



Havarikommisjonen

Accident Investigation Board Denmark

Bulletin 2023-502



Accident to OY-HFS (Robinson R44 Clipper II) 0.9 nm east-southeast of Kolding/Vamdrup (EKVD) on 4-10-2023

ISSUED AUGUST 2024

INTRODUCTION

This bulletin reflects the opinion of the Danish Accident Investigation Board regarding the circumstances of the occurrence and its causes and consequences.

In accordance with the provisions of EU Regulation 996/2010, the Danish Air Navigation Act and pursuant to Annex 13 of the International Civil Aviation Convention, the safety investigation is of an exclusively technical and operational nature, and its objective is not the assignment of blame or liability.

The safety investigation was carried out without having necessarily used legal evidence procedures and with no other basic aim than preventing future accidents and serious incidents.

Consequently, any use of this bulletin for purposes other than preventing future accidents and serious incidents may lead to erroneous or misleading interpretations.

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GENERAL

State file number: 2023-502
UTC date: 4-10-2023
UTC time: 08:42
Occurrence class: Accident
Location: 0.9 Nautical Miles (NM) east-southeast of Kolding/Vamdrup (EKVD)
Injury level: None
Aircraft registration: OY-HFS
Aircraft make/model: Robinson Helicopter Company R44 Clipper II
Current flight rules: Visual Flight Rules (VFR)
Operation type: Private
Flight phase: Approach
Aircraft category: Helicopter
Last departure point: Private Airfield near Varde
Planned destination: EKVD
Aircraft damage: Substantial
Engine make/model: 1 x Lycoming IO540-AE1A5

SYNOPSIS

Notification

All time references in this bulletin are Coordinated Universal Time (UTC).

The Aviation Unit of the Danish Accident Investigation Board (AIB) was notified of the accident by the Kolding/Vamdrup (EKVD) Aerodrome Flight Information Service (AFIS) operator on 4-10-2023 at 09:00 hours (hrs).

The AIB notified the United States (US) National Transportation Safety Board (NTSB), the European Aviation Safety Agency (EASA), the Directorate-General for Mobility and Transport (DG MOVE) and the Danish Civil Aviation and Railway Authority (DCARA) on 4-10-2023 at 18:25 hrs.

Summary

En route close to Holsted, the helicopter engine and rotor Revolutions Per Minute (RPM) dropped below 70%. The pilot managed to recover from the situation and continued the flight.

During approach to EKVD, the helicopter engine and rotor RPMs increased to 120%. The pilot did not attempt to recover from the high RPM situation. The pilot performed an autorotation. The ground contact was hard, and the helicopter crashed in a field.

The safety investigation did not identify the cause of neither the low engine RPM state nor the high engine RPM state.

Preventative measures to mitigate engine RPM runaways, in the form of emergency procedures and a safety alert, were available at the time of the accident.

The accident occurred in daylight and under Visual Meteorological Conditions (VMC).

FACTUAL INFORMATION

History of flight

The flight was a private VFR-flight from a private helipad near the city of Varde to Kolding/Vamdrup (EKVD).

The pilot performed a pre-flight check and start-up checks (including governor check) without remarks and departed.

Approximately 10 minutes after departure, close to the city of Holsted, the pilot experienced a drop in engine and rotor RPMs (just below 70%).

The pilot declared an emergency (Mayday) to Esbjerg Information but managed to recover the engine and rotor RPMs. The governor controller/Engine Monitoring Unit (EMU) reactivated (above 80% engine RPM), and automatic engine RPM governing functioned normally. The pilot cancelled the emergency to Esbjerg Information and continued the flight to EKVD.

During the Left Hand (LH) approach to runway 25 at EKVD, after turning towards the final leg, the pilot experienced engine and rotor RPM increasing to 120%.

The pilot did not attempt to recover from the high RPM situation. The pilot initiated an autorotation and declared an emergency (Mayday) to Vamdrup Information. The landing in a field with low vegetation was hard, and the helicopter sustained substantial damage.

The pilot informed Vamdrup Information that he was uninjured. The Aerodrome Flight Information Service (AFIS) operator initiated the emergency response plan and contacted the rescue services.

Injuries to persons

Injuries	Crew	Passengers	Others
Fatal			
Serious			
None	1		

Damage to aircraft

The helicopter sustained substantial damage to the following parts:

- The landing gear skid was bent.
- The firewall/bulkhead.
- The main rotor blades.
- The tail boom.



Figure 1. Damage to the helicopter (the AIB has removed logos on the helicopter)

Other damage

None.

Personnel information

License and medical certificate

The pilot - male, 53 years - was the holder of a valid Private Pilot License (Helicopter) (PPL (H)) issued by DCARA on 24-5-2022.

The latest Proficiency Check (PC) was completed on 20-4-2023, and the rating R44 was valid until 31-5-2024.

The medical certificate (class 2) was valid until 27-1-2024.

Flying experience

	Last 24 hours	Last 90 days	Total
All types	0:45	7:30	132:35
This type	0:45	7:30	132:35
Landings this type	1	15	282

The AIB obtained the pilot's training records from the completed PPL (H) training in 2022, the latest PC and consulted the responsible instructor from the flight school. Nothing indicated the pilot experiencing problems associated to training of governor failures or other engine or rotor RPM control problems.

Aircraft informationGeneral information

Manufacturer:	Robinson Helicopter Company
Type:	R44 Clipper II
Serial number:	14473
Airworthiness review certificate:	Valid until 5-11-2023
Engine manufacturer:	Lycoming
Engine type:	IO-540-AE1A5
Maximum gross mass:	2,500 pounds (lb) (1,134 kilogram (kg))
Fuel on board (Main/Aux tank):	50 litres (l) / 10 l
Helicopter total Flight Hours (FH) (Collective activated):	355.61
Latest maintenance:	20-9-2023 at 354.61 FH (100 FH/Annual inspection & EMU replacement)

On 20-9-2023, the EMU was replaced, to the latest version (part number D270-1, revision F) in accordance with R44 service bulletin SB-114, to provide enhanced moisture protection. The helicopter had accumulated one flight after EMU replacement prior to the accident flight.

RPM sensor wiring shielding issues in combination with Electro Magnetic Interference (EMI) had previously contributed to engine RPM control issues on the helicopter type. On 8-3-2022, the RPM sensor wiring on OY-HFS was modified with improve wiring shielding by completion of SB-111 to ensure compliance with Airworthiness directive US-2022-12-08.

Governor failure emergency procedure

The helicopter Pilot Operating Handbook (POH) Emergency procedures page 3-7 described the following for handling of governor failures:

If engine RPM governor malfunctions, grip throttle firmly to override the governor, then switch governor off. Complete flight using manual throttle control.

To inform pilots about potential engine RPM governor failures, the helicopter manufacturer published a safety alert on 4-2-2022. See [appendix 1](#).

Throttle and RPM control

With reference to the R44 Pilot Operating Handbook (POH) and the R44 Maintenance Manual (MM), the AIB prepared the following system description:

Collective operation was conventional.

A twist grip throttle control was located on each collective stick. The throttle controls were interconnected and actuated the throttle valve through a mechanical linkage. The engine throttle was also correlated to collective inputs through a mechanical linkage. When the collective was raised, the throttle moved towards open, and when the collective was lowered, the throttle moved towards closed.

The electronic governor maintained the engine RPM by sensing changes and applying corrective throttle inputs through a friction clutch, which could be easily overridden by the

pilot. Manual manipulation of the twist grip was not typically required except during start up, shut down, autorotation practice and emergencies.

The governor could be switched on or off using the toggle switch on the end of the right side collective. When switched on, the governor was active from 80% to 112% engine RPM. Below 80% and above 112% engine RPM, the governor would take no action.

When operating in the active range, the governor would attempt to maintain engine RPM at approximately $102\% \pm 0.5\%$.

Later aircraft were equipped with an EMU, which was a digital recording device within the engine RPM governor control box. The EMU continuously monitored and recorded engine and rotor parameters.

EMU status was indicated by the EMU segment on the annunciator panel when the annunciator test button was pressed. Steady illumination of the annunciator meant normal EMU operation. A slow-flashing indication (once every two seconds) or no illumination meant there was a fault in the EMU's senders or circuitry. A fast-flashing indication (four times per second) was given if the EMU had detected an exceedance.

Illustration of the throttle and governor installation. See [appendix 2](#).

A low-RPM warning horn sounded when the rotor RPM was below 97%. A high RPM warble tone sounded when the rotor RPM approached 108%.

Meteorological information

Terminal Aerodrome Forecast (TAF)

TAF EKVD 040655Z 0406/0415 26015KT 9999 SCT020 TEMPO 0406/0409
SCT020CB TEMPO 0409/0415 26016G26KT SHRA BKN015CB=

TAF EKEB 040505Z 0406/0415 29012KT 9999 SCT020 TEMPO 0406/0415
28015G25KT SHRA SCT020CB=

Aviation Routine Weather Report (METAR)

METAR EKVD 040750Z 26013KT 9999 FEW030 14/09 Q1017=

METAR EKVD 040850Z 26014KT 9999 FEW030 15/09 Q1017=

METAR EKEB 040820Z AUTO 26018KT 9999 SCT035/// 15/09 Q1017=

METAR EKEB 040850Z AUTO 26018KT 9999 FEW035/// 15/10 Q1017=

Communication

The pilot communicated with Esbjerg Information (120.150 megahertz (MHz)) and Vamdrup Information (118.650 MHz).

The AIB obtained a copy of the audio recordings. The recordings were of good quality and useful to the investigation.

Aerodrome information

General information EKVD

Aerodrome Reference Point:	55 26 10.62N 009 19 51.36E
Elevation:	141 feet (ft)
Runway directions:	01/19, 07/25
Runway dimensions (Runway 25)	704 meters (m) x 23 m
Runway surface (Runway 25):	Grass

Flight recorders

Governor controller/Engine Monitoring Unit (EMU)

The helicopter was fitted with an electronic governor controller, which also functioned as an EMU. A maintenance facility downloaded the flight data file from the EMU and the AIB electronically sent the data file to the NTSB and the helicopter manufacturer. The EMU logged an exceedance report with a maximum recorded engine RPM of 127.6%.

The helicopter manufacturer decoded the data, and the AIB received a copy of the decoded data in a spreadsheet. The data were of good quality and useful to the investigation.

The EMU recorded the following parameters:

- Time stamp (from an internal clock).
- Engine RPM.
- Rotor RPM.
- Governor switch position (on/off).
- Ambient pressure.
- Manifold pressure (MAP).
- Oil temperature.
- Cylinder head temperature (CHT).

The EMU recorded data at a resolution of 1 Hertz (Hz) during normal operation. When the EMU detected certain exceedance events (RPM overspeed or high CHT or oil temperature), the EMU increased the recording resolution to 15 Hz on all parameters starting 30 seconds prior to the exceedance event.

The AIB and the helicopter manufacturer analysed the EMU data. The helicopter manufacturer concluded that the RPM sensor system had functioned normally. Past problems with EMI in combination with insufficient shielding of RPM sensor signal (corrected by R44 SB-111) had been evident as scatter on the recorded engine RPM signal. No scatter was present on the recorded data from OY-HFS.

As the collective position, throttle input and governor output were not recorded in the data, the helicopter manufacturer was unable to isolate the cause of the RPM runaways to neither pilot nor EMU/governor manipulation of engine throttle position.

Automatic Dependent Surveillance-Broadcast (ADS-B) data

The helicopter was fitted with an ADS-B transponder. The AIB obtained a copy of the recorded ADS-B flight data from the Danish Air Navigation Service Provider (ANSP). The ADS-B data were of good quality and useful to the investigation.

The ANSP recorded ADS-B data at a resolution of 0.5 Hz. The ADS-B data contained the following parameters:

- GNSS (Global Navigation Satellite System) timestamp.
- GNSS position.
- GNSS altitude (25 ft resolution).
- Barometric altitude (25 ft resolution).
- Ground speed.
- Heading.
- Transponder (squawk) code.

Tablet data

The pilot used a tablet with navigation software during the flight. The navigation software recorded the flight at a resolution of 1 Hz. The navigation software recorded the following parameters:

- GNSS timestamp.
- GNSS position.
- GNSS altitude.

The AIB processed the GNSS data to obtain ground speed and bearing.

The AIB compared the tablet navigation software data to the ADS-B data. The ADS-B and tablet data showed good correlation.

Data plots

The AIB synchronized the EMU data to the tablet and ADS-B data (based on peak altitude) and combined the data to produce the following plots:

Low RPM event flight track plots. See [appendix 3](#).

Low RPM event data plot. See [appendix 4](#).

High RPM events flight track plot. See [appendix 5](#).

High RPM events data plot. See [appendix 6](#).

On the flight track plots, tablet data is red, ADS-B data is white and timestamps are yellow. Data between 08:39:00 hrs and 08:40:20 hrs showed no abnormalities and was removed from the high RPM data plot ([appendix 6](#)) for clarity.

The governor switch was activated during the pre-flight run-up and remained on for the duration of the flight.

Fire

There was no fire.

Survival aspects

The pilot used the installed lap belt and shoulder harness, and suffered no physical injuries during the accident.

Tests and research

The on-site technical investigation of the collective and throttle control system did not identify any deficiencies. All linkages were in good working condition.

Throttle overtravel spring force was checked within limit, and governor friction clutch was also found in proper working condition. The governor motor was powered and moved without binding.

The AIB obtained access to the EMU compartment. The compartment was found completely dry. The EMU data was downloaded, and the EMU was removed and shipped to the helicopter manufacturer. The scope of the EMU testing was agreed between the AIB, the helicopter manufacturer and the NTSB. The NTSB supervised all testing of the EMU.

The helicopter manufacturer conducted a bench test (according Acceptance Testing Procedures (ATP)) of the EMU. The EMU passed the bench test.

The helicopter manufacturer installed the EMU in a test helicopter (with additional recording capabilities). The EMU was subjected to a 40-minute ground test and exposed to Electro Magnetic Interference (EMI). The EMU was not affected by the EMI, and the test was unable to replicate the fault scenario.

The helicopter manufacturer subjected the EMU to a one-hour flight test which included hover operations, throttle manipulation while in a hover, climbs, descents and cruise including inflight throttle manipulations. The EMU performed engine control functions normally, and the RPM exceedance scenarios could not be replicated.

Additional bench testing (outside the scope of the ATP tests) was completed on the EMU without being able to replicate the fault. The purpose of the test was also to investigate correlation between governor input voltage and governor operation. The correlation was found to be insignificant and unusable for analysis.

The EMU was disassembled and inspected. No faults were evident on the Printed Circuit Board (PCB) of the EMU.

Additional information

Pilot interview

The AIB conducted several interviews with the pilot. Nothing during the interviews indicated that the pilot had unintentionally manipulated the throttle handle.

The pilot acknowledged not properly identifying RPM governing issues and applying the corrective actions according to the emergency procedures. The pilot normally considered RPM governing issues to be associated to low RPM conditions, as this had been the basis of the PPL (H) flight training.

The pilot was not aware of the safety alert ([appendix 1](#)) issued by the helicopter manufacturer.

ANALYSIS

General

The pilot was the holder of a valid PPL (H).

The helicopter was airworthy prior to the flight.

The weather conditions were good and largely as predicted and are not considered a factor in the sequence of events.

Technical investigation

Substantial technical investigations and testing of the governor/EMU by the helicopter manufacturer did not result in replication of the RPM failure scenario. Neither testing nor inspections revealed any faults on the installed governor controller/EMU.

Inspection of the EMU compartment shortly after the accident, found the compartment and EMU very dry. Furthermore, enhanced moisture protection in the newly installed modified EMU should have prevented moisture from entering the EMU. The AIB considers EMU problems associated to moisture as unlikely.

Throttle and collective control system examinations revealed no faults.

The AIB did not identify a technical reason for the RPM exceedances during the safety investigation.

Data analysis

EMI on the engine RPM sensor wiring was ruled out during the helicopter manufacturer's EMU data analysis. Past problems with engine RPM sensor wiring shielding would have been evident as scatter on the engine RPM signal. There was no scatter in the data from OY-HFS. Furthermore, the engine RPM sensor wire shielding was previously improved by completion of SB-111.

Combined data from the three independent sources (EMU, ADS-B and tablet data) was insufficient to conclude either an EMU malfunction or pilot inputs (overriding governor function) as the causal factor of the RPM runaways.

An EMU governor motor output voltage recording parameter would likely have allowed to identify or exclude an EMU failure.

Despite not being able to identify the cause of initiation of the RPM under- and overspeed, the data allowed for analysis of the pilot handling during the events.

Pilot handling during engine RPM underspeed

The RPM underspeed event ([appendix 3](#) and [appendix 4](#)) lasted for about 20 seconds and the main rotor RPMs were below 70%. Despite low weight of the helicopter, this was very close to a catastrophic (unrecoverable) main rotor stall (which can occur below 80% rotor RPM).

A proper response to the low rotor RPMs, according to the POH, would be to lower the collective and open the throttle with the grip handle. The manifold pressure remained low for about 10 seconds. It seems likely that the pilot eventually managed to open the throttle to recover the RPMs before the governor resumed automatic control (above 80%). The pilot did not select the governor switch to off during this sequence.

Pilot handling during engine RPM overspeed

Data ([appendix 5](#) and [appendix 6](#)) indicated that a minor overspeed (below 108%) occurred during the LH base turn to runway 25 (over the city of Ødis). The RPM governing was resumed and remained normal for about 100 seconds until the major RPM overspeed event occurred after turning final to runway 25.

The major overspeed initiated at approximately 120% RPM. The pilot apparently did not attempt to control the RPMs (by switching governor off and closing the throttle) but immediately initiated a descent/autorotation. During the late part of the descent (at approximately 500 ft), the throttle/manifold pressure was reduced, and the engine RPMs went below 110%. Shortly after (6-7 seconds at 08:41:00 hrs and 350 ft) the throttle was increased and RPMs exceeded 125%. This sequence repeated once more just before impact.

Adherence to procedures

The pilot handling during the flight was not in accordance with the procedures published by the helicopter manufacturer. These required deactivating the governor (by the switch on the collective handle) and controlling the RPMs manually.

The AIB considers the emergency procedures for governor failure described in the POH and the safety alert ([appendix 1](#)) information as clear and unambiguous.

The pilot was not aware of the referenced safety alert. The AIB considers being familiar with published safety information (safety alerts) in combination with effective and continuous training of emergency procedures, such as governor failure and autorotation, as effective safety barriers.

However, the AIB also acknowledges that training of actual RPM runaway scenarios are limited to very benign scenarios to avoid damage to hardware. The scenarios might therefore not be fully representative of actual emergency situations.

CONCLUSIONS

Summary

En route close to Holsted, the helicopter engine and rotor Revolutions Per Minute (RPM) dropped below 70%. The pilot managed to recover from the situation and continued the flight.

During approach to EKVD, the helicopter engine and rotor RPMs increased to 120%. The pilot did not attempt to recover from the high RPM situation. The pilot performed an autorotation. The ground contact was hard, and the helicopter crashed in a field.

The safety investigation did not identify the cause of neither the low engine RPM state nor the high engine RPM state.

Preventative measures to mitigate engine RPM runaways, in the form of emergency procedures and a safety alert, were available at the time of the accident.

APPENDIX 1 R22/R44 SAFETY ALERT

Return to [procedures](#), [pilot interview](#) or [adherence to procedures](#)

**ROBINSON
HELICOPTER COMPANY**

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R22-Series and R44-Series SAFETY ALERT

Issued: 04 February 2022

PILOT MONITORING OF ENGINE GOVERNOR

Recently, there have been occurrences where governor malfunction was not recognized by the pilot in time to prevent an overspeed or an unsafe low RPM condition.

The governor has been extremely reliable to the point that some pilots trust it without guarding against malfunction. Malfunctions can and do occur on any aircraft system and pilots need to consciously monitor system operation.

For the governor:

1. Monitor governor operation during flight by keeping hand lightly on throttle twist grip. If twist grip rotation becomes erratic or stops altogether, governor may be malfunctioning. If twist grip rotates steadily open or closed, override promptly to prevent RPM excursion.

NOTE

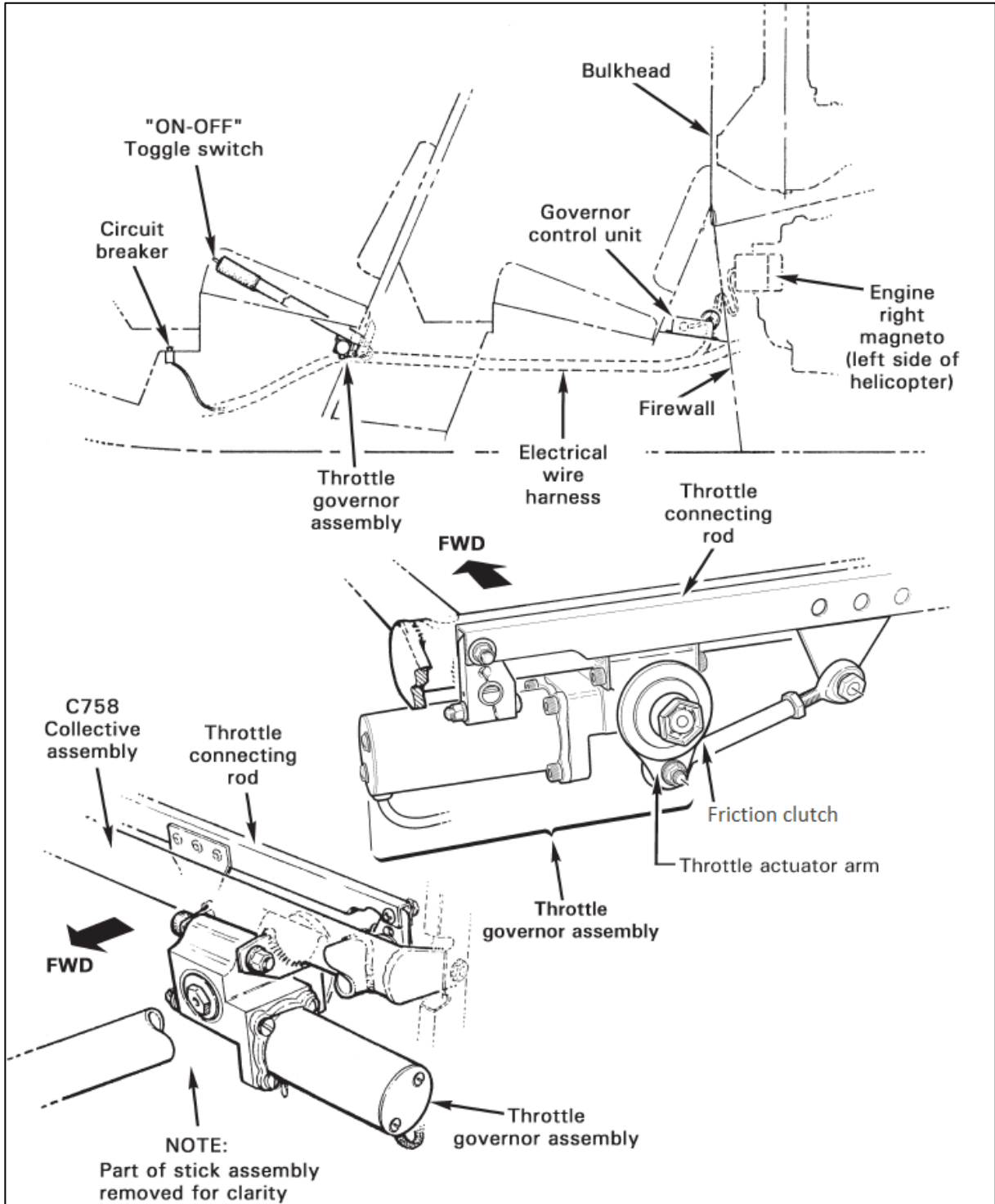
Do not unintentionally override governor by squeezing throttle twist grip too tightly during normal operation.

2. If a governor malfunction is suspected, switch governor off and assume manual RPM control using twist grip.

APPENDIX 2 R44 THROTTLE AND COLLECTIVE CONTROL SYSTEM

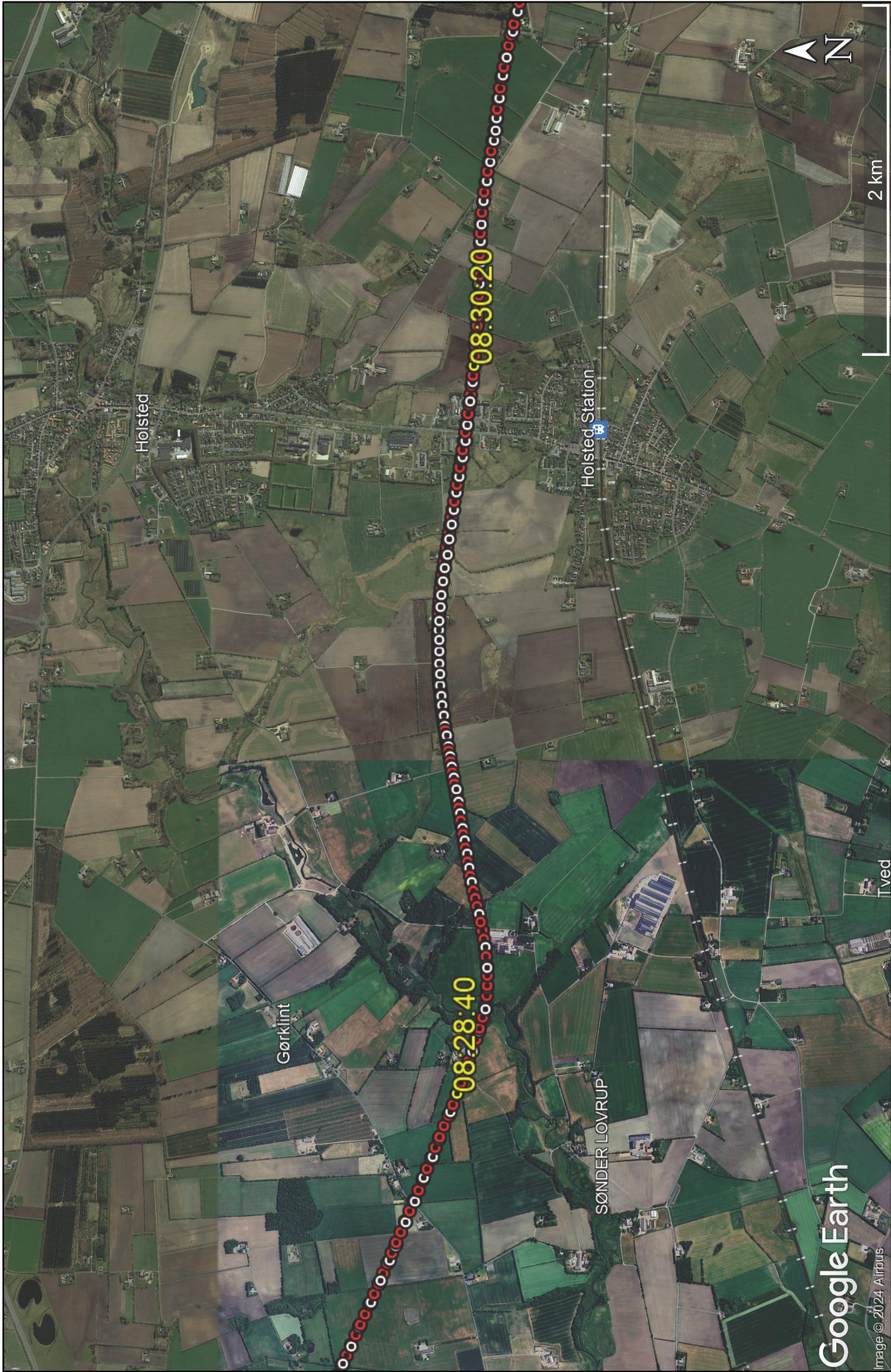
Return to [throttle and RPM control](#)

Appendix 2 R44
Throttle and Collective
control system



APPENDIX 3 FLIGHT TRACK PLOT RPM UNDERSPEED EVENT

Return to [data plots](#) or [pilot handling during RPM underspeed event](#)

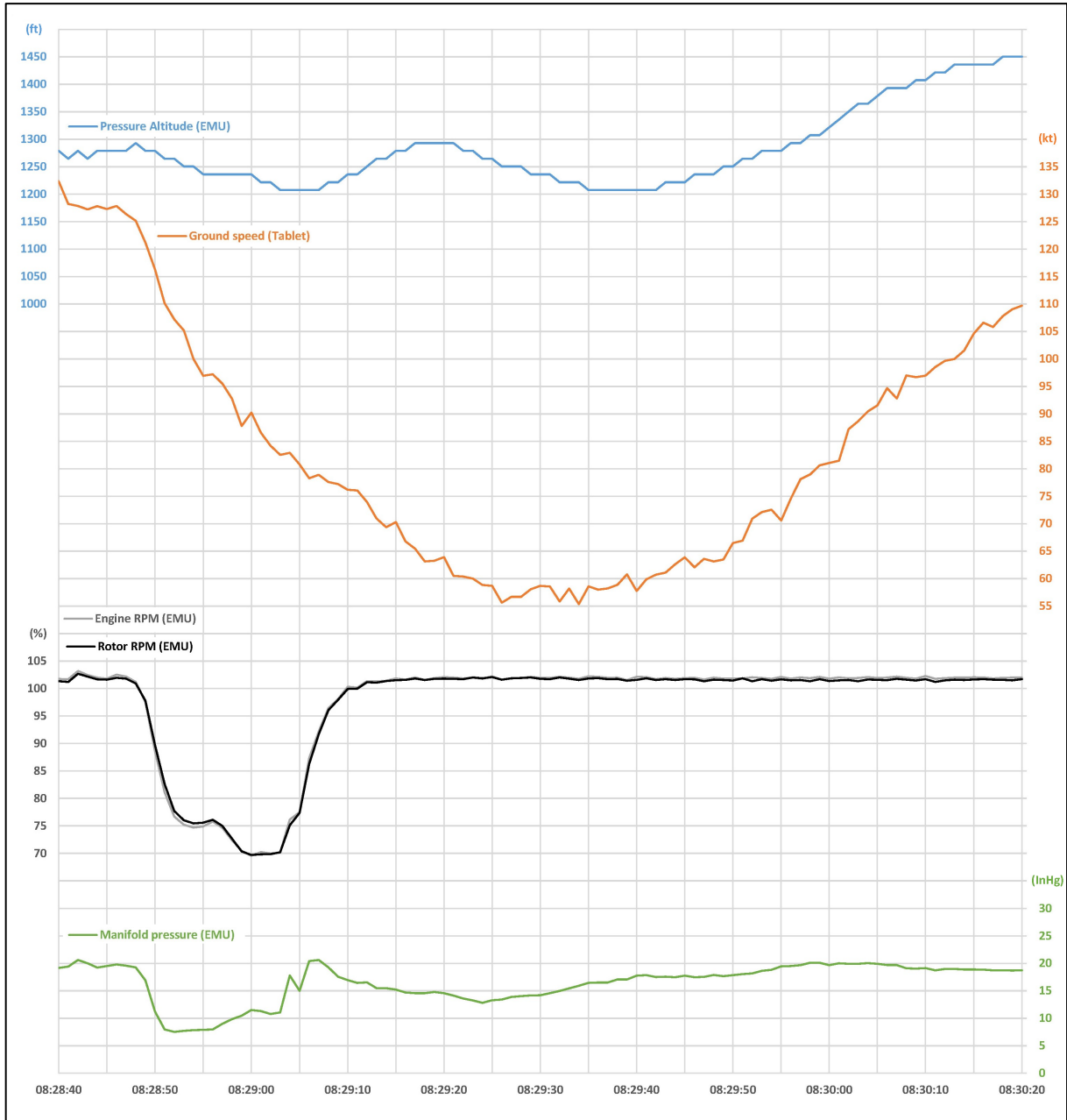


Appendix 3 Flight track plot RPM underspeed event

APPENDIX 4 DATA PLOT RPM UNDERSPEED EVENT

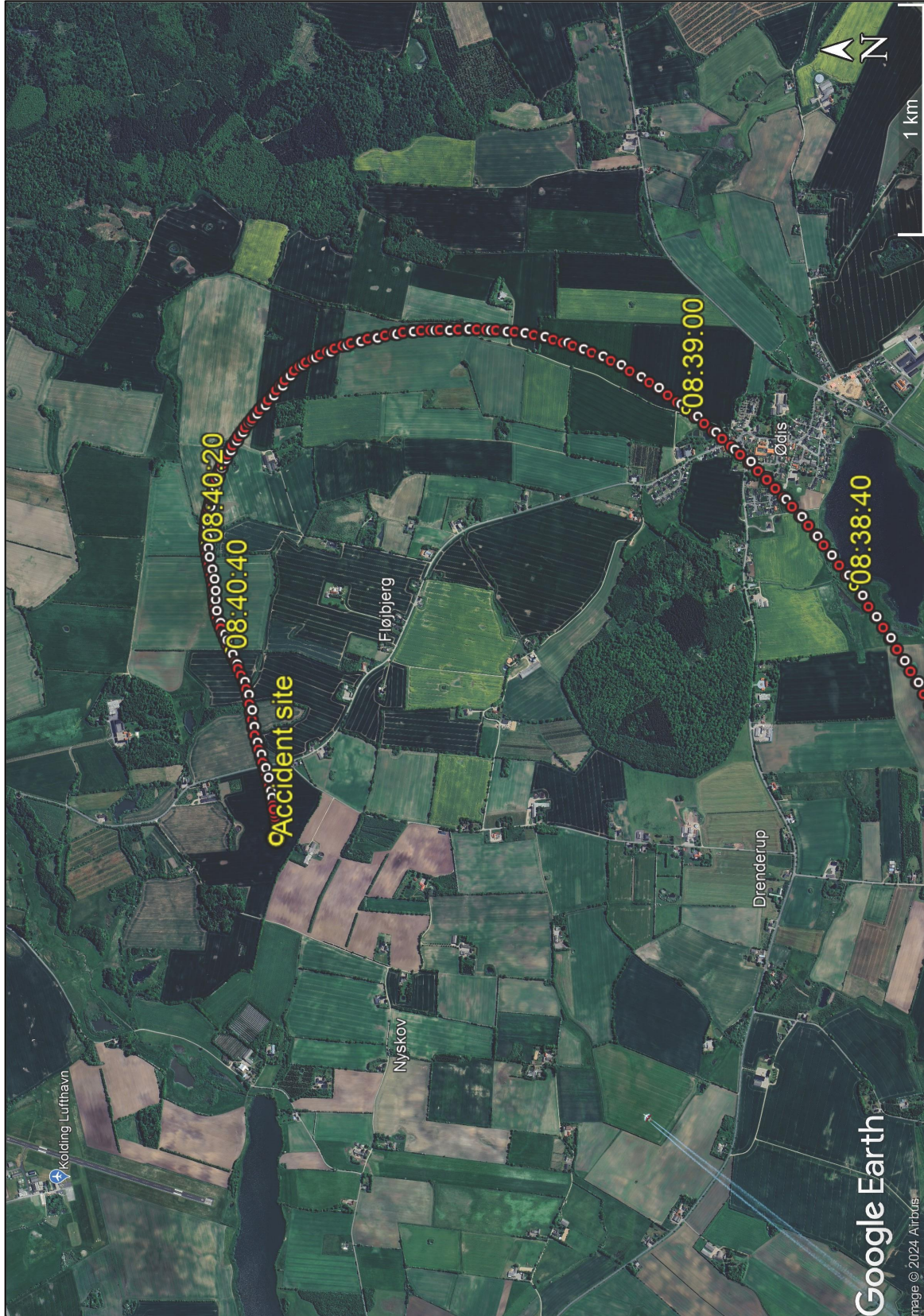
Return to [data plots](#) or [pilot handling during RPM underspeed event](#)

Appendix 4 Data plot
RPM underspeed event



APPENDIX 5 FLIGHT TRACK PLOT RPM OVERSPEED EVENT

Return to [data plots](#) or [pilot handling during engine RPM overspeed](#)



Appendix 5 Flight track plot RPM overspeed event

APPENDIX 6 DATA PLOT RPM OVERSPEED EVENT

Return to [data plots](#) or [pilot handling during engine RPM overspeed](#)

Appendix 6 Data plot
RPM overspeed event

