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ROYAL GOVERNMENT OF BHUTAN
MINISTRY OF INFRASTRUCTURE & TRANSPORT
THIMPHU: BHUTAN



FINAL ACCIDENT INVESTIGATION REPORT

ON

A5-BHT (EC130 T2 / H130, MSN:8160)

HELICOPTER

OPERATED BY DRUKAIR HELICOPTER SERVICES

OCCURRED

AT

WACHEY- LUNANA, GASA, BHUTAN

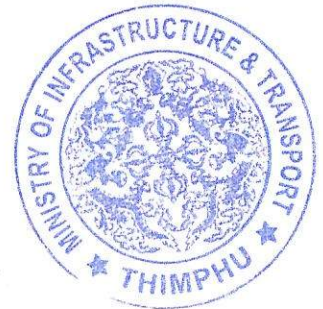
ON

03 MARCH 2023

PREPARED BY:

***AIR ACCIDENT INVESTIGATION UNIT
MINISTRY OF INFRASTRUCTURE & TRANSPORT
ROYAL GOVERNMENT OF BHUTAN***

January 23, 2024





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GLOSSARY

| | |
|----------------|---|
| AAIU | Air Accident Investigation Unit |
| AOC | Air Operator Certificate |
| BCAA | Bhutan Civil Aviation Authority |
| BEA | Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile |
| CPL | Commercial Pilot License |
| DoAT | Department of Air Transport |
| ECU | Engine Control Unit |
| EDR | Engine Data Recorder |
| ELT | Emergency Locator Transmitter |
| EPC | Engine Power Check |
| HOD | Head of Division |
| ICAO | International Civil Aviation Organization |
| IGE | In Ground Effect |
| LT | Local Time |
| MAUW | Maximum Usable Weight |
| MEL | Minimum Equipment List |
| MSN | Manufacturer Serial Number |
| MTOW | Maximum Take Off Weight |
| N ₁ | Gas Generator Speed |
| N ₂ | Power Turbine Speed |
| NCHM | National Centre for Hydrology and Meteorology |
| MoIT | Ministry of Infrastructure and Transport |
| NR | Main Rotor Speed |
| OAT | Outside Air Temperature |
| OGE | Out of Ground Effect |
| OM | Operations Manual |
| P3 | Combustion Chamber Pressure |
| RBHSL | Royal Bhutan Helicopter Services Limited |
| SACAA | South African Civil Aviation Authority |
| T45 | Turbine Temperature |
| VEMD | Vehicle and Engine Multifunction Display |
| VFR | Visual Flight Rules |
| XPC | Collective Lever Signal |





INTRODUCTION

The accident was notified to the Air Accident Investigation Unit (AAIU) under Ministry of Infrastructure and Transport (MoIT) at 16:44 hours by the helicopter operator on 3 March 2023.

The following day, the investigator from the AAIU travelled to Wachey to secure the site and initiate the investigation. Subsequently, an investigation team was formed by the MoIT Minister with the members comprising from Bhutan Civil Aviation Authority (BCAA) and Department of Air Transport (DoAT), with the AAIU investigator leading the team. After publishing the preliminary report, the investigation team was disassembled and the AAIU was tasked with developing the final investigation report.

In accordance with the provisions of ICAO annex 13, France (state of design and manufacture) had appointed an accredited representative from BEA who was assisted by advisers from Safran (engine manufacturer) and Airbus (helicopter manufacturer).

The sole objective of the investigation is to prevent future aircraft accidents and incidents. It shall not be the purpose of this investigation to apportion blame or liability.





SYNOPSIS

At 14:25 (Local time) on 3 March 2023, the A5-BHT Drukair helicopter with four passengers and a pilot crashed during the short final approach at Wachey, Gasa. Two passengers onboard received fatal injuries while two other passengers and the pilot survived with minor to serious injuries.

The weather condition on approach as per witness/pilot was fine with scattered high cloud base with a good visibility of more than 10 kilometers. There were no adverse weather conditions like rain and snow but light variable winds are common at that time of the day (in the afternoon).

The pilot and the two passengers were airlifted the following day to the Jigme Dorji Wangchuck National Referral Hospital (JDWNRH). Both the pilot and the child suffered serious injuries while the adult passenger sustained minor injuries.





1. FACTUAL INFORMATION

1.1 History of the flight

On 03 March 2023, the A5-BHT helicopter of Drukair Helicopter Services was operating local chartered commercial flights between Khuruthang (Punakha) and Lunana (Gasa). The first trip on 03 March 2023 was operated between Khuruthang and Thango and thereafter, four trips to Wachey. Departing from Paro helipad at approximately 09:30 local time (03:30 UTC), the helicopter landed at Khuruthang around 09:47 local time (03:47 UTC). Subsequently, at about 10:17 local time (04:17 UTC), it took off from Khuruthang for its first trip to Thango.

The accident occurred during its fourth flight towards Wachey from Khuruthang with the pilot and four passengers onboard. During its final flight, the helicopter took off from Khuruthang at 14:08 LT (08:08 UTC) and had the flight duration of 16 minutes 35 seconds before it crashed at 14:25 LT (08:25 UTC) about 200 metres north-east of the intended landing site. The flight adhered to the Visual Flight Rules (VFR) under Visual Meteorological Conditions (VMC).

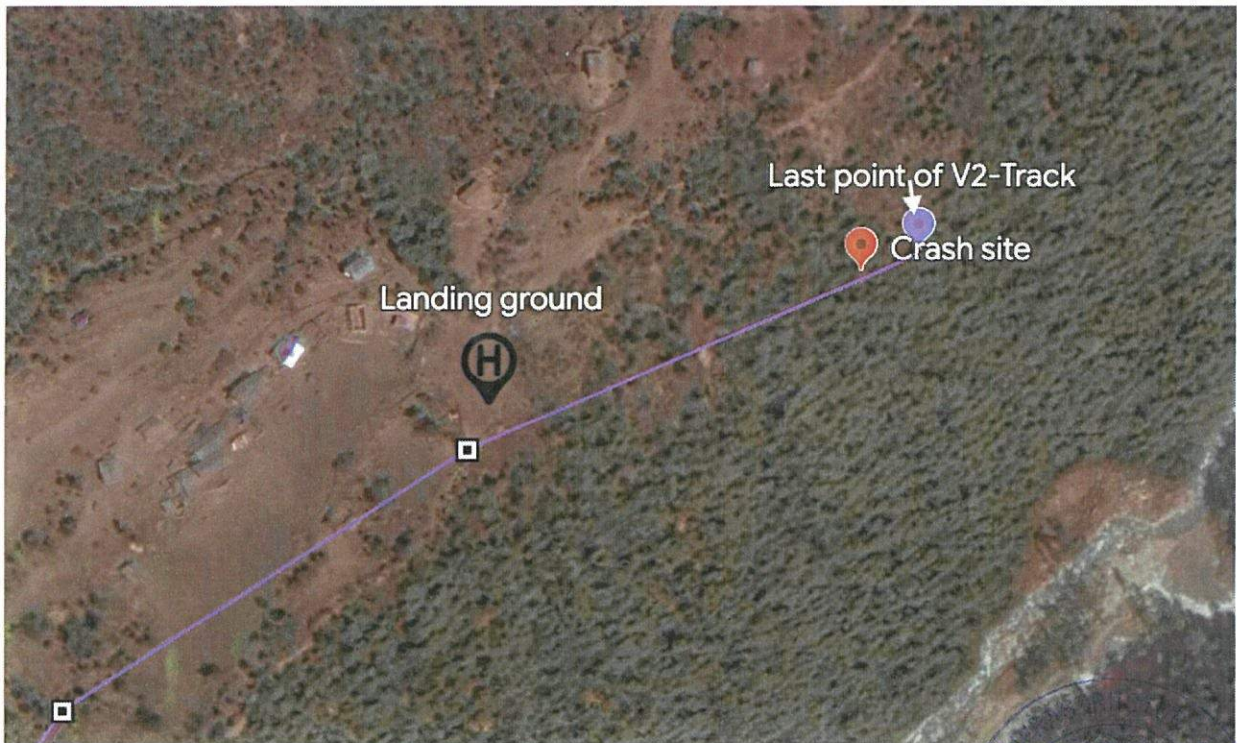


Fig 1: Helicopter crash site at Wachey, Lunana.





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Fig 2. Crash site

The Helicopter was on its short final approach at Wachey when it crashed about 200 meters north-east of the landing site at nearby ridge of coordinate N28°00'34" E089°59'53" at an altitude of about 3880 meters above mean sea level (AMSL). At the crash site, the helicopter was destroyed with two fatalities and three survivors.

| | |
|---------------------------|---|
| Date of Flight | 03 March 2023 |
| Aircraft Registration | A5-BHT |
| Aircraft Type | EC130-T2/ H130 |
| Type of Operation | Local Chartered/Commercial Operation |
| Last Point of Departure | Khuruthang, Punakha, Bhutan |
| Time of Departure | 08:08 UTC (14:08 LT) |
| Point of intended Landing | Wachey, Lunana; 28°00'32.4"N 089°59'45.6" at 3901.44 meters AMSL |
| Time of Accident | 08:25 UTC (14:25 LT) |
| Flight rules | Visual Flight Rules (VFR) |





1.2 Injuries to Persons

| <i>Injuries</i> | <i>Crew</i> | <i>Passengers</i> | <i>Others</i> |
|-----------------|-------------|-------------------|---------------|
| Fatal | 0 | 2 | 0 |
| Serious | 1 | 1 | 0 |
| Minor/Non-fatal | 0 | 1 | 0 |

1.3 Damage to Aircraft

The aircraft was destroyed.

1.4 Pilot Information

| | |
|------------------------|---------------------------------------|
| Nationality | South African |
| License Type | Commercial Pilot License (Helicopter) |
| License No & validity | CPL/H/08, Expiry date: 30-12-2023 |
| Flight hours in Bhutan | 467.5 FH (since 01 January 2022) |
| Abroad flying hours | 3053.3 FH |
| Total Flight Hours | 3520.8 FH |
| Medical Certificate | Class 1 - Expiry on 31/01/2024 |

The maximum allowable daily flight time for each pilot is 8 hours and at the time of accident the pilot has accrued about 2.7 hours of flight time. The pilot said that he felt well rested and he did not experience fatigue on the day of the accident. The pilot has been on flight duty for 6 days straight from 26 February 2023 till 3 March 2023.

The pilot had a Commercial Pilot License (CPL) issued by the South African Civil Aviation Authority (SACAA) on 11 January 2011. His South African Commercial Pilot License no. 0272335035 has been converted to Bhutanese license no. CPL/H/08 after completing his induction training as per the company's Operations Manual (OM) and passing the Airlaw Examination conducted by the BCAA. The BCAA verified the pilot's license with the SACAA, and a drug test was conducted by the BCAA before granting the Bhutanese license.





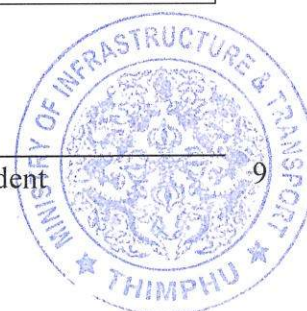
1.5 Aircraft Information

The A5-BHT helicopter is a single-engine aircraft powered by Safran Arriel 2D engine. It was manufactured in the year 2015 and registered in Bhutan on 30 October 2015. It was purchased by the erstwhile Royal Bhutan Helicopter Service Ltd. (RBHSL) and maintained by the same maintenance organization since that time.

At the time of the occurrence, the helicopter had accumulated approximately 3205 hours of total flight time. Engine overhaul (replacement) has been carried out on 17 November 2021 where the old engine with MSN 50555 (3031.7 Engine Flight Hours) has been replaced with new engine with MSN 53048 (51.43 Engine Flight Hours).

The last engine power check (EPC) before the accident has been carried out on 1 March 2023 (at power on number 7123 and flight number 7236) and it was found satisfactory and the CRS has been issued. During the time of the accident, the helicopter frame has accrued about 3205.7 Flight Hours while the engine has accumulated 717.1 hours. Vision 1000 cockpit camera has been removed for maintenance under Minimum Equipment List (MEL) Category D on 1 March 2023. As per the Operations Manual (OM), it has to be installed within 120 days from the day it has been declared inoperative. Being in MEL Category D, the helicopter can operate without the camera onboard since it doesn't result in any adverse safety issues.

| | |
|--|--|
| Model | EC130T2/ H130 |
| Manufacturer | Airbus Helicopters |
| Registration | A5-BHT |
| Seating capacity | 7 including pilot |
| Manufacturing Serial Number (MSN) | 8160 |
| Engine Make and Model | Safran, Arriel 2D Turbomeca |
| Certificate of Airworthiness | Valid Until 25 November 2023 |
| Entry into Service | 30 October 2015 |
| Certificate of Release to Service (Line Maintenance) | 600 Flight Hours Check on 05 December 2022 & 150 Flight Hours Check on 24 February 2023 (CRS: No: 902 & 903) |
| Type of Fuel Used | JET-A1 |
| Flight Hours (FH) | 3205 FH |
| Engine Hours since the last engine overhaul done on 17 November 2021 | 717 EH |
| Maximum Take Off Weight (MTOW) | 2500Kg |





| | |
|---|-------------------|
| Weight and balance of the accident flight on 03 March 2023: | |
| 1. Actual weight & balance | 2070 Kg |
| 2. IGE MAUW | 2198 Kg |
| 3. OGE MAUW | 2082 Kg |
| 4. Temperature | 7 degrees Celsius |
| 5. Altitude | 3901.44 m |

IGE- In Ground Effect, MAUW- Maximum Usable Weight, OGE- Out of Ground Effect

1.6 Meteorological Information

Typically, the operator obtains weather data from the prescribed Windy TV App, reviewing the weather forecast provided by the National Centre for Hydrology and Meteorology (NCHM), and gathering visual information from locals. This information is assessed by both pilots and ground staff before the aircraft takes off from the Paro base.

According to the pilot, on 03 March 2023, the weather en-route to Wachey was favorable with a high cloud base, broken or scattered clouds, suitable wind condition and a good visibility of more than 10 kilometers. The wind direction is assessed by using the prayer flags near the landing site. Overall, the Pilot reported that the weather was suitable for Visual Flight Rules (VFR). The temperature conditions are being recorded continuously from every landing and the temperature at the landing site was recorded as 7 degrees Celsius from the previous trip to Wachey.

Also, the NCHM forecasted partly cloudy weather for Gasa District on the day of the accident. Moreover, the satellite images showed scattered low cloud cover all over the country and no weather warnings were issued by NCHM on 03 March 2023.

1.7 Landing Site Information

| | |
|-------------|--------------------------------|
| Name | Landing site at Wachey, Lunana |
| Coordinates | 28°00'32.4"N 089°59'45.6" |
| Elevation | 3901.44 meters |





Fig 3. Landing site, Wachey

1.8 Aids to Navigation

The helicopter relies on the onboard GPS system and visual references of the surrounding as navigation aids.

1.9 Communications

Communication and coordination between the flight crew and ground staff are facilitated through mobile networks.





1.10 Recorded Information

1.10.1 Engine Data Recorder (EDR)

EDR data download of A5-BHT helicopter with engine serial no. 53048 has been performed by the French BEA team and sent to Safran Helicopter Engine (manufacturer) for analysis. EDR is not similar to a black box found on fixed wing aircraft, but it is a light non-protected recorder that exclusively records data sent by the Engine Control Unit (ECU), in a non-volatile memory component for maintenance purposes.

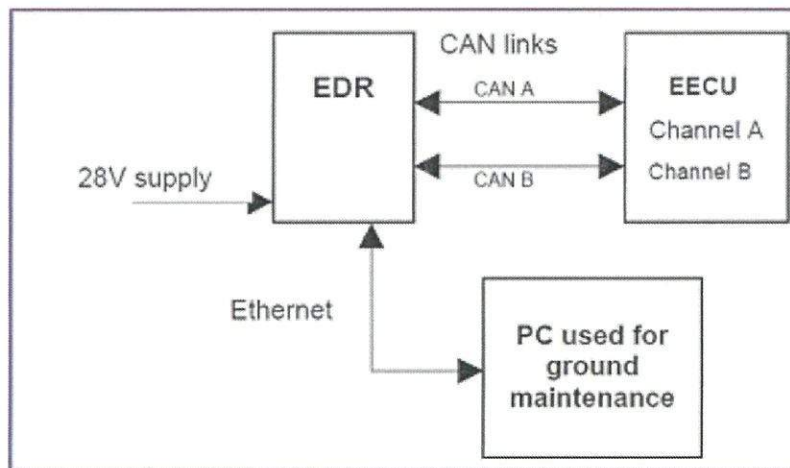
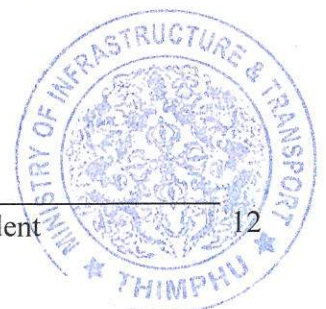


Fig 4. EDR (French BEA)

The EDR's recorded data includes *continuous recording*, *context recording* and *failure flags* for both channel A and B. Continuous recording records the engine parameters at a sample rate of 1 second for the last 50 hours of the operation. Context recording, on the other hand, records the engine parameters when discrepancies or over-limits occur at a sample rate of 20ms for a short duration. Each context can record up to 8 seconds of operation around the time of discrepancy.

All recordings are identifiable with a power-on number and the time elapsed since the EDR was powered. Based on the power-on number, it is possible to determine the data associated with the most recent flight.

The EDR was visually examined and was found in good condition. Subsequently, decided to perform a direct readout with the manufacturer software. The readout generated the following dump file: *DUMP_ENG53048_9580119130_EDR03233_20230417_163607.dmp*. It was then converted to generate continuous and context recording file, failure flags file, engine power check file, overlimits file and errors file.





a. Continuous recording



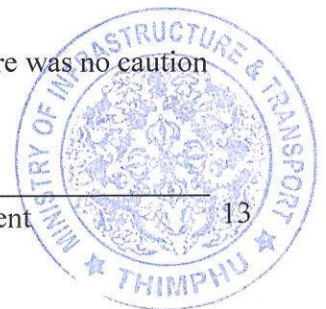
Fig 5. EDR Continuous recording (Safran)

The graph depicted above shows the continuous recording of EDR recorded in the Channel A (graph from channel B was quasi-identical). The time indicated in the graph corresponds to the EDR time, which may differ from the actual flight time. The continuous recording contains about 17 minutes 15 seconds of recording after the ECU power on, and approximately 16 minutes 35 seconds of flying time.

The EDR Continuous recording contains the following parameters:

- Gas generator speed (N1)
- Power turbine speed (N2)
- Turbine temperature (T45)
- Torque
- Main rotor speed (NR)
- Collective lever position (XPC)
- Aircraft altitude (1/P0)

The “1/P0” value gives an indication of the variation in aircraft altitude. There was no caution recorded during this recording.





b. Context recording

The channel B contained 5 seconds of context recording, which was analysed. The context recording started 36 seconds after the end of the continuous recording. The context recording consists of the following engine parameters:

- Main rotor speed (NR)
- Gas generator speed (N1)
- Power turbine speed (N2)
- Torque
- Turbine temperature (T45)
- Collective lever position (XPC)
- Combustion chamber pressure (P3)
- Engine's fuel flow target (WF Cons)
- Fuel control system's actuator (XR)

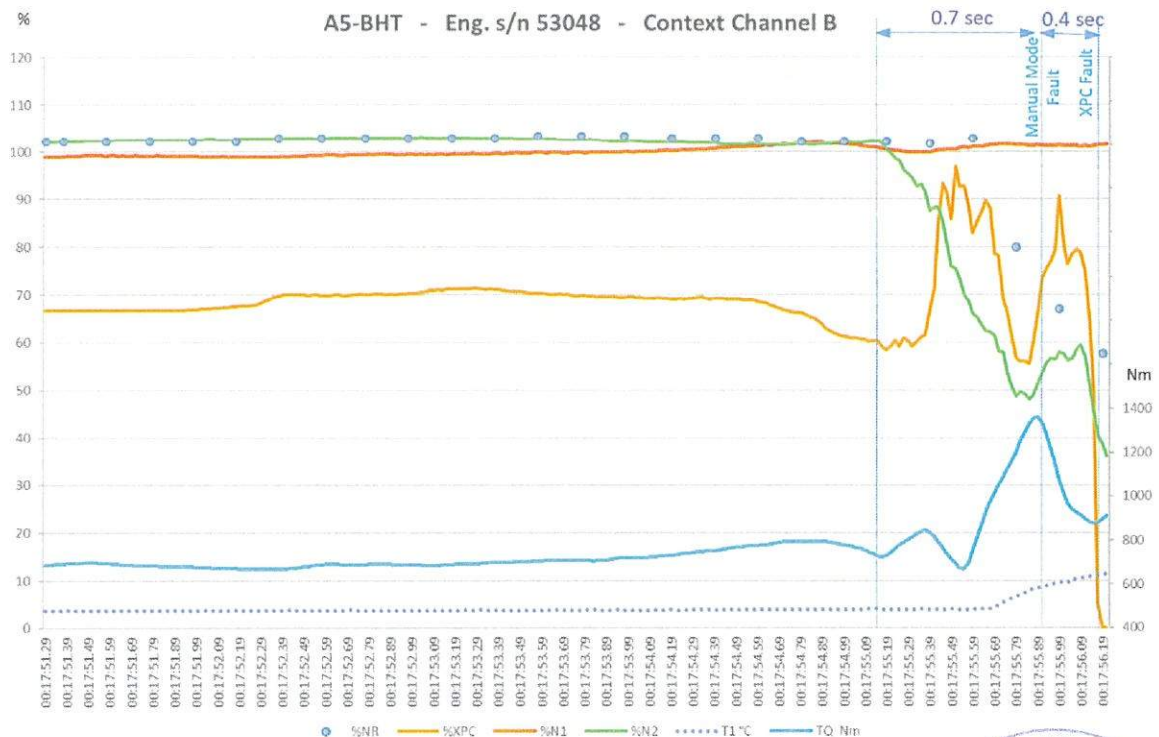
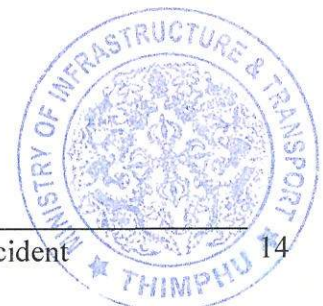


Fig 6. EDR context recording (Safran)



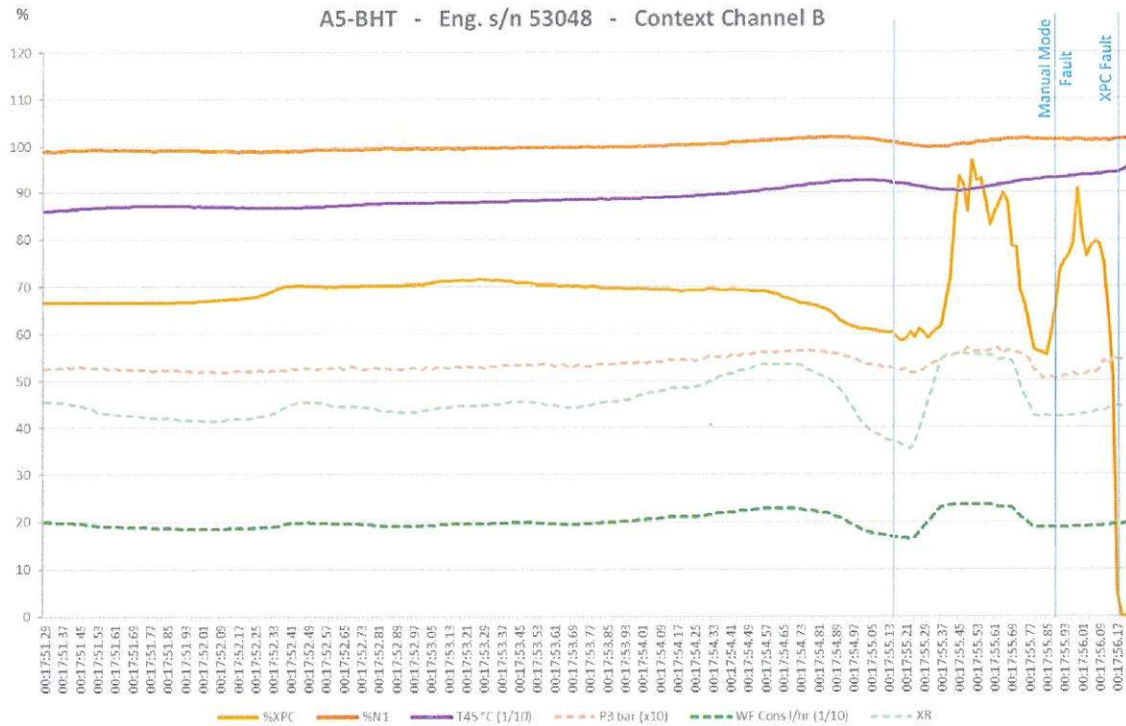


Fig 7. EDR context recording (Safran)

1.10.2 V2-Track

The V2Track is a GNSS tracker, uses both cellular and satellite communications to send recorded positions of the aircraft in real time to the operator. By default, the device sends the recorded position through cellular communications. When cellular connectivity is lost, it switches into satellite mode. Typically, positions are sent every 10 or 15 seconds in cellular mode and every 2 minutes in satellite mode. Last tracking points can be recovered from the V2Track internal micro-SD card.

The V2Track was visually examined and the files were recovered by the French BEA. The back connector was damaged and the plastic casing was cracked at the top. The front of the computer was opened and the internal micro-SD card was removed. The SD-card was tested for short-circuit and no anomaly was detected. The card was connected to PC and the following files were recovered:

- 58.dat
- 59.dat
- 60.dat
- 61.dat
- 62.dat
- 63.dat
- 64.dat
- 65.dat





- 66.dat
- 67.dat
- 68.dat
- 69.dat
- 70.dat

A total of 13 missing data points has been recovered and the files were sent to manufacturer (V2-TRACK) for decoding. The following files were generated:

- Flight track data points: *A5-BHT Last Flight.pdf*
- Trajectory in Google Earth format: *v2track Export 1 Plotted Trips 16-11-39 UTC+12.kml*
- Flight track data points as csv: *v2track Trip Data - A5-BHT Friday 3 March 2023 447062832.csv*

1.10.3 Vision 1000

The helicopter is typically equipped with Vision 1000, which was not present onboard, on the day of the accident, since it was removed for maintenance (Removed on 01 March 2023, declared inoperative under MEL category D). The Vision 1000 device collects inertial and positioning data, ambient acoustic data and cockpit imagery, which are stored on a crash-hardened memory module, as well as a removable secure digital card. Vision 1000 is also critical in supporting accident investigations – helping Airbus Helicopters to construct its innovative Enhanced Virtual Environment (EVE), which provides investigators with a virtual pilots-eye view of what happened.

1.10.4 Engine Control Unit (ECU)

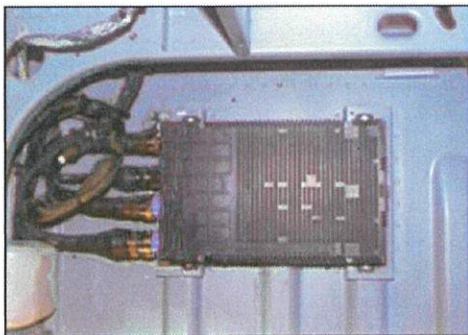


Fig 8. ECU (BEA)

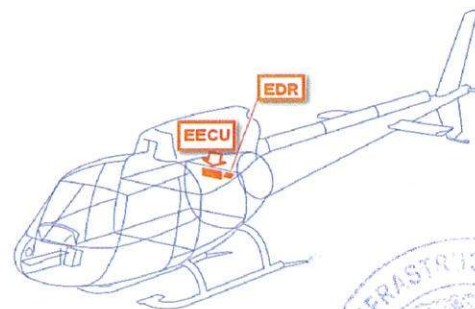


Fig 9. Location of ECU (BEA)

The ECU is a dual module computer which performs fuel regulation and engine parameter management. Each module records engine parameters, logical words and failure flags. Engine parameters are continuously recorded at a sample rate of 1 second (continuous recording) and



at a sample rate of 20 ms for a limited duration when the failure occurs (context recording). Engine parameters are periodically sent to the EDR. ECU is connected to the VEMD and the major failures, concerning the fuel regulation function are transmitted by the ECU to the VEMD.

The ECU was visually examined by the French BEA and was found in good condition. Since the data recorded in the EDR was fully recovered, no further work was performed on the ECU, as it would not contribute further insights to the investigation.

1.10.5 Vehicle and Engine Monitoring Display (VEMD)

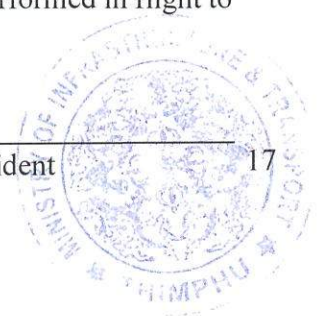


Fig 10. VEMD (BEA)

The VEMD is a multifunction screen installed on the instrument panel and designed to display flight data and engine data. The VEMD is a dual module system and in each module, failure information associated to the flight parameters can be stored on a non-volatile memory component for maintenance purposes. The relevant VEMD data for accident investigations are:

- Flight reports
- Failure messages with associated parameters
- Overlimits reports (overlimits are not dated).

The VEMD also records the last 8 Engine Power Checks (EPC) that are performed in flight to check the engine health according to the maintenance and flight manuals.





The VEMD was visually examined and found damaged. It was crushed on the back and the top of the casing. The screen was in good condition. Since EDR data was fully recovered, no further work was performed on the VEMD as it wouldn't bring anymore insights for the investigation.

1.11 Wreckage and impact information

The helicopter crashed down the ridge after truncating three trees about a quarter length from the top and fell down about 10 meters below the first impact point. The helicopter uprooted another fir tree while it fell down after its first impact.

The wreckage was found at the base of two trees with the tail boom separated from the main body and a broken piece of one of the main rotor blades was found about 3 meters above. The main wreckage was located at the base of two trees, with right side of the skid buried in the ground while the left was being wedged against the tree trunk. There were few traces of fuel leakage near the fuel port but no traces of fire. The front windshield sustained complete damage, and the main impact was taken by the main rotor blades and the tail boom, which got separated from the main body. There was no evidence of pre-impact failure or detachment. All the damages to the structure and main rotor blades are consistent with the impact with the trees and the ground.

The GPS coordinates of the crash site are as follows:

- latitude: 28°00'34'' N
- longitude: 089°59'53'' E at an altitude of about 3880 meters AMSL.





Fig 11. First probable impact of the helicopter

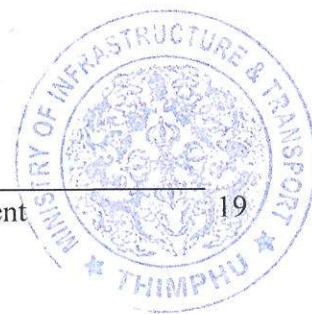


Figure 12. Wreckage of A5-BHT at the crash site.

1.12 Medical and Pathological information

During the crash, there were two fatal injuries, two serious injuries and one adult with minor injuries. One adult and a child suffered a fatal injury and upon visual assessment by the local Health Assistant (HA), it was concluded that the cause of death for both the passengers were head trauma. Both of them suffered severe head injuries with profuse bleeding for the adult and no major bleeding for the child.

All three survivors were airlifted and treated at the JDWNRH, Thimphu. According to their medical report, the pilot survived with closed fracture of right radial and ulna shaft with multiple laceration over his legs. Drug test was carried out immediately when he was evacuated to the JDWNRH, Thimphu, by the designated medical examiner of BCAA and he tested negative. The young child survivor has her left forearm splinted and the final diagnosis was closed fracture of left distal radial and ulna. The adult occupant who survived was tested for any signs of internal injuries and he didn't have any serious injuries.





1.13 Survival aspects

Injured passengers and crew members were rescued from the crash site and subsequently, medically evacuated to Jigme Dorji Wangchuck National Referral Hospital (JDWNRH) in Thimphu. The injured passengers and one crew member were reported to be in stable condition and were later discharged.

Two passengers received fatal injuries from the initial impact. The severity of these injuries might have been mitigated, had the passengers been equipped with some form of head protection device, such as high-impact-resistant helmets. All the occupants in the front seats have received the most injuries while the adult in the rear seat was spared with minor injuries. All the passengers and pilot had their seat belts intact even after the impact.

1.14 Organizational information

The helicopter was being operated by the Drukair Helicopter Services which has their base operation at Paro International Airport. Initially, it was operated under Royal Bhutan Helicopter Services Limited (RBHSL) and the RBHSL was merged with Drukair in December 2022 to operate as Drukair Helicopter Services with different Air Operator's Certificate (AOC) for the rotorcraft.

The air traffic services in Bhutan are provided by the Department of Air Transport (DoAT) and the weather information being provided by the National Centre for Hydrology and Meteorology (NCHM). All the air operators and the air navigation service providers are regulated by the Bhutan Civil Aviation Authority (BCAA). The Air Accident Investigation Unit (AAIU) under Ministry of Infrastructure and Transport (MoIT) conducts investigations into aircraft accidents and serious incidents.

1.15 Examination and readout

The investigation team had retrieved helicopter critical equipment such as Engine Data Recorder (EDR), Vehicle and Engine Multifunction Display (VEMD), Engine Control Unit (ECU) and V2-track which were sent to the French **Bureau of Enquiry and Analysis (BEA)** for the examination and readout.





1.16 Additional Information

1.16.1 Pilot Statement

The pilot reported completing four trips before the accident on that day. The initial trip was to Thango, followed by four subsequent trips to Wachey. The accident occurred during the fourth trip to Wachey from Khuruthang and the impact time was at 14:25 LT as per the Emergency Locator Transmitter (ELT). The pilot noted favorable weather conditions during the approach to Wachey, characterized by high-level scattered/broken clouds and excellent visibility exceeding 10 kilometers. Light and variable wind conditions were observed during first three trips to Wachey and the temperature reading of 7 degrees Celsius (reading taken by the VEMD during third trip) was used during the fourth trip to Wachey. He stated that the total payload was 330 kgs according to the manifest.

On approach to Wachey, the helicopter demonstrated good performance and positioned to approach the landing pad after carrying out the wind check. The wind direction was confirmed by referring the prayer flags located north-west of the landing site. During the short final approach towards the landing site, the pilot encountered what he suspected to be a negative wind shear, and lost airspeed and lift. The helicopter started to descend rapidly and he immediately attempted to go around using his pre-planned escape path but was unable to arrest the increasing rate of descent of the helicopter. As the helicopter's rate of descent increased and the terrain impact became imminent, he flared and attempted to cushion the terrain impact with the tail of the helicopter in the hope to save the passengers.

He stated that his last day off before the accident was on 25 February 2023, and he was on flight duty for six days straight until the accident on 3 March 2023. On the accident day, he woke up at around 6 A.M and went to sleep about 10 P.M the night before. He affirmed feeling well-rested and not experiencing fatigue during the flights. The flight from Paro to Khuruthang was scheduled at 8 A.M but was delayed until 9:30 A.M due to unfavorable weather around Dochula pass. The pilot arrived on duty at around 9: 15 A.M.

He mentioned that the Head of Division (HOD) for the HELI-Flight Operations and Training Division went for leave and he was appointed as an officiating supervisor during his absence. On 3 March, he was not supposed to be on active duty according to the roster (since another senior pilot was on active duty/D1) but he volunteered to operate on his behalf. He clarified that the senior pilot was not in a good mood and reluctant to fly and sometimes difficult to work with. As a result, he volunteered to be on flight duty on that day to keep the operation smooth. Additionally, he expressed the difficulty he faced when appointed as the officiating supervisor instead of another pilot who was senior in age, experience, and had more years of service in Bhutan.





1.16.2 Survivor/Witness Statement

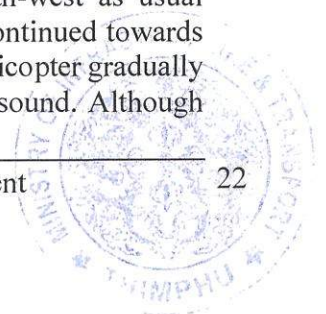
The survivor reported that the entire flight proceeded without any indications of abnormal behavior. He was a regular passenger on chartered flights between Wachey and Khuruthang with his family. According to him, the overall flight experience was usual, mirroring previous trips, except for the final approach to the landing site. During this phase, he described that the pilot made a tight sharp turn (with high banking angle) from the northeast of the landing site. The survivor said that the helicopter struggled to stabilize from that hard left turn and subsequently crashed among the trees. He also noted that the weather conditions were clear with minimal or no clouds, although he couldn't discern the external wind conditions.

He also mentioned that the combined weight, encompassing both passengers and luggage, slightly exceeded the winter weight limit of 330 kilograms. An additional baggage weighing approximately 7 kilograms had been loaded, as indicated by the onsite weight measurement conducted by the investigation team.



Fig 13. Witnesses view of the crash

There were two witnesses who observed the helicopter moments before the impact, although neither witnessed the actual crash, only heard it. The crash site, situated in a narrow ridge, was not within the line of sight for both the witnesses. The first witness had better view of the helicopter during the approach, yet the final impact point remained outside his line of sight. From their combined accounts, the helicopter approached from the south-west as usual towards the landing site. The helicopter approached at a low altitude and continued towards north-east before making a steep left turn. Both the witnesses had seen the helicopter gradually descend among the trees, tilted to the left, before making a soft thumping sound. Although





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both the witnesses lack aviation knowledge, they regularly chartered the flights between Wachey and Khuruthang.





2. ANALYSIS

2.1 *Final moments of the flight*

As per the pilot's account, the helicopter was on its final approach towards landing site after making a successful turn, when it encountered sudden and violet change in wind direction, resulting in a loss of airspeed and lift. However, the survivor's recollection differs, stating that the helicopter failed to recover from the sharp left turn and was still banking left when it lost lift, ultimately crashing among the trees. A witness corroborated this by describing the helicopter's left turn followed by a swift descent. The witness observed the helicopter banking left as it descended into the trees. According to the witnesses, the weather was fine with no clouds and no strong winds during the time of the accident. There were no adverse weather conditions like rain and snow but light winds are common at that time of the day (especially in the afternoon).

2.2 *Helicopter serviceability*

No evidence has been found which indicates that the helicopter has not been maintained and certified according to the existing regulations of civil aviation of Bhutan. No discrepancies and omissions have been observed in the maintenance records, and techlogs. EDR readout analysis produced by the manufacturer along with the assessments by the French BEA investigation team, found no technical faults and discrepancies occurred during the accident flight which could have contributed to the accident.

2.3 *Human Performance*

The pilot's duty off on previous day was at around 12:10 P.M (LT) and the departure was planned at 8 A.M on the accident day. The pilot had a rest of approximately 19 hours and about 8 hours of sleep which is reasonably adequate. The pilot's flight duty time on previous day was 5 hours 10 minutes, and on 3 March was about 7 hours, still within the maximum flight duty limit of 10 hours per day. At the time of the accident, the pilot had accumulated approximately 2.7 hours of flight time, well below the maximum allowable flight time of 8 hours per day. The weather conditions during the approach were not challenging, therefore the pilot's fatigue couldn't have significantly affected the pilot's performance during the flight. Additionally, the pilot himself affirmed feeling well-rested before the flights on that day, emphasizing that fatigue was not an issue.





2.4 Operational issues

2.4.1 Operation and working environment

The pilots failed to comply with the scheduled flight roster. The published flight roster for February and March 2023 indicates that another senior pilot was designated for active duty on February 26, March 1, and March 3. However, the pilot involved in the accident flew continuously from February 26, 2023, to March 3, 2023, covering 6 consecutive days before the accident. It indicates lack of proper communication and coordination among the pilots and also no proper supervision by the HOD. Additionally, there are indications of strained working relationship among the pilots.

2.4.2 Passenger norms

It came apparent from the interview of ground staff and passengers that the passengers try to sneak in extra baggage without weighing it (hiding it from the ground staff). They try to load in the baggage that are not weighed and not accounted for. There is also a norm where few extra luggage which comes above the weight limitations are accepted by the pilot/ground crew due to the commercial pressure and passenger requests.

2.4.3 Passenger's observation

All the locals, witness and survivor stated that the approach and landing into Wachey has changed over the years. In the past, pilots used to make wider approach far from the landing site which was more comfortable to passengers as well. Moreover, wind curfew during windy season was strictly adhered in the past where no flights were operated after 2:30 P:M. A detailed pre-flight inspection by the pilot as well as maintenance engineer were carried out in the past. Recently, the approach paths are not consistent with what it used to be before and the wind curfew is also not adhered strictly.

The affected pilot has the track record of performing sharp maneuvering at low approaches. On 1 March 2023, while landing at Khuruthang, the pilot's aggressive maneuvering was captured on video and corroborated by accounts from passengers onboard. These passengers, also serving as witnesses, reported a pattern of the pilot engaging in assertive and tightly controlled maneuvers. Numerous witnesses and passengers have recounted their alarming experiences on several occasions with these flight maneuvers.





2.5 Weight and balance

The helicopter's maximum take-off and landing mass is 2500 kg. The Out of Ground Effect (OGE) maximum usable weight at the landing site in Wachey, situated at an altitude of 12,360 ft with the outside air temperature (OAT) of 7 degree Celsius was calculated to be 2082 kg. The total weight of the helicopter was 2070 kg at the time of the accident. The helicopter was within the IGE and OGE weight limitations. The longitudinal centre of gravity was at 3.27 metres from the datum which is well within the allowable envelope of 3.10 metres to 3.55 metres. The lateral centre of gravity was at -0.017 metres which is within the allowable limit of -0.1 metres to + 0.1 metres. A few extra kgs have not been accounted in the manifest but it couldn't have significantly affected its weight and balance and hence the performance.

2.6 Engine Data Recorder (EDR) analysis

EDR data download of A5-BHT helicopter with engine serial no. 53048 has been performed by the French BEA team and sent to Safran (manufacturer) for analysis. It is essential to note that an EDR is not similar to a black box found on a fixed wing aircraft, instead the recorded data is mainly intended for maintenance purposes.

The flight duration according to EDR recording was approximately 16 minutes 35 seconds. The last flight was associated as the accident flight as it is consistent with the flight duration from the V2-Track trajectory. The *continuous recording* of both channel A and B were equivalent while the *context recording* of channel B contained 1 second more data than channel A.





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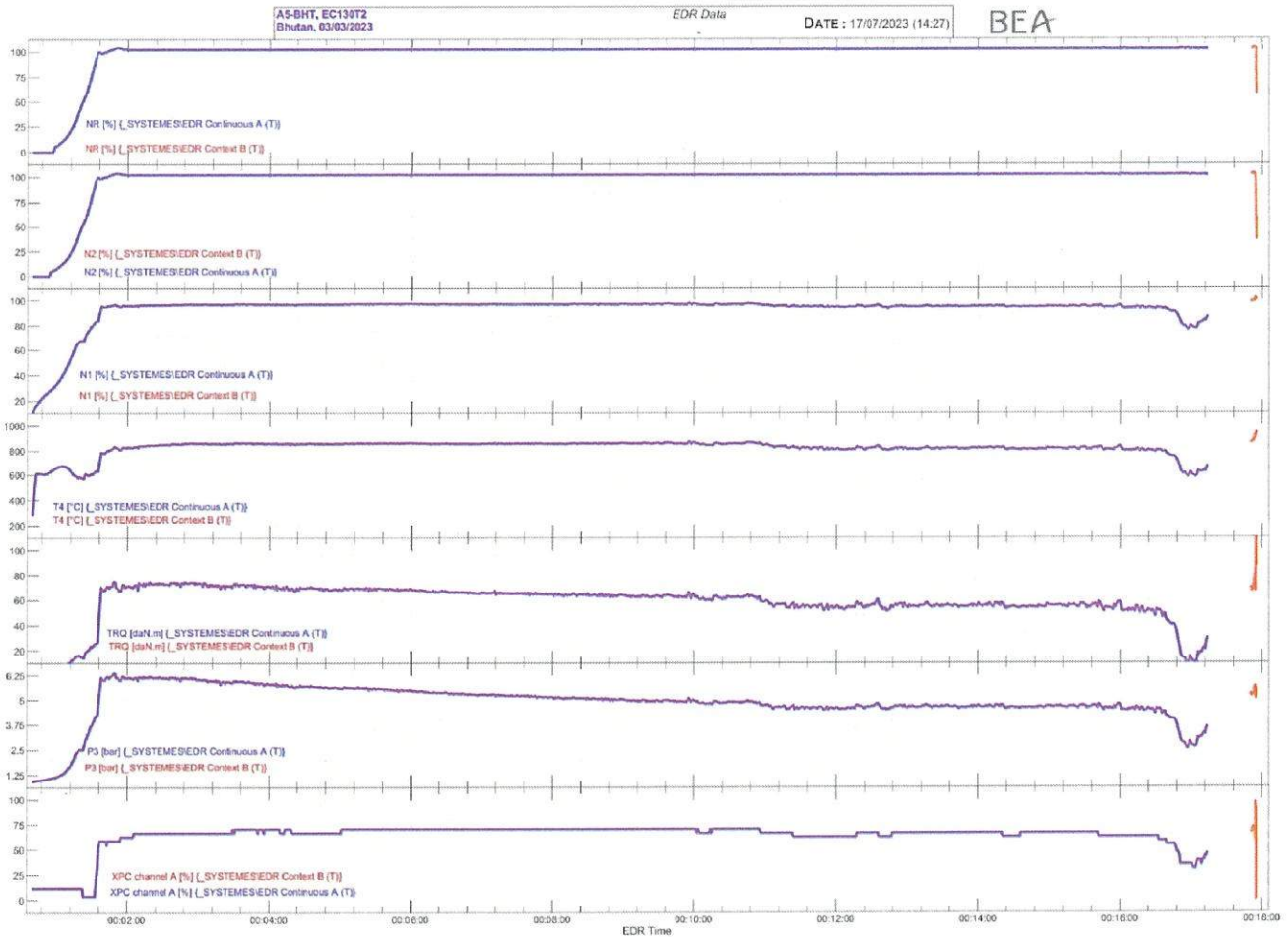
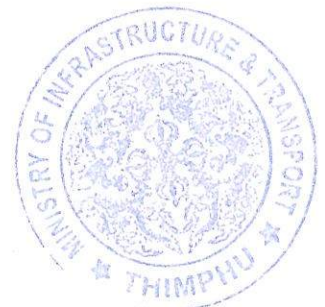


Fig 14. EDR complete flight (BEA)

The continuous recording contains 17 minutes 15 seconds of recording since the ECU power on. Throughout the continuous recording period, all the engine parameters were nominal and evolved in good synchronicity with the pilot's power demands. The main rotor (NR) speed remained quasi-constant at the nominal value and it suggests that the engine was delivering the power required during the flight. No discrepancies concerning the engine and its control systems were observed during the flight.





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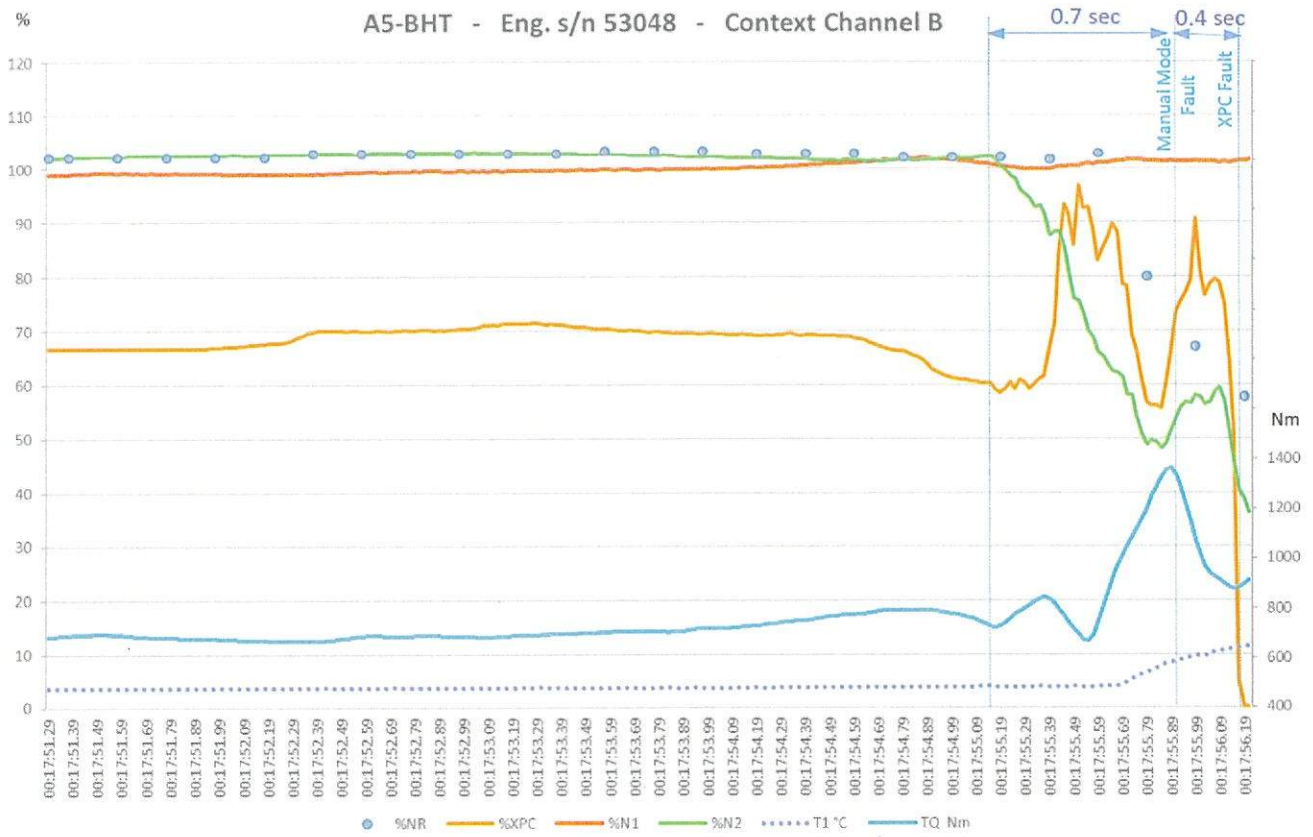


Fig 15. Context recording (Safran)



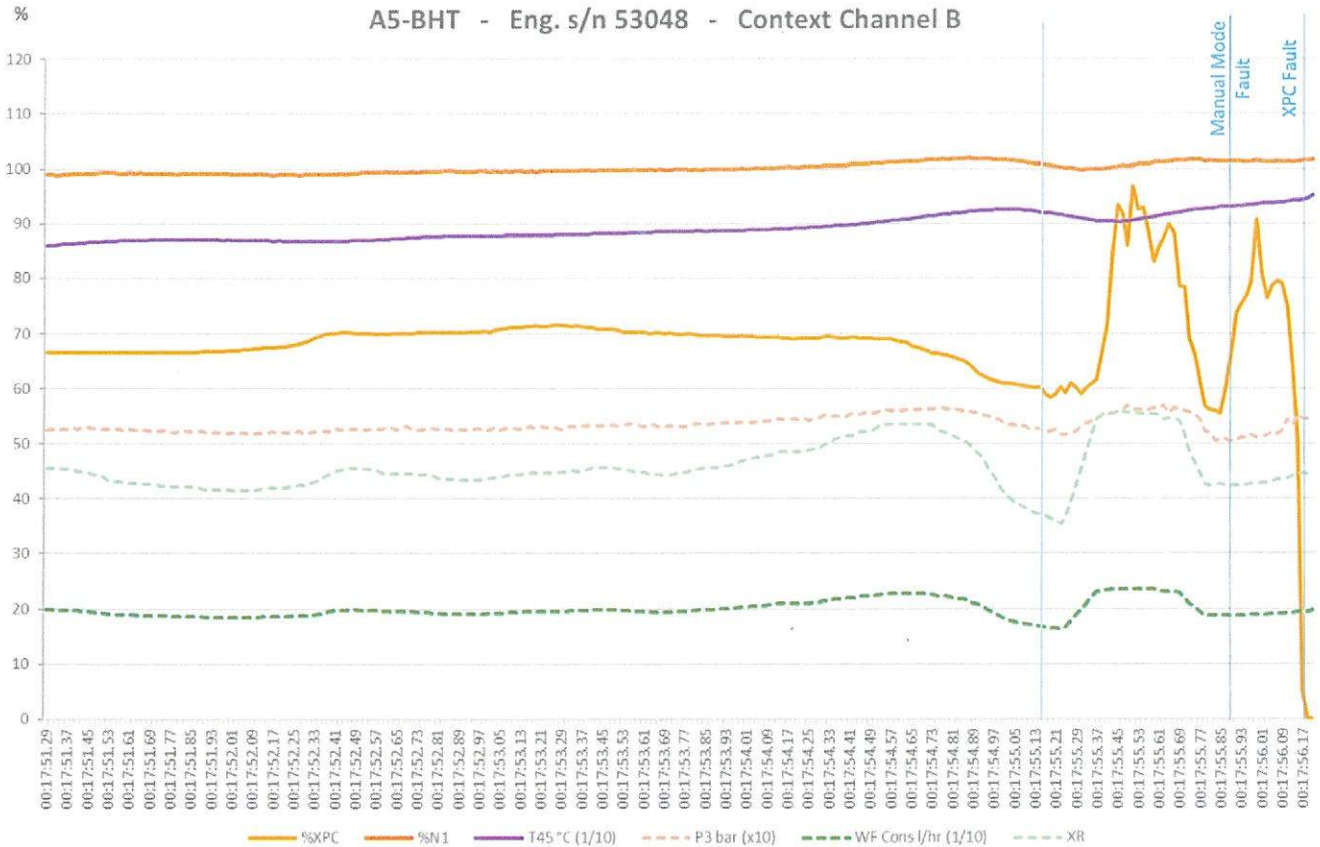
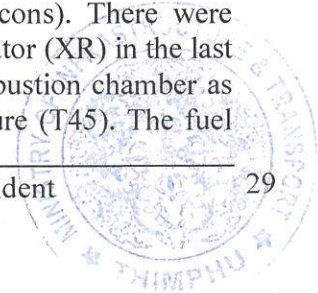


Fig 16. Context recording (Safran)

The channel B contained 5 seconds of context data which was analysed. The continuous recording stopped at 17 minutes 15 seconds (EDR time) and the context recording started from 17 minutes 51 seconds and stopped at 17 min 56 seconds. There is a gap of 36 seconds which are missing between the continuous recording and the context recording. The ECU sends the continuous recording every minute to the EDR for recording and the missing 36 seconds is consistent with the recording logic of the EDR.

All the engine parameters including the engine's fuel flow target (WF Cons) were nominal until the last 1.5 seconds of the recording. The turbine speed (N2) and main rotor speed (NR) reduced to about 48 % within 0.7 seconds during the final 1.5 seconds of the recording. Torque overlimit (reached a value of 138 daNm) was recorded at around 17 minutes 56 seconds and also collective pitch measurement (XPC) fault was noted within the last 1.5 seconds of the recording.

During the first 3.5 seconds there was a good synchronicity between the pilot's power demand (collective lever signal XPC) and the engine's fuel flow target (WF cons). There were variations in the fuel flow (WF cons) as well as fuel control system's actuator (XR) in the last 1.5 seconds of the recording, which led to fuel flow changes in the combustion chamber as seen in the combustion chamber pressure (P3) and the turbine temperature (T45). The fuel





flow parameters appeared erratic in the last 1.5 seconds of the recording, as it was likely that the engine control system was not able to keep up with the rapidly changing aircraft attitudes during the crash sequence.

All the overlimits and discrepancies within the last 1.5 seconds were probably due to the consequence of the crash sequence. There were no faults and anomalies recorded throughout the entire flight except for the last 1.5 seconds of the recording. The failure of the collective pitch anticipator potentiometer (XPC) occurred most probably as a result of impact with the trees or ground. The helicopter was on the ground (or at least on the trees) when it recorded the torque overlimit and other overlimits in the final 1.5 seconds of the recording.

2.7 V2-Track analysis

The V2-Track trip data consists of 70 data points and a total of 17 minutes 19 seconds flight trajectory.

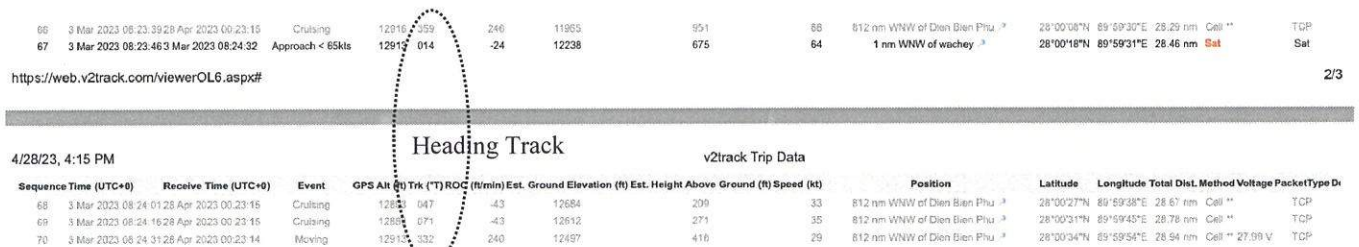


Fig 17. Accident flight trip profile (V2-Track)

The V2-Track trip profile indicates that the approach speed was about 65 knots and the rate of descend (ROD) during the approach was from 24 - 43 ft/min. The ROD is minimal which ties in with the low approach seen by the witnesses. During the approach, the heading change was from 359° at 08:23:39 (UTC) to 071° at 08:24:16 which was followed by sudden heading change from 071° to 332° within 15 seconds (99 degree heading change within 15 seconds). This corroborates with the witness account of helicopter's approach from Southwest to Northeast before making a steep left turn. The V2-track registered a climb during the left turn which seems to tie with the increase in collective.



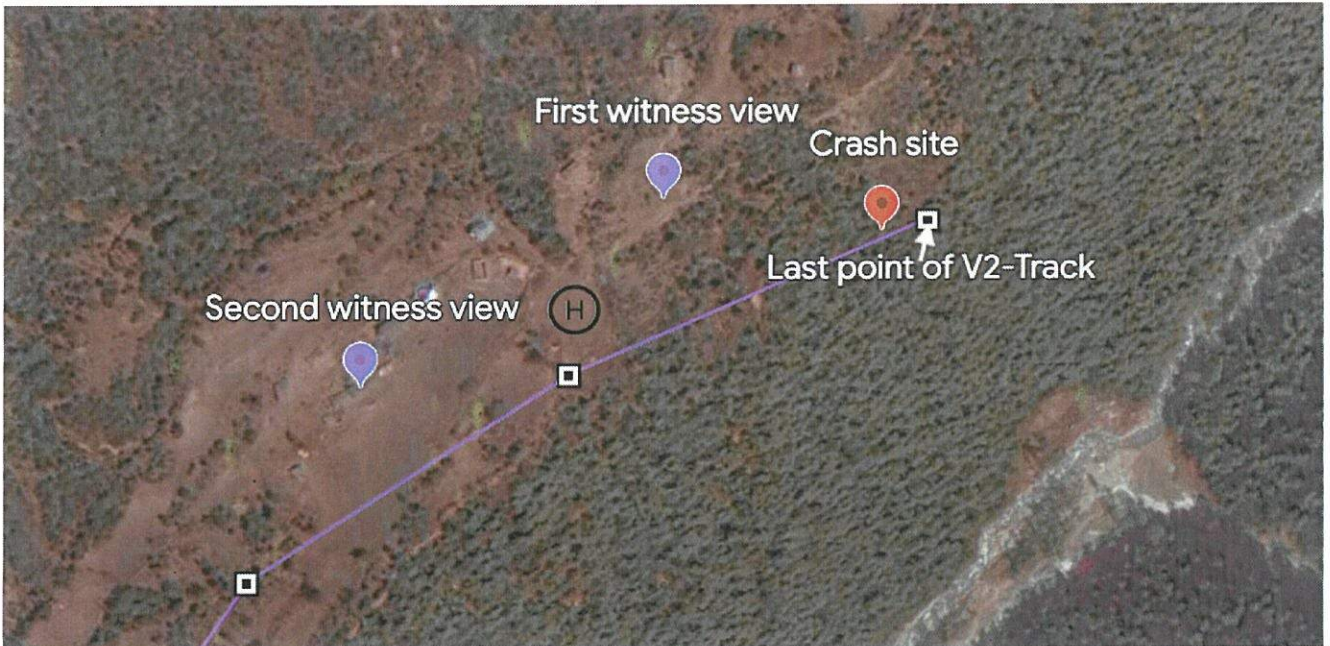


Fig 18. Crash site and V2-Tracker

A total of 13 missing data points has been recovered. There were no anomalies observed regarding the V2-Track flight trajectory. The flight path of the helicopter has been recovered until few seconds before the crash as seen from the last point of the V2-Track.





3. CONCLUSION

3.1 Findings

a) Operational aspects

1. The pilot was properly licensed and qualified to conduct the flight. He fulfilled the training requirements for direct entry pilots and also passed the medical and airlaw examination conducted by the BCAA.
2. The pilot had previously flown to Wachey, and is familiar with its terrain and approach.
3. The pilot underwent a drug test on March 4 at JDWNRH and tested negative.
4. The pilot has the history of performing aggressive maneuvers at low approach.
5. The company flight roster was not followed strictly and replacement was done without valid reason.
6. There is a presence of poor working relationship between the pilots and lack of proper supervision from the supervisor.
7. The total weight of the helicopter was within the OGE weight limitation at the time of the accident.
8. There is a bad norm of passengers loading an extra luggage without the knowledge of the pilot and the ground-crew.
9. There are differences in the statement of pilot and the survivor in their accounts of the final approach and moments before the impact.

b) EDR/ V2-Track

1. The EDR analysis done by French BEA revealed no defects with the engine and all parameters were nominal during the entire flight until the suspected crash sequence.
2. The variations in engine parameters and occurrences of overlimits towards the end of the EDR recording are attributed to the consequences of the crash and subsequent impact with trees or ground.
3. The V2-Track trajectory has been fully recovered and no anomalies were observed.



3.2 Probable Cause

- Terrain impact due to the pilot attempting an abrupt change of its flight maneuver in a low approach which could have resulted in a loss of obstacle clearance.

3.3 Contributing Factors

The investigation had outlined following contributing factors:

- Failure to adhere to the pilot roster since another senior pilot was on active duty on the day of the accident, but the pilot involved in the accident operated the flights on that day. The pilot involved in the accident was on active duty for 6 consecutive days including the day of the accident.
- The pilot experienced emotional distress due to the bad attitude and reluctance of the senior pilot to listen to him (the pilot involved in the accident was acting as an officiating supervisor while the supervisor was on leave).
- The pilot involved in the accident was not assertive enough to report the issues of the working environment to the supervisor and the management.
- There was no proper supervision of the working relation among the pilots and the working environment by the supervisor and the management.
- There is also a history of the pilot performing aggressive maneuvering at low approach.





SAFETY RECOMMENDATIONS

1. Drukair Helicopter Services shall encourage the pilots and crews to adhere to the roster and refrain from unnecessary change of the flight duty without valid reasons.
2. Drukair Helicopter Services shall encourage the voluntary reporting of any safety issues concerning the organization and working environment.
3. Drukair Helicopter Services shall strictly monitor the passenger and baggage weights prior to every departure and strictly adhere to the weight limit. The BCAA shall take necessary action in case of non-compliance to the weight limit.
4. Drukair Helicopter Services shall create awareness among the ground staffs/pilots on the importance of mitigating the unhealthy practice of passengers loading extra weights that are not weighed and manifested.
5. In line with the Operations Manual Chapter 9.4, the Drukair Helicopter Services shall ensure that the pilot along with ground staff to use correct payload onboard to develop the weight and balance manifest.
6. The Drukair Helicopter Services shall assess and comment on the overall flying style of the pilot during the 6 monthly Operators Proficiency Check (OPC) and take pre-emptive action in case of unconventional and unsafe maneuvering by the pilots at any time.





Appendix I. Flight paths

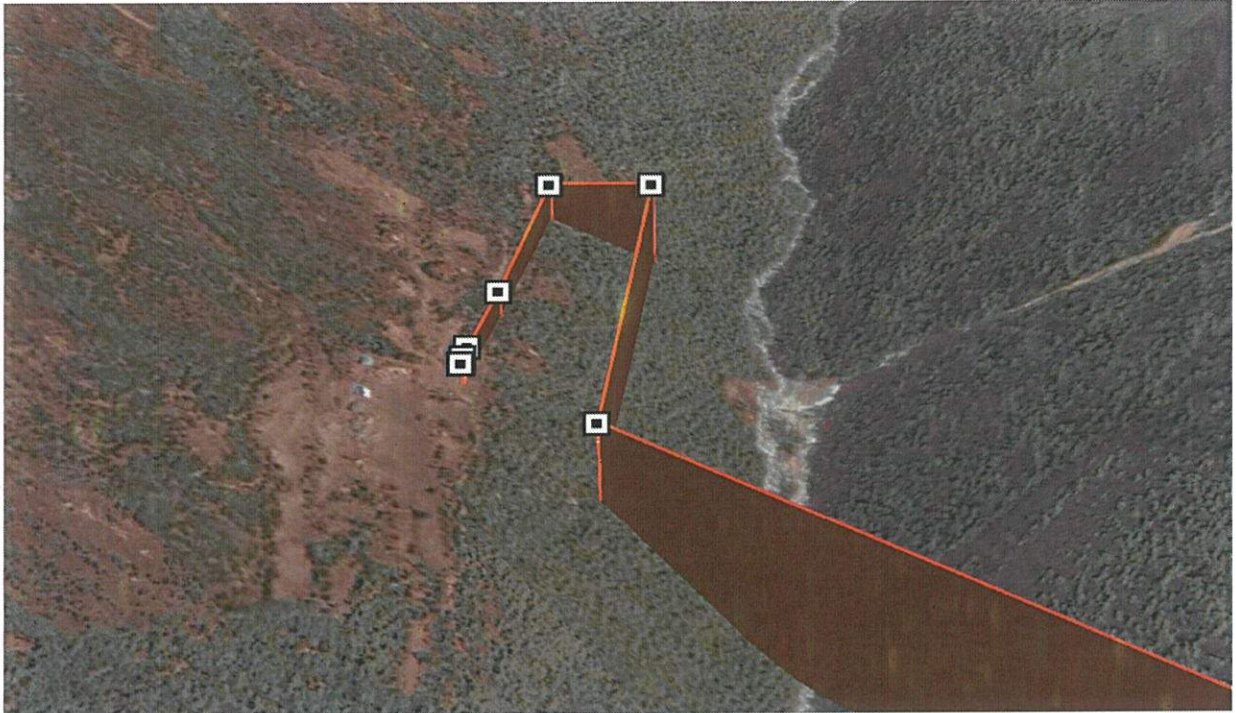


Fig 19. Landing flight path of first trip to Wachey

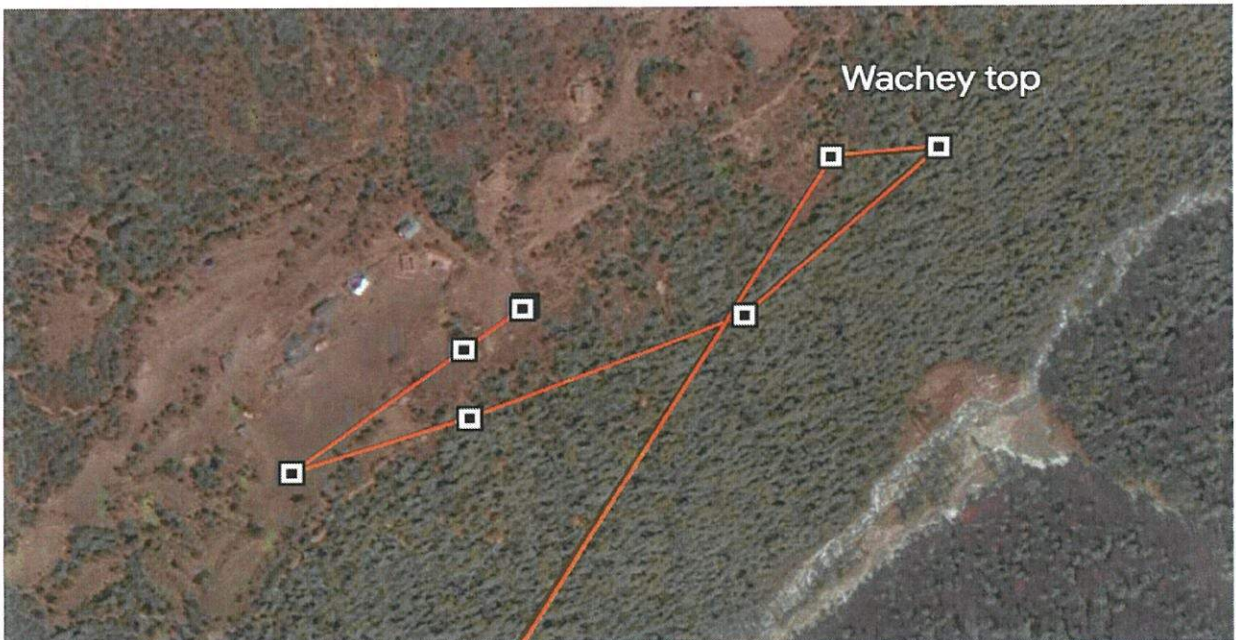


Fig 20. Landing flight path of second trip to Wachey



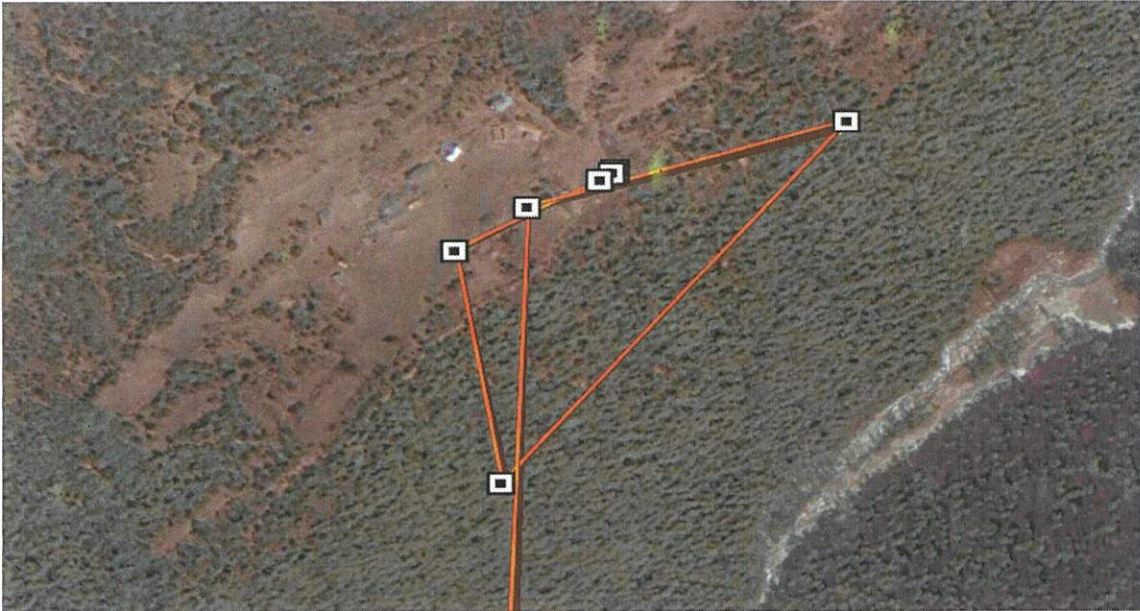


Fig 21. Landing flight path of third trip to Wachey

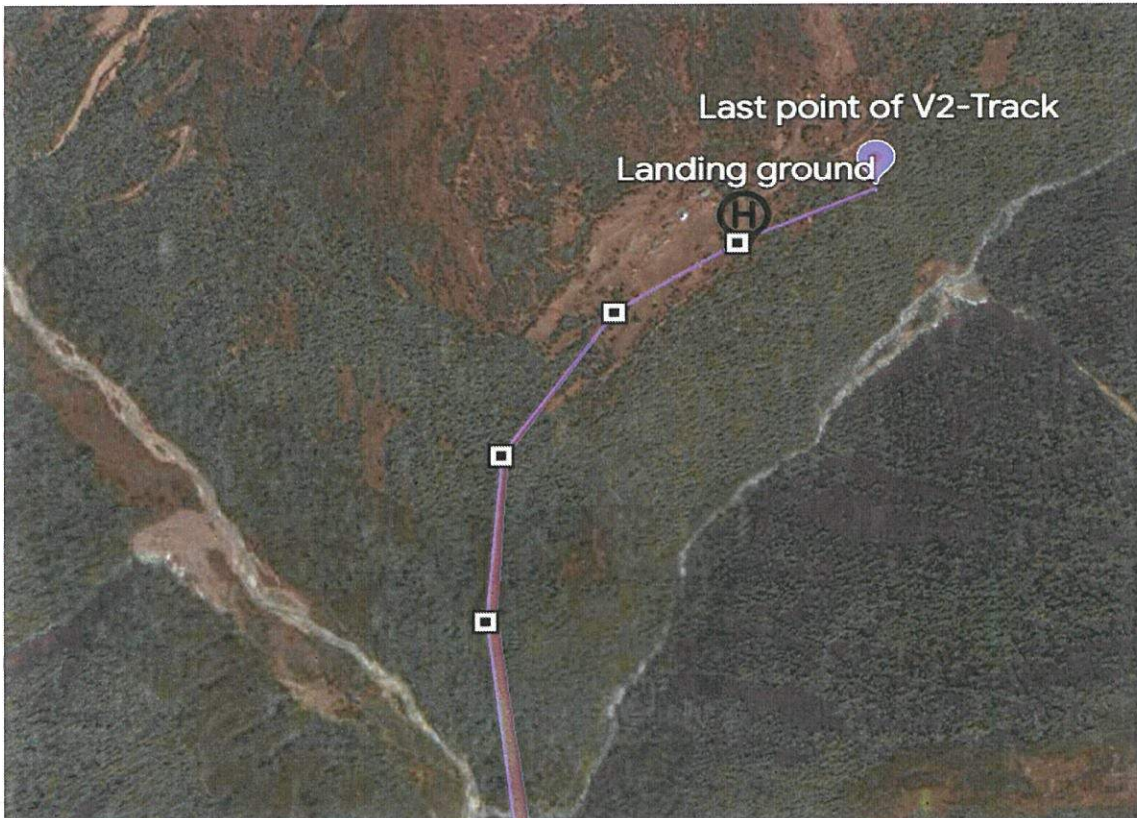


Fig 22. Accident flight path recovered





Appendix II: Retrieved components from A5-BHT

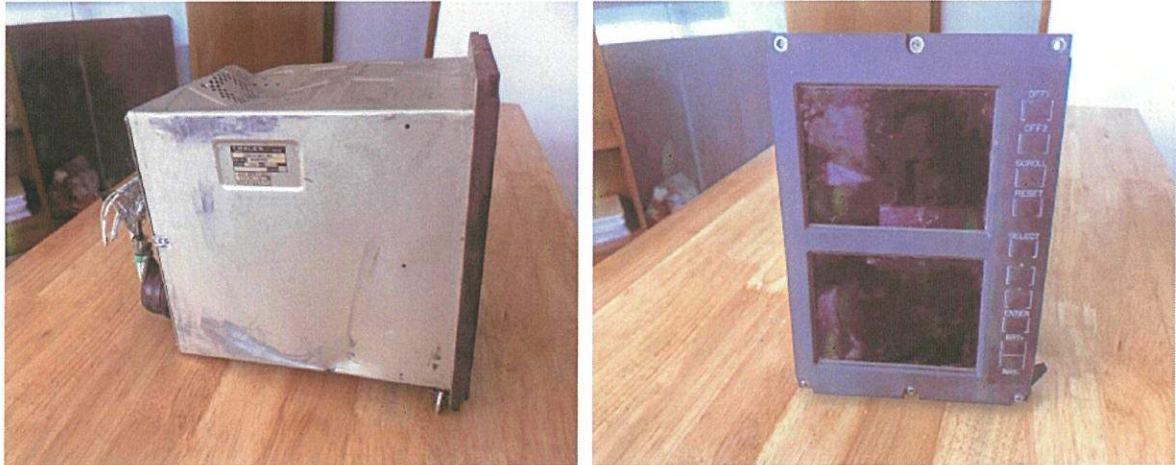


Fig 23. VEMD

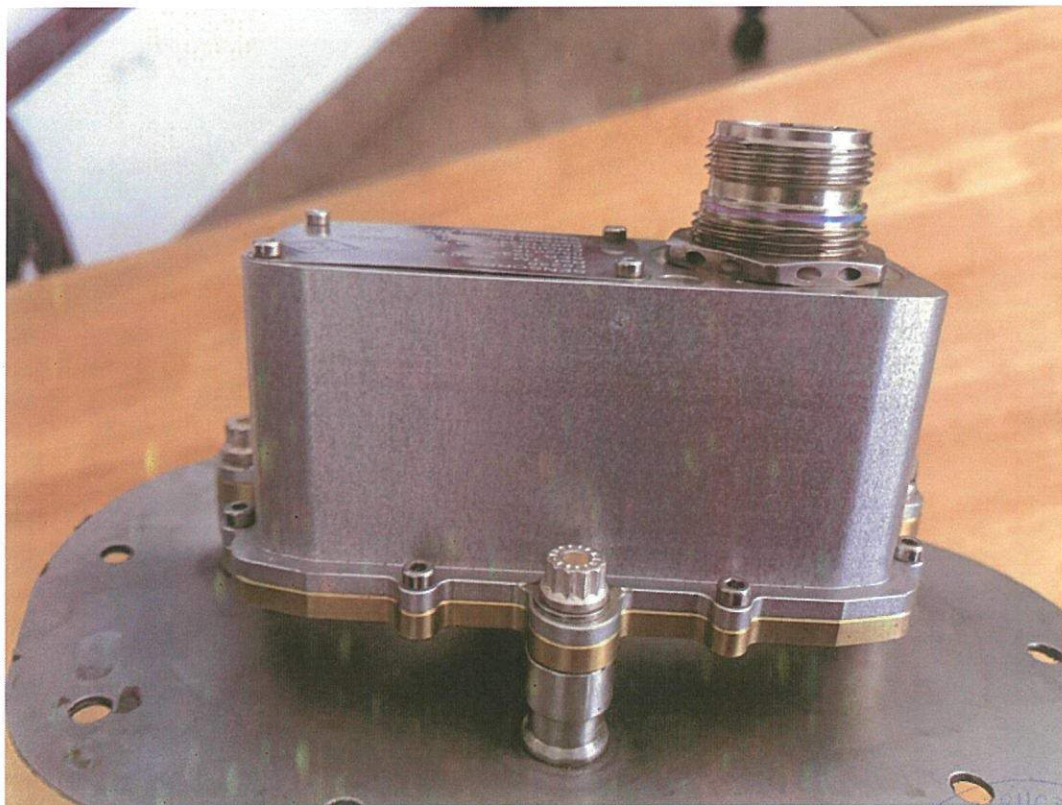
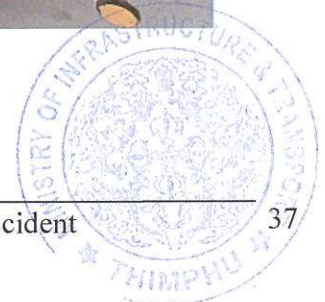


Figure 24. EDR



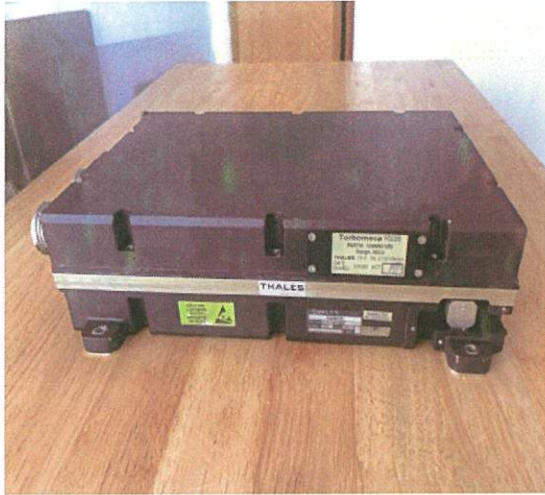


Figure 25. ECU



Figure 26. V2-Track





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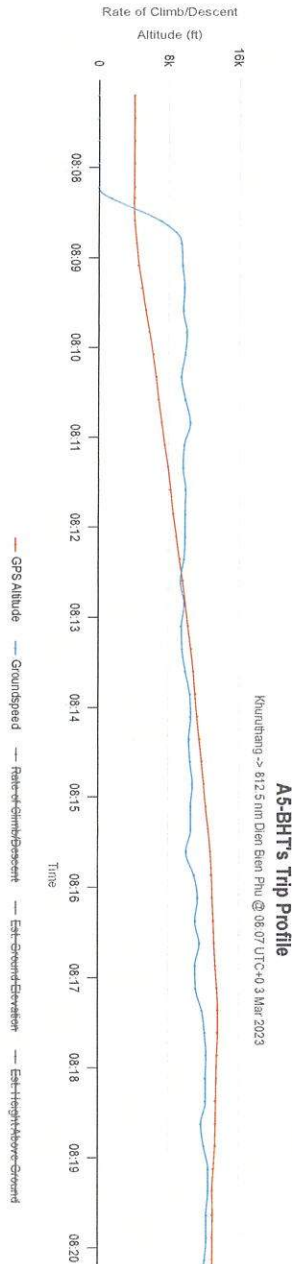
Appendix III. V2-Track trip data

<https://web.v2track.com/view/06.aspx#>

| Sequence Time (UTC+0) | Receive Time (UTC+0) | Event | GPS Alt (ft) | Tk (TT) ROC (ft/min) | Est. Ground Elevation (ft) | Est. Height Above Ground (ft) | Speed (kt) | Position | Latitude | Longitude | Total Dist. Method | Voltage | Packet Type |
|-----------------------|-----------------------|-------------|--------------|----------------------|----------------------------|-------------------------------|------------|--------------------------------|------------|------------|--------------------|---------|-------------|
| 0 | 3 Mar 2023 08:07:12.3 | Starting Up | 4101 | | 3890 | 121 | 0 | Khurudhang | Z7°34'17"N | 89°52'24"E | 0 mm Cell | 25.61 V | TOP |
| 1 | 3 Mar 2023 08:07:27.3 | Stationary | 4101 | | 3890 | 121 | 0 | Khurudhang | Z7°34'17"N | 89°52'24"E | 0 mm Cell | | TOP |
| 2 | 3 Mar 2023 08:07:42.3 | Stationary | 4101 | | 3890 | 121 | 0 | Khurudhang | Z7°34'17"N | 89°52'24"E | 0 mm Cell | | TOP |
| 3 | 3 Mar 2023 08:07:57.3 | Stationary | 4101 | | 3890 | 121 | 0 | Khurudhang | Z7°34'17"N | 89°52'24"E | 0 mm Cell | | TOP |
| 4 | 3 Mar 2023 08:08:13.3 | Stationary | 4101 | | 3890 | 121 | 0 | Khurudhang | Z7°34'17"N | 89°52'24"E | 0 mm Cell | | TOP |
| 5 | 3 Mar 2023 08:08:29.3 | Take Off | 4061 | 333 | 3890 | 81 | 14 | Khurudhang | Z7°34'17"N | 89°52'24"E | 0 mm Cell | | TOP |
| 6 | 3 Mar 2023 08:08:35.3 | Climbing | 4140 | 352 | 3975 | 164 | 71 | Khurudhang | Z7°34'29"N | 89°52'21"E | 0.16 mm Cell | | TOP |
| 7 | 3 Mar 2023 08:08:50.3 | Climbing | 4383 | 306 | 3975 | 282 | 95 | Khurudhang | Z7°34'50"N | 89°52'21"E | 0.54 mm Cell | | TOP |
| 8 | 3 Mar 2023 08:09:05.3 | Climbing | 4648 | 279 | 4131 | 517 | 96 | 1 mm ESE of ZOMLINGTHANG 2 | Z7°35'15"N | 89°52'39"E | 1.35 mm Cell | | TOP |
| 9 | 3 Mar 2023 08:09:20.3 | Climbing | 5019 | 370 | 4226 | 769 | 98 | 1 mm ENE of ZOMLINGTHANG 2 | Z7°35'59"N | 89°52'28"E | 1.57 mm Cell | | TOP |
| 10 | 3 Mar 2023 08:09:35.3 | Climbing | 5433 | 416 | 4544 | 869 | 97 | 1 mm E of ZOMLINGTHANG 2 | Z7°36'07"N | 89°52'41"E | 1.78 mm Cell | 28.01 V | TOP |
| 11 | 3 Mar 2023 08:09:50.3 | Climbing | 5972 | 540 | 4944 | 928 | 101 | 1 mm ENE of ZOMLINGTHANG 2 | Z7°36'25"N | 89°52'49"E | 2.21 mm Cell | | TOP |
| 12 | 3 Mar 2023 08:10:05.3 | Climbing | 6279 | 308 | 5089 | 1190 | 99 | 1 mm NE of ZOMLINGTHANG PUAKHA | Z7°36'50"N | 89°52'58"E | 2.59 mm Cell | | TOP |
| 13 | 3 Mar 2023 08:10:20.3 | Climbing | 6642 | 363 | 5540 | 2031 | 96 | 2 mm NE of ZOMLINGTHANG PUAKHA | Z7°37'13"N | 89°53'07"E | 3.02 mm Cell | | TOP |
| 14 | 3 Mar 2023 08:10:35.3 | Climbing | 6942 | 297 | 5940 | 1302 | 100 | 2 mm NE of ZOMLINGTHANG PUAKHA | Z7°37'35"N | 89°53'17"E | 3.4 mm Cell | | TOP |
| 15 | 3 Mar 2023 08:10:50.3 | Climbing | 7280 | 338 | 6640 | 640 | 105 | 2 mm NE of ZOMLINGTHANG PUAKHA | Z7°37'50"N | 89°53'29"E | 3.83 mm Cell | | TOP |

Manifest Data
 Pilot: Stefan Smuts
 Pilot2:

** Denotes a delayed cellular position data that was stored on the device because there was no cellular coverage at that time and sent to our server once the device had cellular connectivity again.



Khurudhang -> 812.5 nm Dien Bien Phu @ 08:07 UTC+0 3 Mar 2023
 AS-BHT's Trip Profile

Print Refresh

AS-BHT Trip Data
 EC-130 T2
 V2Track SANCHEL V2T-SVC-WSP
 V2Track Trip #417065832
 Friday, 3 March 2023



4/28/23, 4:15 PM

V2Track Trip Data





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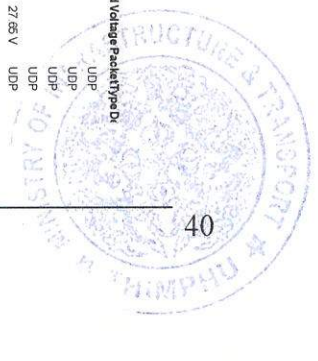
4/28/23, 4:15 PM

Vtrack Trip Data

| Sequence Time (UTC+0) | Receive Time (UTC+0) | Event | GPS Altitude (ft) (T) ROC (ft/min) | Est. Ground Elevation (ft) | Est. Height Above Ground (ft) | Speed (kt) | Position | Latitude | Longitude | Total Dist. Method | Voltage | PacketType |
|-----------------------|-----------------------|------------------|------------------------------------|----------------------------|-------------------------------|------------|--------------------------------|----------------------|-----------|--------------------|---------|------------|
| 16 | 3 Mar 2023 08:11:05.9 | Climbing | 7631 024 | 1143 | 7375 | 266 | 3 nm NE of ZOMLINGTANG-PUNAKHA | Z7-38222N 89°53'44"E | 4327 nm | Cell | 28.42 V | UDP |
| 17 | 3 Mar 2023 08:11:20.3 | Climbing | 8024 025 | 1181 | 6588 | 1436 | 3 nm SW of Dawakha | Z7-38437N 89°54'01"E | 4175 nm | Cell | | UDP |
| 18 | 3 Mar 2023 08:11:35.3 | Climbing | 8207 028 | 1049 | 6276 | 2021 | 2 nm SW of Dawakha | Z7-39004N 89°54'16"E | 5133 nm | Cell | | UDP |
| 19 | 3 Mar 2023 08:11:51.3 | Climbing | 8935 032 | 1141 | 6096 | 2519 | 2 nm SW of Dawakha | Z7-39292N 89°54'30"E | 5567 nm | Cell | | UDP |
| 20 | 3 Mar 2023 08:12:06.3 | Climbing | 8663 031 | 1334 | 5449 | 3504 | Z7-39477N 89°54'45"E | 5597 nm | Cell | Z7-65 V | UDP | |
| 21 | 3 Mar 2023 08:12:21.3 | Climbing | 9907 034 | 1397 | 5983 | 3444 | 1 nm WSW of Dawakha | Z7-40008N 89°54'60"E | 6377 nm | Cell | | TCP |
| 22 | 3 Mar 2023 08:12:36.3 | Climbing | 9688 035 | 1389 | 6250 | 3418 | 1 nm WSW of Dawakha | Z7-40278N 89°55'15"E | 6.8 nm | Cell | | UDP |
| 23 | 3 Mar 2023 08:12:51.3 | Climbing | 9903 033 | 1161 | 5699 | 4234 | Dawakha | Z7-40471N 89°55'31"E | 718 nm | Cell | | UDP |
| 24 | 3 Mar 2023 08:13:06.3 | Climbing | 10291 032 | 1240 | 4649 | 5642 | Dawakha | Z7-41068N 89°55'46"E | 7.61 nm | Cell | | UDP |
| 25 | 3 Mar 2023 08:13:21.3 | Climbing | 10513 035 | 1220 | 5846 | 4672 | Dawakha | Z7-41271N 89°55'01"E | 7.99 nm | Cell | | TCP |
| 26 | 3 Mar 2023 08:13:36.3 | Climbing | 10895 037 | 1049 | 7323 | 3572 | Dawakha | Z7-41477N 89°55'17"E | 8.42 nm | Cell | | UDP |
| 27 | 3 Mar 2023 08:13:51.3 | Climbing | 11108 035 | 787 | 7918 | 3460 | 1 nm N of Dawakha | Z7-42067N 89°55'35"E | 8.86 nm | Cell | | UDP |
| 28 | 3 Mar 2023 08:14:06.3 | Climbing | 11335 034 | 874 | 6647 | 2788 | 1 nm N of Dawakha | Z7-42307N 89°55'51"E | 9.29 nm | Cell | | UDP |
| 29 | 3 Mar 2023 08:14:21.3 | Climbing | 11578 035 | 1005 | 8110 | 3468 | 2 nm N of Dawakha | Z7-42527N 89°57'08"E | 9.72 nm | Cell | | TCP |
| 30 | 3 Mar 2023 08:14:36.3 | Climbing | 11863 038 | 1027 | 7073 | 4780 | 2 nm NNE of Dawakha | Z7-43137N 89°57'28"E | 10.15 nm | Cell | Z7-57 V | TCP |
| 31 | 3 Mar 2023 08:14:51.3 | Climbing | 12096 036 | 895 | 8871 | 3225 | 2 nm NNE of Dawakha | Z7-43347N 89°57'45"E | 10.58 nm | Cell | | TCP |
| 32 | 3 Mar 2023 08:15:06.3 | Climbing | 12309 033 | 863 | 10144 | 2185 | 3 nm NNE of Dawakha | Z7-43567N 89°58'03"E | 11.07 nm | Cell | | TCP |
| 33 | 3 Mar 2023 08:15:21.3 | Climbing | 12591 035 | 1058 | 8634 | 3634 | 3 nm NNE of Dawakha | Z7-44207N 89°58'21"E | 11.56 nm | Cell | | UDP |
| 34 | 3 Mar 2023 08:15:36.3 | Climbing | 12857 038 | 1042 | 9408 | 3369 | 4 nm NNE of Dawakha | Z7-44417N 89°58'38"E | 11.99 nm | Cell | | UDP |
| 35 | 3 Mar 2023 08:15:52.3 | Climbing | 13021 038 | 546 | 10046 | 2975 | 4 nm NNE of Dawakha | Z7-45027N 89°58'57"E | 12.42 nm | Cell | | UDP |
| 36 | 3 Mar 2023 08:16:07.3 | Climbing | 13113 039 | 344 | 10210 | 2033 | 3 nm NNE of Dawakha | Z7-45247N 89°59'16"E | 12.9 nm | Cell | | TCP |
| 37 | 3 Mar 2023 08:16:22.3 | Climbing | 13218 032 | 492 | 8635 | 4693 | 5 nm NNE of Dawakha | Z7-45477N 89°59'35"E | 13.34 nm | Cell | | UDP |
| 38 | 3 Mar 2023 08:16:37.3 | Climbing | 13316 036 | 295 | 7733 | 5933 | 5 nm SSW of Isarna Village | Z7-46117N 89°59'53"E | 13.82 nm | Cell | | TCP |
| 39 | 3 Mar 2023 08:16:52.3 | Climbing | 13444 035 | 666 | 5933 | 5933 | 4 nm SSW of Isarna Village | Z7-46347N 90°00'12"E | 14.31 nm | Cell | | UDP |
| 40 | 3 Mar 2023 08:17:07.3 | Climbing | 13622 037 | 765 | 5933 | 5933 | 4 nm SSW of Isarna Village | Z7-46577N 90°00'31"E | 14.79 nm | Cell | 28.37 V | UDP |
| 41 | 3 Mar 2023 08:17:22.3 | Climbing | 13746 034 | 442 | 5933 | 5933 | 4 nm SSW of Isarna Village | Z7-47207N 90°00'51"E | 15.28 nm | Cell | | TCP |
| 42 | 3 Mar 2023 08:17:37.3 | Climbing | 13740 027 | -73 | 5933 | 5933 | 3 nm SSW of Isarna Village | Z7-47457N 90°01'09"E | 15.77 nm | Cell | | TCP |
| 43 | 3 Mar 2023 08:17:52.3 | Climbing | 13641 006 | 442 | 5933 | 5933 | 3 nm SSW of Isarna Village | Z7-48167N 90°01'17"E | 16.31 nm | Cell | | UDP |
| 44 | 3 Mar 2023 08:18:07.3 | Climbing | 13589 358 | -295 | 5933 | 5933 | 2 nm SSW of Isarna Village | Z7-48477N 90°01'18"E | 16.79 nm | Cell | | TCP |
| 45 | 3 Mar 2023 08:18:22.3 | Climbing | 13510 369 | -221 | 5933 | 5933 | 2 nm SSW of Isarna Village | Z7-48717N 90°01'18"E | 17.33 nm | Cell | | TCP |
| 46 | 3 Mar 2023 08:18:37.3 | Climbing | 13471 357 | -147 | 5933 | 5933 | 1 nm SSW of Isarna Village | Z7-49487N 90°01'17"E | 17.82 nm | Cell | | TCP |
| 47 | 3 Mar 2023 08:18:52.3 | Climbing | 13408 356 | -282 | 5933 | 5933 | 1 nm SW of Isarna Village | Z7-50187N 90°01'19"E | 18.3 nm | Cell | | UDP |
| 48 | 3 Mar 2023 08:19:07.3 | Climbing | 13257 352 | -516 | 5933 | 5933 | Isarna Village | Z7-50517N 90°01'17"E | 18.9 nm | Cell | | UDP |
| 49 | 3 Mar 2023 08:19:22.3 | Climbing | 13123 353 | 442 | 5933 | 5933 | Isarna Village | Z7-51237N 90°01'07"E | 19.44 nm | Cell | | UDP |
| 50 | 3 Mar 2023 08:19:37.3 | Climbing | 13139 352 | 88 | 5933 | 5933 | 1 nm NW of Isarna Village | Z7-51547N 90°01'02"E | 19.92 nm | Cell | 28.42 V | UDP |
| 51 | 3 Mar 2023 08:19:52.3 | Climbing | 13126 350 | -123 | 5933 | 5933 | 1 nm NW of Isarna Village | Z7-52257N 90°00'57"E | 20.46 nm | Cell | | TCP |
| 52 | 3 Mar 2023 08:20:07.3 | Climbing | 13103 352 | 0 | 5933 | 5933 | 2 nm NW of Isarna Village | Z7-52557N 90°00'52"E | 20.95 nm | Cell | | TCP |
| 53 | 3 Mar 2023 08:20:22.3 | Climbing | 13149 354 | 221 | 5933 | 5933 | 2 nm NNW of Isarna Village | Z7-53257N 90°00'48"E | 21.49 nm | Cell | | UDP |
| 54 | 3 Mar 2023 08:20:37.3 | Climbing | 13182 351 | 24 | 5933 | 5933 | 3 nm NNW of Isarna Village | Z7-53557N 90°00'44"E | 21.98 nm | Cell | | UDP |
| 55 | 3 Mar 2023 08:20:52.3 | Climbing | 13162 352 | -88 | 5933 | 5933 | 3 nm NNW of Isarna Village | Z7-54287N 90°00'40"E | 22.52 nm | Cell | | UDP |
| 56 | 3 Mar 2023 08:21:07.3 | Climbing | 13173 350 | 0 | 5933 | 5933 | 3 nm ESE of Gangjuna | Z7-54577N 90°00'35"E | 23 nm | Cell | | UDP |
| 57 | 3 Mar 2023 08:21:22.3 | Climbing | 13172 350 | 163 | 5933 | 5933 | 3 nm ESE of Gangjuna | Z7-55287N 90°00'30"E | 23.54 nm | Cell | | UDP |
| 58 | 3 Mar 2023 08:21:37.3 | Climbing | 13146 354 | -221 | 5933 | 5933 | 3 nm WNW of Dren Bian Phu | Z7-55507N 90°00'26"E | 24.08 nm | Cell | | TCP |
| 59 | 3 Mar 2023 08:21:52.3 | Climbing | 13083 353 | -196 | 5933 | 5933 | 3 nm WNW of Dren Bian Phu | Z7-56207N 90°00'22"E | 24.62 nm | Cell | | TCP |
| 60 | 3 Mar 2023 08:22:07.3 | Climbing | 13063 353 | -24 | 5933 | 5933 | 3 nm WNW of Dren Bian Phu | Z7-57057N 90°00'18"E | 25.16 nm | Cell | 28.61 V | TCP |
| 61 | 3 Mar 2023 08:22:22.3 | Climbing | 13090 351 | 123 | 5933 | 5933 | 3 nm WNW of Dren Bian Phu | Z7-57367N 90°00'13"E | 25.7 nm | Cell | | TCP |
| 62 | 3 Mar 2023 08:22:37.3 | Climbing | 13034 348 | -221 | 5933 | 5933 | 3 nm WNW of Dren Bian Phu | Z7-58077N 90°00'07"E | 26.19 nm | Cell | | TCP |
| 63 | 3 Mar 2023 08:22:52.3 | Climbing | 13034 348 | 24 | 5933 | 5933 | 3 nm WNW of Dren Bian Phu | Z7-58407N 89°59'59"E | 26.78 nm | Cell | | TCP |
| 64 | 3 Mar 2023 08:23:07.3 | Climbing | 12916 337 | -713 | 5933 | 5933 | 3 nm WNW of Dren Bian Phu | Z7-59117N 89°59'45"E | 27.32 nm | Cell | | TCP |
| 65 | 3 Mar 2023 08:23:22.3 | Climbing | 12837 346 | -123 | 5933 | 5933 | 3 nm WNW of Dren Bian Phu | Z7-59427N 89°59'30"E | 27.86 nm | Cell | | UDP |
| 66 | 3 Mar 2023 08:23:37.3 | Climbing | 12916 339 | 246 | 5933 | 5933 | 3 nm WNW of Dren Bian Phu | Z8-00067N 89°59'30"E | 28.29 nm | Cell | | TCP |
| 67 | 3 Mar 2023 08:23:46.3 | Approach < 65kts | 12913 014 | -24 | 12238 | 675 | 1 nm WNW of wachey | Z8-00197N 89°59'31"E | 28.46 nm | Cell | | Sat |

https://web.vtrack.com/ViewerOL6.aspx#

2/3





དབལ་ཕྱན་འབྲུག་གཞུང་། གཞི་རྒྱུ་མཁོ་ཆས་དང་སྐྱེལ་འདྲེན་ལྷན་ཁག།
 ROYAL GOVERNMENT OF BHUTAN
 MINISTRY OF INFRASTRUCTURE & TRANSPORT
 THIMPHU: BHUTAN



<https://web.v2track.com/viewer/QL6.aspx#>

4/28/23, 4:15 PM

V2Track Trip Data

| Sequence Time (UTC+0) | Receive Time (UTC+0) | Event | GPS Alt (ft) TK (ft) HOC (ft/min) | Est. Ground Elevation (ft) | Est. Height Above Ground (ft) | Speed (kt) | Position | Latitude | Longitude | Total Dist. Method | Voltage PacketType |
|-----------------------|---|-----------|-----------------------------------|----------------------------|-------------------------------|------------|-----------------------------|-----------|------------|--------------------|--------------------|
| 68 | 3 Mar 2023 02:24:01.284 Apr 2023 00:23:15 | Grounding | 12693 647 | -43 | 12654 | 33 | 812nm WVVV of Dorn Blen Phu | 28.0027°N | 89.55938°E | 28.67nm Cell ** | TCF |
| 69 | 3 Mar 2023 06:24:16.294 Apr 2023 00:23:15 | Climbing | 12883 071 | -43 | 12842 | 35 | 812nm WVVV of Dorn Blen Phu | 28.0031°N | 89.55945°E | 28.78nm Cell ** | TCF |
| 70 | 3 Mar 2023 08:24:31.284 Apr 2023 00:23:14 | Mooring | 12913 332 | 249 | 12467 | 29 | 812nm WVVV of Dorn Blen Phu | 28.0034°N | 89.55954°E | 28.91nm Cell ** | TCF |

