ACCIDENT INVESTIGATION COMMISSION

FINAL REPORT

AIC 21 - 1002

Hevilift (PNG) Aviation Limited

P2-MHM

MIL MI-8 MTV-1

Loss of control – In-flight

Gobo, Jiwaka Province

Papua New Guinea

15 May 2021

About the AIC

The Accident Investigation Commission (AIC) is an independent statutory agency within Papua New Guinea (PNG). The AIC is governed by a Commission and is entirely separate from the judiciary, transport regulators, policy makers and service providers. The AIC's function is to improve safety and public confidence in the aviation mode of transport through excellence in: independent investigation of aviation accidents and other safety occurrences within the aviation system; safety data recording and analysis; and fostering safety awareness, knowledge and action.

The AIC is responsible for investigating accidents and other transport safety matters involving civil aviation in PNG, as well as participating in overseas investigations involving PNG registered aircraft. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The AIC performs its functions in accordance with the provisions of the *PNG Civil Aviation Act 2000 (As Amended)*, and the *Commissions of Inquiry Act 1951,* and in accordance with *Annex 13* to the *Convention on International Civil Aviation.*

The objective of a safety investigation is to identify and reduce safety-related risk. AIC investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not a function of the AIC to apportion blame or determine liability. At the same time, an investigation report must include relevant factual material of sufficient weight to support the analysis and findings. At all times the AIC endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why it happened, in a fair and unbiased manner.

About this report

The AIC was informed at 12:14 local time (02:14 UTC) on 15 May 2021, through a phone call by Hevilift PNG Aviation Limited (HPAL) of an accident involving a Mil-8 helicopter, registered P2-MHM, owned by Captston Aviation PTE Limited and operated by HPAL. The AIC immediately commenced an investigation.

On 16 May 2021, AIC dispatched a team of investigators to the Hevilift base at Mt. Hagen, Western Highlands Province, Papua New Guinea to commence on-site investigation activities. On 17 May 2021, the investigators were airlifted to the accident site at Gobo, Jimi District, Jiwaka Province where they conducted the initial examinations.

This accident investigation *Final Report* has been produced by the AIC, P O Box 1709, Boroko 111, NCD Papua New Guinea. It has been approved for public release by the Commission in accordance with *Para 6.5* of *ICAO Annex 13*. The report is published on the AIC website www.aic.gov.pg.

The report is based on the investigation carried out by the AIC under the Papua New Guinea *Civil Aviation Act 2000 (As Amended)*, and *Annex 13* to the *Convention on International Civil Aviation*. It contains factual information, analysis of that information, findings and contributing (causal) factors, other factors, safety actions, and safety recommendations.

Although AIC investigations explore the areas surrounding an occurrence, only those facts that are relevant to understanding how and why the accident occurred are included in the report. The report may also contain other non-contributing factors which have been identified as safety deficiencies for the purpose of improving safety.

Readers are advised that in accordance with *Annex 13* to the *Convention on International Civil Aviation*, it is not the purpose of an AIC aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the final report is the prevention of accidents and incidents (Reference: *ICAO Annex 13, Chapter 3, paragraph 3.1*). Consequently, AIC reports are confined to matters of safety significance and may be misleading if used for any other purpose.

Captain Aria Bouraga, MBE

Acting Chief Commissioner

8 May 2023

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GLOSSARY OF ABBREVIATION

AD	: Airworthiness directives
AFM	: Aircraft flight manual
AGL	: Above ground level
AIC	: Accident Investigation Commission
AMP	: Aircraft maintenance program
AMSL	: Above mean sea level
AOA	: Angle of attack
AOC	: Air operator certificate
APU	: Auxiliary power unit
ARCC	: Aviation rescue coordination centre
ASTM	: American society for testing and materials
ATC	: Air traffic control
ATS	: Air traffic services
BEW	: Basic empty weight
CAR	: Civil aviation rules
CASA	: Civil aviation safety authority
COVID	: Corona virus
CPL H	: Commercial pilot license Helicopter
CRM	: Crew resource management
CVR	: Cockpit voice recorder
DFR	: Daily flight record
EFOB	: Estimated fuel onboard
ELT	: Emergency locator transmitter
ELW	: Estimated landing weight
EPIRB	: Emergency position-indicating radio beacon
ERP	: Emergency response plan
ETA	: Estimated time of arrival/Estimating arrival
FDR	: Flight data recorder
FE	: Flight engineer
FIS	: Flight information service
FM	: Flight Manual
Ft	: Feet
GPS	: Global positioning system
GS	: Ground staff
H	: Hour(s)
HF	: High frequency
HIGE	: Hovering in ground effect
HLS	: Helicopter landing site
HOGE	: Hovering out of ground effect
hPa	: Hectopascal
ICAO	: International civil aviation organisation
Kg	: Kilograms (s)
Km	: Kilometres
Kts	: Knot(s)
L	: Litre (s)

LMLG	: Left main landing gear
LTD	: Limited
LUT	: Local user terminal
m	: Metre(s)
MEL	: Minimum equipment list
MCC	: Mission control centre
MH_z	: Megahertz
MI-8	: MIL MI-8 MTV-1 helicopter (PNG C of A listing) (Abbreviation MI-8 used in this report unless quoting a reference from an official document)
MOC	: Maintenance organisation certificate
MR	: Main rotor
MRB	: Main rotor blade (s)
MRCC	: Maritime rescue coordination centre
MTOW	: Maximum take-off weight
NM	: Nautical mile (s)
NPC	: Normal procedure checklist
NSPL	: NiuSky Pacific Limited
NW	: Northwest
OCA	: Operational competency assessment
PF	: Pilot flying
PIC	: Pilot in command
PLB	: Portable locator beacon
PM	: Pilot monitoring
PNG	: Papua New Guinea
POB	: Person onboard
RMLG	: Right main landing gear
RPM	: Revolutions per minute
SAR	: Search and rescue
SE	: Southeast
SMS	: Safety management system
SOP	: Standard operating procedure(s)
SPOC	: SAR point of contact
SSCVR	: Solid-state cockpit voice recorder
SSFDR	: Solid-state flight data recorder
SW	: Southwest
TR	: Tail rotor
TRB	: Tail rotor blade (s)
UTC	: Coordinated universal time
VFR	: Visual flight rules
VHF	: Very high frequency (30 to 300 MHz)

INTRODUCTION

SYNOPSIS

On 15 May 2021, at 11:14:21 local time (01:14:21 UTC[1]), a MIL Mil-8 MTV-1 (MI-8[2]) helicopter, registered P2-MHM (MHM), owned by Captston Aviation PTE LTD[3] and operated by Hevilift (PNG) Aviation Limited, impacted terrain following loss of control after take-off at Gobo, Jiwaka Province. The VFR[4] charter flight was carrying 75 bags of coffee to Mt. Hagen, Western Highlands Province, Papua New Guinea. Gobo is located 30 NM (55.4 Km) from Mt. Hagen on a track of 073ºM. The helicopter was destroyed by impact forces.

There were four persons onboard: two pilots, one flight engineer and one passenger, an employee of the Operator who was on the flight to assist with unloading of cargo, at Gobo. The flight crew sustained minor injuries and the passenger sustained serious injuries and was hospitalised for 54 days.

Maintenance records showed that the helicopter had undergone scheduled maintenance on 12 May 2021, where the tail rotor and chain block were replaced. The tail rotor was re-torqued, following a post maintenance hover test flight on 13 May 2021, and the helicopter was released to service. The helicopter was certified as being serviceable prior to departure from Mt. Hagen.

The crew reported that earlier that day, they had conducted a charter flight from Mt. Hagen to Gobo to drop off some building material. On arrival at Gobo, the crew became aware of a cargo of seventy-five bags of coffee beans for the return flight. The passenger offloaded the cargo from the helicopter with the assistance of the locals and loaded the bags of coffee beans into the helicopter's cargo hold and secured them for the return flight to Mt. Hagen. The co-pilot recalled that they ensured the cargo was loaded correctly before departure. However, the crew did not weigh the cargo or complete a Flight Manifest and so they were unaware of the actual weight of the helicopter.

Cockpit Voice Recorder (CVR) data and the Cockpit imagery recorder revealed that between 11:04 and 11:12, the crew completed all *Mil-8 MTV Normal Procedure Checklists* that were required to be completed prior to takeoff. After starting the engines, the crew completed the *Pre-takeoff Checklist* and the PIC handed controls over to the co-pilot. The co-pilot then assumed control and indicated to the PIC and FE the route that she would fly due to the prevailing quartering tailwind at Gobo.

At 11:13:15, the helicopter lifted off on a heading of 100º and began yawing left and turning the helicopter's heading towards the North of its position. Eleven seconds later, the FE called out the Main Rotor reading as 95%[5] RPM. At that time, the helicopter had established its heading in the North direction and the co-pilot on instruction from the PIC eased it forward as it continued lifting from the hover.

At 11:13:34 as they continued lifting off, the FE called out the MR RPM reading as 94 then 91, which the co-pilot repeated as a challenge and the PIC indicated for them to continue. Recorded data showed that at that time, the helicopter had reached 63 ft AGL, the peak of its initial lift, then started settling back down with a Northwest heading. As they settled back down into a hover, the MR RPM drooped to 90 then 89, which the PIC recalled subsequently beeping[6] up the RPM by 2%, a usual practice for such instances, before lifting off again.

1 The 24-houl clock, in Coordinated Universal Time (UTC), is used in this report to describe the local time as specific events occurred. Local time in the area of the accident, Papua New Guinea Time (Pacific/Port Moresby Time) is UTC + 10 hours.

2 Abbreviation MI-8 used based on the PNG CofA details, unless quoting a reference from an official document.

3 Private Limited company.

4 Visual flight rules: as prescribed by national authority for visual flight, with corresponding relaxed requirements for flight instruments (Source: *The Cambridge Aerospace Dictionary*)

5 MR RPM is a %. The crew called the MR RPM without using the word percent. That is acceptable. The % symbol is used in this report to ensure clarity.

6 Beeping up the main rotor RPM trims the MR RPM to the desired rotor rpm using a rotor rpm trim, or "beep" switch.

As they continued lifting off, the FE indicated to the co-pilot to go a little bit to the left, to which the co-pilot responded by querying what she should do. The PIC instructed her to continue. Recorded data showed that the helicopter continued yawing to the left even though the co-pilot had right pedal input applied.

At 11:13:57, as they continued lifting through 71 ft AGL, the PIC instructed the co-pilot to go a little bit to the left and ease forward. At about the same time the FE called out the MR RPM as 90 and the helicopter yawed further to the left as it began forward transition. Recorded data showed that as the helicopter transitioned forward, it reached 79 ft AGL the peak of the climb, then began losing height.

At 11:14:03, as they continued, at 75 ft AGL the FE called out the MR RPM as 91, then 90. The PIC instructed the co-pilot to go a little to the left and emphasised that the co-pilot apply the left pedal. Recorded data showed that at 11:14:06, when passing 72 ft AGL, the helicopter's heading was established on the Southwest direction and continued descending.

Recorded data showed that at 11:14:08 at 65 ft AGL, the forward right quarter of the helicopter was passing over the south-western end of the level ground (field), before the slope into the valley. At about the same time, the helicopter began spinning to the left. The co-pilot recalled that it was around this time she had lost control of the tail rotor authority.

At 11:14:11, the helicopter was spinning through a southerly direction, descending through 47 ft AGL. The PIC emphasised that the co-pilot should apply left pedal. Recorded data showed that at that time, the helicopter continued an intense yaw to the left.

At 11:14:14, as the helicopter continued spinning to the left descending through 23 ft AGL with a Southeast track, the co-pilot asked the PIC to take control, which the PIC acknowledged and took over control. During interview, the co-pilot recalled that she handed over the controls to the PIC when she felt that she had lost control of the helicopter.

Recorded data indicated that at 11:14:21, the right side of the helicopter initially impacted the ground and subsequently rolled over on its right side before coming to rest inverted, 147.3 m Southwest of its take-off location.

The crew reported that the PIC and co-pilot evacuated first, followed by the passenger and the FE was the last to evacuated after he had shut down the engines. The passenger sustained serious injuries, while the crew sustained minor injuries.

The crew were unaware that the helicopter's weight exceeded the permissible hover out of ground effect weight for the takeoff from Gobo. The investigation found that the accident occurred due to loss of tail rotor authority. Contributing to the loss of tail rotor authority were the overweight condition, and both PIC and co-pilot lacking appropriate training and currency on the MIL-8. The PIC was conducting checking flight with the co-pilot. CASA PNG had issued the PIC an *Instrument of Approval* to conduct training and checking flights without conducting a check flight with a CASA Flying Operations Inspector as required under Civil Aviation Rules.

The operator conducted an internal investigation and took safety actions to prevent similar occurrences.

The PNG AIC issued Safety Recommendations to the operator, Hevilift (PNG) Aviation Limited, in relation to improving Quality Assurance in relevant organisational systems, processes and procedures to identify deviations from the requirements of Ground Operations, Flight Operations and Training and Competency and Maintenance including the areas of documentation and records.

Safety Recommendations were also issued to the Civil Aviation Safety Authority of PNG in their role as the safety auditor and regulator.

1 FACTUAL INFORMATION

1.1 History of the flight

On 15 May 2021, at 11:14:21 local time (01:14:21 UTC[7]), a MIL Mil-8 MTV-1 (MI-8[8]) helicopter, registered P2-MHM (MHM), owned by Captston Aviation PTE LTD[9] and operated by Hevilift (PNG) Aviation Limited, impacted terrain following loss of control after take-off at Gobo, Jiwaka Province. The VFR[10] charter flight was carrying 75 bags of coffee to Mt. Hagen, Western Highlands Province, Papua New Guinea. Gobo is located 30 NM (55.4 Km) from Mt. Hagen on a track of 073ºM. The helicopter was destroyed by impact forces.

There were four persons onboard: two pilots, one flight engineer and one passenger[11]. The flight crew sustained minor injuries and the passenger sustained serious injuries and was hospitalised for 54 days.

(Refer to *Section 1.2*.)

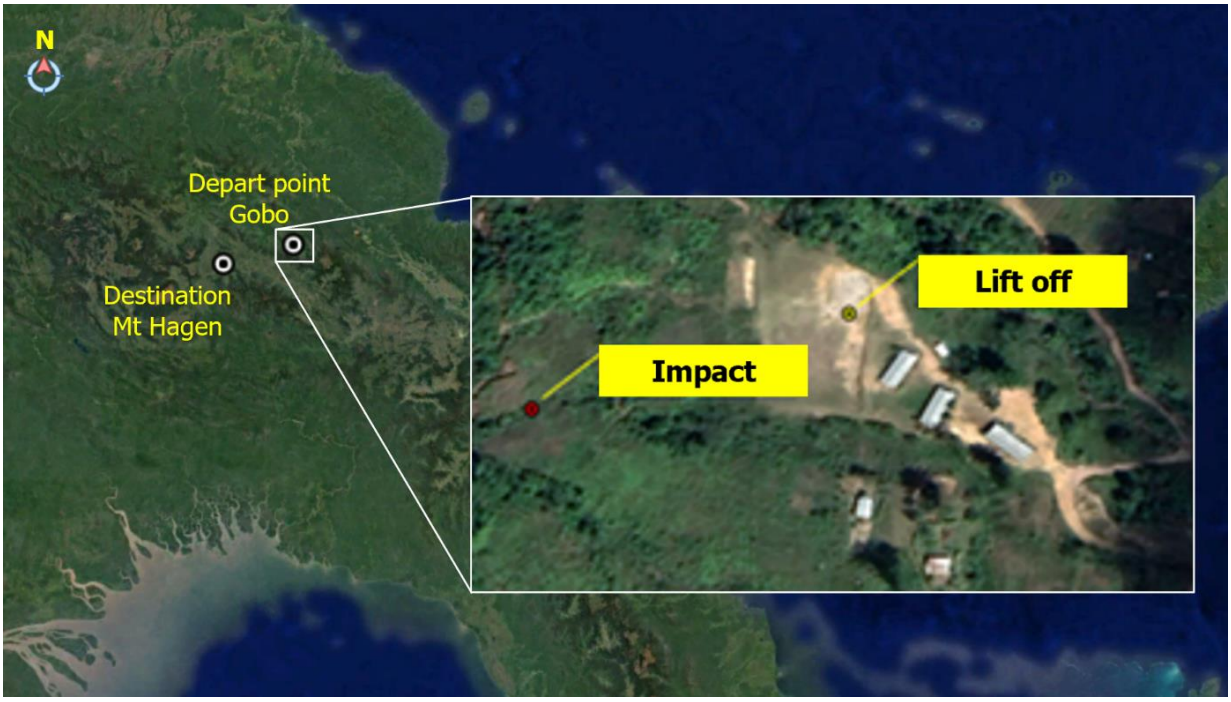


Figure 1: Depiction of P2-MHM accident site location

The helicopter was certified as being serviceable prior to departure from Mt. Hagen.

The co-pilot, occupying the right seat, was the pilot flying (PF) from Gobo. The pilot in command (PIC), seated on the left seat was the pilot monitoring (PM). The flight engineer (FE) was occupying the centre seat in the cockpit.

The passenger was occupying the seat next to the main entry door in the cabin. (Refer to *Figure 26*).

7 The 24-houl clock, in Coordinated Universal Time (UTC), is used in this report to describe the local time as specific events occurred. Local time in the area of the accident, Papua New Guinea Time (Pacific/Port Moresby Time) is UTC + 10 hours.

8 Abbreviation MI-8 used based on the PNG CofA details, unless quoting a reference from an official document.

9 Private Limited company.

10 Visual flight rules: as prescribed by national authority for visual flight, with corresponding relaxed requirements for flight instruments (Source: *The Cambridge Aerospace Dictionary*)

11 Refer to section 1.5.4 and 1.18.6 for more information.

The crew[12] had conducted a charter flight with cargo from Mt. Hagen to Gobo. The crew said that the job was to fly cargo to Gobo and return to base. There was no other job scheduled for the return sector. According to the Cockpit Voice Recorder (CVR) records, during the approach to land at Gobo, the crew queried what they expressed as a pile of white bags they could see on the field near the landing area.

They continued the approach and landed at the landing area facing the buildings to the East of the field (see *Figure 4*). Recorded data[13] shows a landing time of 10:12. Following shutdown, the passenger unloaded the cargo from the helicopter with the help of the locals.

The crew stated during interview that they confirmed upon landing that the bags they had observed were coffee bags that they were to transport to Mt. Hagen. The passenger, with the help of locals, subsequently loaded the helicopter with the bags. There was a total of seventy-five bags loaded onto the cargo hold. During his interview with the AIC investigators, the passenger stated that the locals carried the bags into the cargo hold as he arranged and strapped them down. The co-pilot stated that prior to departure they ensured the cargo was loaded correctly.

Between 11:04 and 11:09, the crew completed the following *MIL-8 MTV Normal Procedures Checklists* (NPC):

- *Pre-Start* Checks (refer to *Section 5.1 Appendix A, 5.1.2*). All action items were completed.
- *Pre-Start: APU[14] Start* Checks (refer to *Section 5.1 Appendix A, 5.1.3*) and started up the APU. The crew subsequently completed the *Pre-Start: APU Running* checks (refer to *Section 5.1 Appendix A, 5.1.4*).
- *Starting: First Engine Running* and *Second Engine Running* checklists (refer to *Section 5.1 Appendix A, 5.1.5-6*) and started the No. 2 Engine[15] and No. 1 Engine[16] respectively.
- *Engine Running at Ground Idle* checklist (refer to *Section 5.1 Appendix A, 5.1.7*). The engines were started successfully, and ground idle checks were completed.

At 11:11:17, the crew commenced the *MIL-8 MTV NPC Engines Running at Flight Idle* checklist (refer to *Section 5.1 Appendix A, 5.1.8*). While actioning this checklist at 11:11:26, the co-pilot asked the crew if they should switch off the dust protection system[17], adding "cos we're very heavy". Recorded data showed that the FE confirmed that he had switched off the dust protection system in response to the co-pilot's request. The co-pilot also called "Altimeters 4200" and the FE responded "4200".

The crew then completed the *MIL-8 MTV NPC Pre-Take Off checks* (refer to *Section 5.1 Appendix A, 5.1.9*) and completed the action items.

Recorded data showed that at 11:12:40 the PIC handed controls over to the co-pilot. The co-pilot acknowledged and took over controls. The co-pilot then briefed the crew on the route that she was going to fly. The briefed take-off and departure direction was toward their left, i.e., toward the North over the valley (Refer to *Figures 4 and 8*). The PIC agreed saying the wind was coming up the valley[18].

During interview, the co-pilot stated that she opted to take off towards the valley as that was where the wind was blowing from.

At 11:13:15, the helicopter lifted off on a heading of 100º and immediately began yawing left. The co-pilot started turning the helicopter left towards the North.

12 The pilot in command (PIC), co-pilot and the flight engineer (FE).

13 FDR, CVR and appereo recorded data.

14 Auxiliary Power Unit

15 Right engine

16 Left engine

17 Refer to *Section 1.6.2.3* for information on the Dust Protection System

18 The wind direction gave a quartering tailwind for the hover in ground effect and the initial hover out of ground effect.

At 11:13:26, during the lift off phase, the FE called out the Main Rotor (MR) RPM[19] reading as 95 (95%[20]). About three seconds later, the helicopter established on a northerly heading. The co-pilot commenced forward flight from hover.

Recorded data showed that at 11:13:34, as they continued, the FE called out the MR RPM reading as 92, then 91, which the co-pilot, bewildered, repeated 91. The PIC stated that they were okay, and the FE, at about the same time called out the MR RPM reading as 90. The PIC responded, *"yep drooping now"*.

During the interview, the crew stated that following the drooping RPM they had to settle the helicopter into a hover. The crew also stated that they usually experienced drooping RPM when they had a heavy load. The normal practice was to set the helicopter back down or into a hover in ground effect (HIGE) and beep up[21] the MR RPM before lifting from the hover again.

The helicopter settled in a hover at 44 ft AGL for 2 seconds, with a MR RPM of 89 and on a Northwest (NW) heading. During interview, the PIC stated that he beeped up the MR RPM by 2%. The co-pilot then applied power to start climbing again. The recorded data shows that the helicopter remained at a bank angle of about 5 degrees to the right during this climb.

As the helicopter climbed through 50 ft AGL, the FE said to the co-pilot to *"go a little bit to the left, right"*[22] and raised his left hand pointing in the forward right direction. The co-pilot subsequently asked what she should do, and the PIC responded stating *"yeah let's go! let's go!"*[23].

Recorded data showed that at 11:13:53, climbing through 58 ft AGL, there was a slight application of the left pedal which lasted for about two seconds and the helicopter yawed to the left.

At 11:13:57, as they continued through 76 ft AGL, with a MR RPM at 90, the PIC instructed the co-pilot to go a *"little bit to the left turn, just ease it forward"* [with cyclic forward input]. Recorded data showed a nose pitch down to around 10 degrees and an intermittent and slight left pedal depression, but not enough to bring the pedals from right deflection to neutral. The helicopter subsequently yawed left as it tracked forward. The bank angle remained to the right.

At 11:14:03, as they continued forward transition and descending through 75 ft AGL over the level field on a NW heading, the FE called out the MR RPM as 91, then 90.

At 11:14:04 the PIC said, *"Let's just go a little, little bit to the left, left pedal, left pedal, left pedal"*, during transition to forward flight, as the helicopter reached 81 ft AGL still over the level field, it began losing height.

Recorded data showed that at this time, the pedals were brought to the neutral position.

The helicopter continued to yaw to the left and skid right.

At 11:14:08, at 58 ft AGL, the helicopter began crossing from over the level field to over the downslope toward the valley west of the field. (Refer to *Figure 3*). Recorded data showed that at about the same time, the left yaw and right skid became more pronounced. The co-pilot stated that she was unsure of what was happening, but recalled suspecting that she was losing tail rotor authority.

19 Revolution per minute. The Mil-8 prescribed range is 95% (± 2% allowed)

20 MR RPM is a %. The crew called the MR RPM without using the word percent. That is acceptable.

21 The left collective pitch control lever is installed on the bracket with engine separate throttle control levers. One of the buttons on the top of the collective pitch lever is a selector switch for main rotor speed re-adjustment. Beeping up the main rotor RPM trims the MR RPM to the desired rotor rpm using a rotor rpm trim, or "beep" switch.

22 During interview the FE stated that when he said go a little bit to the left, right, he had observed a high parapet on which locals were standing in that area. He said he had a feeling of moving to the right and was recommending that the co-pilot move to the left of the take-off point to remain clear of them.

23 A non-standard phrase/call believed to indicate to the co-pilot to go to the left as stated by the FE.

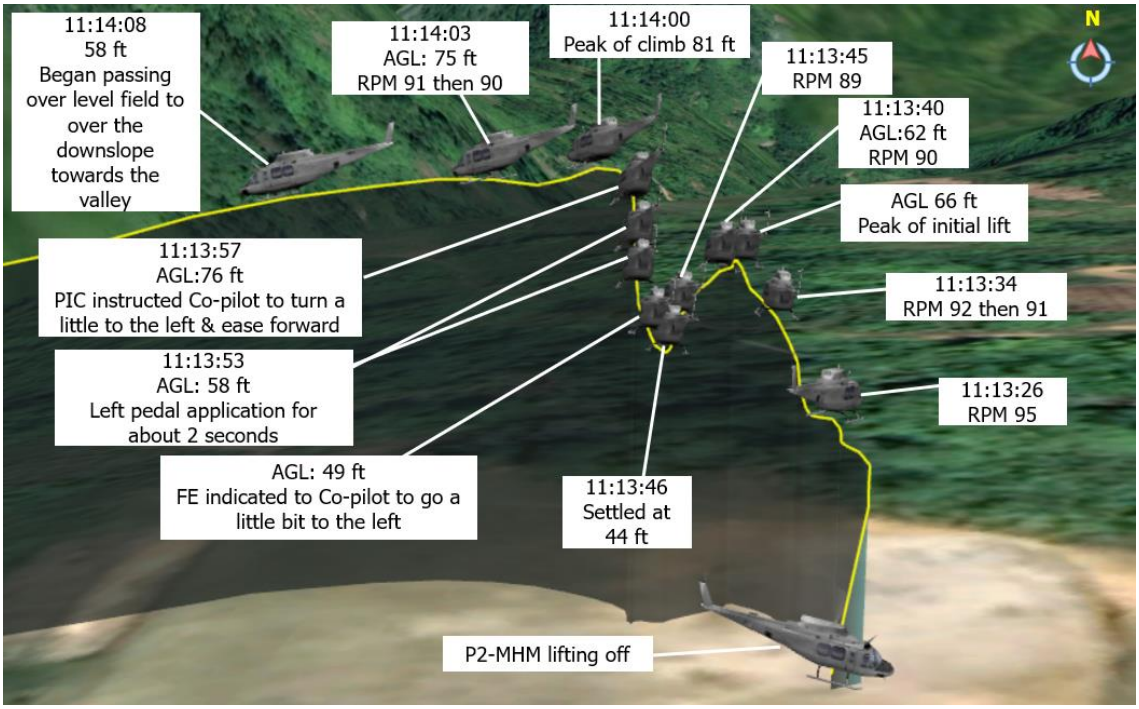


Figure 2: Extended view of the accident flight - from start to before leaving the level field.

The helicopter continued to yaw left and began to spin**.** At 11:14:11, the FE called out: *"left, left, left, left".* The PIC immediately followed with the call out: *"left pedal, left pedal, left pedal"*. Recorded data showed that by that time the helicopter was entering a rapidly developing left yaw and right roll.

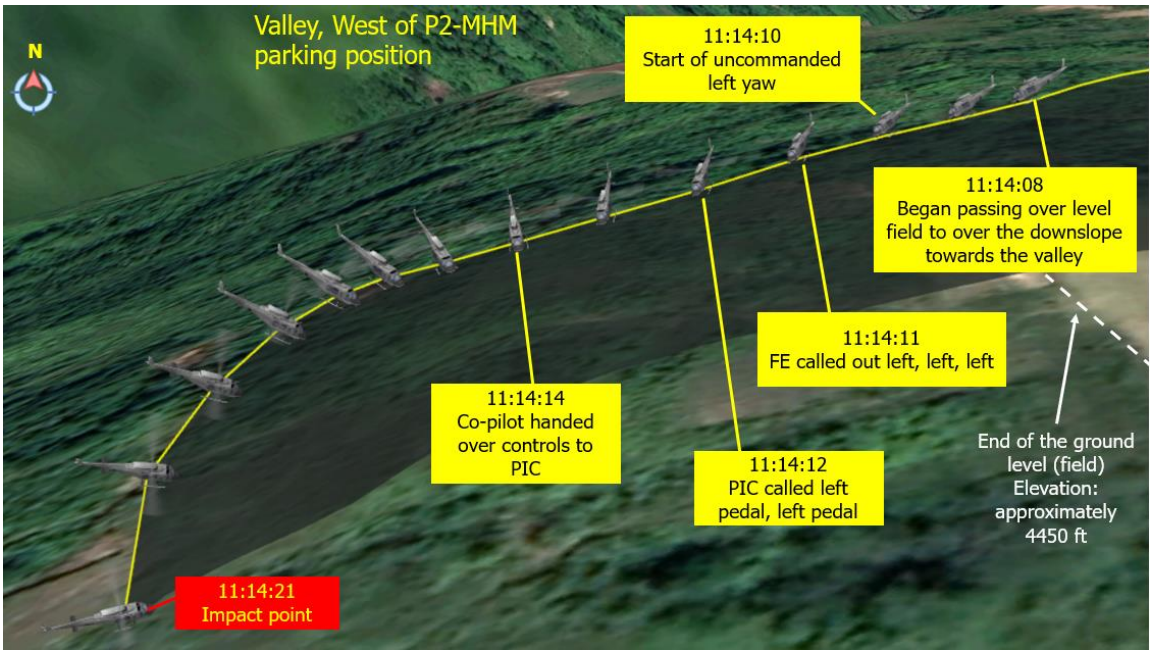


Figure 3: Extended view of the accident flight - from after leaving the level field to impact.

According to recorded data, at 11:14:14, the co-pilot asked the PIC to take control. Two seconds later the PIC said, "I have control". Upon assuming controls, the PIC immediately applied full right pedal.

At 11:14:21, the helicopter impacted the ground flipped over on its side and rolled numerous times before

it came to rest inverted. The helicopter's final resting position was about 147 m Southwest of the take off point at an elevation 49 ft lower than its helipad in the field. (Refer to *Figure 4*).

The cockpit image recorder showed that the PIC was following through with his feet on the pedals and his right hand lightly holding the cyclic throughout the take-off sequence. The imagery showed that right pedal was applied during the lift off and throughout the takeoff. When the PIC called with urgency for left pedal, right pedal deflection was reduced to almost neutral. Left pedal (beyond neutral) was not applied as instructed by the PIC, nor did the PIC override the co-pilot at that moment. However, immediately after taking control at the request of the co-pilot, the PIC applied a large amount of right pedal, but that application of right pedal was too late, and it was insufficient to regain tail-rotor effectiveness and avert the loss of control resulting in the accident.

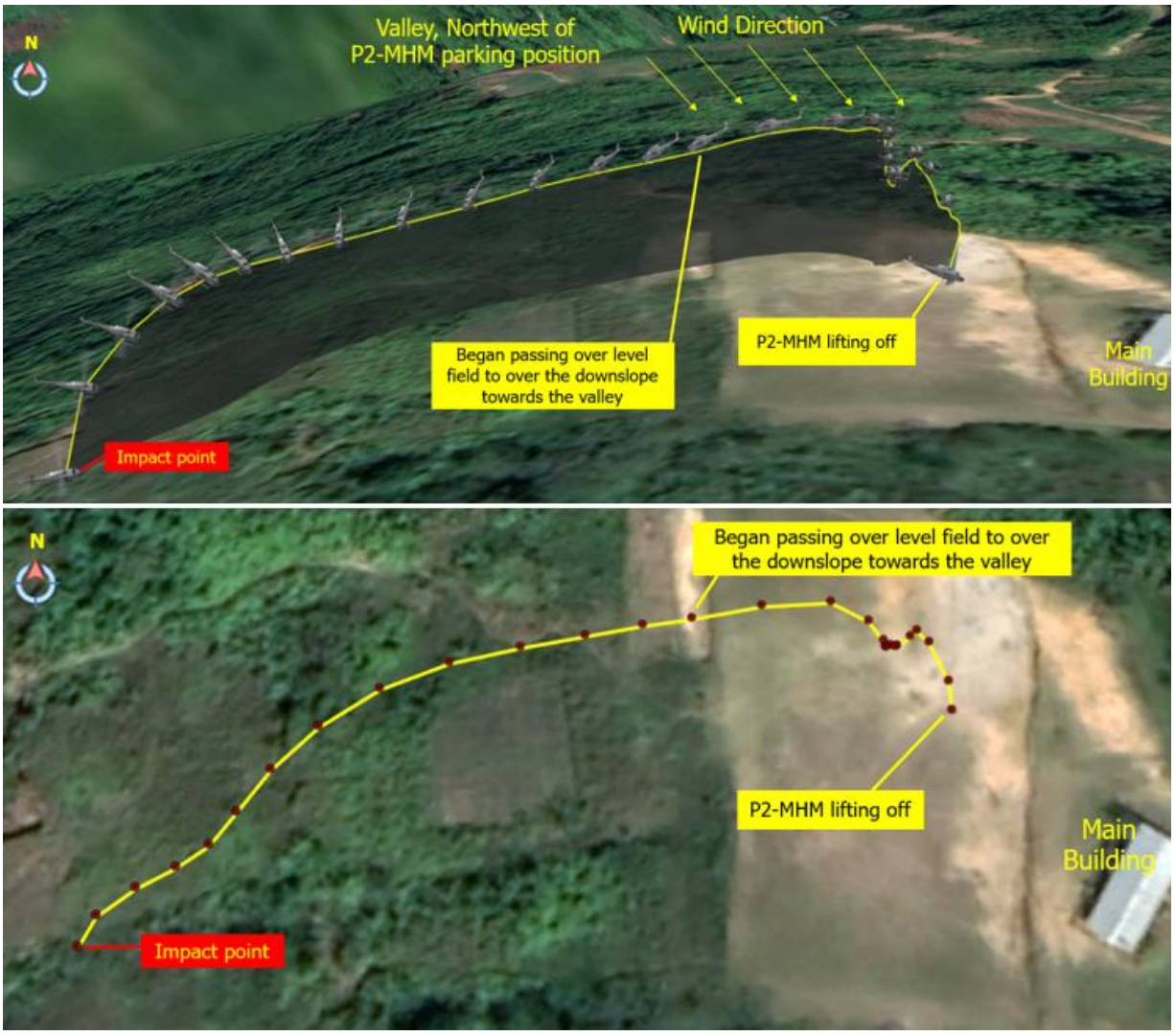


Figure 4: Depiction of side and overhead view of the accident flight path

During their interview, the crew stated that the PIC and co-pilot evacuated first, followed by the passenger and they moved away from the helicopter with the assistance of the local villagers. They also stated that the FE was the last person to evacuate after he had shut down the engines. (Refer to *Section 1.15.2.)*

1.2 Injuries to persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	-	-	-	-
Serious	-	1	1	-
Minor	3	-	3	Not applicable
Nil Injuries	-	-	-	Not applicable
TOTAL	3	1	4	-

Table 1: Injuries to persons

1.2.1 Serious injuries

During his interview, the passenger stated that he sustained serious injuries to his head and neck. He said he was seated with his seat belt fastened during the take-off and impact sequence. He said his seat remained structurally in place and the seatbelt remained fastened and was not damaged. He informed the AIC that he sustained the injuries when the back of his head struck the fuselage bulkhead behind his seat during the impact and roll-over. He also stated that he could feel pain in both his knees.

According to a medical report dated 11 February 2022, provided to the AIC by Western Highlands Provincial Heath Authority, the medical team initially suspected the passenger had sustained a neck spinal injury. After a subsequent diagnostic process the attending Doctors made their final diagnosis that the injury was cervical spine 3 and 4 subluxation[24]. The patient (passenger) was discharged from hospital on 9 July 2021, 54 days after the accident.

1.2.2 Minor injuries

During interview the PIC and co-pilot stated that they sustained minor injuries. The investigators observed that the PIC and the co-pilot each had bruises on their right arms.

According to the initial report from the Western Highlands Provincial Health Authority, provided to the AIC on 24 May 2021, the PIC, co-pilot and FE had minor abrasions and were in a state of shock.

1.3 Damage to aircraft

The helicopter was destroyed by impact forces. Refer to *Section 1.12* for detailed description of damage to relevant components of the helicopter.

1.4 Other damage

Evidence from the accident site showed that the environment around the area of impact sustained minimal damage. (Refer to *Section 1.12*.)

24 An Incomplete or partial dislocation of Cervical Vertebrae 3 and 4.

1.5 Personnel information

1.5.1 Pilot in command

Age	: 47
Gender	: Male
Nationality	: Canadian
Position	: Check and Training Pilot
Type of license	: CPL (H)[25]
Type rating	: Single Engine Helicopters (Land): R44; AS350; BH206; BH407
	: Multi Engine Helicopters (Land): BH212; Mil8
	Design Features (Special) Sling Load Operations: All helicopters <2750 kg MTOW[26]; Floating Operations; winching Operations BH212
Competency Assessment Checks Mil 8[27]	: 30 April 2021
Expiry Date	: 30 April 2022
Total hours flying time	: 8,757.3
Total hours on type	: 381.3
Total hours in command	: 8,261.7
Total hours in command on type	: 228.1
Total hours last 90 days	: 22.3
Total hours last 90 days on type	: 3.9
Total hours last 7 days	: 12.8
Total hours on type last 7 days	: 0.4
Total hours last 24 hours	: 0.4
Total hours last 24 hours on type	: 0.4
Medical class	: One (1)
Valid to	: 30 April 2021 (Single Crew) expired
	30 April 2022 (Multicrew)
Medical limitation	: Colour Blindness (AMC[28])

The PIC's personal records were provided to the AIC by the operator and the Civil Aviation Safety Authority of PNG (CASA PNG). A review of the PIC's personal records showed that he had initially been employed by Hevilift (PNG) Limited, on 29 January 2015, as a rotary wing pilot flying Bell 212 and Bell 407 helicopters. The PIC's *PNG Flight Crew License*, re-issued on 19 May 2017 was endorsed to include MI-8 helicopters.

25 Commercial Pilot Licence (Helicopter)

26 Maximum take-off weight

27 Operational Competency Assessment covered the following checks: Line/Area Check 136.907 (a) (1) (i), Competency Check VFR 136.907 (a)(2), Knowledge Check 136.907 (a) (4) and Competency Check External Load 136.907 (b) (2).

28 Acceptable Means of Compliance.

According to the operator's *Internal Investigation Report*, the PIC had resigned from Hevilift Limited on 29 March 2019. He rejoined Hevilift PNG Limited on 15 April 2021, but was in isolation in accordance with COVID 19 Quarantine requirements[29] until 28 April 2021. The report also stated that during his 24 months absence, the PIC did not operate a MI-8 helicopter.

Refer to *Section 1.17.1.5.2* for information relating to PIC's training and competency records.

According to information gathered from a CASA PNG Medical Examiner, the PIC has had a Class 1 medical since 21 September 2015. Prior to the PNG medical examination, he held a Canadian Class 1 medical without any limitations/restrictions.

The medical examination carried out on the 30 April 2021 identified a limitation (colour blindness). This was because he was not able to accurately identify more than two colour plates on the *Ishihara Chart*[30]. However, he did pass his *Farnsworth test*[31] and therefore, was issued a medical certificate.

According to Papua New Guinea *Civil Aviation Rule (CAR) Part 67.105 (j)* '*Colour Perception Standards*'

> *A medical certificate may be issued if accredited medical conclusion indicates that the applicant has a minor colour perception defect which is compatible with safe use of the license provided the certificate is endorsed with the following limitations:*
>
> *Not valid for flight in the vicinity of a controlled aerodrome (unless the aircraft is in radio contact with aerodrome control).*
>
> *Not valid for night flying.*
>
> *Such endorsements may be removed only after special medical assessment.*

There were no records to show that the PIC had undergone a special medical assessment since he had a minor color perception defect (Unable to read more than two colour plates on the *Ishihara Chart*).

1.5.2 Co-pilot

Age	: 36
Gender	: Female
Nationality	: South African/British
Position	: Line Pilot
Type of license	: CPL (H)
Type rating	: Single Engine Helicopter (Land): R44; AS350; BH206; BH407
	: Multi Engine Helicopters (Land): BH212; Mil-8 (co-pilot)
Competency Assessment Checks Mil 8	: 09 June 2020[32]
Expiry Date	: 09 June 2021
Total hours flying time	: 2,131.8
Total hours in command	: 127.3
Total hours on type	: 1,969.2
Total hours in command on type	: 21.5

29 Corona virus 19 Pandemic requirements at that time, included isolation for 14 consecutive days for international travelers into Papua New Guinea.

30 A colour vision test for detection of red-green colour deficiencies, named after its designer, Shinobu Ishihara.

31 A colour vision test where different shades of the same colour are lined up a certain way.

32 Records from her previous employment period with Hevilift PNG

Total hours last 90 days	:	0.1
Total hours last 90 days on type	:	0.1
Total hours last 7 days	:	0.1
Total hours last 24 hours	:	0.1
Total hours last 24 hours on type	:	0.1
Medical class	: One (1)	
Valid to	: 22 June 2021	
Medical limitation	: Nil	

The co-pilot's personal records were provided to the AIC by the operator and CASA PNG. The co-pilot's *PNG Flight Crew License*, issued on 19 July 2017 endorsement included Mil-8 (Co-pilot).

According to the operator's *Internal Investigation Report*, the co-pilot's current employment at Hevilift commenced on 15 March 2021, having returned to the company after a 6-month absence. The co-pilot had previously been employed with Hevilift as a MI-8 co-pilot for more than 2 years.

The report stated that on return to PNG, the co-pilot completed a COVID Quarantine on 6 May 2021.

The co-pilot's records provided to the AIC, did not contain any of the information as indicated in the operator's *Internal Investigation Report*.

Refer to *Section 1.17.1.5.3* for information relating to the co-pilot's training and competency information.

1.5.3 Flight Engineer

Age	: 45	
Gender	: Male	
Nationality	: Russian	
Position	: Flight Engineer	
Type of license	: Flight Engineer License (Helicopter)	
Type rating	: Multi Engine Helicopter (Land): Mil-8	
Operation Competency Assessment		
MIL Mi8	: 22 April 2021	
Operation Competency Expiry date	: 22 April 2022	
Total hours flying time	: 6,098.7	
Total hours on type	: 6,098.7	
Total hours last 90 days	:	25.4
Total hours last 90 days on type	:	25.4
Total hours last 7 days	:	0.9
Total hours last 24 hours	:	0.4
Total hours last 24 hours on type	:	0.4
Medical class	: Two (2)	
Valid to	: 03 May 2023	
Medical limitation	: Nil	

The FE's personal records were provided to the AIC by the operator and CASA PNG. The records showed that the FE had commenced employment with Hevilift PNG Limited on 28 April 2009. *Air Maestro*[33] records dated 13 March 2022 showed that he was on leave from 1 November 2020 and returned on 6 April 2021 (5 months).

The report also indicated that the FE was in COVID isolation from 6 April to 19 April 2021 and resumed duties on 20 April 2021. His actual flight time started on 22 April 2021, which was his competency check flight and he continued operating flights as a Flight Engineer from 23 to 30 April 2021. In May 2021, he operated as Flight Engineer on 1 May 2021 and 13 May 2021 (Post maintenance hover test flight) before the accident flight on 15 May 2021.

1.5.4 Passenger

For details of the passenger refer to *Additional information, Section 1.18.6.*

1.6 Aircraft Information

1.6.1 Aircraft data

Aircraft manufacturer	: KAZAN Helicopters
Model	: MIL Mil-8 MTV1
Serial number	: 95881
Year of manufacture	: 1992
Total airframe hours	: 9985.29
Total airframe cycles	: 13,861
Registration	: P2-MHM
Certificate of Registration number	: 279
Certificate of Registration issued	: 25 July 2019
Certificate of Registration valid to	: Perpetual
Name of the owner	: Capstone Aviation PTE LTD
Name of the operator	: Hevilift Aviation Limited
Certificate of Airworthiness issued	: 9 December 2011
Certificate of Airworthiness valid to	: Non-terminating

1.6.1.1 Engine data

Engine type	: TV3-117VM
Manufacturer	: KLIMOV
Model	: T3B-117 BM

33 *Air Maestro* is an integrated safety and operational management software solution empowering aviation organisations to operate safely and efficiently. Refer to Section 1.17.1.1

No. 1 engine (Left)

Serial number	: 7087881900207
Year of manufacture	: 1989
Total time since new	: 3508.29
Cycles since new	: 3491
Time hours since overhaul	: 142.01
Cycles since overhaul	: 125

No. 2 engine (Right)

Serial number	: 7087851403068
Year of manufacture	: 1984
Total time hours since new	: 3556.96
Cycles since new	: 3539
Total time hours since overhaul	: 142.01
Cycles Since Overhaul	: 125

1.6.1.2 Rotor blades

Main rotor blades

Main Rotor blades manufacturer	: Kazan helicopter plant
Year of manufacture	: 2016
Main Rotor model	: Bp-14
Main Rotor Blade #1 serial number	: 2TE-04548
Main Rotor Blade #2 serial number	: 2TE-02548
Main Rotor Blade #3 serial number	: 2TE-01548
Main Rotor Blade #4 serial number	: 2TE-03548
Main Rotor Blade #5 serial number	: 2TE-05548

Tail rotor blades

Tail Rotor blades manufacturer	: “Vpered” manufacture plant, Russia
Year of manufacture	: 2018
Tail Rotor Blade set Part number	: 246-3925-00
Tail Rotor serial number	: MXBG553017

1.6.1.3 Fuel information

All relevant documents containing fuel information were provided to the AIC by the Refuelling Agent, Puma Energy, Mt. Hagen. According to the fuel dockets, on 13 May 2021, two days before the day of the accident, MHM was last refuelled with 1,351 Litres (L) of Jet A-1 fuel.

A fuel sample from MHM was retained by the operator and was provided to the AIC after the accident. The fuel sample was sent to Intertek for testing at their laboratory in Port Moresby. The test results did not show any significant variation from approved specifications. Refer to *Section 1.16.1* for the *Fuel Sample Laboratory Test Result*.

The engine performance data and gauge readings viewed on the cockpit image recorder also show that the engines were performing normally and within the specified ratings.

1.6.1.4 Aircraft weight

According to Kazan Helicopters *Flight Manual, Section 2.1,* the helicopter (P2-MHM) was certified to transport cargo with a maximum mass (weight) of 4,000 kg in the cargo cabin.

During his interview with the AIC, the PIC confirmed that the *Passenger and Cargo Manifest* was not used to calculate the all-up weight. The *Daily Flight Return* form of the accident flight was incomplete. As a result, a pre-flight calculated record of take-off weight of the helicopter, the fuel weight onboard, the payload and the centre of gravity at the time of the occurrence were not determined by the crew and were not available to the investigation.

The co-pilot stated that she supervised the cargo being loaded and tied down by the passenger who was not trained as a loadmaster.

The PIC informed the AIC that the crew made rough calculations on a clipboard and estimated a total all up weight of approximately 12,100 kg. No clipboard was found in the cockpit or at the accident site, nor was it provided to the AIC by the crew or the operator.

Although this statement of estimated all up weight could not be verified with documents, the investigation accepted this value as the PIC's estimate for the purpose of reference and that it was used by the PIC and crew during the accident flight.

According to the *Flight Manual Weight Report* sheet of the helicopter, the basic empty weight (BEW) of the helicopter was calculated on 1 March 2017 to be 6,902 kg and the centre of gravity of the aircraft was documented as 72 mm[34].

Although the operator's *Ground Handling Manual Part A, Section 3.37 Standard Passenger Weight* states that the company standard weight value for adults in rotary wing operations is 82 kg, the AIC adopted the figures used in the operator's *Internal Investigation Report* as 100 kg per person on board (POB). This was done to predict a slightly more conservative take-off weight. Therefore, the total weight of the four POB was estimated to be 400 kg.

The on-site investigation established the actual weight of the cargo (payload) by weighing the individual coffee bags at the accident site. The total weight of the coffee bags was 4,156.41 kg.

According to CVR data, prior to commencing pre-start checks out of Gobo, the FE made a fuel read out of 1350 L (1,046.25 kg).

Therefore, the AIC determined that the take-off weight (TOW) of the aircraft from Gobo during the accident flight was:

Basic Empty Weight (BEW)	6,902.00 kg
Persons On Board (POB)	+ 400.00 kg
Payload (cargo)	+ 4,156.41 kg
Fuel On Board (FOB)	+ 1,046.25 kg
Take Off Weight (TOW)	**= 12,504.66 kg**

Table 2: Take-Off Weight Calculation

34 Centre of Gravity datum.

During the interview with the flight crew, there was conflicting information provided regarding the actual outside air temperature at the time of the occurrence. Additionally, the *Area Forecast* provided to the investigation did not contain the forecast temperature within the Gobo area. The operator's *Investigation Report* listed the temperature as 25ºC.

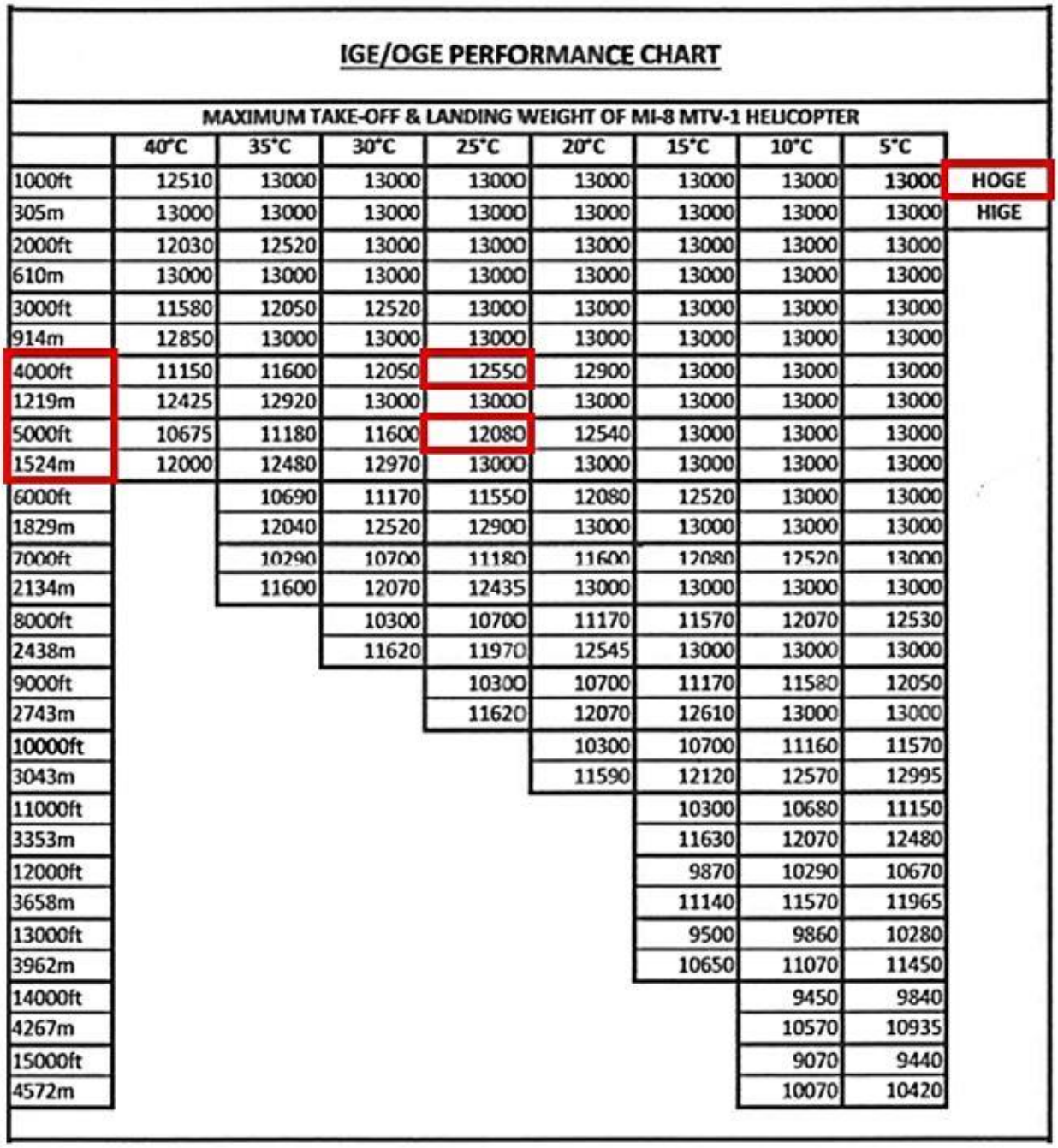
The AIC investigation accepted the operator's stated temperature of 25ºC. The AIC used a GPS on site to determine the coordinates of the take-off location of the helicopter and its elevation. Gobo elevation is 4,454 ft[35].`

The operator's *(3-E011) OPERATIONS MANUAL ROTARY WING Section 4.5.3 Performance Class 3 Helicopter Operations* states:

> *Hevilift Performance Class 3 helicopters operate at take-off weights such that the helicopter is capable of hovering within ground effect with the engine operating normally, having taken account of the pressure altitude and ambient temperature of the HLS being used, and with the capability of clearing all obstacles within the take-off flight path by a distance of not less than 15 feet.*
>
> *The helicopter is operated at a take-off weight such that the helicopter is capable of flying en-route at or above the appropriate minimum VFR altitudes for the area of operations.*
>
> *The helicopter is operated at a take-off weight at the heliport or HLS of intended landing, such that it is able to hover in ground effect with the engine operating normally, taking account of the pressure altitude and ambient temperature of the heliport or helideck, and able to conduct a baulked landing clearing all obstacles within the flight path by a vertical distance of at least 15 feet.*

According to the helicopter's recorded data, the crew used hover out of ground effect (HOGE). The investigation used the *Mil-8 MTV-1 Performance Chart* to determine whether the helicopter was within operational limits in the prevailing conditions at the time of the accident.

35 The FDR recorded barometric elevation as 1,260, which is 4,132.8 ft. This figure of 4,454 ft was based on the GPS data taken onsite by the AIC.



IGE/OGE PERFORMANCE CHART

MAXIMUM TAKE-OFF & LANDING WEIGHT OF MI-8 MTV-1 HELICOPTER

	40°C	35°C	30°C	25°C	20°C	15°C	10°C	5°C	
1000ft	12510	13000	13000	13000	13000	13000	13000	13000	HOGE
305m	13000	13000	13000	13000	13000	13000	13000	13000	HIGE
2000ft	12030	12520	13000	13000	13000	13000	13000	13000	
610m	13000	13000	13000	13000	13000	13000	13000	13000	
3000ft	11580	12050	12520	13000	13000	13000	13000	13000	
914m	12850	13000	13000	13000	13000	13000	13000	13000	
4000ft	11150	11600	12050	12550	12900	13000	13000	13000	
1219m	12425	12920	13000	13000	13000	13000	13000	13000	
5000ft	10675	11180	11600	12080	12540	13000	13000	13000	
1524m	12000	12480	12970	13000	13000	13000	13000	13000	
6000ft		10690	11170	11550	12080	12520	13000	13000	
1829m		12040	12520	12900	13000	13000	13000	13000	
7000ft		10290	10700	11180	11600	12080	12520	13000	
2134m		11600	12070	12435	13000	13000	13000	13000	
8000ft			10300	10700	11170	11570	12070	12530	
2438m			11620	11970	12545	13000	13000	13000	
9000ft				10300	10700	11170	11580	12050	
2743m				11620	12070	12610	13000	13000	
10000ft					10300	10700	11160	11570	
3043m					11590	12120	12570	12995	
11000ft						10300	10680	11150	
3353m						11630	12070	12480	
12000ft						9870	10290	10670	
3658m						11140	11570	11965	
13000ft						9500	9860	10280	
3962m						10650	11070	11450	
14000ft							9450	9840	
4267m							10570	10935	
15000ft							9070	9440	
4572m							10070	10420	

Figure 5: Mil-8 MTV-1 performance chart

Given that the elevation at Gobo is 4,454 ft, the performance chart was interpolated between 4,000 ft and 5,000 ft at a temperature of 25ºC[36] to determine the helicopter's maximum allowable take-off weight for HOGE as:

$$\frac{12{,}550 \text{ kg} + 12{,}080 \text{ kg}}{2} = \textbf{12,315 kg}$$

36 For performance calculations, due to the uncertainty of the actual temperature the Operator's listed temperature of 25ºC was used as a conservative figure.

According to the AIC's estimated weight calculations and the plotting using the approved HOGE performance chart:

At 4,454 ft altitude and 25ºC, the helicopter was determined to have been operating outside its HOGE maximum allowable take-off weight in the prevailing conditions at the time of the accident. The HOGE maximum allowable weight would have been 12,315 kg. The helicopter would have exceeded the HOGE weight by 189 kg.

1.6.1.5 Minimum equipment list

According to the maintenance records that were provided to the AIC by the operator, there were no outstanding *Minimum Equipment List (MEL)* items at the time of the accident.

1.6.1.6 Maintenance information

The investigation reviewed maintenance records for MHM for the 12-month period prior to the accident date.

The investigation found that on 12 May 2021, 3 days prior to the accident, during a 6-month seasonal inspection, entries were made in the defects report section of the *Aircraft Technical Logbook* with instructions to change the tail rotor (TR) and the chain block. However, there were no detailed descriptions showing why these components were to be replaced on MHM.

The maintenance log records indicated that on 12 May 2021, during a scheduled maintenance, TR and blades were replaced. An entry was made on the serviceable tag stating that the TR and blades were removed from another MI-8 helicopter P2-MHL and were installed on MHM. An additional worksheet noted that the chain block was replaced on the same day.

The Daily Flight Record (DFR) dated 13 May 2021 showed that a post-maintenance hover test flight was conducted on MHM. According to the operator, no test flight is required for a TR change, except for a hover test flight that was conducted as indicated in the DFR.

The *Aircraft Technical Logbook* entries dated 13 May 2021, indicated that following the hover test, the PIC reported that there were no defects, and a re-torque of the tail rotor was due. The *Additional Worksheet Form* dated 13 May 2021 showed that re-torque of the tail rotor hub was carried out and the helicopter was released to service.

1.6.2 Aircraft systems

1.6.2.1 Main rotor system

According to the *Mi-8 MTV-1 Maintenance Manual,* the five main rotor blades (MRB), each weighing not more than 140 kg and about 9,775 mm long are mounted on the main rotor hub that connects to the main gearbox shaft. The helicopter's engines rotate the gearbox and transfers the rotational energy through shaft linkages to the MR blades causing them to rotate in the clockwise direction when viewed from above. This rotation of the MR blades creates lift and thrust for forward movement and allows the helicopter to fly.

The MR thrust is controlled from the cockpit by the pilot changing the collective pitch and engine power using collective pitch power control lever. The indications for collective pitch of the main rotor and engines' power are respectively indicated on the rotor pitch indicator and engine pressure ratio meter on the instrument panel in the cockpit and helps the pilot to take appropriate action to control the helicopter.

1.6.2.2 Tail rotor system

The TR system consists of three rotor blades, which form a disc with a diameter of 3,908mm. Each rotor blade weighs 3.85 kg. They are fitted onto the tail-rotor hub, which is fitted onto the flange of the tail-rotor gearbox output shaft. The rotations of the rotor system are transferred from the engine revolutions per minute through the tail shaft linking to the tail rotor gear box.

The engine torque through the shafts rotates the TR blades in a clockwise direction when viewed from the port side and provide a counteracting/opposing force to the torque produced by helicopter's MR system to maintain the helicopter in the controlled direction with stability while in flight. The pilot achieves directional stability of the helicopter by adjusting the pitch angle of the tail rotor blades (TRB) using the foot pedals in the cockpit.

The TR is controlled by deflecting the pedals. When the TR is controlled with the use of the pedals, the setting angle of the TRBs is changed at a rate that is proportional to the rate of the pedals' deflection and in the direction of the helicopter deviation. Stopping pedal deflection results in stopping the tail rotor setting angles changing. With the pedals in the neutral position, the tail rotor has a medium positive pitch angle. In medium positive pitch, the tail rotor thrust approximately equals the torque of the main rotor during cruise flight., so the helicopter maintains a constant heading in level flight.

1.6.2.3 Dust protection system

According to the manufacturer's *Flight Manual Vol 2, Section 8.22.1:*

The dust protector device (DPD) is intended to clean the air, coming into the engines TB-117BM, from dust and foreign objects during taxiing, take-off and landing. In the dust protection design, the hot-air and electro-thermal anti-icing systems are provided.

Flight Manual Vol 1, Section 3.1.5.2 states:

> The nomographs of Fig. 3.1.1 and 3.1.3 are plotted for TB3-117BM engines operating in takeoff conditions.
>
> The maximum permissible takeoff (landing) mass (weight) found from the nomographs Figs. 3.1.1 and 3.1.3 must be decreased:
>
> - by 200 kg in case of switching on the DPD at the altitudes from 0 to 3 km inclusive.
> - by 1,000 kg in case of switching on the anti-icing system of engines and rotors.

Section 3.1.9.7 last sentence in paragraph (c) states in part:

> After switching on the DPD ejector while hovering the hourly consumption of fuel increased by 3% …

For engine performance in different conditions with or without Dust Protection, refer to *Section 5.2 Appendix B, 5.2.1 and 5.2.2.*

1.6.2.4 Collision avoidance systems

The aircraft was fitted with a Radio Altimeter Make/Model: KRA 4058 U1071 and its serviceability was not a factor to this occurrence.

1.7 Meteorological information

1.7.1 PNG National Weather Service Forecast Data

The Area Forecast issued by the PNG National Weather Service on 15 May 2021 was valid from 0900 to 2100. Information is as follows:

Upper Winds					
2000 ft	5000 ft	7000 ft	10,000 ft	14,000 ft	18,500 ft
Variable winds at 10 kts	Variable winds at 10 kts	090 Degrees at 10 kts	090 Degrees at 10 kts	280 Degrees at 10 kts	260 Degrees at 10 kts
Cloud below 20,000 ft above Mean Sea Level (MSL)					
Type		**Base**		**Tops**	
Isolated Cumulonimbus		18,000 ft		45,000 ft	
Broken Stratus		500 ft		3000 ft in Precipitation	
Scattered Cumulus		1500 ft		10,000 ft with Broken Showers	
Scattered Strata Cumulus		3000 ft		8000 ft in Broken Rain and Drizzle	
Scattered Altocumulus Altostratus		10,000 ft		18,000 ft	
Visibility					
500 m in Fog		3000 m in Thunderstorms and Rain		4000 m in Showers with Rain and Rain with Drizzle	
Overview					
Scattered showers and thunderstorms with rain areas					
Weather					
Fog Thunderstorms, Showers and Rain, and Rain Drizzle					
Turbulence					
Severe vicinity of cirrus and cumulonimbus. Moderate adjacent mountains associated with cumuli form.					

Table 3: Area Forecast

1.7.2 Gobo Local Weather

According to the operator's standard practice, local weather is normally verbally received by the operator's Mt. Hagen Operations Department for remote landing sites. According to the operator's *Internal Investigation Report*, their Mt. Hagen Operations Department received a verbal report on the Gobo weather from a reliable contact person in Gobo on the day of the accident. Gobo weather on the day of the accident, as reported was less overcast than Mt. Hagen, with some scattered cloud.

1.7.3 Flight crew weather observation

During his interview the PIC informed the AIC that the weather was good with a light breeze coming up the valley [from the west/northwest] about 5 to 8 km per hour [less than 5 kts] and was steady the whole time as they unloaded and loaded the helicopter. The PIC recalled that the transit period was more than an hour. The PIC stated that it was cool, guessing about 20 degrees. He added that it was just the type of flight they had previously done many times.

The co-pilot stated during interview that the weather was pretty good and there was not much wind when they arrived in Gobo. She recalled that the wind started picking up a bit during their transit period of about an hour.

1.8 Aids to navigation

Gobo is a *Helicopter Landing Site* located near Kol, a small remote airstrip Jiwaka Province, Papua New Guinea. This landing site caters for visual flights only and has no ground-based navigation or approach aids, or landing lights.

1.9 Communication

The aircraft was equipped with High Frequency (HF) and a Very High Frequency (VHF) two-way communication radios. Both communication systems were determined to have been serviceable.

On departure out of Mt. Hagen to Gobo, after reporting their departure to Mt. Hagen Tower MHM was then transferred to call Moresby Flight Information Service (FIS) on High Frequency. The two-way communication with both Mt. Hagen Tower and Moresby Flight Service was normal throughout the flight and the arrival at Gobo.

The accident occurred during the takeoff phase of Gobo for the flight to Mt. Hagen and the crew had not contacted Moresby FIS.

1.10 Aerodrome information

1.10.1 Gobo helicopter landing area

The helicopter landing area at Gobo is in Jiwaka Province at an elevation of 4,454 ft and about 30 NM (55.4 Km) Northeast (073ºM) of Mt. Hagen. According to the topography data, the landing area is in a valley that runs in a Northeast/Southwest direction and is surrounded with mountain ranges. There is a river also located in the valley to the West of the landing area, which flows in a North-east direction.

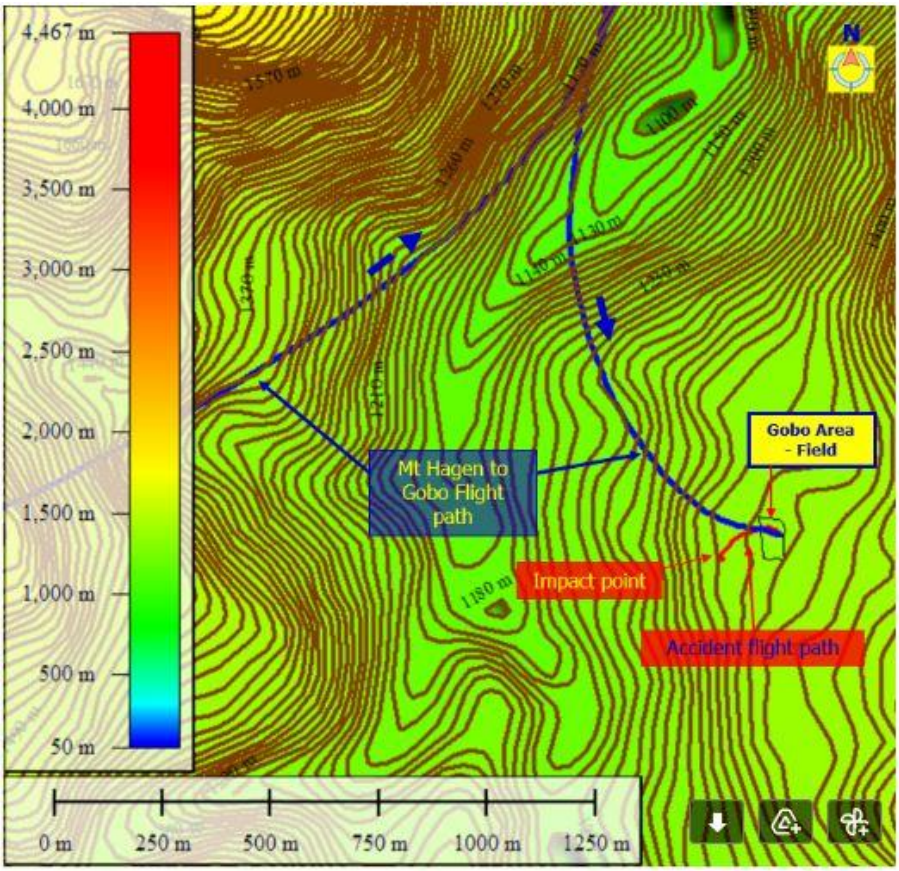


Figure 6: Gobo area topography.

The recorded data indicated that MHM entered the valley west of Gobo having flown a track of 073º from Mt. Hagen. It then made a left turn and tracked to the northwest of Gobo before turning right to return via the river valley, making its final approach to the helicopter landing site, which is a sports field at Gobo Village, tracking 110º. (Refer to *Figure 7.)*

Figure 7: Track flown to Gobo.

The geographical location of the landing area and the surrounding terrain gives the area its own local wind and weather patterns. (Refer to *Figure 8.*)

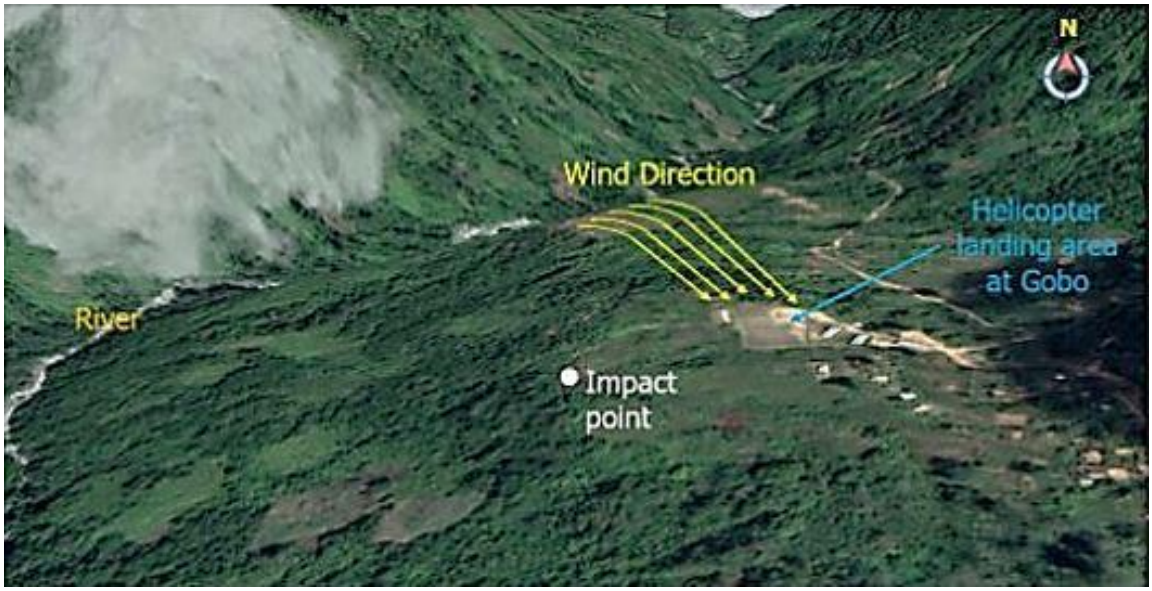


Figure 8: Localised wind pattern at Gobo.

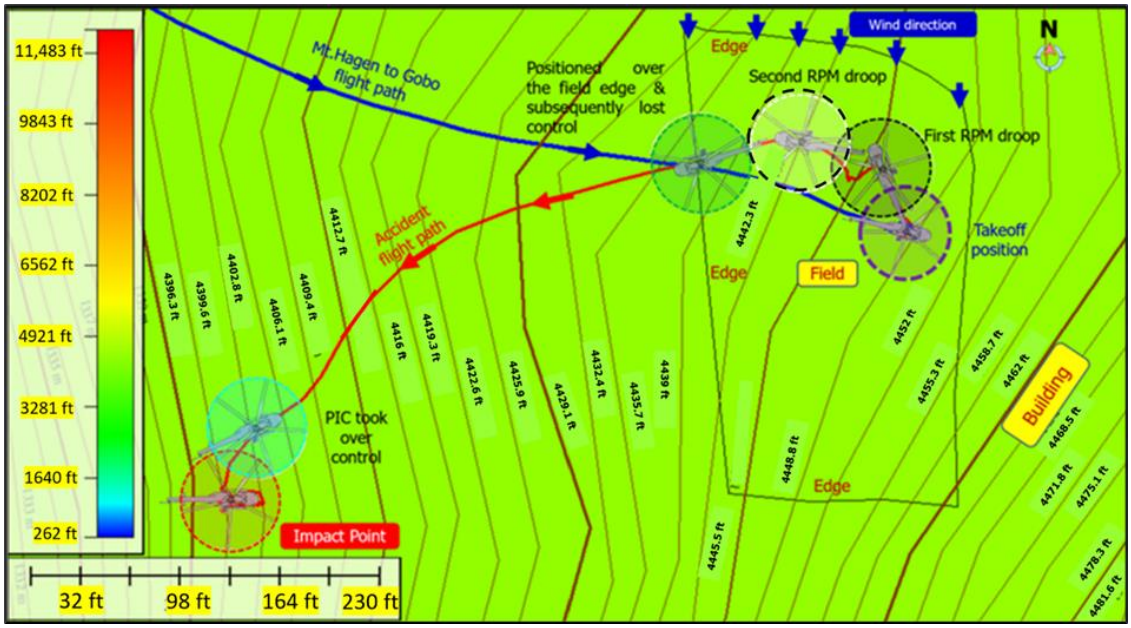


Figure 9: Accident flight path in relation to Gobo topography.

1.10.2 On-site observation

During the onsite investigation, the AIC investigators observed that the landing/take-off area is on a level field. According to information obtained from the local villagers, it is the Gobo school's sports field. School buildings are located on higher ground adjacent to the field, towards the East of the landing/take-off area. The terrain, with medium density vegetation, slopes down-hill from the edge of the field on the Northern, Western, and Southern sides.

Figure 10: Aerial view of the school area and the surrounding area.

1.11 Flight recorders

The helicopter was fitted with a Solid-State Cockpit Voice Recorder (SSCVR) and a separate Solid-State Flight Data Recorder (SSFDR). Refer to *Table 4* for more information of the recorders.

CVR		FDR	
Manufacturer	L3 Communications	**Manufacturer**	JSC "DIAGNOSTICS
Model	FA2100	**Model**	SDK-8
Recording Duration	At least 2 hours	**Recording Duration**	More than 25 hours
Model FA2100 CVR Recording Specifications	4 Channels Channel 1- 3rd Crew Member, Channel 2-Co-pilot Audio Channel 3- Pilot Audio Channel 4 – Cockpit Area Microphone (CAM)	**Recording Capability**	1 sample per second
		Number of Parameters Recorded	12 Parameters

Table 4: CVR and FDR information.

1.11.1 Cockpit Voice Recorder System of P2-MHM

During the CVR playback, Channel 2 and Channel 4 were the only channels with full recordings. Channels 1 and 3 only recorded when the respective microphone was switched was on.

Channel 2 and Channel 4 are for the co-pilot and Cockpit Area Microphone (CAM) respectively. Channel 1 was for the FE, and channel 3 was for the PIC.

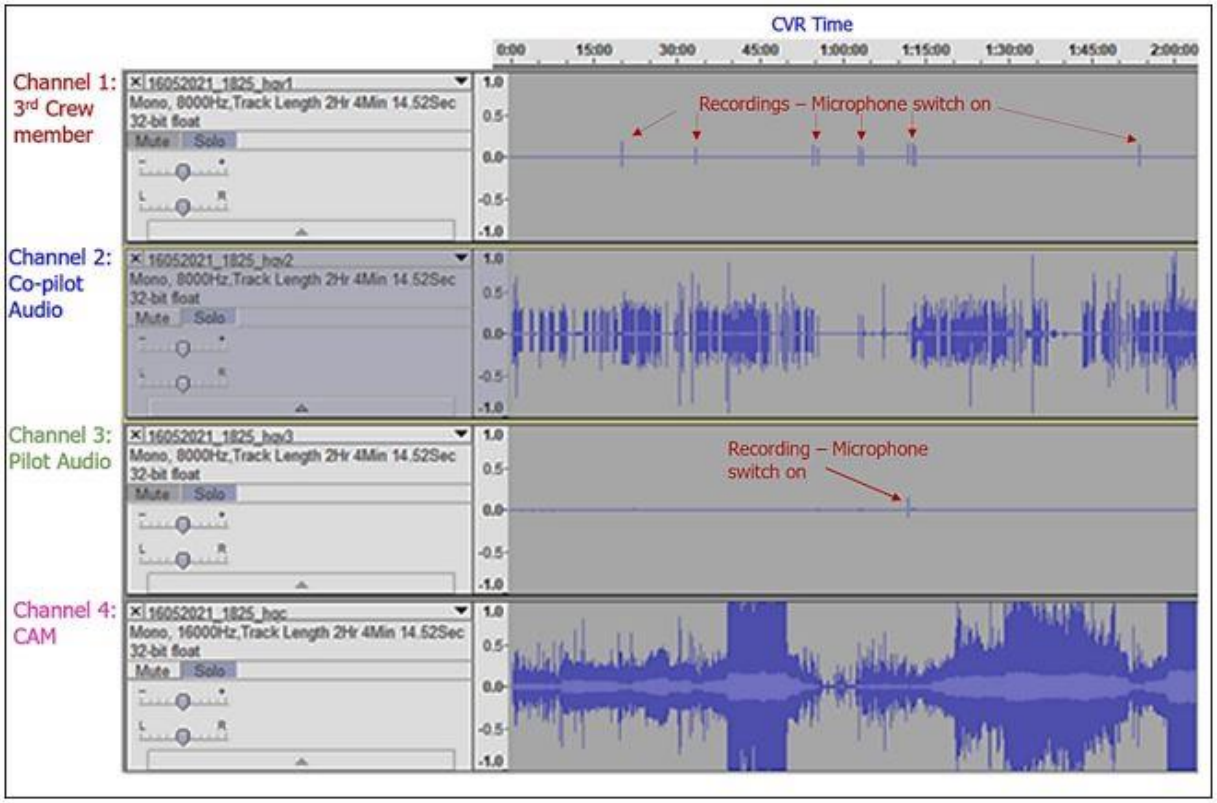


Figure 11: CVR play back.

1.11.2 Flight Data Recorder System of MHM

The flight data recorder system of MHM was recording at a rate of one sample per second and recorded the following flight parameters: Barometric Altitude, Pitch Angle, Roll Angle, Main Rotor Revolution, Rotor Pitch, Engine Temperature, Engine Revolution, Swash Plate and Radio Altitude.

The recording system comprises the following components:

- flight data recorder;
- signal conditioning unit; and
- sensors

During the investigation, the FDR's recorded left and right Engine Temperature and Main Rotor Revolution were plotted and analyzed by AIC to determine if there were any abnormalities during the accident flight. (Refer to *Figure 12*.)

The investigation observed no abnormalities with the engine and main rotor parameters.

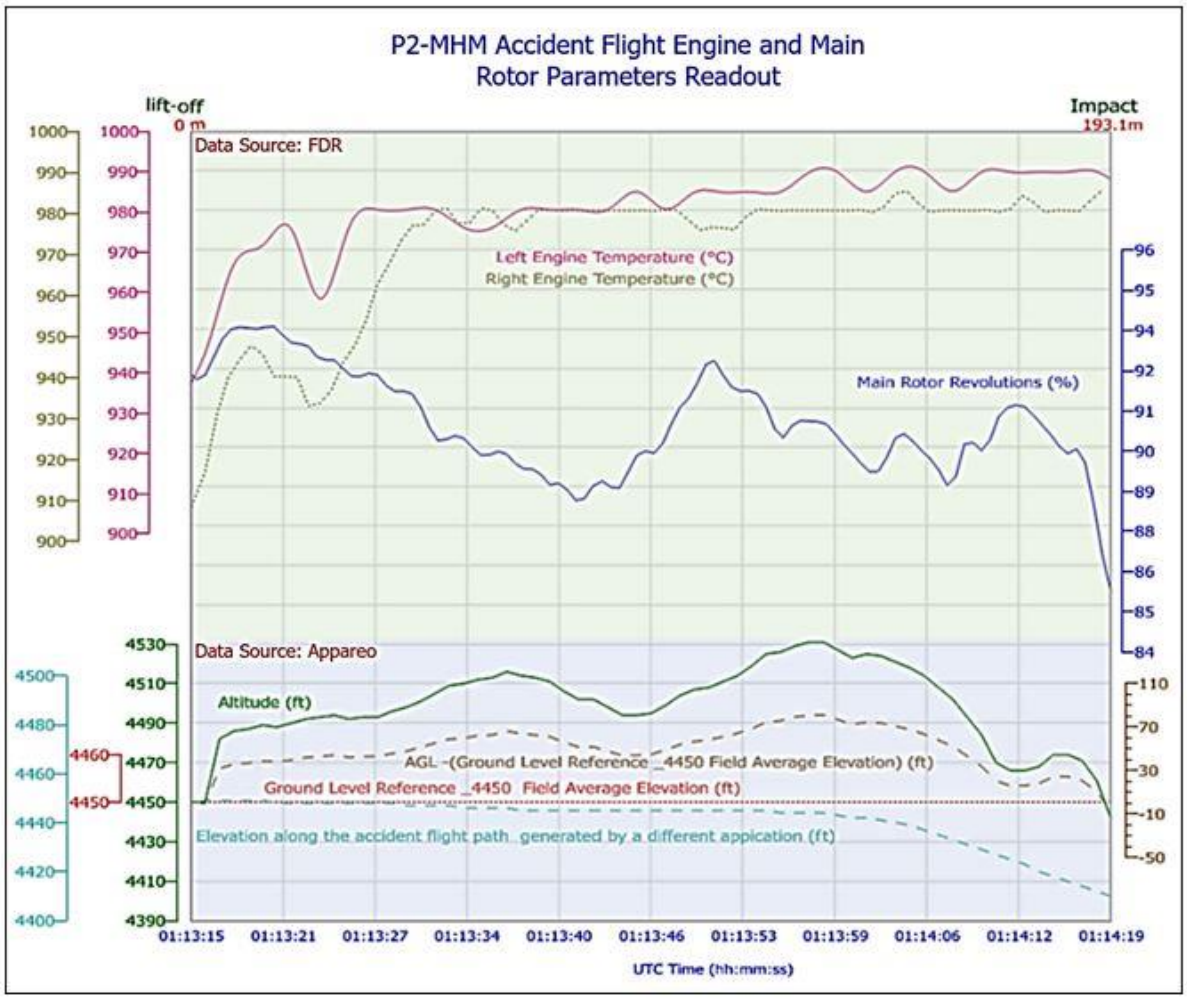


Figure 12: P2-MHM accident flight engine & main rotor RPM parameters.

1.11.3 Other electronic data recording device

1.11.3.1 *Appareo Vision 1000*

The helicopter was fitted with an *Appareo Vision 1000* recorder for flight data monitoring purposes. The unit captured the following information: cockpit image recording, intercom system audio for crew and air traffic control (ATC) communications and WAAS[37] GPS (latitude, longitude, groundspeed, vertical speed, GPS altitude, etc), Attitude data (G forces) and rates of rotation. The unit has a SD card for storing the recorded information.

The recorded information and parameters of the accident flight were extracted from the SD card by the AIC and it was used during the investigation to complement the CVR and FDR data.

The relevant recorded information and parameters of the accident sequence were plotted and analysed by the AIC, to understand the circumstances of the accident flight. (Refer to *Figure 13*.)

37 WAAS. The Wide Area Augmentation System is an air navigation aid developed by the Federal Aviation Administration to augment the Global Positioning System, with the goal of improving its accuracy, integrity, and availability.

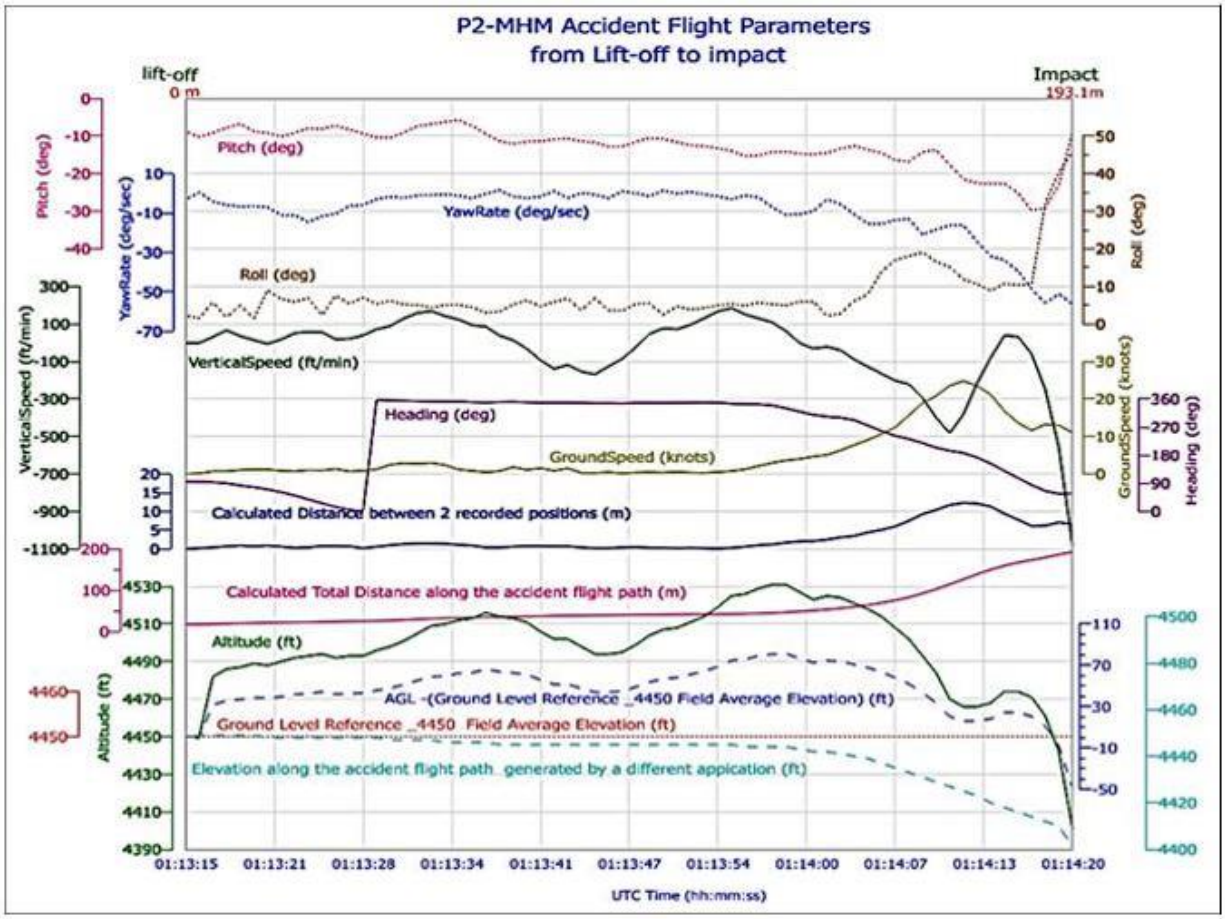


Figure 13: P2-MHM accident flight parameters from lift-off to impact.

1.12 Wreckage and impact information

1.12.1.1 Inspection at the Accident Site

The helicopter wreckage was located at its impact area near the Gobo school sports field. (Refer to *Figure 14.*)

Figure 14: Wreckage distribution location near Gobo village.

The main wreckage was found inverted, in a gulley with its nose pointing towards the East. (*Refer to Figures 15 and 16.*)

Figure 15: MHM main wreckage. Picture on the day of the accident.

Figure 16: MHM main wreckage site (Aerial photo taken two days after the occurrence).

The damage to the helicopter was consistent with being caused by impact forces. Most of the aft fuselage was significantly damaged, with the engine remaining attached to the engine deck. The forward suspension strut of the left main landing gear (LMLG) was detached from the fuselage bracket, indicating that the helicopter landed with significant force before it flipped over. (Refer to *Figure 17*.)

The impact mark on the ground, evidence of dry ground mark on the right wheel and the damage sustained to the right main landing gear (RMLG) strut, indicated that the helicopter impacted the ground with its nose facing to the Northeast and the tail to the Southwest.

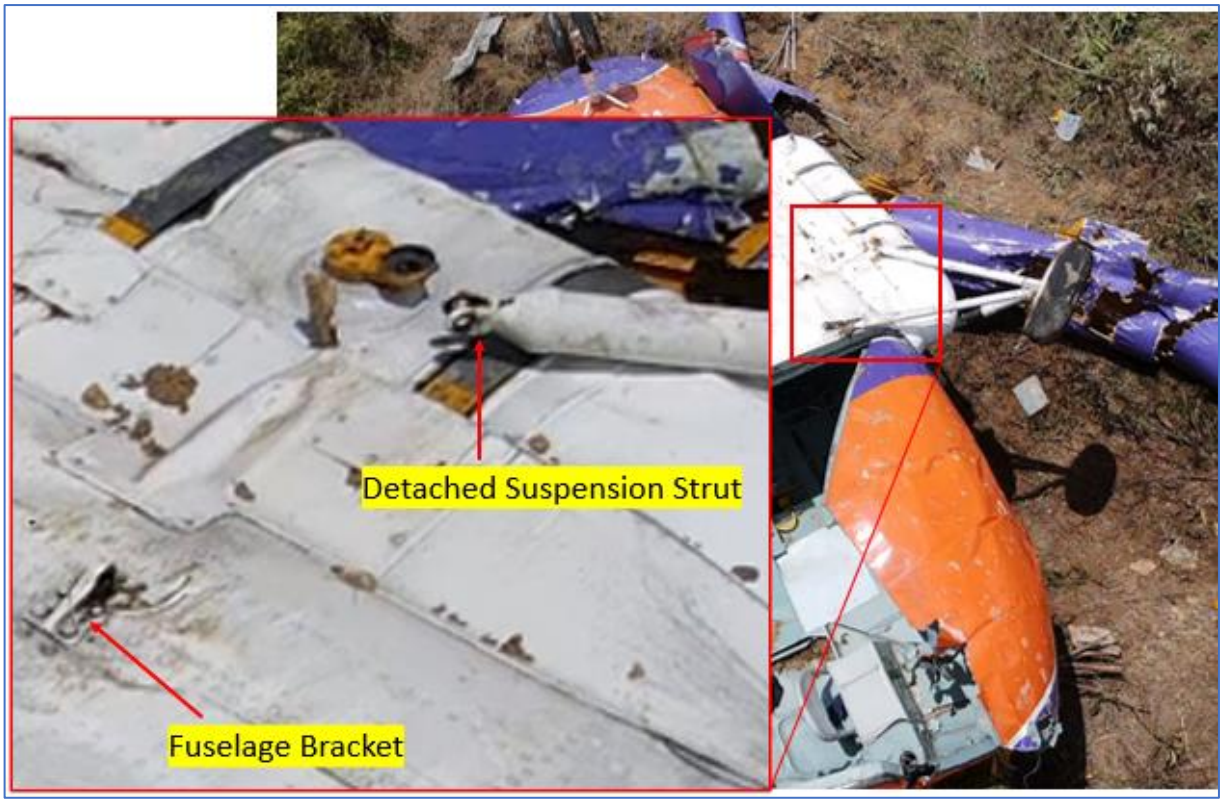


Figure 17: Damage to the left main landing Gear.

The ground surface, the momentum of the rotating main rotor and the angle at which the helicopter impacted the ground, indicated that the tail boom separated from the fuselage during the impact, and the pylon also fractured and separated from the tail boom.

The pylon impacted the ground, and TR blade No. 4 and TR blade No.5 were driven into the ground due to the impact force. Following the initial impact, the helicopter rolled laterally and came to rest inverted. (Refer to *Figure 18*.)

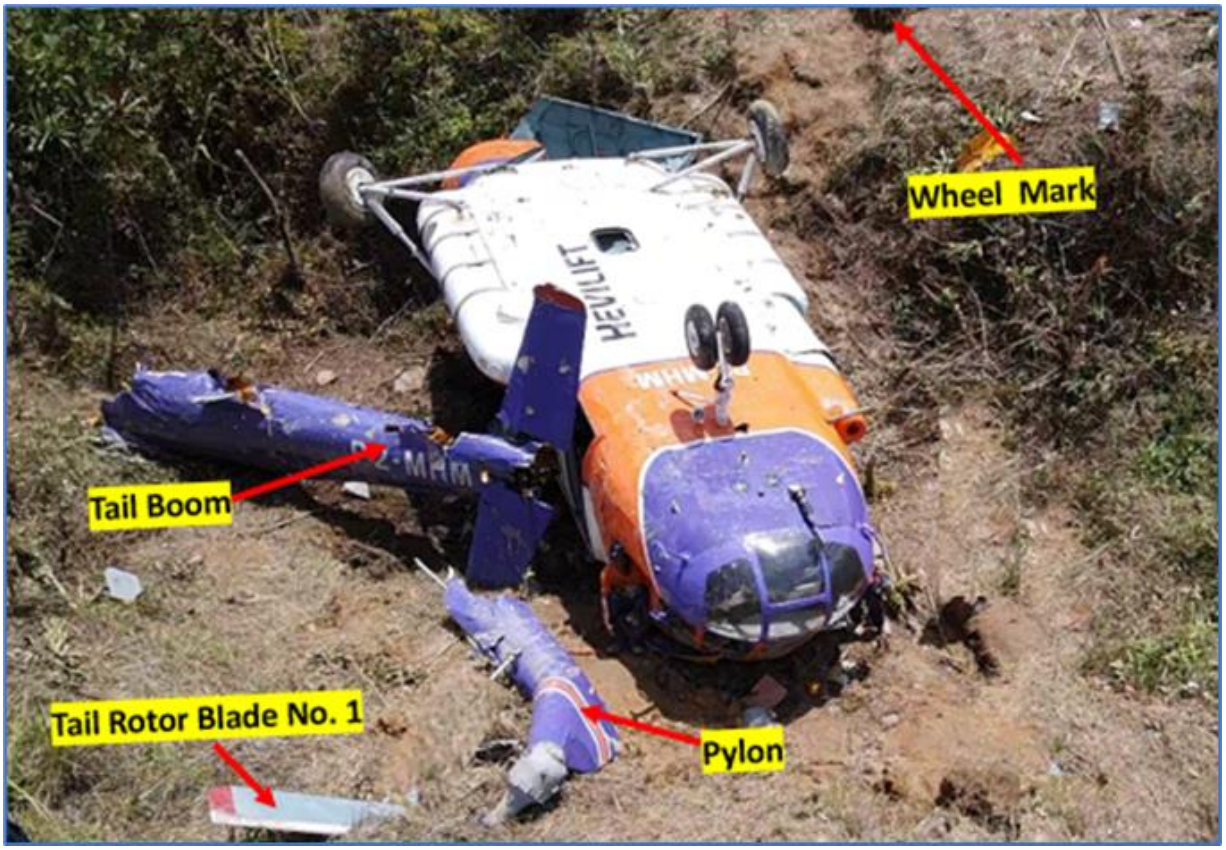


Figure 18: Main Damage.

The damage on the tail boom indicated that it impacted more than once after it had initially separated. The damage on the tail shaft suggested that the helicopter impacted with significant engine power. (Refer to *Figure 19*.)

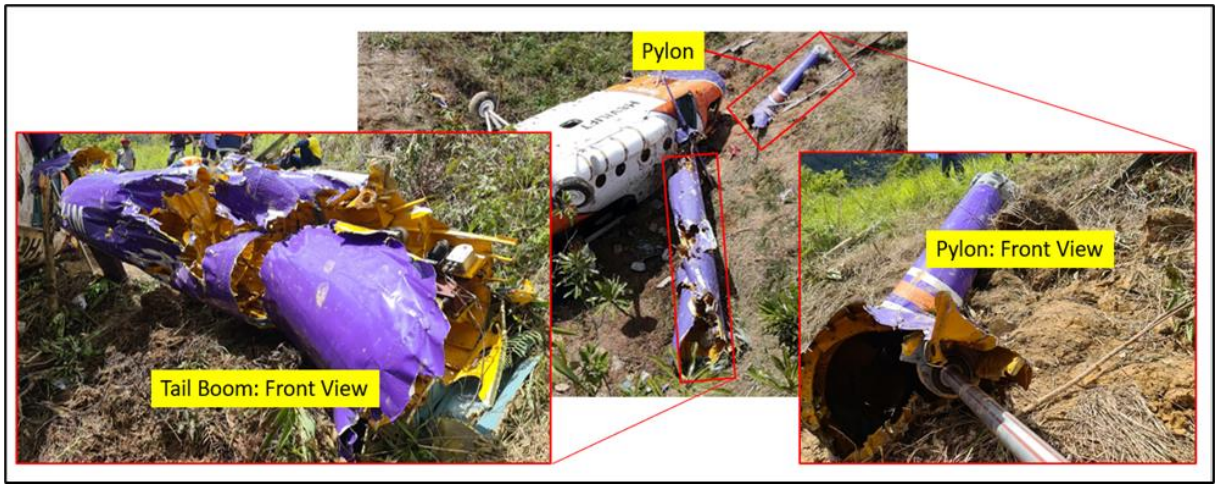


Figure 19: Damage to the tail boom and surrounding components.

The end of the first tail shaft connecting to the TR system was disconnected from the rest of the tail shaft. The other tail shaft connecting to the intermediate gearbox was also damaged. It had fractured and separated and was found with a twist on its fractured end. This suggested that the shaft was still connected to the engine which was delivering significant power before it fractured and separated.

The main rotor drive shaft remained attached to the main transmission gearbox and the main rotor head, and all other powerplant components were attached to the engine at the time of the accident. Refer to *Figure 19*.

All five MR blades were found to have been fractured due to the severity of the impact forces.

The tip of MR blade No. 1 was found at about 147 m north of the main wreckage. The tip edge of the blade was covered with dry mud. The blade rested in grass on a dry surface. It was found with the tip of the blade missing and the two bolts bent. The mud and the bent bolts suggested that the blade tip struck the ground with significant engine power that caused it to snap off and be projected that distance. (Refer to *Figure 20*.)

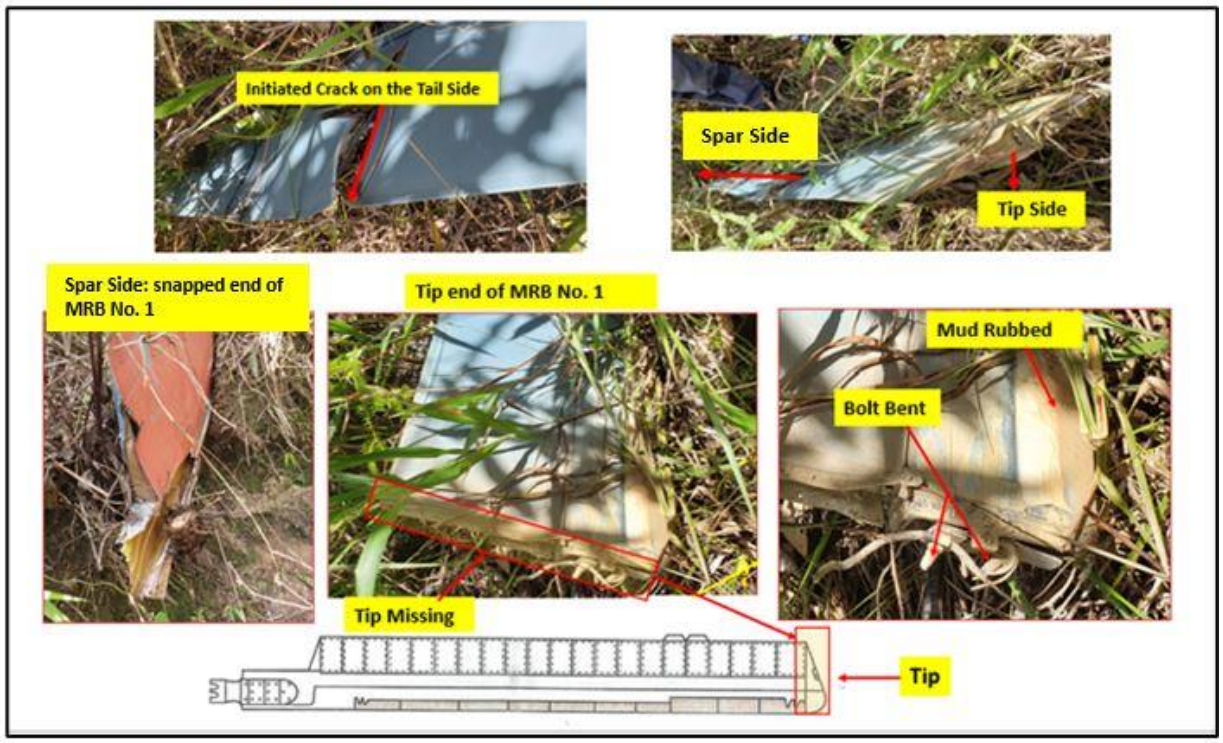


Figure 20: Piece of the MR Blade.

The spar side MR blade No.4 was found about 29 m East of the main helicopter wreckage. It was driven into the mud and was leaning towards the South. The blade had visible ground marks and two cracks at its trailing edge. The damage suggested that the blade cracked and snapped with significant engine power during the ground impact. (Refer to *Figure 21.)*

Figure 21: Main rotor blade No.4

The MR blades No.2, No.3 No.5 were found within the vicinity of the main wreckage. They were significantly damaged indicating that they were damaged during the ground impact.

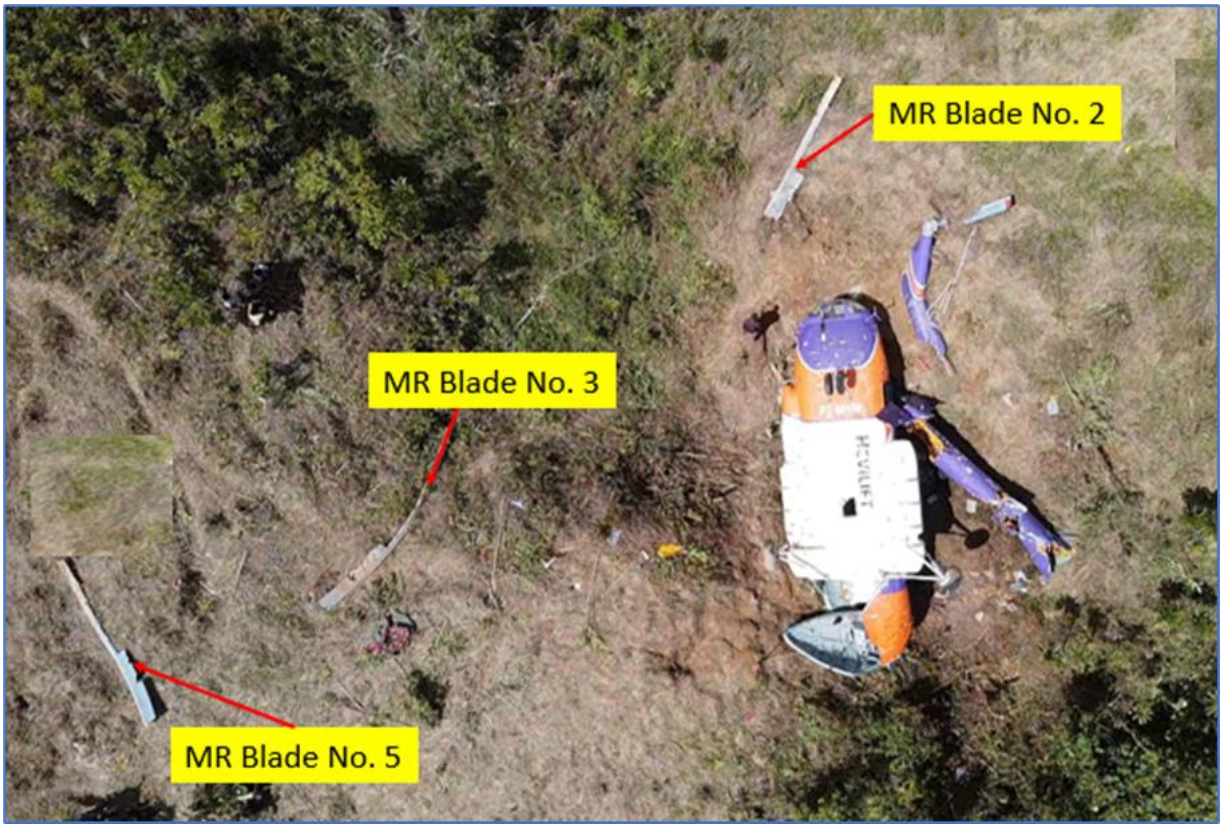


Figure 22: Pieces of main rotor blades 2, 3 and 5 at the main wreckage location.

1.12.2 Examination at the operator's base

On 18 May 2021, the TR assembly was retrieved from the accident site and brought to the operator's base at Mt. Hagen under the supervision of the AIC. The examination of the TR assembly indicated that it was in is normal operating position.

The salvage operation for the wreckage was carried out by the operator, in liaison with the AIC. The wreckage was returned to the operator's base at Mt. Hagen and the recovery process was completed on 3 June 2021.

The AIC conducted further examinations on the wreckage at the operator's base. The airframe, engines, the rotor hub, tail shaft, hydraulic lines and rotor blades were examined.

The left and right engines were found attached to the helicopter structure that surrounds the engine compartment. The engines were in their normal operating locations. Both engines' freewheel units operated correctly, and the main rotor head turned when drive was applied to the engines' input shafts. There was no evidence of a failure within the MR gearbox.

Examination of the MR, TR drive system and the complete rotor system revealed no pre-impact failures. One of the four sections of the TR drive shaft was fractured, and the other three sections of the TR drive shaft were detached from the tail-cone structure.

All four MR blades were found to have fractured and with their blade roots still attached to the MR hub. All blade fractures were consistent with impact damage and showed no evidence of manufacturing defects or pre-impact fatigue.

All notable damage revealed that component fractures and associated damage were due to the accident impact forces.

1.12.2.1 Tail rotor blades' examination

Tail rotor blade No.2 was snapped off indicating fracturing due to the ground impact. The TR Blade No. 3 sustained a substantial dent on the edge of the blade. Tail rotor blade No. 1 did not have any physical damage.

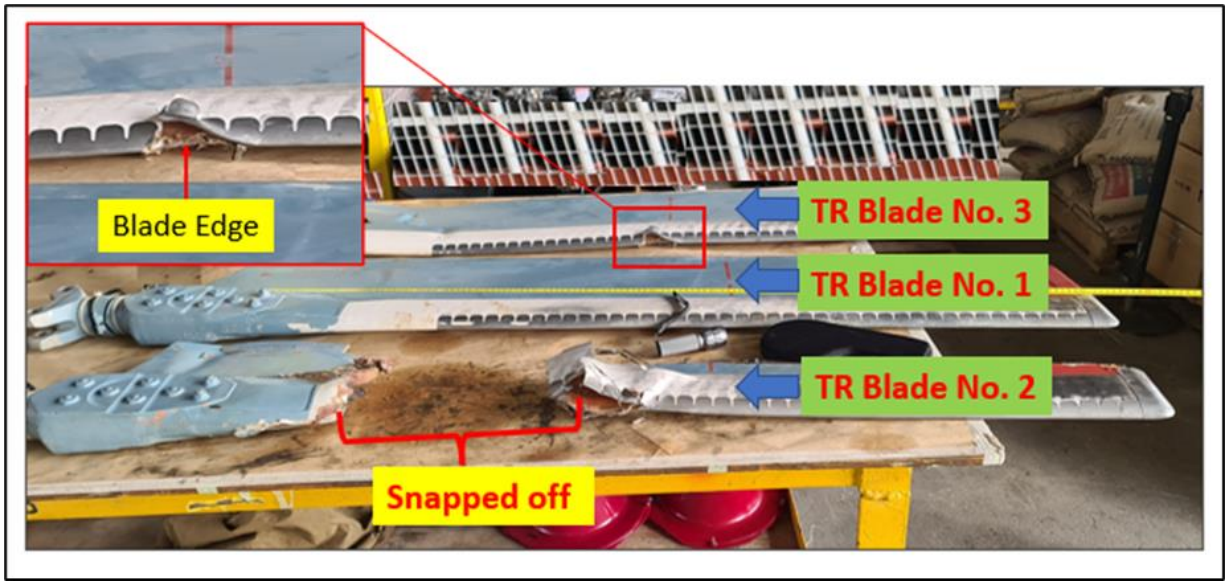


Figure 23: Tail rotor blades at the operator's base.

Tail rotor blade No. 2 tip side of the blade was snapped off from the spar. During the recovery, one of the locals found the piece of the blade edge, about 170 m Southeast of the main wreckage site.

The AIC further examined the two TR blade pieces at the AIC laboratory in Port Moresby and noted that 624 mm of the spar section and about 780 mm of the tail stringer side of the TR blade had separated due to impact forces. The edge of the blade was found to have sustained an impact force that caused it to bend on its edge and subsequently fracture and separate.

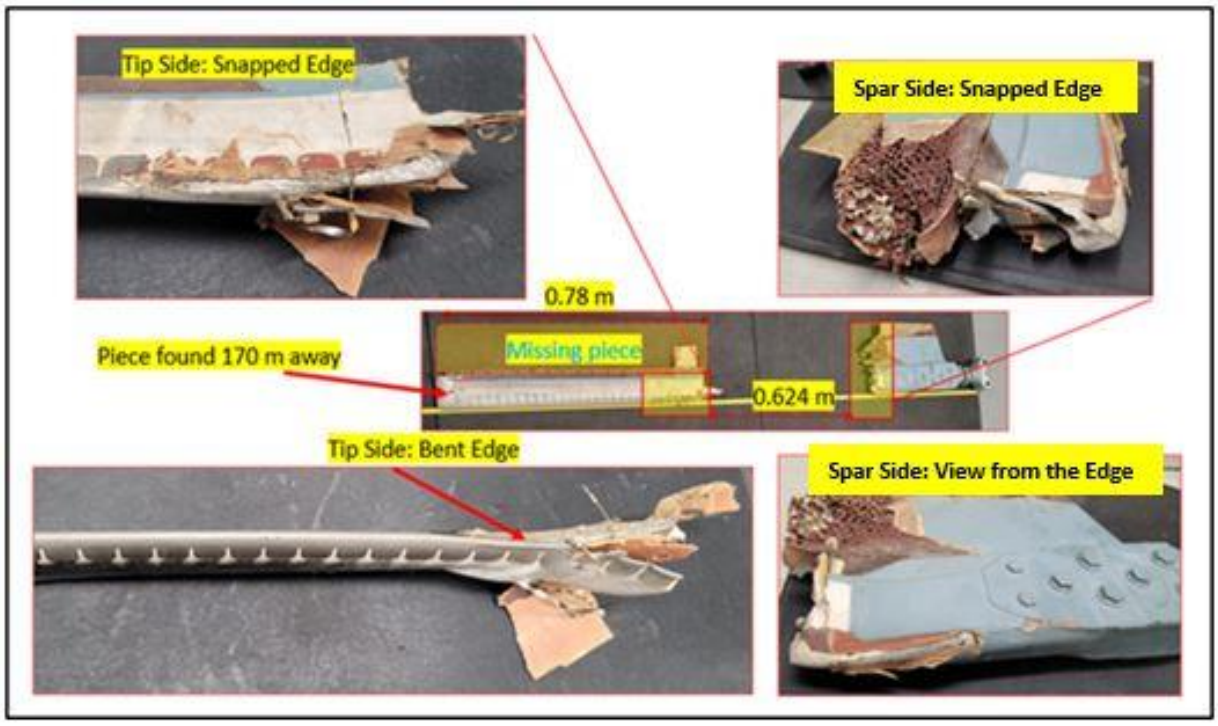


Figure 24: Tail rotor blade No.2 examination at the PNG AIC Engineering Laboratory.

The following details were established during the examination:

- The rotor blade edge impacted a solid object, other than metal, being driven with significant engine power.
- The spar end of the TR Blade impacted the ground after it snapped off.
- The blade edge sustained a significant bend and bruise where it snapped off.

The damage sequence of the helicopter was determined to be as follows:

The helicopter impacted the ground at an angle with the tail boom leading, which caused the MR blades and TR blades to strike the ground. Subsequently, the TR blades were significantly damaged and separated, and the pylon fractured and separated from the fuselage tail boom causing further damage to the tail boom. The impact on the tail boom forced the helicopter to impact the ground with its left main landing gear (LMLG). The LMLG gear then detached from the fuselage assembly and the right main landing gear (RMLG) subsequently contacted the surface of the uneven and soft ground. Due to the weight of the helicopter and the momentum of the torque produced by the main rotor system, the RMLG bogged, and the helicopter rolled in the gulley and came to rest inverted.

1.13 Medical and pathological information

1.13.1 Drug and Alcohol test

The *Hevilift Drug and Alcohol Test* results from samples taken from the crew prior to the flight from Mt. Hagen to Gobo were provided to the AIC. These revealed that the flight crew (PIC, co-pilot and FE) tested negative on the day of the accident, specifically the sector before the accident flight.

The passenger was not operational crew and did not undergo the Drug and Alcohol test, nor was he required to undergo a test.

1.14 Fire

There was no evidence of pre- or post-impact fire.

1.15 Survival aspects

1.15.1 Emergency Locator Transmitter

The helicopter was fitted with a KANNAD 406 AF-H Emergency Locator Transmitter (ELT). The unit was installed on the right side of frame 5H in the cargo cabin. It operates on the 406 MHz frequency and can be manually switched on by depressing the ACCIDENT-ELT button or automatically from the signal of the check sensor in a case of a heavy landing or crash of the helicopter.

The Distress COSPAS-SARSAT[38] Initial Alert message provided to the AIC by NiuSky Pacific Limited (NSPL) indicated that MHM's ELT signal was detected at 11:18 on the day of the accident. (Refer to *Figure 25*.)

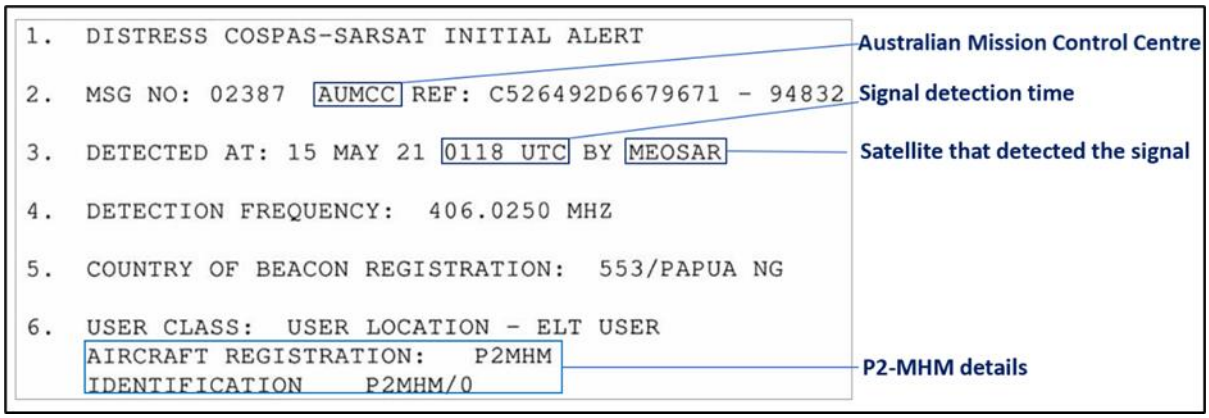


Figure 25: Extract from MHM ELT activation COSPAS-SARSAT message.

Evidence gathered indicated that the ELT activated automatically when the helicopter impacted ground.

[38] COSPAS (COsmicheskaya Sisteyama Poiska Avariynich Sudov) is a Russian acronym for Space System for Search of Distress Vessels, and SARSAT means Search and Rescue Satellite-Aided Tracking. Refer to section xxx for more information on COSPAS SARSAT.

1.15.2 Crew and Passenger

During the interview with the AIC, the passenger stated that at the time of the accident he had his seatbelt fastened, however he was not wearing a helmet at the time of the accident.

The flight crew and the passenger survived the impact and egressed the helicopter after it came to rest. During their interviews with the AIC, the flight crew indicated that they egressed the helicopter through the left emergency exit. (Refer to *Figure 26*.)

They said that the PIC and co-pilot had already evacuated while the FE remained on board and shut down the engines before evacuating.

The passenger stated that he egressed the helicopter through the main door after the PIC and co-pilot had evacuated.

The FE stated during interview that he turned the shut-off valve off and switched off the battery. He said that he obtained a fire extinguisher and a mobile phone before egressing the helicopter through the left emergency exit.

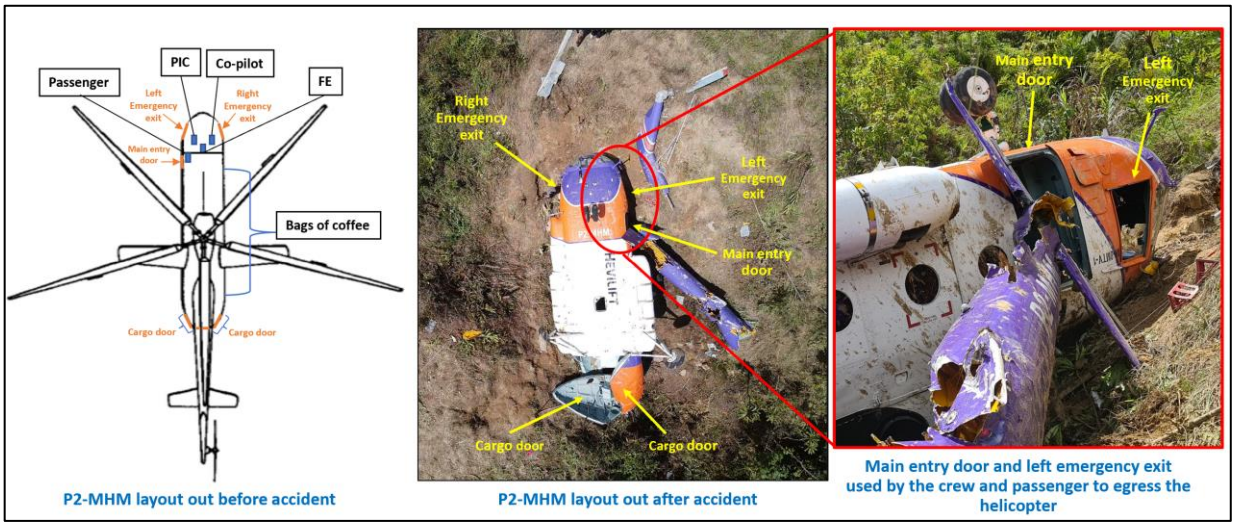


Figure 26: MHM layout before impact and main wreckage after impact.

During the interview with the AIC, the crew and passenger stated that they were assisted by the local villagers to move away from the helicopter.

1.15.3 Emergency response in relation to P2-MHM

The investigation reviewed the NiuSky Pacific Limited (NSPL) Centre Supervisor (CS) Journal entries and the operator's *Emergency Response Plan (ERP) Occurrence / Communication Log* which were provided to the AIC by NSPL and the operator, respectively. The records contained information on the emergency response activities in relation to MHM.

The investigation found that at 11:23, the ATS CS received the ELT message 5 minutes after its activation.

At 11:30, the operator was notified of the accident by the PIC via mobile phone and the operator subsequently formed an ERP committee.

At 11:33, ATS received a call from the operator advising that MHM was on the ground at Gobo and informed Maritime Rescue Coordination Centre (MRCC). ATS received another call from the operator 16 minutes later, advising that MHM was safe on the ground at Gobo and confirmed that the helicopter and the crew were all good[39]. The CS notified the NSPL Manager Jackson accordingly.

At about 13:20, a Hevilift rescue helicopter, P2-HCI landed at Gobo with their rescue team.

The last COSPAS SARSAT reference ELT P2-MHM was received at 13:40.

The rescue helicopter departed Gobo at 14:20 with the rescue team, the crew and passenger of MHM and arrived at Mt. Hagen about 20 minutes later. The passenger was taken to the Mt. Hagen hospital.

After the operator's CEO was provided a briefing, the ERP was closed at 17:50.

1.16 Tests and research

1.16.1 Fuel sample Test

The fuel sample taken after MHM was refueled prior to departing for Gobo was held by the operator. The AIC obtained the sample from the operator and sent it to Intertek Testing Services in Port. Moresby for recertification testing.

According to the *Intertek Laboratory Test Report*, all the test results were within specifications and were traceable to the supplying batch except for the Appearance Test, Final Boiling Point (FBP) Test and Existent Gum Test. The Appearance indicated that there was presence of particulates, while the FBP and Existent Gum both had a slight increase.

A further interpretation of Intertek's test results by Puma Quality Department confirmed that there were particulates in the fuel sample that were not traceable to the supplying batch, but rather related to the type of sample provided. The presence of the particulates resulted in both the FBP and Existent Gum results to slight increase.

The Puma Quality Department concluded that despite the slight increase, the results were still within JetA1 specification.

1.17 Organisational and management information

1.17.1 Hevilift (The operator)

Hevilift is a Fixed- and Rotary-wing Aviation Services operator providing charter operations.

Hevilift head office is in Singapore, with regional offices in Myanmar, Indonesia, Malaysia, Australia, and Papua New Guinea (PNG). The head office and maintenance facility for the PNG operations is in Mt. Hagen, Western Highlands Province and a branch is in Port Moresby, National Capital District.

Hevilift has an *Air Operator Certificate, AOC number: 119/040* issued on 24 March 2020 and expires on 31 March 2023.

Hevilift also has a *Maintenance Organisation Certificate, MOC number: 145/040* effective on 01 April 2020 and expires on 31 March 2022. Maintenance is conducted in-house at the registered maintenance facility at Mt. Hagen, Western Highlands Province.

39 Given the severity of the damage to the helicopter the operator's statement that the helicopter and crew were all good was somewhat misleading. The injuries sustained by the passenger may not have been comprehended at that time.

1.17.1.1 *Air Maestro*

Hevilift (3-E011) Operational Manual Rotary Wing, Operational Administration Section 2.1 states in part:

> Hevilift has engaged the widely accepted *Air Maestro* web-based aviation software application allowing pilots to update and manage operational information anywhere, anytime via a secure connection over the internet with remote secure backup data storage for a minimum of 12 months.
>
> *Air Maestro* enables Hevilift to enhance the Safety, Compliance and Efficiency of regulatory compliance.

1.17.1.2 Flight crew ground training

The PNG *Civil Aviation Rule Part (CAR) Part 136, Sub-parts M & N* detail flight crew training and competency requirements.

A review of the operator's *Training and Checking Manual Rotary Wing (T&CM RW)* showed that the crew training and competency assessment requirements include a recurrent training program.

According to the operator's *T&CM RW*, recurrent training is training provided where the standard of performance is shown not to have been met and corrective action is required, or in cases where circumstances including periods of absence from duty cause reasonable concern that performance may have degraded. However, the *T&CM RW* does specify the length of absence periods, nor does the recurrent training program include training and competency requirements for flight crew in such instances.

According to the *T&CM RW Section 4.2.1*, all *General Subject* and examinations are reviewed and completed respectively by all company pilots, using the operator's *Learning Management System (LMS)*. All *General Subjects* are to be completed upon initial hire/employment and then biennially or as directed.

The PIC's personal records did not have recent records to demonstrate that the *General Subjects* had been completed.

The co-pilot's personal records showed that she had recently completed the *General Subject* courses except for the *Controlled Flight into Terrain (CFIT) Awareness*, which she last completed on 7 January 2020.

The FE's records showed that he had completed all required *General Subject* courses.

The *Type Technical Training* on the operator's aircraft and other examinations as required by the operator, are completed using *Air Maestro*. These examinations are to be completed upon initial hire then biennially or as directed. The PIC's records showed that he had completed the MI-8 crew knowledge test on 30 April 2021. A review of the T&CM RW indicated that there was no documented *Examination Syllabus* for the MI-8 helicopter. The investigation was unable to assess the status of the crew's *Type Technical Training*.

1.17.1.3 Flight crew recency requirements

PNG CAR Part 61.37 (b) states:

> *(b) Commercial pilot, private pilot – day flight: A person who holds a commercial pilot license must not act as pilot-in-command or co-pilot of an aircraft during the day, and a person who holds a commercial pilot license or a private pilot license must not act as pilot in-command or co-pilot of an aircraft carrying a passenger during the day, unless (subject to paragraph (g)), within the immediately preceding 90 days, —*
>
> *(1) the person has carried out (as pilot-in-command or co-pilot of an aircraft or an approved synthetic flight trainer of the same type) not less than 3 take-offs and 3 landings during the day.*

This requirement is captured in the operator's *T&CM RW Section 4.5.1 & 4.5.3*, which states that all pilots must complete three take-offs, and three landings on a specific type within the preceding 90 days (or have passed a check) before carrying passengers. In addition to the CASA PNG recency requirements, the operator requires its pilots to have flown at least 3 hours on category[40] within the preceding 90 days.

There were inconsistencies in flight and duty times for the PIC that were provided to the AIC by the operator. The AIC reviewed the operator's *Daily Flight Record* (DFR) to confirm the number of flights the PIC had operated on MI-8 to determine the total take-offs and landings he had completed before the accident flight. DFR records shows that he did one take-off and one landing in the Mt. Hagen Training Area on 30 April 2021 (Check and Training Flight) and on 1 May 2021 he did a total of two take offs and two landing in the Mt. Hagen Training Area (*Instrument of Approval (IOA)* evaluation flight and *Flight External Operations*) with the operator's MI-8 Fleet Captain, the *IOA* holder.

The co-pilot had not satisfied the requirement of three take offs and three landings within preceding 90 days. The accident flight was initially scheduled for her training, but due to operational requirements it was cancelled, and she operated as co-pilot on the charter flight to Gobo.

The operator's *Operations Manual Rotary Wing* (OM RW), *Section 4.1 Flight Requirements* is not consistent with the *T&CM RW* requirements of three take offs and three landings within a 90-day period and three hours flying time on type. The *OM RW* states that PIC of a Hevilift helicopter must have completed no less than 5 hours of flight, including 5 take-offs and landings (single engine), or 10 hours with 10 take-offs and landings (multi-engine) in the make and basic type of aircraft scheduled for the air operation.

The AIC's review of the PICs competency requirements in the operator's *T&CM RW* revealed compliance with *CAR 136.907 (a) (1), (2)* & *(4)* competency requirements and *CAR 61.305 (d) Flight Instructor*. However, the PIC experience requirements as stated in *Section 2* of the operator's *Training and Checking Manual Rotary Wing* focuses on Bell 407 and Bell 212 helicopters. The MI-8 has different handling characteristics since their MR rotates in an opposite direction to that of the Bell 407 and Bell 212 helicopters. Since rejoining the operator at the end of April 2021 he had gained recency primarily on the Bell 407 and Bell 212 helicopters.

40 Category refers to the category of aircraft.

1.17.1.4 Minimum crew for Mi-8 operations

The Civil Aviation Safety Authority of PNG (CASA PNG) approved *MIL MI – 8MTV-1 Flight Manual* and *Quick reference Handbook* were recovered from the helicopter at the accident site.

Section 2.1 of the *Flight Manual* titled *Helicopter Category* states:

> 2.1.1 It is allowed to transport by the helicopter of the transport version the cargoes with a mass (weight) of up to 4t in the cargo cabin and cargoes with a mass (weight) of up to 3t (4t or 5t) suspended on an external sling (depending on the type of the external sling system installed in helicopter). It is allowed to carry at the same time the people accompanying the cargo or the cargo in the cabin and the load on the external load sling system in accordance with the Weight and Balance Manual of helicopter.
>
> 2.1.2 It is allowed to carry the passengers by the helicopter of passenger version. It is FORBIDDEN to carry the passengers and cargoes at the same time, except the baggage, which belongs to the passengers.
>
> If additional external fuel tanks (AnT5) are installed the transportation of passengers is PROHIBITED!
>
> **Note.** The helicopter can be re-equipped from one version to another if provision is made for such re-equipment in the operation and maintenance documentation, approved by the Federal Aviation Service of Russia for this helicopter.

Sub-section 2.1.1 refers to cargo that is owned by the passenger. *Sub-section 2.1.2* is explicit in its directive that passengers are forbidden to be carried at the same time as cargo, other than passengers' personal baggage.

Section 2.3 Minimum Crew states:

> 2.3.1 The flight crew consists of three persons:
>
> The Captain (CAPT).
>
> Copilot (CPLT)
>
> Flight Engineer (F/E)
>
> 2.3.2 During flights with load on external load sling …
>
> Notes:
>
> Notes:
>
> 1. …
>
> 2. …
>
> 3. To service the passengers the flight attendant is included in the crew.

A passenger was carried on the helicopter for the flights from Mt. Hagen to Gobo and return. The passenger, termed by the operator as ground staff, assisted with unloading and loading tasks, however he was not an operating crew member.

A flight attendant was not part of the crew for either sector as required when a passenger was carried, as specified in the operator's CASA PNG approved *Flight Manual*.

1.17.1.5 Ground staff Training

CAR 136.953 Ground crew member training states:

> The holder of an air operator certificate must ensure that every person providing operational ground support to a helicopter operation has satisfactorily completed an initial course of training which includes the following:
>
> *(*1) helicopter safety;
>
> (2) helipad safety;
>
> (3) helicopter refuelling;
>
> (4) firefighting;
>
> (5) communications;
>
> (6) helicopter marshalling;
>
> (7) helicopter loading and dispatch;
>
> (8) preparation of loads;
>
> (9) use of rigging and slinging equipment;
>
> (10) removal and installation of helicopter role equipment;
>
> (11) dangerous goods awareness.

CAR Part 136.955 Competency assessment states:

> A holder of an air operator certificate must establish and control an operational competency assessment programme that ensures that within the preceding 24 months every loadmaster and operational ground crew member satisfactorily has completed a competency assessment administered by the senior loadmaster.

There was no training record provided to the AIC for the passenger, to establish if he was trained appropriately to carry out the duties of a Traffic Officer/Porter. The Traffic Officer/Porter's key accountabilities as stated in the operator's *Ground Handling Manual, Section 1.2.4* was general loading and unloading of aircraft.

The passenger was not trained appropriately in accordance with *CAR 136.953* and *136.955* and the operator's documented training requirements.

1.17.1.5.1 Standard Operating Procedures Manual MIL 8 MTV

Section 1 Introduction[41]

This manual contains the policies and procedures applicable to the operation of Mil 8 MTV helicopters operating to *CASA PNG Part 93.103* & *Part 136.*

Sub-section 1.1 Purpose first paragraph states:

> The SOP provides operational and administrative information relating to operations conducted using the Mil 8 MTV which is restricted to cargo and crew only operations. Carriage of passengers is prohibited.

Sub-section 1.1 Purpose third paragraph, second sentence states:

> Nothing contained in this manual is to be construed as relieving the Pilot-in-Command (PIC) of the responsibility to take or direct action in an emergency or unusual circumstance which he considers necessary to preserve the safety of the aircraft and its passengers or cargo.

41 This quote refers to the PNG Civil Aviation Rules.

1.17.1.5.2 Pilot in Command competency and recency

According to a review of the PIC's *Competency Assessment* records dated 30 April 2021, maintained on the operator's form *HL902A/B/C – Operational Competency Assessment – Helicopter*, he was checked to line on the MI-8. The checks covered *Line/Area Checks*, *Knowledge Check*, *Competency Check VFR*, and *Competency Check External Load*.

According to *Air Maestro* records, the PIC completed his *Area Familiarisation Check* on 6 May 2021. The operator's records also showed that the PIC had completed his *External Load-Rappel Winch/Sling Check*, *Non-cockpit Emergency Proficiency Check*, *Role Equipment and Maintenance Check*, *Crew Knowledge Examination* and *Technical Examination* for the Mil-8. The PIC had also been checked to line on the Bell 407 and Bell 212 before the accident flight providing him with recency on these helicopter types.

Air Maestro records provided to the AIC showed that since rejoining the operator on 15 April 2021[42] he had a total of 3.9 hours on the MI-8 at the time of accident with 1.2 hours recorded for 30 April 2021 with a Check and Training Captain for his competency checks. On 1 May 2021, he recorded 2.3 hours flight time. The post maintenance hover test flight conducted on 13 May 2021 was not recorded in the PIC's logbook, nor was it recorded in *Air Maestro*. However, *Daily Flight Report (DFR)* records confirmed a total of 0.4 hours for the post maintenance test flight. The accident flight on 15 May 2021 was his third flight on the MI-8 since re-joining the company and the first as a PIC since re-joining.

PNG Civil Aviation Rule (CAR) Part 61, Section 61.37 specifies the minimum recency requirements for a pilot license holder before being eligible to act as PIC or co-pilot of an aircraft.

The operator's *T&CM Section 4.5.1* mirrors these rules with all pilots required to complete three take-offs, and three landings on type within the preceding 90 days (or have passed a check flight) before carrying passengers.

According to a review of the PIC's Competency Assessment records dated 30 April 2021, maintained on the operator's form '*HL902A/B/C – Operational Competency Assessment – Helicopter'*, he was checked to line on the MI-8. The form also indicated that the check flight was conducted at the training area at Mt. Hagen. However, it did not indicate the number of take-offs and landings.

The PIC was also issued an *Instrument of Approval (IOA)* by CASA PNG. The *IOA* authorised the PIC to carry out the functions of a Category D Flight Instructor in accordance with *CAR Part 61.305 (d)* and to carry out the functions of an Airline Flight Examiner in accordance with *CAR Part 61.905 (a)(2)*.

According to the operator's *Internal Investigation Report*, the PIC of the accident flight was re-employed by Hevilift on the expectation that he would replace the outgoing MI-8 Fleet Captain, who held the *IOA* for checking and training on the MI-8. Before leaving the operator, the experienced MI-8 Fleet Captain was to train the PIC involved in this accident for his *Instrument of Approval (IOA),* and conduct re-induction training for several other incoming flight crew.

However, there was a breakdown in this plan with a change in who was intended to carry out the training and checking for the PIC, co-pilot, and another MI-8 captain. Instead of the experienced *IOA* holder being responsible for continuing the training and checking of the pilots, the PIC of the accident flight was tasked with being responsible for these functions immediately upon receiving his *CASA PNG IOA* approval on 6 May 2021.

CAR Part 136.703 (a) (4) states:

> (a) A holder of an operator certificate must ensure that every person assigned as a flight crew member, on an air operation conducted under the authority of the certificate,
>
> (3) meets all the experience, training, and competency requirements for the task assigned; …

42 The PIC rejoined the operator on 15 April 2021, but was in Covid isolation until 28 April 2021. He commenced duty on 28 April with his first flight on 30 April 2021.

The PIC met the experience and qualification requirements stated in chapter two of the operator's *Training and Check Manual*, however, apart from the 3.5 hours flown since rejoining the operator on 15 April 2021, he had not flown the MI-8 for 24 months and lacked recent experience as a PIC and as a Check and Training Captain. There was no evidence provided of previous instructor or flight examiner ratings.

According to the operator, the accident flight was originally intended as a training flight for the co-pilot, with check flights to follow. However, subsequent operational requirements caused the training flight to be cancelled and the charter (accident) flight was rostered. Information gathered by the AIC showed that the co-pilot was the pilot flying at the time of the accident.

1.17.1.5.3 Co-pilot competency and recency

CAR Part 136.703 Assignment of flight crew duties states:

> (a) A holder of an air operator certificate must ensure that every person assigned as a flight crew member, on an air operation conducted under the authority of the certificate,
>
> (1) holds a current pilot license and rating appropriate to the category of helicopter and to the tasks assigned; and
>
> (2) holds a current class 1 medical certificate appropriate to the task assigned; and
>
> (3) meets all the experience, training, and competency requirements for the task assigned; and
>
> (4) meets all route and aerodrome qualification requirements for the intended operation.

The co-pilot's record provided to the AIC by the operator showed that she was an experienced MI-8 co-pilot and was appropriately licensed and rated to the category of helicopter and to the tasks assigned. She also held a current *Class 1 Medical Certificate*. According to the PIC and the operator's *Internal Investigation Report*, the accident flight was originally intended as a training flight for the co-pilot, with check flights to follow, however, subsequent operational requirements caused the training flight to be cancelled and she was rostered to crew the charter flight (the accident flight).

At the time of accident, she was not appropriately trained and competent to operate as a flight crew member when she re-joined the operator.

This co-pilot was the pilot flying at the time of the accident.

The post-maintenance hover test flight on 13 May 2021 was her first flight as co-pilot since returning to the operator (Hevilift) on 15 May 2021.

1.17.1.5.4 Flight Engineer competency and recency

The Flight Engineer's training and competency records were reviewed. He was appropriately licensed and rated to the category of helicopter and to the tasks assigned and appropriately trained and competent to operate as a Flight Engineer since resuming duties on 20 April after a period of long leave.

1.17.1.5.5 Discrepancies with flight times and roster

The AIC noted discrepancies between the PIC's flight times that were extracted from *Air Maestro* records provided to the AIC, dated 15 May 2021, and subsequently provided 10 months later dated 13 March 2022, and the *Air Maestro* records in the operator's *Internal Investigation Report dated 9 September 2021*.

Flight time records from *Air Maestro* provided to the AIC indicated that the PIC had flown on the MI-8 from 1 May 2022 to 14 May 2021 before the accident flight on 15 May, however, DFR records showed that since rejoining the company, he had only flown the MI-8 on 30 April 2021 with the Check and Training captain (Check and Training flight) in the Hagen training area for 1.2 hours and on 1 May 2021 (non-revenue Instrument of Approval Evaluation and flight external operations) for 2.3 hours. The other flight on the MI-8 was on 13 May 2021 which was an engine ground run and post-maintenance hover test flight.

The engine ground run and post-maintenance hover test flight were operated by the same crew as the crew for the accident flight, and they had varying figures recorded for the post-maintenance hover test flight in their logbooks on *Air Maestro*. The co-pilot recorded 0.1 hours, the Flight Engineer recorded 0.5 hours and the PIC had no record of this flight in his logbook, so the AIC reviewed the DFR for this flight and confirmed a total of 0.4 hours being 0.1 hours engine ground run and 0.3 hours for the post maintenance test flight.

The AIC determined from the records provided that the PIC flew a total of 3.9 hours on the MI-8 since re-joining the company before the accident flight on 15 May 2021. From 2 May to 12 May, there was no evidence to show he had flown the MI-8.

The operator's *Internal Investigation Report* also showed that flights on the MI-8 were operated on 30 April 2021, 1 May 2021, and 13 May 2021. Between 2 and 14 May 2021, the PIC operated the Bell 212 and the Bell 407 helicopters and not the MI-8 as showed on the timesheets in *Air Maestro* and the pilot duty roster record provided to the AIC by the operator.

The PIC's Class One medical (Single pilot) expired on 30 April 2021. CASA PNG informed the AIC that a Class One medical (Multicrew) may be used for Single Pilot operation unless it has restrictions for multi-crew operations only. His Class one medical (multicrew) was valid to 30 April 2022 and had no restrictions.

1.17.1.6 Flight Documentation

1.17.1.6.1 MIL-8 Dispatch Manifest

The *Standard Operating Procedures Manual, Mil 8 MTV, Section 4.3* states:

> *[. . . .] Loadmasters or the appointed ground supervisor must complete the Mil-8 Dispatch Manifest showing the cargo weight and location.*
>
> *The Loadmaster and an Accepting Flight Crew member will sign the appropriate manifest, with copies to be held by the crew and personnel at the point of departure.*

The AIC found that the *MIL-8 Dispatch Manifest* used for the accident flight was incomplete. Most of the data fields were not completed. The *Dispatch Manifest* for the flight from Mt. Hagen to Gobo did not have the accepting Flight Crew Members name and signature. It only had the Load masters name and signature.

1.17.1.7 Crew Resource Management

The operator's *Standard Operating Procedures Manual, Section 1.3 Crew Resource Management* states:

> Good flight crew resource management should be practiced in any aircraft, regardless of the level of technical sophistication. The term 'CRM' refers to using all available resources to achieve a safe and efficient flight operation. Close to the heart of CRM is the assertion that any pilot, however junior, will become increasingly assertive and will be heard, if a colleague begins to deviate from the Company's Standard Operating Procedures without due cause.

According to the recorded flight data and the operator's *Internal Investigation Report*, the FE and the co-pilot were aware of the helicopter being too heavy and the abnormal RPM readings. Just after lift-off for departure, the co-pilot who was the pilot flying (PF) had mentioned to the PIC who was the pilot monitoring (PM) that the aircraft was heavy, however, he advised her to continue the flight.

The operator's *Standard Operating Procedures Manual (SOPM) Mil 8 MTV, Section 1.4.1 Crew Structure* states:

> The Flight Engineer reports to the flight crew and ultimately the PIC of the aircraft. He is required to perform his duties as described in the HL Mil 8 MTV SOP, checklists, and AFM. The Flight Engineer is expected to inform the PIC immediately of any mechanical malfunction, parameter deviation from normal, as to maintain safe flight or, if required precautionary landing. He will also assist the flight crew with any emergency procedures when necessary. With the permission of the PIC he may leave his station to do a periodic inspection of relevant items in the cargo compartment. He will exit the aircraft during hot refuelling operations to supervise refuel.

Section 3.7 of the operator's *SOPM Mil 8 MTV, Flight Parameters* also states:

> The PM and FE shall monitor the flight and ensure that the parameters specified in the aircraft flight manual are not exceeded. This includes bank angle, rate of turn, airspeed etc. They shall alert the PF of any abnormalities using standard flight deck phraseology . . . Anytime the PM or FE observes parameters exceeding these or judge that the flight envelope has the possibility of becoming unstable, they should call values and notate to the PF, who should verbally respond `noted` and carry out remedial action to stabilise the flight parameters.

The CVR data showed that the co-pilot and FE were aware of the abnormal MR RPM and called out the decaying values to the PIC.

According to the operator's *Internal Investigation Report*, the PIC had seen low power on departures before, and in his experience they could be operated safely. The report also stated that after the initial RPM droop, the co-pilot and FE were concerned that the helicopter was overweight. However, neither one of them voiced their concern to the PIC.

Although not causal to the accident, from the evidence provided by the operator, the AIC found that initial and recurrent *Crew Resource Management and Human Factors* training for the flight crew is done online instead of a classroom-based training with discussion and interaction between the trainer and the flight crew.

1.17.1.8 *Safety and Quality Management System*

According to the operator's *Safety and Quality Manual*, a safety management system (SMS) is a systematic approach to managing safety, including the necessary organisational structures, accountabilities, policies, and procedures. The ultimate goal of these structures, accountabilities, and policies and procedures is to ensure that operations are conducted safely thereby protecting the safety and wellbeing of the staff.

The operator's *Quality Assurance System* is integrated within the *Safety Management System* in accordance with the *PNG Civil Aviation Rules*. *CAR 119.73* requires an applicant for the grant of an *Air Operator Certificate* to establish an internal quality assurance system to ensure compliance with, and the adequacy of, the procedures required by *CAR Part 100*.

CAR 145.117 similarly requires an applicant for the grant of a *Maintenance Organisation Certificate* to establish an internal quality assurance system to ensure compliance with, and the adequacy of, the procedures required by *CAR Part 100*.

Accordingly, the operator's internal *QA* procedures are required to be put in place for all areas of Hevilift's activities that are covered by *CAR Parts 119* and *145*, with this manual *[Safety and Quality Manual]* being the primary reference for safety and quality guidance.

The investigation found that the operator did not appropriately implement safety management and quality assurance processes to ensure operational, maintenance and safety related documents are correctly completed and retained. The AIC reviewed the *Flight Manifest* and identified that it was partially completed for the flight from Mt. Hagen to Gobo and Gobo to Mt. Hagen (accident flight).

The operator's *Internal Investigation Report* also reported that a quality check of flight documents retained in the Flight Operations archives identified that the aircraft weight and balance documentation was [quote] *not sporadically*[43] submitted, and poorly completed, with numerous fields left blank. There was no Quality Control performed and/or feedback to the flight crews or loadmasters. The internal investigation also found that a review of previous CASA PNG audit reports did not identify incomplete documentation as a finding.

The AIC found that the CASA PNG audit of the Hevilift operations on 20 February 2020, which included *Quality Assurance and Safety (QAS)*, did not identify any findings in relation to safety and quality processes within the Hevilift organisation to ensure operational, maintenance and safety related documents are correctly completed and retained. One major non-compliance for the QAS Department was focused more on the Mil-8 operations.

1.17.1.9 Practical drift of Baseline Performance

According to *ICAO Doc 9859, Section 2.3.8*, practical drift is a term used to define and provide understanding of how performance of any system drifts away from its original design. *Section 2.3.8.1* states:

> Tasks, procedures, and equipment are often initially designed and planned in a theoretical environment, under ideal conditions, with an implicit assumption that nearly everything can be predicted and controlled, and where everything functions as expected. This is usually based on three fundamental assumptions that the:
>
> a) technology needed to achieve the system production goals is available;
> b) personnel are trained, competent and motivated to properly operate the technology as intended; and
> c) policy and procedures will dictate system and human behaviour.

43 Sporadically is defined as occasionally, intermittently, irregularly. The operator's investigation report's use of the term "not sporadically" infers those documents in the operator's archives had been routinely and regularly submitted and therefore the archives held a complete record. This was not so as the investigation report details.

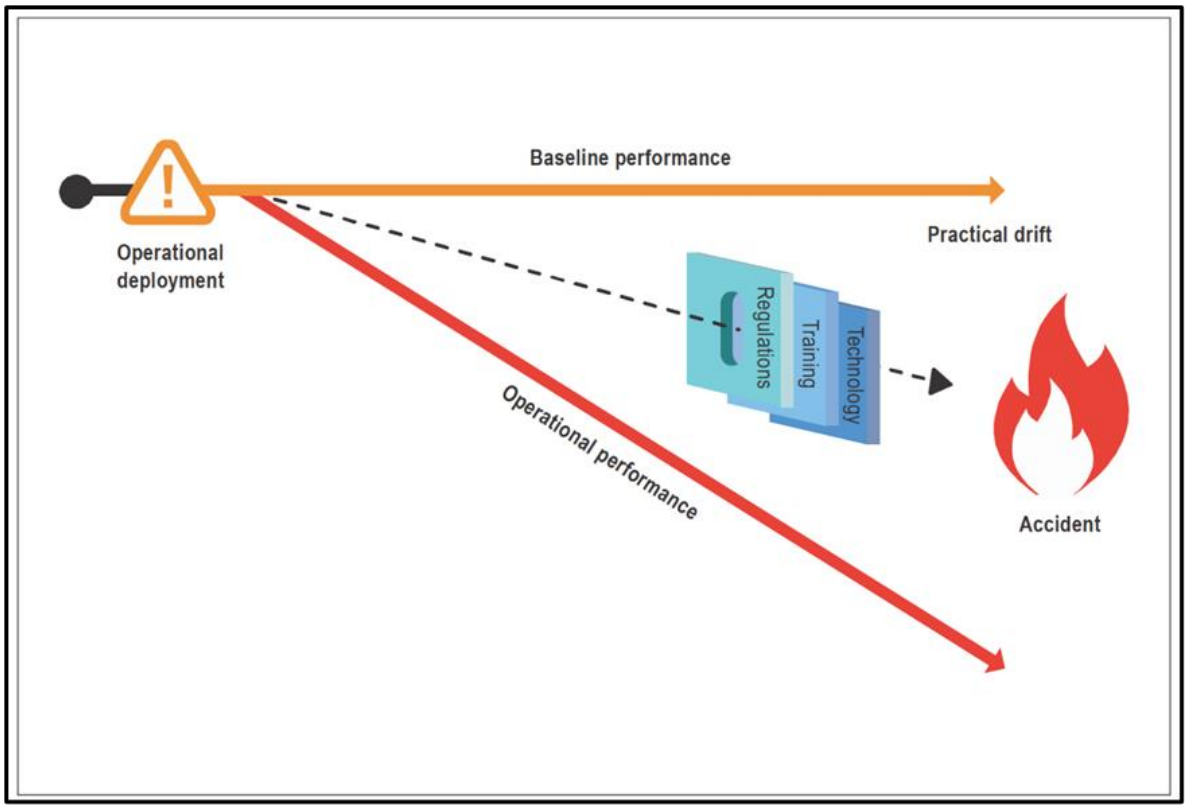


Figure 27: Concept of practical drift (ICAO Doc.9859).

Section 2.3.8.2 Once operationally deployed, the system should ideally perform as designed, following baseline performance (orange line) most of the time. In reality, the operational performance often differs from the assumed baseline performance as a consequence of real-life operations in a complex, ever-changing and usually demanding environment (red line). Since the drift is a consequence of daily practice, it is referred to as a "practical drift". The term "drift" is used in this context as the gradual departure from an intended course due to external influences.

2.3.8.3 Snook [the author] practical drift is inevitable in any system, no matter how careful and well thought out its design. Some of the reasons for the practical drift include:

a) technology that does not operate as predicted;
b) procedures that cannot be executed as planned under certain operational conditions;
c) changes to the system, including the additional components;
d) interactions with other systems;
e) safety culture;
f) adequacy (or inadequacy) of resources (e.g. support equipment);
g) learning from successes and failures to improve operations, and so forth.

The continuum between the base performance and practical drift is called the safety space. Drift toward the base performance is good and drift towards operational performance could lead to an accident. The drift may not always be a result of lack of procedures, processes, policies, regulations etc., but a result of not following the approved procedures and processes.

1.18 Additional information

1.18.1 Helicopter take-off performance

The operator's *(3-E011) Operations Manual Rotary Wing, Section 4 - Conduct of Flight* states:

> **4.5.3 Performance Class 3 Helicopter Operations**
>
> Hevilift Performance Class 3 helicopters operate at take-off weights such that the helicopter is capable of hovering within ground effect with the engine operating normally, having taken account of the pressure altitude and ambient temperature of the HLS being used, and with the capability of clearing all obstacles within the take-off flight path by a distance of not less than 15 feet.
>
> The helicopter is operated at a take-off weight such that the helicopter is capable of flying en-route at or above the appropriate minimum VFR altitudes for the area of operations.
>
> The helicopter is operated at a take-off weight at the heliport or HLS of intended landing, such that it is able to hover in ground effect with the engine operating normally, taking account of the pressure altitude and ambient temperature of the heliport or helideck, and able to conduct a baulked landing clearing all obstacles within the flight path by a vertical distance of at least 15 feet.

1.18.2 Ground effect

Ground effect is the increased efficiency of the rotor system caused by interference of the airflow under the rotor blades. The closer the helicopter is to a surface, the more pronounced the ground effect will be. This gives rise to the rotor efficiency.

Depending on the magnitude of the interference of airflow under the rotor blades, the helicopter can be:

- In Ground Effect (IGE)
- Out of Ground Effect (OGE)

1.18.2.1 In Ground Effect (IGE)

When a helicopter is IGE, according to the *FAA-H-8083-21B Helicopter Flying Handbook*:

> The air pressure or density is increased, which acts to decrease the downward velocity of air. Ground effect permits relative wind to be more horizontal, lift vector to be more vertical, and induced drag to be reduced. These conditions allow the rotor disk to be more efficient. Maximum ground effect is achieved when hovering over smooth hard surfaces. When hovering over surfaces as tall grass, trees, bushes, rough terrain, and water, maximum ground effect is reduced. Rotor efficiency is increased by ground effect to a height of about one rotor diameter (measured from the ground to the rotor disk) for most helicopters. Since the induced flow velocities are decreased, the AOA[44] is increased, which requires a reduced blade pitch angle and a reduction in induced drag. This reduces the power required to hover IGE.

44 Angle of Attack (AOA is the angle between wing chord or other reference axis and local undisturbed airflow direction

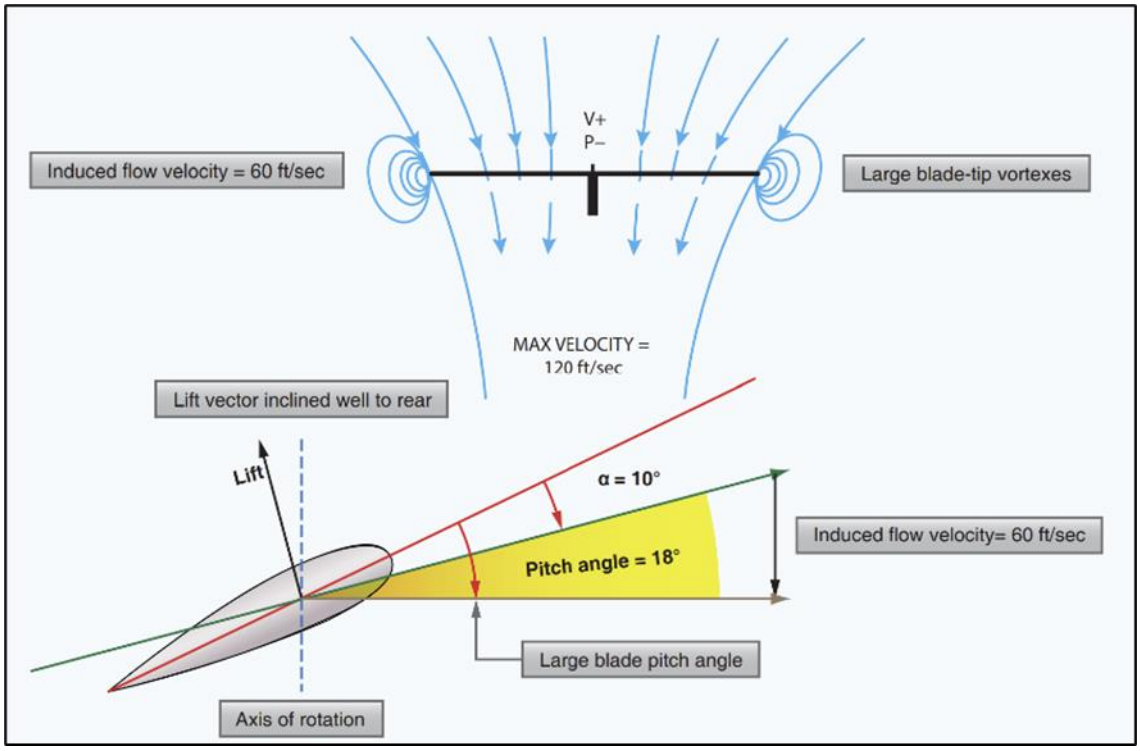


Figure 28: In ground effect.

1.18.2.2 Out of Ground Effect (OGE)

The helicopter uses OGE when it is at a height above one rotor diameter from the surface. According to the *FAA-H-8083-21B Helicopter Flying Handbook:*

> Above this altitude, the power required to hover remains nearly constant, given similar conditions (such as wind). Induced flow velocity is increased, resulting in a decrease in AOA and a decrease in lift. Under the correct circumstances, this downward flow can become so localized that the helicopter and locally disturbed air will sink at alarming rates. This effect is called vortex ring state (formerly referenced as settling-with-power) and is discussed at length in Chapter 11, Helicopter Emergencies and Hazards. A higher blade pitch angle is required to maintain the same AOA as in IGE hover. The increased pitch angle also creates more drag. This increased pitch angle and drag requires more power to hover OGE than IGE.

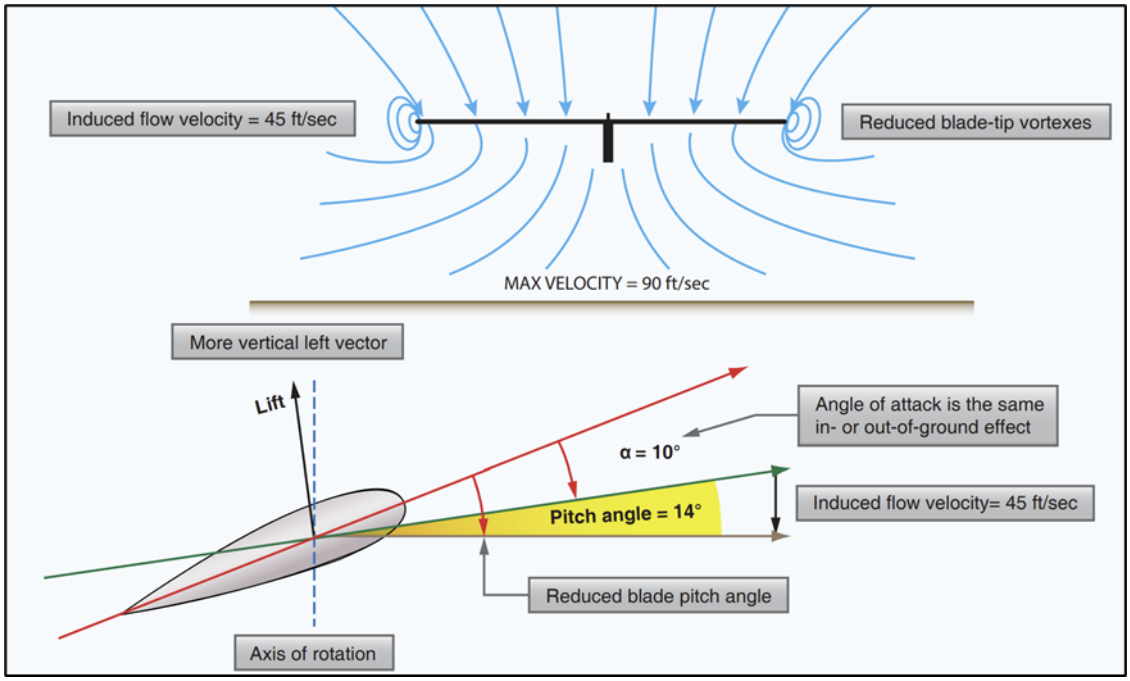


Figure 29: Out of ground effect.

1.18.3 Loss of tail rotor effectiveness

The operator's *Internal Investigation Report*, stated that:

> Any decrease in main rotor RPM will cause a corresponding decrease in tail rotor thrust. The onset of loss of tail rotor effectiveness can be significantly affected by:
>
> - The gross weight of the aircraft which affects the maximum power available to maintain the hover and transition to forward flight.
> - During hover (i.e.: no forward flight), the tail rotor is required to produce nearly 100% of directional control. If the required amount of tail rotor thrust is not available, the aircraft will yaw to the left. Additional right pedal input would be required to counter the main rotor torque, however in this case the right pedal was already fully depressed.

1.18.4 Evidence

1.18.4.1 Local eyewitness statements

A local villager at Gobo stated during an interview with the AIC that during take-off, when the helicopter was passing over the edge of the field towards the valley, that he saw a piece of the tail-rotor (TR) blade detach from the TR and was projected into the bushes towards the north of the helicopter's position at that time. Investigators located the tip of a TR blade about 170m Southeast of the main wreckage.

The investigation determined that the TR blade damage was due to impact forces. (Refer to *Section 1.12.2.1*).

1.18.5 COSPAS-SARSAT satellite system

The COSPAS-SARSAT system is made up of satellites in space and infrastructure to receive signals on the ground. It detects distress Emergency Locator Transmitters (ELTs), Emergency Position-Indicating Radio Beacons (EPIRBs), and Portable Locator Beacon (PLBs) operating on the 406 MHz frequency. Each 406 MHz beacon transmits a unique digital code that identifies the type of beacon and allows registration data to be associated with the beacon. The registration data provides information such as the beacon owner; the type of platform the beacon is associated with; emergency points of contact; and much more.

After the satellite receives a beacon signal, it relays the signal to earth stations referred to as Local User Terminals (LUT). The LUT processes the data, computes the location of the distress beacon, and transmits an alert message to its respective Mission Control Centre (MCC) via a data communication network.

The MCC performs matching and merging of alert messages with other received messages, geographically sorts the data, and transmits a distress message to another MCC or SAR Point of Contact (SPOC), an appropriate SAR authority such as Aviation Rescue Coordination Center (ARCC) or Maritime Rescue Coordination Centre (MRCC).

The PNG Air Services Limited[45], *Manual of Air Traffic Services (MATS) SAR 1-1, Para 3.3* states:

> Port Moresby RCC is a designated search and rescue point of contact (SPOC) for the receipt of COSPAS-SARSAT distress data information which emanates from ELT beacons that are activated.

1.18.6 Passenger

Age	: 45
Gender	: Male
Nationality	: Papua New Guinean
Position description	: Gardener

The passenger was employed by the operator as a gardener. He flew as a passenger to Gobo and together with the local villagers he assisted the crew by loading the coffee bags into the cargo hold, stacking them and strapping them down during the turnaround at Gobo. That was confirmed by the flight crew.

The investigation found no evidence that the passenger had received loadmaster training and there was no evidence that he held a loadmaster qualification.

The operator provided no training records or employment history records to demonstrate that the passenger had aviation related training, qualifications, or an appointment under the approved *Operations Manual*, necessary for the safe operation of the helicopter.

According to the operator's *Internal Investigations Report*, the passenger (referred to by the operator as ground staff) had been employed since 15 March 2021 as a Porter for the operator's Nadzab, Lae operations, and he was transferred back to Mt. Hagen to replace a staff member in the role of a General Hand shortly before the accident flight on 15 May 2021. The report indicated that no timesheet or duty record was found for the passenger.

The report also indicated that the passenger had previously supported loading and unloading duties and had been assigned to accompany aircraft on prior occasions. During the interview, he advised that he had previously been briefed on, and was aware of, the helicopter safety. However, no evidence of training course completion was found. There was no *Air Maestro* record for the passenger.

45 PNG Air Services Limited was renamed NiuSky Pacific Limited

According to the operator's *Position Description* of the *Gardener Position*, the primary objective of the position was being responsible to the General Manager to provide gardening services as directed. However, this document was not signed by the employee, nor his supervisor and manager as required on the form. This was not an aviation related position and so this omission was a company administrative matter.

1.18.7 Loading

During interview with the AIC, the loadmaster who loaded P2-MHM for the flight from Mt. Hagen to Gobo stated that when he signed on for duty that morning, he was advised by Operations personnel that there was a requirement for two loads of cargo to be transported to Gobo, Jiwaka Province. He recalled that as instructed by the PIC during a discussion, the first load would be an internal load consisting of building material, and the second load would be a long line/sling load of freshly cut timber.

The loadmaster recalled that he was one of two loadmasters on duty that morning. He stated that while they were both loading MHM with the first load, his colleague was required for another job and had to leave. According to the loadmaster, the building materials were heavy, so he engaged the passenger (termed by the company as ground staff) to assist him to complete loading.

The loadmaster stated during interview that once the loading was completed, he suggested to the Operations personnel and the crew of MHM if he could do the sling load as well since he was the only available loadmaster at that time.

However, the crew decided to drop off the first load and return for the second load. He recalled that the crew also opted to take the passenger to Gobo to assist with offloading the cargo.

The loadmaster also stated during interview, that at this stage he was unaware of the back load of coffee bags for the return flight from Gobo, so he remained in Mt. Hagen to prepare the long line /sling load for the second trip from Mt. Hagen to Gobo.

The loadmaster said that he was made aware of the cargo (bags of coffee) out of Gobo, after the accident was reported.

1.19 Useful or effective investigation techniques

The investigation was conducted in accordance with the Papua New Guinea *Civil Aviation Act 2000 (As Amended)*, and the Accident Investigation Commission's approved policies and procedures, and in accordance with the Standards and Recommended Practices of *Annex 13* to the *Chicago Convention on International Civil Aviation*.

2 ANALYSIS

2.1 General

The analysis section of this report discusses relevant facts which contributed to the on-set of an emergency and subsequent accident.

2.2 Aircraft

2.2.1 Maintenance records

Maintenance records showed no outstanding defects. The tail rotor, tail rotor blades and chain block were replaced in accordance with the *Mil 8 Maintenance Manual* by, and signed off as complete, by a company LAME.

From the available evidence, the investigation found that the helicopter was certified as being serviceable on the day of the accident flight.

The engines had no outstanding defects on record. The recorded engine data and the analysis of the instrument gauges visible on the cockpit image recorder gave no indication of an abnormal power issue. The investigation determined that the engines were operating normally throughout the accident flight.

The fuel records and laboratory examination report of the fuel sample taken on the morning of the flight found that in terms of fuel quantity and quality, there were no contributing factors in the accident.

No defect was found with the helicopter and its systems.

Weight calculation records were not located, and the AIC was unable to determine with certainty if calculations were completed by the PIC. However, for the purpose of the investigation, the PIC's weight estimation of 12,100 kg provided during the first interview with the AIC, was accepted.

Under the prevailing conditions, the pilot's estimated weight was within the hovering in ground effect (HIGE) limit of 13,000 kg. Based on the actual weight of the cargo as weighed by the AIC, the take-off weight of 12,504.66 kg was also within the HIGE limit.

However, due to the area terrain, particularly the downslope in the direction of the nominated take-off path, the investigation determined that the hovering out of ground effect (HOGE) limit was more applicable and was the appropriate reference to be used for weight considerations.

However, by not conducting actual weight and balance calculations the PIC was unaware that the helicopter's weight exceeded the HOGE limit by 189 kg.

The performance related issues encountered during take-off out of the Gobo were attributed to the helicopter being overweight and the prevailing quartering tailwind, in particular its inability to safely hover and transition out of ground effect over the down-sloping surface, rather than any defect in the helicopter.

2.3 Flight Operations

From the investigation, it was concluded that due to the application of the HIGE limits for weight considerations, under the conditions and area terrain, the helicopter was bound to encounter performance issues.

If uncorrected the MI-8 will yaw to the left to spin against the direction of the main rotor travel.

At the instant the helicopter began a left yaw due to loss of tail rotor authority, the PIC instructed the co-pilot to apply left pedal. This was the opposite input to the correct action to stop the left yaw, which was the right pedal[46] input.

At the point immediately prior to the complete loss of control, the helicopter was yawing left. The PIC continued to instruct the co-pilot, with some urgency, to apply left pedal.

The co-pilot applied left pedal as instructed by the PIC bringing the pedals almost to the neutral position but did not apply left pedal past the neutral position. However, by reducing the right pedal deflection left rotation increased and rapidly developed into the complete loss of helicopter control.

The PIC stated that when he took over control from the co-pilot, he became aware that an accident was inevitable. He tried to orient the helicopter to an upright position for impact. However, the helicopter impacted the ground on its right side.

The investigation found that the PIC was giving instruction that appropriately applied to the other helicopters that he had recently been trained and flown predominantly. The MR of the Bell 407 and Bell 212 rotate in the opposite direction to that of the MI-8 and the yaw effect is therefore opposite that of the MI-8.

With the limited time available and the low height, correct yaw mitigation action was crucial at the onset of the loss of tail rotor authority and left yaw. The investigation concluded that the PIC was giving incorrect instructions, which led to a further inadvertent promotion of an undesired state and ultimate loss of control of the helicopter at a height from which recovery was not considered possible.

The investigation found instances where during the pre-start checks, the co-pilot expressed concern over the weight of the helicopter for the take-off. As the crew were running through the *Engines at flight idle checklist*, prior to take-off, the co-pilot asked if they could switch off the dust protection device for performance, as it was considered that the helicopter was heavy. The AIC determined that the co-pilot had concern about the weight, however, this was not an indication that the co-pilot had any concern that the helicopter was overweight.

46 Rudder pedals are also termed anti-torque pedals. The anti-torque pedals are located in the same place as the rudder pedals in a fixed-wing aircraft, and serve a similar purpose—they control the direction that the nose of the aircraft points. Applying the pedal in a given direction changes the tail rotor blade pitch, increasing or reducing tail rotor thrust and making the nose yaw in the direction of the applied pedal.

2.4 Training and competency

According to the operator's *Internal Investigation Report*, the flight was intended as a Line Check for the co-pilot, who had recently re-joined Hevilift Aviation Limited after approximately six months of absence. The records show that co-pilot had not flown a MI-8 type aircraft during that six-month period.

To comply with *CAR Part 61.303*, the operator's approved *Training & Checking Manual* contains provisions for competency checks for the Training and Checking Captains. The manual states that for initial approval to carry out training and checks, the pilot will demonstrate competency to a CASA PNG Flying Operations Inspector. The PIC's records show that the *Instrument of Approval* issued by CASA PNG was the first for the PIC. However, the PIC did not undergo a competency demonstration with a CASA PNG inspector for issuance of the *Instrument of Approval* as an Instructor and Examiner Pilot.

The PIC accumulated 3.5 hours of flight on the MI-8, P2-MHM on 30 April and 1 May 2021, supervised by an approved MI-8 Check and Training Captain, as training and a check to line on the MI-8. These were conducted in the Mt. Hagen Training Area.

The PIC's records show training and competency flights on the Bell 212 on 2 May and Bell 407 on 4 May 2021, respectively. The PIC's flight records show that all flights between 2 May and 14 May were on either the Bell 212 or the Bell 407.

A 3-minute flight on MHM's DFR dated 13 May 2021, shows that the PIC had flown MHM during a post-maintenance hover test conducted at the operator's Base in Mt. Hagen. The AIC does not attribute this flight to the general familiarity and competence of the pilot for flight operations on the MI-8 helicopter.

The PIC's first operational MI-8 flight without supervision, and as the Check and Training Captain conducting training and a line check on another pilot, was the flight from Mt. Hagen to Gobo and the subsequent accident flight.

Between 24 April and 6 May 2021, the PIC was undergoing command training on three different helicopter types.

From the available evidence, the AIC investigation found that the operator had drifted from baseline performance. Lack of appropriate and adequate training processes and procedures and staff, especially flight crew, not following approved procedures and processes had led to a culture of complacency and practices becoming a norm in the company. Normalisation of deviation from the approved processes and procedures due to the lack of negative outcomes had led to the operator gradually drifting towards degraded operational performance, resulting in an accident.

2.5 Weight and Balance

The helicopter was found to have been overweight in reference to the HOGE limits. The PIC stated that it was their practice to estimate the weight of the coffee bags at 50 kg. Therefore, at Gobo the crew estimated the coffee bags at 50kg per bag, which would have given them a total cargo weight of 3,750 kg.

At the accident site, the AIC weighed all of the coffee bags in the cargo hold. The actual total weight was 4,156.41 kg. This was about 406 kg more than the PIC's estimated weight. The AIC determined that the cargo weight was almost 10% greater than the weight estimated by the PIC. The crew grossly underestimated the weight of the cargo.

Additionally, the crew did not complete a MI-8 dispatch manifest before commencing the flight. The AIC has determined that the crew could not have been aware of whether they were within prescribed limits for both HIGE and HOGE.

The crew stated that the manifest is completed by the loadmaster for all cargo flights on the MI-8. However, the load master was not carried on the flight to Gobo because the flight was not planned to carry a load back from Gobo. The crew only became aware when they saw coffee bags near their landing area at Gobo.

The co-pilot supervised the cargo being loaded and tied down by the passenger who was not trained as a loadmaster. The investigation found that a Dispatch Manifest was not completed for the flight. The PIC informed the AIC that the crew made rough calculations on a clipboard and estimated a total all up weight of approximately 12,100 kg. No clipboard was found in the cockpit or at the accident site, nor was it provided to the AIC by the crew.

Although the weight under the prevailing conditions at the altitude of Gobo was within the HIGE limits, the AIC believes that due to the terrain, particularly the steep down-sloping terrain under the direction of take-off, the appropriate limit to use would have been the HOGE limit. Furthermore, in reviewing the flight path over the underlying terrain, the investigation determined that the power and performance related issues observed by the crew began to arise as the helicopter was passing over the downslope.

Under the conditions at Gobo, the helicopter was overweight.

2.6 Human Factors

The investigation found several contributing factors that were related to human factors.

Disorientation

The investigation deduced from the evidence that the PIC was not fully cognisant of the uncommanded left yaw and the developing spin. It also appeared from the recorded data and the recorded cockpit imagery that the PIC only recognised that his perception of the helicopter's rotation was contrary to the actual motion of the helicopter when he assumed control of the helicopter. The investigation found that the PIC while becoming increasingly concerned during the HOGE and initial transition, he did not fully recognise that the helicopter was entering an undesired state.

The co-pilot stated during interview that the pedals seemed heavy during the brief flight. However, the co-pilot did not alert the PIC of anything unusual throughout the flight leading up to the accident. The helicopter was yawing left and starting to enter a spin. However, the evidence shows that the PIC did not recognise it and continued calling for left pedal input with increasing urgency.

As the helicopter began to accelerate the left yaw and right roll, the PIC's instruction with higher intonation to input left pedal was interrupted by the FE calling left, left, left, left, left with higher intonation. The investigation was unable to conclusively determine the intent of this urgent call. However, the investigation determined that the only risk that would be reduced by left control input was roll. The FE appeared to be concerned about the severity of the quickly developing loss of flight control.

The recorded data showed that at 11:14:14 the co-pilot asked the PIC to take control. The co-pilot said that she did so when she felt she had lost control of the helicopter. Two seconds later the PIC said 'I have control'. As soon as the PIC assumed the controls, he realised that the helicopter was spinning left and he immediately applied right pedal.

With helicopter maintaining a pitch down attitude throughout the yaw and subsequent spin, the pilots may not have been able to identify and maintain a tracking reference. The investigation considered that, because the shared pedals had a predominant right pedal application and the helicopter a slight right bank angle, the PIC may have perceived that the helicopter was either yawing or turning to the right.

It was evident that the PIC was not aware that he may have been disoriented and did not cross reference to confirm his perception of the helicopters motion. As the spin became more pronounced, the PIC began to give instruction to apply left pedal with more urgency.

The PIC only recognised the need for right pedal input 2 seconds after he assumed control.

From the recorded data and cockpit imagery, the investigation determined that the helicopter had a right bank angle and a predominant right pedal application from the co-pilot. The PIC may have perceived this as excessive right side control input and/or movement. Contrary to the correct action, the PIC continued to give the co-pilot an instruction "little bit of a left turn just ease it forward" and subsequently gave the specific instruction to apply left pedal calling "left pedal, left pedal".

The PIC was relatively more proficient and current on the Bell 212 and Bell 407. These helicopters main rotors rotate counter-clockwise, which is opposite to the MI-8 helicopter. The immediate correct action for uncommanded yaws and loss of tail rotor effectiveness on those helicopters (B212 and B407) is to apply left pedal, whereas the MI-8 would require right pedal. It is probable that the PIC may have been disorientated and did not identify the direction of yaw and subsequent spin. As the PIC recognised that the flight was developing into undesired state, he began commanding the co-pilot by applying skills for which he was more proficient and recent, which were from the Bell helicopters.

Communication

While the crew were actioning the pre-takeoff checklist, the co-pilot asked if they could switch the dust protection system/device off adding "cos we're very heavy". The FE responded, "Okay off". The PIC should have been aware of their concern about the heavy helicopter since he was going through the checklists with them.

The evidence indicated that the co-pilot was aware that the helicopter was yawing left. The co-pilot was observed to be countering it with right pedal input and a right bank. However, the helicopter continued yawing left. The co-pilot did not mention that anything felt abnormal at that time. As the yaw developed into a spin, the co-pilot did not mention anything. When the PIC's instruction to go left and subsequently to apply left pedal, the co-pilot did not respond verbally or challenge the instruction. The co-pilot merely released right pedal and re-applied it because every time the pedals were brought to centre position, the helicopter's left yaw rate increased. The PIC's calm approach appeared to give her the reassurance that there was nothing abnormal about the flight. When the PIC started giving instructions with heightened intonation indicating a sense of urgency, the co-pilot requested that he take control. Two seconds later he said "I have control".

The crew used non-standard phraseology which appeared at times to be ambiguous and may have led to a degree of confusion. The cockpit environment was not conducive for effective Crew Resource Management. The PIC did not appear to be proficient with the MI-8 helicopter. The co-pilot, the pilot under training, had a sense of security that the PIC, being a check and training Captain would take-over, or point out with clarity and urgency as required if something is wrong. When the PIC was giving the wrong instruction, the co-pilot did not question it.

3 CONCLUSIONS

3.1 Findings[47]

3.1.1 Aircraft

a) The helicopter was certified, equipped and maintained in accordance with existing regulations and approved procedures.

b) The helicopter had a valid Certificate of Airworthiness and had been maintained in compliance with the regulations.

c) The helicopter was certified as being airworthy when dispatched for the flight.

d) There was no evidence of airframe or powerplant failure, or system malfunction prior to the accident.

e) The helicopter was structurally intact prior to impact.

f) All control surfaces were accounted for and all damage to the helicopter was attributable to the severe impact forces.

g) The helicopter was destroyed by the impact forces.

h) The sampled fuel was of the proper grade; it met quality and specification standards.

i) Rotor blade damage was consistent with the engines producing power at impact.

3.1.2 Crew / pilot / passenger

a) The PIC was licensed and medically fit and adequately rested to operate the flight. However, he was not appropriately trained in accordance with existing regulations and the operator's approved manuals.

b) The co-pilot was licensed and medically fit and adequately rested to operate the flight. However, she was not appropriately trained in accordance with existing regulations and the operator's approved manuals.

c) The flight engineer was properly licensed and qualified, medically fit and adequately rested to operate the flight. He was appropriately trained in accordance with existing regulations and the operator's approved manuals.

d) The flight crew were in compliance with the flight and duty time regulations.

e) The PIC's actions and statements indicated that his knowledge and understanding of the helicopter's systems was inadequate.

f) The crew used non-standard phraseology.

g) The accident flight did not have a qualified loadmaster onboard.

h) A passenger was carried in contravention of the operator's approved *Flight Manual.*

i) The helicopter did not have a flight attendant as required when carrying passengers.

47 Findings are not listed in an order of hierarchy or importance.

3.1.3 Flight operations

a) The flight was not conducted in accordance with the procedures in the operator's *Operations Manual*.

b) The flight crew carried out normal radio communications with the relevant Air Traffic Services units.

c) The crew did not complete the required *Hover Check* after completing the *Pre take-off Checklist*.

d) During forward transition, the aircraft began an uncommanded yaw to the left.

e) During forward transition, the co-pilot lost control of the helicopter.

f) The PIC took control from the co-pilot but was unable to regain tail-rotor effectiveness and avert the loss of control resulting in the accident.

3.1.4 Operator

a) The presentation of the operator's *Normal Procedure Checklist* (*Pre take-off checklist*) was inadequate for use under conditions of stress.

b) The operator's *Quality Assurance Systems* had not identified frequent deviations from the requirements of the operator's operational procedures over a considerable period of time.

c) The operator's on-line *Crew Resource Management* training was not adequate to enhance effective communication and be able to manage threats in flight.

- Training was conducted online and not is a classroom environment allowing for discussion.

d) The operator allowed a passenger to be carried in direct contravention of Section 2.1 of the operators *Flight Manual*.

3.1.5 Flight Recorders

a) The aircraft was equipped with an FDR and a CVR as required by the PNG CARs.

3.1.6 Medical

a) Toxicological tests for common drugs and alcohol were negative.

3.1.7 Survivability

a) The ELT activated at 11:18 on frequency 406 MHz.

b) The seats, seat belts and their associated structures maintained their integrity during the impact.

c) The head injuries sustained by the passenger might have been prevented if he had worn helmet.

d) The flight crew egressed the helicopter with minor injuries.

3.1.8 Safety Oversight

a) CASA PNG did not meet the high standard of evidence-based assessment required for safety assurance.

- The CASA PNG monitoring and audit systems had been ineffective in identifying organisational deficiencies and ensuring the operator corrected the procedural lapses.

b) In contravention of *CAR Part 61.303* and the operator's approved *Training & Checking Manual*, the PNG Civil Aviation Safety Authority (CASA) issued the PIC an initial *Instrument of Approval* for *Examiner and Training* purposes without being flight checked by a CASA PNG Flying Operations Inspector.

3.2 Causes [Contributing factors]

The helicopter accident occurred due to uncorrected loss of tail rotor authority.

The loss of tail rotor authority resulted from the helicopter being significantly heavier than permitted for its hover out of ground effect.

The crew did not weigh the cargo, nor did they complete pre-takeoff weight and balance calculations to provide assurance of the helicopter being within prescribed limits for both HIGE[48] and HOGE[49].

Crew Resource Management was inadequate. Communication between the flight crew was ineffective through their use of non-standard terms and phrases leading to ambiguity.

The co-pilot, the pilot flying, did not immediately alert the PIC of the uncommanded left yaw.

The PIC issued instructions that were contrary to effective yaw mitigation.

Lack of training and lack of proficiency resulted in the crew not taking timely appropriate action to mitigate the unsafe situation.

3.3 Other factors

The investigation found non-contributing safety deficiencies. These are addressed in the factual and safety recommendations.

48 HIGE. Hover in ground effect.

49 HOGE. Hover out of ground effect.

4 SAFETY ACTIONS AND RECOMMENDATIONS

4.1 Safety action

Hevilift PNG Limited, through its Internal Investigation Report dated 9 September 2021, informed the Accident Investigation Commission (AIC) of the following Safety Actions completed and proposed following the accident:

Procedural

Safety Action taken:

A Safety Alert has also been issued to stipulate if coffee bags cannot be weighed, any estimation of Coffee bags in future is to be 75 kgs as moisture content can affect the weight of the coffee beans.

The Safety Alert had been issued to stipulate if coffee bags cannot be weighed, any estimation of the coffee bags in the future is to be 75 kg as a moisture content can affect the weight of the coffee beans. The Safety Alert had also stipulated that when standard weights are used, a minimum of 15% margin within maximum limitation must be used.

Safety Action taken:

The operator amended its Mil 8 Normal Operations Checklist to include a new procedure, 'Hover Check', if no taxi required'. This is to ensure the MR RPM is within AFM limits prior to transitioning. A copy of the amended Mil 8 Normal Operations Checklist Revision: 2.4, dated 1 September 2021 was provided to the AIC. (Refer to *Section 5.3 Appendix C, 5.3.1*).

Operational

Safety Action taken:

A Safety Alert had been issued to all pilots, to reinforce the importance of adhering to aircraft limitations during departure.

A copy of Internal Pilot Memorandum was provided to the AIC.

Safety Action taken:

A Safety Alert has been issued to all pilots to reinforce the importance of completing aircraft documentation, including the Flight / Dispatch Manifest.

Training

Safety Action taken:

All Hevilift Mil-8 Flight Crew Members shall undertake simulator training at Avia-Lux (training center) in United Arab Emirates (UAE) prior to undertaking duties as a Hevilift Mil-8 Flight Crew Member, with the first team already completing their training. This training includes practice of normal procedures, and the recognition and recovery of non-normal and emergency manoeuvres as identified during this investigation (operator's investigation).

Simulator training records for MI-8 Flight Crew Members were provided to the investigation.

Safety Action taken:

The managing Pilot Part 136 issued a "Rotary Wing Mi8 / Training Recovery Plan" to Hevilift management. This 3-phase plan is on-going.

A copy of the *Rotary Wing Mi8 / Training Recovery Plan* was provided to the investigation.

Organisational

Safety Action taken:

Shortly after the accident, the CEO issued an email to all staff informing them of the accident. The Managing Pilot Part 136 shortly thereafter, distributed a memo to all RW flight crew reinforcing safety and best practices when operating.

Safety Action taken:

A Safety Alert has been issued, highlighting key learnings from this initial Occurrence Report to all Pilots and Aircrew.

Operational

Safety Action taken:

The T&C Manager Part 136 has re-issued a PowerPoint "Pre-Operational Competency Assessment" brief to the senior Mil 8 T&C pilot to ensure that all Mil T&C pilots correctly brief prior to a competency check. He also has stipulated that all HEVILIFT IOAs will be observed by a CASA PNG Flight Operation Inspector (or his delegate) prior to applying for an issue or renewal of an IOA. A "Training of Flight Instructor/Examiner: training manual is being created and will be a standalone to the OMD-Training manual.

Operational

Safety Action taken:

The T&C Manager Part 136 has carried out a briefing with the PIC, using the FDM and Appareo video, to review the occurrence, identifying potential casual factors and opportunities for improvement.

Operational

Safety Action taken:

The Mil-8 Fleet Captain has been renominated by the Managing Pilot Part 136.

4.2 Recommendations

As a result of the investigation into the accident involving the MI-8 helicopter registered P2-MHM, about 30 NM Northeast of Mt. Hagen, at Gobo, Jiwaka Province, Papua New Guinea on 15 May 2021, the Papua New Guinea Accident Investigation Commission issued the following recommendations to address concerns identified in this report.

4.2.1 Recommendation number AIC 23-R01/21-1002 to Hevilift (PNG) Aviation Limited

On 8 March 2023, the PNG AIC issued the following safety recommendation:

The PNG Accident Investigation Commission recommends that Hevilift (PNG) Aviation Limited should ensure that flight crew who have not flown on an aircraft / helicopter type for more than 24 months complete *Crew Resource Management* and *Human Factors* classroom-based training with discussion and interaction between the trainer and the flight crew.

Action requested

The AIC requests that Hevilift (PNG) Aviation Limited note recommendation *AIC 23-R01/21-1002* and provide a response to the AIC within 90 days of the issue date and explain (including with evidence) how Hevilift (PNG) Aviation Limited has addressed the safety deficiency identified in the safety recommendation.

4.2.1.1 Hevilift PNG Aviation Limited response

On 25 April 2023, Hevilift (PNG) Aviation Limited (HL) provided evidence of their corrective action to address Safety Recommendation AIC 23-R01/21-1002, which included the amended *page 3-25* of HL *Operations Manual Part D – Part 136, Section 3 Content of Training Syllabi*, which states:

> **3.20.1 Introduction**
>
> CRM and ADM training on Air Maestro, depicting helicopter situations, will be reviewed by all pilots both on initial hire and annually at the time of one of the Part 136 Competency Checks. Classroom based HF/CRM[50] training conducted by a CRMF will be provided by the Company. This will be carried out annually and will be tracked in the recency section of Air Maestro.
>
> **3.20.3 Frequency**
>
> FCMs will review the AM courses upon commencement with the Company and every 12 months thereafter in conjunction with Competency and/or Line Checks or during type simulator training. The classroom based initial or refresher training will be conducted by the CRMF[51] annually to biennially to suit HEVILIFT client's requirement.

HL also provided copies of the CRM, HF and Pilot Decision Making Training certificate of completion for the PIC, co-pilot and Flight Engineer (FE) of the accident flight.

PNG Accident Investigation Commission (AIC) assessment of the Hevilift (PNG) Aviation Limited response

The AIC reviewed the Hevilift (PNG) Aviation Limited (HL) corrective actions to address *Safety Recommendation AIC 23-R01/21-1002* and notes that the safety actions address the safety deficiencies identified in the safety recommendation. The AIC assigned this response as *fully satisfactory* rating.

The AIC recorded the **Status of the AIC Recommendation: CLOSED**

4.2.2 Recommendation number AIC 23-R02/21-1002 to Hevilift (PNG) Aviation Limited

On 8 March 2023, the PNG AIC issued the following safety recommendation:

The PNG Accident Investigation Commission recommends that Hevilift (PNG) Aviation Limited should conduct a review of its recurrent training program to ensure that adequate and appropriate flight training is provided to pilots and flight engineers who have not flown on an aircraft / helicopter type in the preceding 24 months, and that flight crew meet the specified recurrency/recency requirements.

Action requested

The AIC requests that Hevilift (PNG) Aviation Limited note recommendation *AIC 23-R02/21-1002* and provide a response to the AIC within 90 days of the issue date and explain (including with evidence) how Hevilift PNG Aviation Limited has addressed the safety deficiency identified in the safety recommendation.

50 HF/CRM: Human Factors / Crew Resource Management.

51 CRMF: Crew Resource Management Facilitator.

4.2.2.1 Hevilift (PNG) Aviation Limited response

On 25 April 2023, Hevilift (PNG) Aviation Limited (HL) provided evidence of their corrective action to address *Safety Recommendation AIC 23-R02/21-1002*, which included the amended page *3-25* of *HL Operations Manual Part D – Part 136, Section 3 Content of Training Syllabi*, which states:

> **3.10.2 Multi Engine (ME) and/or IFR**
>
> ….
>
> ME and/or IFR OCA also incorporate written tests covering relevant CARs, Company operational procedures, flight planning, aircraft systems, performance, emergencies etc. Records are maintained on forms HL-PNG-902A/B/C/E- *Operational Competency Assessment*, which are held on file in the pilot's Training and Checking records. Air Maestro will be updated to reflect currency.
>
> OCA and/or Line Checks may also be required:
>
> ….
>
> d. VFR and IFR Flight Crew who have not flown for 90 days or more are to complete a Line Check on return to flight duty status.

PNG Accident Investigation Commission (AIC) assessment of the Hevilift (PNG) Aviation Limited response

The AIC reviewed the Hevilift (PNG) Aviation Limited (HL) corrective actions to address *Safety Recommendation AIC 23-R02/21-1002* and notes that the safety action addresses the safety deficiencies identified in the safety recommendation. The AIC assigned this response as *fully satisfactory* rating.

The AIC recorded the **Status of the AIC Recommendation: CLOSED**

4.2.3 Recommendation number AIC 23-R03/21-1002 to Hevilift (PNG) Aviation Limited

On 8 March 2023, the PNG AIC issued the following safety recommendation:

The PNG Accident Investigation Commission (AIC) recommends that Hevilift (PNG) Aviation Limited should ensure that its *Quality Assurance System* and any other relevant organisational systems, processes and procedures identify deviations from the requirements of the Ground Operations, Flight Operations, and Training and Competency.

Action requested

The AIC requests that Hevilift (PNG) Aviation Limited note recommendation *AIC 23-R03/21-1002* and provide a response to the AIC within 90 days of the issue date, and explain (including with evidence) how Hevilift (PNG) Aviation Limited has addressed the safety deficiency identified in the safety recommendation.

4.2.3.1 Hevilift (PNG) Aviation Limited response

On 25 April 2023, Hevilift (PNG) Aviation Limited (HL) provided a response to *Safety Recommendation AIC 23-R03/21-1002*, stating;

> There are two specific processes to assist in monitoring deviations from the required standard.
>
> 1. Flight Data Monitoring (FDM) program. The FDM program assists us in monitoring high risk trends in the operation of company aircraft through the monitoring and analysis of various ground and flight parameters as applicable to the aircraft type.

A monthly report is provided detailing the various events and risks, and any high risk "red" events are immediately investigated through our QAS SMM system. Actions are then taken through additional training / procedures to prevent future occurrences.

2. The second monitoring system we have in place is reviewing trends associated with crew member's annual exams. All exams are completed through our online Air Maestro system, which also provides statistical analysis of where knowledge deficiencies exist amongst our pilots and crew members. The statistics are reviewed, and additional training is provided to respective individuals to rectify such deficiencies. See below for an example of exam statistical analysis.

Hevilift also provided copies of two recent notices sent to crews as evidence of the FDM program, and a copy of *Results per Question Category Group* for their Bell 212 fleet, as evidence for annual exam statistical analysis.

PNG Accident Investigation Commission assessment of the Hevilift (PNG) Aviation Limited response

The AIC reviewed the HL response and evidence to address *Safety Recommendation AIC 23-R03/21-1002* and notes that the safety actions address the safety deficiencies identified in the *Safety Recommendation AIC 23-R03/21-1002* relating to flight data monitoring of Flight Operations and annual exam statistical analysis of the Training and Competency aspects.

The AIC notes that the response does not address the safety deficiencies identified in *Safety Recommendation AIC 23-R03/21-1002* relating to Ground Operations, including maintenance. The AIC assigned this response as *satisfactory in parts* rating.

The AIC recorded the **Status of the AIC Recommendation: CLOSED**

4.2.4 Recommendation number AIC 23-R04/21-1002 to Hevilift (PNG) Aviation Limited

On 8 March 2023, the PNG AIC issued the following safety recommendation:

The PNG Accident Investigation Commission (AIC) recommends that Hevilift (PNG) Aviation Limited should ensure that effective operational control measures and/or quality controls are in place to ensure company documents, especially operational documents including training records, flight and duty records are maintained and records kept up to date and retained.

Action requested

The AIC requests that Hevilift (PNG) Aviation Limited note recommendation *AIC 23-R04/21-1002* and provide a response to the AIC within 90 days of the issue date and explain (including with evidence) how Hevilift (PNG) Aviation Limited has addressed the safety deficiency identified in the safety recommendation.

4.2.4.1 Hevilift (PNG) Aviation Limited response

On 25 April 2023, Hevilift (PNG) Aviation Limited (HL) provided a response to *Safety Recommendation AIC 23-R04/21-1002*, stating;

Updated SMM and Air maestro control measures.

SMM 2.6 Document & Record Control *Reference CAR Part 100.111(a),(b)(1,2,3)*

Document control provides a means of managing the development, approval, issue, change, distribution, maintenance, use, storage, security and disposal of documents. The purpose of this procedure is to define the activities required to ensure all documents and records are reviewed and approved by authorised personnel prior to issue. It reduces the likelihood that Company operations compromise safety by the use of incorrect or out of date information, that the correct version of all necessary documentation and data is available to the user, that documents and data are correctly approved before use and that changes are effectively controlled. Documentation in this category includes but is not limited to:

a. Policies
b. Manuals
c. Procedures
d. Standing Orders
e. Safety Alerts, Notices and Operational Information
f. Forms, Records and Guidelines
g. Group Standards and Technical Publications
h. Data Bases, and
i. Safety Briefing Cards.

All document control processes are outlined in the *Hevilift Group Document Control manual Reference CAR Part 100.133(a), (b)(1,2,3)(c)* and are to be complied with at all times.

In their response, Hevilift (PNG) Aviation Limited also provided updated document control procedure and related AIR Maestro control segment including monthly aircraft documented checks, which included Aircraft document monthly check overview for a fleet of their aircrafts, P2-MHO Aircraft recency as an example for Aircraft document monthly check and a Helicopter Status Checklist Mi-8MTV-1, for P2-MHO.

Hevilift (PNG) Aviation Limited also provided evidence of related Air Maestro recency records of a Flight Engineer, which included all *General Subjects.*

PNG Accident Investigation Commission (AIC) assessment of the Hevilift (PNG) Aviation Limited response

The AIC reviewed the HL response and evidence to address *Safety Recommendation AIC 23-R04/21-1002* and notes that the corrective actions do not address the safety deficiencies identified in the *Safety Recommendation AIC 23-R04/21-1002.* The AIC assigned this response as *fully satisfactory* rating.

The AIC recorded the **Status of the AIC Recommendation: CLOSED**

4.2.3 Recommendation number AIC 23-R05/21-1002 to Hevilift (PNG) Aviation Limited

On 8 March 2023, the PNG AIC issued the following safety recommendation:

The PNG Accident Investigation Commission (AIC) recommends that Hevilift (PNG) Aviation Limited should review its suite of Manuals to ensure they address and meet or exceed the requirements of *PNG Civil Aviation Rules*.

Action requested

The AIC requests that Hevilift (PNG) Aviation Limited note recommendation *AIC 23-R05/21-1002* and provide a response to the AIC within 90 days of the issue date and explain (including evidence) how Hevilift has addressed or plans to address the safety deficiency identified in the safety recommendation.

4.2.4.2 Hevilift (PNG) Aviation Limited response

On 25 April 2023, Hevilift (PNG) Aviation Limited (HL) provided a response to address *Safety Recommendation AIC 23-R05/21-1002*, stating;

> **Updated SMM and Air maestro control measures.**
>
> **SMM 2.6 Document & Record Control** *Reference CAR Part 100.111(a),(b)(1,2,3)*
>
> Document control provides a means of managing the development, approval, issue, change, distribution, maintenance, use, storage, security and disposal of documents. The purpose of this procedure is to define the activities required to ensure all documents and records are reviewed and approved by authorised personnel prior to issue. It reduces the likelihood that Company operations compromise safety by the use of incorrect or out of date information, that the correct version of all necessary documentation and data is available to the user, that documents and data are correctly approved before use and that changes are effectively controlled. Documentation in this category includes but is not limited to:
>
> a. Policies
> b. Manuals
> c. Procedures
> d. Standing Orders
> e. Safety Alerts, Notices and Operational Information
> f. Forms, Records and Guidelines
> g. Group Standards and Technical Publications
> h. Data Bases, and
> i. Safety Briefing Cards.
>
> All document control processes are outlined in the *Hevilift Group Document Control manual Reference CAR Part 100.133(a), (b)(1,2,3)(c)* and are to be complied with at all times.

In their response, Hevilift also provided evidence including the *Air Maestro Recency Item: 'Department: General'*, containing the '90-day recency (3X Take-off & Landing)' requirement.

PNG Accident Investigation Commission (AIC) assessment of the Hevilift (PNG) Aviation Limited response

The AIC reviewed Hevilift (PNG) Aviation Limited (HL) response and notes that the corrective actions address the deficiencies identified in *Safety Recommendation AIC 23-R05/21-1002*. The AIC assigned this response as *fully satisfactory* rating.

The AIC recorded the **Status of the AIC Recommendation: CLOSED**

4.2.4 Recommendation number AIC 23-R06/21-1002 to the Civil Aviation Safety Authority of PNG

On 8 March 2023, the PNG AIC issued the following safety recommendation:

The PNG Accident Investigation Commission (AIC) recommends that the Civil Aviation Safety Authority of PNG should ensure, during audits of Hevilift (PNG) Aviation Limited, that the operator's suite of Manuals meets or exceeds the requirements of *PNG Civil Aviation Rules*.

Action requested

The AIC requests that CASA PNG note recommendation *AIC 23-R06/21-1002* and provide a response to the AIC within 90 days of the issue date, and explain (including evidence) how CASA PNG has addressed the safety deficiency identified in the safety recommendation.

Status: ISSUED

4.2.5 Recommendation number AIC 23-R07/21-1002 to the Civil Aviation Safety Authority of PNG

On 8 March 2023, the PNG AIC issued the following safety recommendation:

The PNG Accident Investigation Commission (AIC) recommends that the Civil Aviation Safety Authority of PNG should ensure that Hevilift (PNG) Aviation Limited flight operations are conducted in accordance with *PNG Civil Aviation Rules* and the CASA PNG approved *Hevilift Operations Manual* and *Aircraft Flight Manuals*.

Action requested

The AIC requests that CASA PNG note recommendation *AIC 23-R07/21-1002* and provide a response to the AIC within 90 days of the issue date and explain (including evidence) how CASA PNG has addressed the safety deficiency identified in the safety recommendation.

Status: ISSUED

5 APPENDICES

5.1 Appendix A: Hevilift Mil-8 MTV Normal Procedures Checklist

5.1.1 General notes

The use of this checklist does not take away the responsibility of the crew to ensure that they have completed all the required checks as shown in the Approved Flight Manual
NOTE: Items highlighted in yellow are NOT required for second and subsequent starts

ABBREVIATIONS:

LP = Left Seat Pilot	NR = Rotor RPM
RP = Right Seat Pilot	N1 = Engine RPM
FE = Flight Engineer	TGT = Turbine Gas Temperature
PF = Pilot Flying	No. 1 Engine = Left Engine
PM = Pilot Monitoring	No. 2 Engine = Right Engine
TDP = Take Off Decision Point	LDP = Landing Decision Point
QRH = Quick Reference Handbook	

CALL =	Item or system to be Identified or Confirmed
ACTION =	Crew member responsible for carrying out the action
RESPONSE =	Crew member responsible for carrying out action and confirming action has been completed. NOTE: When crew are required to respond - RP, FE, LP - response will be separately and in that order
CHALLENGE =	ALL CREW MEMBERS ARE RESPONSIBLE TO CHALLENGE ANY CALL THAT MAY BE INCORRECT OR UNSAFE

NOTE: ITEMS MARKED "CHECK" IN APU & MAIN ENGINE START ARE MEMORY ITEMS TO BE CALLED BY THE FE
GENERAL NOTES

5.1.2 Pre-start checks

MIL-8 MTV CHECKLIST

PRE-START CHECKS:

CALL		ACTION		RESPONSE
BATTERIES		FE		ON OR GPU IN USE, ...VOLTS (24V Min)
VOICE RECORDER		FE		ON, SERVICEABLE
INTERCOM	LP	FE	RP	GOOD
BRIEFING	LP	FE	RP	DONE
CONTROL LOCKS	LP	FE		REMOVED, SIGHTED
CYCLIC & PEDALS	LP			NEUTRAL
DOORS & HATCHES		FE		OPEN OR CLOSED
CARGO HOOK		FE		CHECKED, SERVICEABLE
CIRCUIT BREAKERS		FE	RP	ON
WARNING LIGHTS		FE		SERVICEABLE
WHEEL BRAKES	LP			ON, SERVICEABLE, PRESSURE NORMAL
ROTOR BRAKE		FE		RELEASED

PRE-START CHECKS

MIL-8 MTV CHECKLIST

PRE-START CHECKS CONT'D

CALL	ACTION			RESPONSE
ENGINE CONTROL LEVERS	LP			NEUTRAL AND LATCHED
COLLECTIVE	LP		RP	DOWN, THROTTLE FULLY LEFT
VOICE REPORTING SYSTEM		FE		SERVICEABLE
FLIGHT DATA RECORDER		FE		MANUAL
VIBRATION EQUIPMENT		FE		SERVICEABLE
FIRE SYSTEM		FE		ON, SERVICEABLE OR OFF, ON AFTER APU START
GENERATORS		FE		OFF
FUEL GAUGE		FE		SERVICEABLE
SERVICE TANK		FE		ON
FUEL VALVES		FE		OPEN
ENGINE SHUTDOWN LEVERS	LP	FE		CLOSED
115v INVERTERS		FE		MANUAL
ANTI COLLISION LIGHT			RP	ON
READY TO START APU	LP	FE	RP	READY

PRE-START CHECKS CONT'D

5.1.3 Pre-start: APU start

MIL-8 MTV CHECKLIST				
PRE-START: APU START				
CALL		ACTION		RESPONSE
NOTE: IF ANY PARAMETER IN "CHECK" IS EXCEEDED, FE IS TO ABORT THE START. PRESS STOP FOR 2 - 3 SEC				
APU START SELECTOR		FE		START OR CRANK
START BUTTON		FE	RP	STARTING (PRESS 2 - 3 sec)
STOPWATCH		FE		STARTED
CHECK:	VOLTAGE	FE		..... VOLTS (MIN 18v)
	AUTO START	FE		ON
	OIL PRESSURE	FE		ON ..... SECONDS (MAX 20 sec)
	TGT	FE		RISING (WITHIN 9 Sec & MAX 880°C)
	GOVERNOR SPEED	FE		ON ..... SECONDS (MAX 30 sec)
	AUTO START	FE		OUT ..... SECONDS (MAX 60 sec)
STOPWATCH		FE	RP	RESET & STARTED
APU START				

5.1.4 Pre-start: APU running

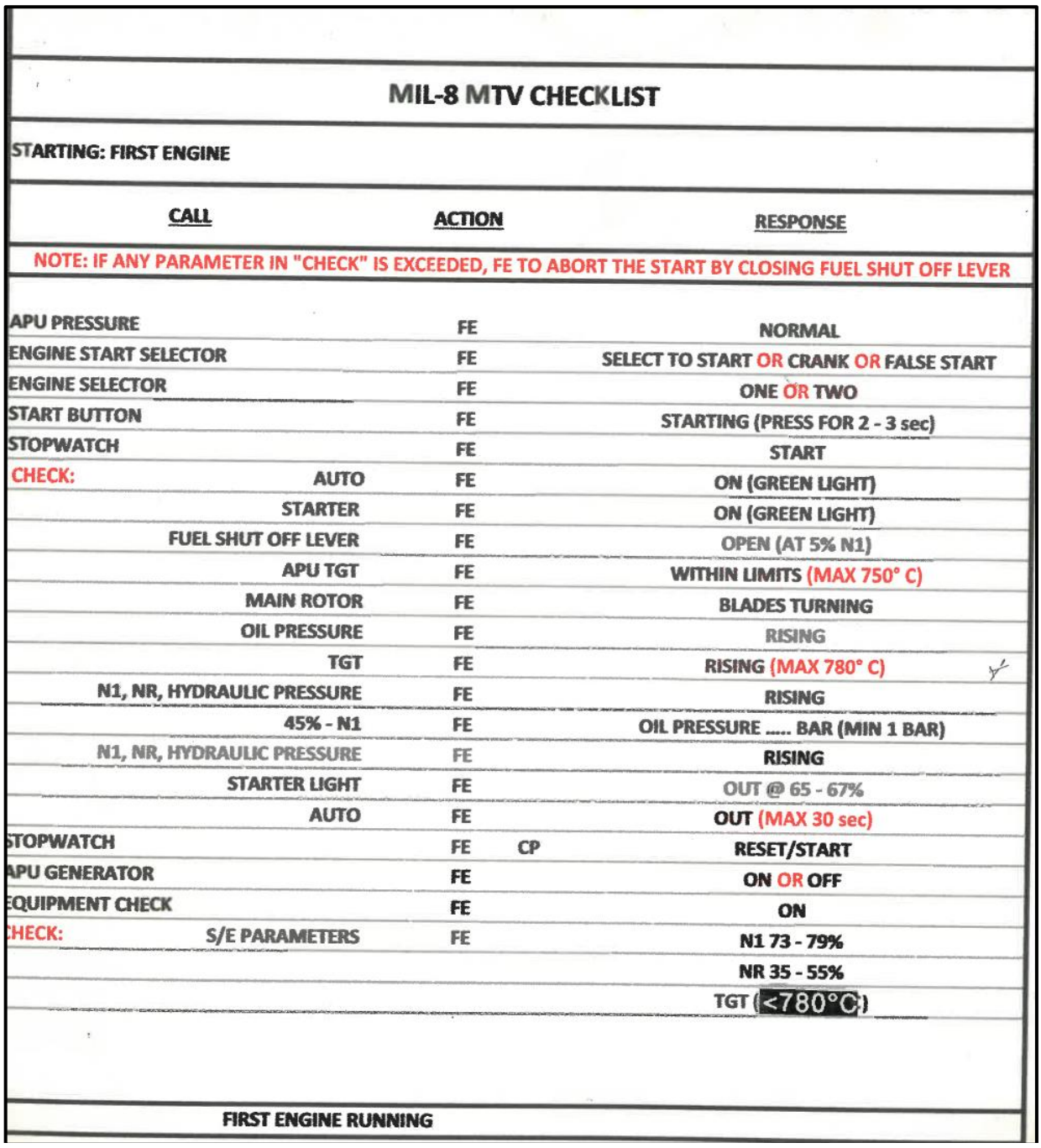
MIL-8 MTV CHECKLIST

PRE-START: APU RUNNING

CALL		ACTION		RESPONSE
APU PARAMETRS		FE		NORMAL, FIRE SYSTEM ON
S/BY GENERATOR		FE		OFF OR ON
MAIN & AUX HYDRAULIC SYSTEM	LP			ON
APU RUNNING		FE	RP	ONE MINUTE COMPLETE
PRE START CHECKS	LP	FE	RP	COMPLETE
READY TO START FIRST ENGINE	LP	FE	RP	READY, CLEAR LEFT & RIGHT

APU RUNNING

5.1.5 Starting: First engine



MIL-8 MTV CHECKLIST

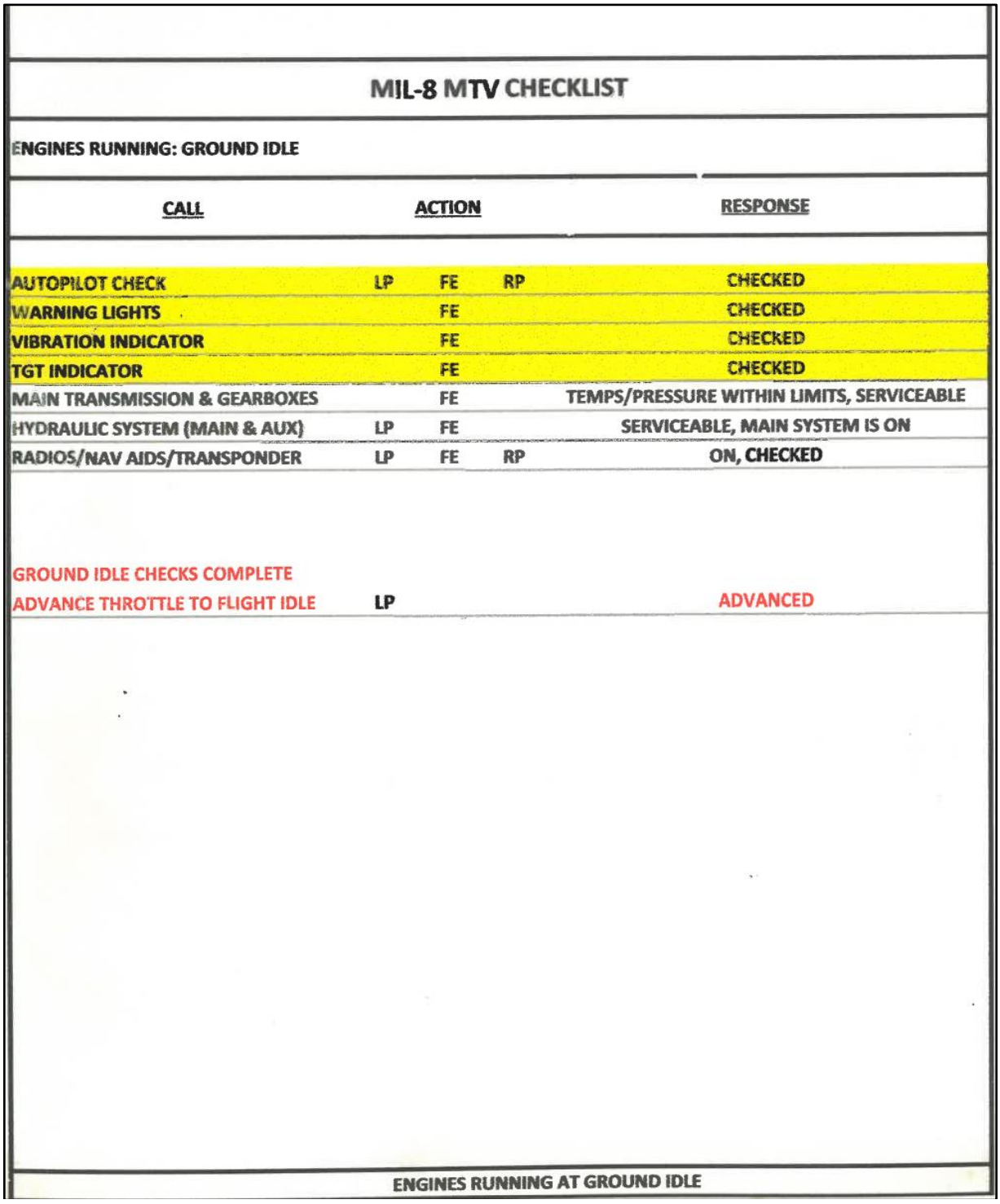
STARTING: FIRST ENGINE

CALL		ACTION		RESPONSE
NOTE: IF ANY PARAMETER IN "CHECK" IS EXCEEDED, FE TO ABORT THE START BY CLOSING FUEL SHUT OFF LEVER				
APU PRESSURE		FE		NORMAL
ENGINE START SELECTOR		FE		SELECT TO START OR CRANK OR FALSE START
ENGINE SELECTOR		FE		ONE OR TWO
START BUTTON		FE		STARTING (PRESS FOR 2 - 3 sec)
STOPWATCH		FE		START
CHECK:	AUTO	FE		ON (GREEN LIGHT)
	STARTER	FE		ON (GREEN LIGHT)
	FUEL SHUT OFF LEVER	FE		OPEN (AT 5% N1)
	APU TGT	FE		WITHIN LIMITS (MAX 750° C)
	MAIN ROTOR	FE		BLADES TURNING
	OIL PRESSURE	FE		RISING
	TGT	FE		RISING (MAX 780° C)
	N1, NR, HYDRAULIC PRESSURE	FE		RISING
	45% - N1	FE		OIL PRESSURE ..... BAR (MIN 1 BAR)
	N1, NR, HYDRAULIC PRESSURE	FE		RISING
	STARTER LIGHT	FE		OUT @ 65 - 67%
	AUTO	FE		OUT (MAX 30 sec)
STOPWATCH		FE	CP	RESET/START
APU GENERATOR		FE		ON OR OFF
EQUIPMENT CHECK		FE		ON
CHECK:	S/E PARAMETERS	FE		N1 73 - 79%
				NR 35 - 55%
				TGT (<780°C)
FIRST ENGINE RUNNING				

5.1.6 Starting: Second engine

MIL-8 MTV CHECKLIST				
STARTING: SECOND ENGINE				
CALL			ACTION	RESPONSE
NOTE: IF ANY PARAMETER IN "CHECK" IS EXCEEDED, FE TO ABORT THE START BY CLOSING FUEL SHUT OFF LEVER				
EQUIPMENT CHECK			FE	OFF
APU GENERATOR			FE	OFF
ENGINE SELECTOR			FE	ONE OR TWO
START BUTTON			FE	STARTING (PRESS FOR 2 - 3 sec)
CHECK:	AUTO		FE	ON (GREEN LIGHT)
	STARTER		FE	ON (GREEN LIGHT)
	FUEL SHUT OFF LEVER		FE	OPEN (AT 5% N1)
	APU TGT		FE	WITHIN LIMITS (MAX 750° C)
	MAIN ROTOR		FE	BLADES TURNING
	OIL PRESSURE		FE	RISING
	TGT		FE	RISING (MAX 780° C)
	N1, NR, HYDRAULIC PRESSURE		FE	RISING
	45% - N1		FE	OIL PRESSURE ..... BAR (MIN 1 BAR)
	N1, NR, HYDRAULIC PRESSURE		FE	RISING
	STARTER LIGHT		FE	OUT @ 65 - 67%
	AUTO		FE	OUT (MAX 30 sec)
APU GENERATOR			FE	ON OR OFF
EQUIPMENT CHECK			FE	ON
36 V INVERTER			FE	MANUAL
FLASHER UNIT			FE	ON
P/H INSTRUMENTS:	ARTIFICIAL HORIZON	LP	FE	CAGED
	GYRO STABILSER	LP	FE	ON
	T/R PITCH LIMITER	LP	FE	ON
ENGINE PARAMETERS:	N1	LP	FE	73 - 79%
	NR	LP	FE	45–70%
	TGT	LP	FE	<780°C
	ENGINE OIL PRESSURE	LP	FE	> 2 BAR
	ENGINE OIL TEMPERATURE	LP	FE	> 30° C
SECOND ENGINE RUNNING				

5.1.7 Engines running: Ground idle



MIL-8 MTV CHECKLIST

ENGINES RUNNING: GROUND IDLE

CALL		ACTION		RESPONSE
AUTOPILOT CHECK	LP	FE	RP	CHECKED
WARNING LIGHTS		FE		CHECKED
VIBRATION INDICATOR		FE		CHECKED
TGT INDICATOR		FE		CHECKED
MAIN TRANSMISSION & GEARBOXES		FE		TEMPS/PRESSURE WITHIN LIMITS, SERVICEABLE
HYDRAULIC SYSTEM (MAIN & AUX)	LP	FE		SERVICEABLE, MAIN SYSTEM IS ON
RADIOS/NAV AIDS/TRANSPONDER	LP	FE	RP	ON, CHECKED
GROUND IDLE CHECKS COMPLETE				
ADVANCE THROTTLE TO FLIGHT IDLE	LP			ADVANCED

ENGINES RUNNING AT GROUND IDLE

5.1.8 Engines at Flight idle

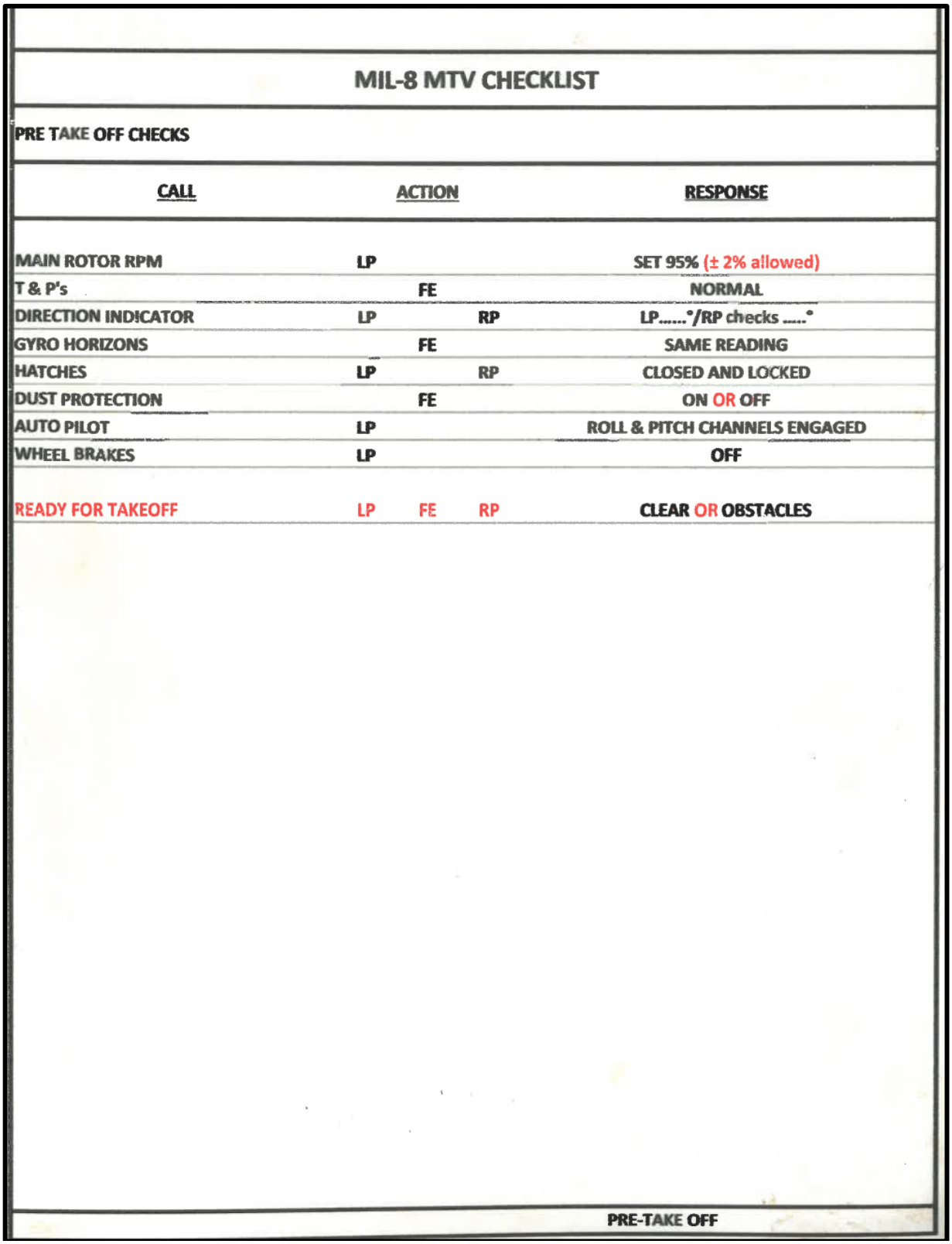
MIL-8 MTV CHECKLIST

ENGINES AT FLIGHT IDLE

CALL				ACTION / RESPONSE
EER SYSTEM	LP	FE		CHECKED
ACCELERATION TEST	LP	FE		CHECKED
GENERATORS		FE		ON
RECTIFIERS		FE		ON
115/36V INVERTERS		FE		AUTO
FUEL PUMPS		FE		ON
EQUIPMENT TEST SWITCH		FE		OFF
S/BY GENERATOR		FE		OFF
GROUND POWER UNIT	LP			DISCONNECTED
GYRO HORIZONS	LP	FE	RP	ON, READINGS NORMAL
COMPASS SYSTEM			RP	ON, CHECKED
RADIO ALTIMETR	LP			ON
ALTIMETERS	LP		RP	LP (QNH) & ....ft/RP checks (QNH) & ....ft
AUTO PILOT	LP	FE	RP	CHECKED, OFF
ROTOR BEEP RANGE	LP			CHECKED SET 95% (± 2% allowed)
T/ROTOR PITCH LIMITER		FE		ON
TEMPS AND PRESSURES	LP	FE		WITHIN LIMITS
WARNING LIGHTS	LP	FE	RP	OFF
ROTOR RPM	LP			SET 95% (± 2% allowed)
TAXI LIGHT/STROBE LIGHTS	LP			ON OR OFF
APU		FE		OFF
CLEAR FOR TAXI/TAKE OFF	LP	FE	RP	CLEAR (LEFT / FORWARD / RIGHT)

ENGINES RUNNING AT FLIGHT IDLE

5.1.9 Pre take off checks



MIL-8 MTV CHECKLIST

PRE TAKE OFF CHECKS

CALL	ACTION			RESPONSE
MAIN ROTOR RPM	LP			SET 95% (± 2% allowed)
T & P's		FE		NORMAL
DIRECTION INDICATOR	LP		RP	LP……°/RP checks ……°
GYRO HORIZONS		FE		SAME READING
HATCHES	LP		RP	CLOSED AND LOCKED
DUST PROTECTION		FE		ON OR OFF
AUTO PILOT	LP			ROLL & PITCH CHANNELS ENGAGED
WHEEL BRAKES	LP			OFF
READY FOR TAKEOFF	LP	FE	RP	CLEAR OR OBSTACLES

PRE-TAKE OFF

5.2 Appendix B: Operational performance

5.2.1 Take-off weight limitation for HOGE performance *(Flight Manual Vol 1 Figure 3.1.1)*

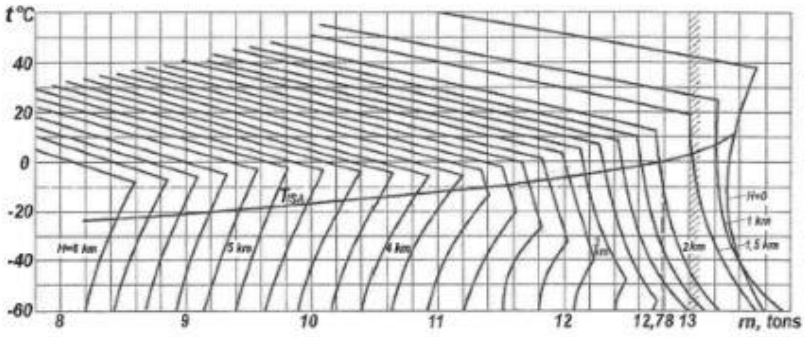


Fig. 3.1.1. Nomograph for Determining Maximum Allowable Mass (Weight) of Helicopter during Vertical Takeoff and Landing out of Ground Effect (takeoff power of engines, with dust protection device installed and switched off).If it is planned to switch on the ejector of the dust protection device at altitudes within 0 to 3 km, the takeoff mass (weight) must be reduced by 200 kg. For flight with the anti-icing system (AIS) of the engines, main and tail rotors switched on, the takeoff mass must be reduced by 1,000 kg .

5.2.2 Take-off weight limitation for HIGE performance *(Flight Manual Vol 1 Figure 3.1.3)*

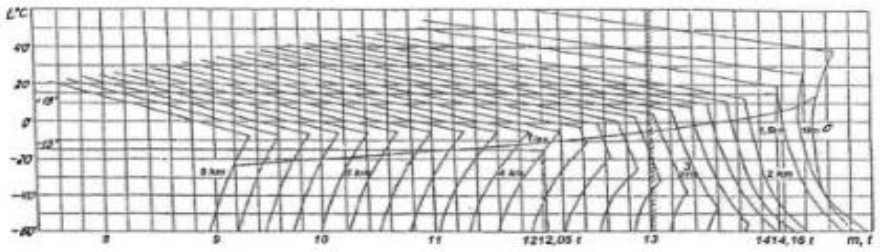


Fig. 3.1.3. Nomograph for Determining Maximum Allowable Mass (Weight) of Helicopter during Vertical Takeoff and Landing in Ground Effect (takeoff power of engines, with the dust protection device installed and switched off).

If it is planned to switch on the ejector of the dust protection device at altitudes within 0 to 3 km, the takeoff mass (weight) must be reduced by 200 kg. For flight with the anti-icing system (AIS) of the engines, main and tail rotors switched on, the takeoff mass must be reduced by 1,000 kg.

5.3 Appendix C: Operator's safety actions

5.3.1 Amended Mil-8 MTV Normal Procedures checklist *(Pre-take off/hover checks)*

MIL-8 MTV CHECKLIST

PRE TAKE OFF/HOVER CHECKS

CALL	ACTION			RESPONSE
PRE-TAKE OFF				
MAIN ROTOR RPM	LP			SET 94/95%
T's & P's		FE		NORMAL
DIRECTION INDICATOR	LP		RP	LP……°/RP checks …..°
GYRO HORIZONS		FE		SAME READING
HATCHES	LP		RP	CLOSED AND LOCKED
DUST PROTECTION		FE		ON OR OFF
AUTO PILOT	LP			ROLL & PITCH CHANNELS ENGAGED
WHEEL BRAKES	LP			OFF
HOVER CHECK				
CONTROLS & C of G		PF		VERIFY
ENGINE PARAMETERS		PM		…..%
MAIN ROTOR RPM		PM/FE		93% (MINIMUM)
EXTERNAL LOAD		PF/FE		ATTACHED OR NONE ATTACHED
READY FOR TAKE-OFF	LP	FE	RP	CLEAR OR OBSTACLES

PRE-TAKE OFF/HOVER