in the project are Trigana, Avialift and Manunggal.
2. Manunggal as operator and project manager, Trigana as AOC holder, and Avialift as the aircraft owner.
3. However, there are only two contracts existed. Those are between Manunggal and Avialift, and between Trigana and Manunggal. There are no contract that bound Trigana and Avialift. There are no contact between Avialift and Trigana, while Trigana is the AOC holder in the project. Since Trigana do not have any contract with Avialift, every contact from Trigana to Avialift have to go through Manunggal. The difficulty arises as all the function of control have to be mediated.
4. According to Manunggal, they are only responsible for the logistic of the operation, while the technical aspect of the operation is solely done by Avialift. Therefore, Avialift is responsible for the quality control. Manunggal and Trigana only monitor and supervise the operation, as mentioned in article no 9 # 4 of the contract.
5. It is regulated that to become AOC, Trigana do not need rating for Kamov, since its responsibility is solely to supervise Avialift to operate according to Indonesia's laws.
6. On the contract between Manunggal and Trigana, it is mentioned that Manunggal has to operate according BOM and flight manual of Trigana and Avialift. However, this term was not applied, due to lack of communication between Trigana and Avialift.
7. How far supervision that Trigana does on the operation and exactly what kind of check that Trigana did on the operation was not clearly determined. It is seemingly that there are overlapping on the responsibility of control on the contract. However, on the field, there are some holes on supervision, so that, nobody in-charge to remind the captain about the route.
8. The contract between Manunggal and AOC (Trigana) was made monthly. Therefore, there was time when the contract did not applied. As the AOC holder, Trigana is responsible **on** the control of maintenance and operation. Trigana has tried to make the program. However, since the time of the contract is always very short, the program never went into place. The short-term contract has very high risk on the safety. (contradict w/ Manunggal-Avialift contract on maintenance art 4 # 1).

3 CONCLUSIONS

3.1 Event Links of Occurrence

1. Low clouds, adverse visibility. Absent of ground support for instrument flight, the A/C flew close to the ground to maintain VFR.
2. In finding alternative way, the A/C went into unfamiliar route in the absent of accurate contour map.
3. Face 12,000 feet obstacle (box valley).
4. Decided to make spiral climb to the right, but initiated by making left turn, therefore wasting horizontal clearance from the obstacle.
5. A/C too close to the ridge.
6. Deep right bank.
7. Downdraft.
8. High blade pitch hike due to autopilot's reaction to down draft.
9. Blade stall, loss of lift.
10. Propeller RPM dropped.
11. Further stall.
12. Quick "up and down" on collective to remedy the stall, which was not the correct action to escape from the downdraft.
13. Aircraft crashed.

3.2 Findings

1. The investigation team did not found any indication of engineering failure contributed to the mishap.
2. The A/C load is within its prescribed limit for flying on the altitude.
3. The KA-32 Flight Manual did not include procedures for flying close to the ridge and experiencing downdraft.
4. The crew violated the flight manual on establishing cyclic trim, and company SOP on alternative route check.
5. The main cause of the accident was the crew flight technique in trying to go over 12,000 ft ridge with high payload.
6. The contributing factors of the accident were the adverse weather that forced the crew to fly close to the ground and the crew failure to perform alternative route check.
7. Another contributing factors of the accident are the absent of ground supports for instruments flight and the absent of accurate contour terrain map.
8. Latent safety threat in the accident is the lack of comprehensive contracts between the three parties involved in the operation. Lack of comprehensive contracts made Trigana do not have a proper communication protocol to supervise Avialift.
9. Another latent safety threat in the accident is the difficulty in communication between the parties involved in the operation due to most of Avialift crew did not speak English.

4 RECOMMENDATIONS

1. It is recommended that ground support for instrument flight installed around Jayawijaya area, since the frequency of flight is high and the natural challenges are extreme (high altitude, severe weather).
2. It is recommended that accurate terrain contour map be established for Jayawijaya area, since the frequency of flight is high and the natural challenges are extreme (high altitude, severe weather).
3. It is recommended that the data on weather en-route around the area be collected in a meteorology database and the crew designated for such mission be briefed on the possible conditions.
4. It is recommended that the crew designated for such mission be trained in special procedure involving extreme natural condition.
5. In the absent of ground support for instrument flight and accurate terrain contour map, alternative route check must be conducted for flying in the area.
6. It is recommended that the DGAC made extra supervision on the contracts in the case where the operation involved aircraft in which the Indonesian AOC do not have the rating and there is a potency for language barrier.

APPENDICES

APPENDIX A – PICTURES



Picture 1. Structural and Surrounding Area Damages



Picture 2. Damages on the rotor blades indicating rotation at impact



Picture 3. Static loading damage on the tail

APPENDIX B – FDR PLOTS



