

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



ERA22FA387

ONBOARD IMAGE RECORDER

Specialist's Factual Report

April 24, 2024

TABLE OF CONTENTS

A. ACCIDENT.....	3
B. ONBOARD IMAGE RECORDER SPECIALIST	3
C. DETAILS OF THE INVESTIGATION	3
1.0 DEVICE DESCRIPTION	3
2.0 DEVICE CONDITION	3
3.0 DEVICE RECORDING DESCRIPTION.....	3
4.0 VIDEO FILE INFORMATION	4
4.1 Video Timing	4
D. VIDEO SUMMARY	4
E. SOUND SPECTRUM STUDY.....	6
F. GPS DATA SUMMARY	8

A. ACCIDENT

Location: Emily, Minnesota
Date: August 28, 2022
Time: About 17:34 central daylight time (CDT)
Airplane: Sea and Sky Krucker Cygnet, private, N505DB

B. ONBOARD IMAGE RECORDER SPECIALIST

Specialist Kyle Garner
Sr. Aerospace Engineer – Recorder Specialist
National Transportation Safety Board (NTSB)

C. DETAILS OF THE INVESTIGATION

An onboard image recorder group was not convened.

The NTSB Vehicle Recorder Division received the following device:

Device Manufacturer/Model:	GoPro HERO7
Device Serial Number:	C3301124904178
microSD card:	64GB SanDisk Extreme

1.0 Device Description

The GoPro HERO7 is a compact digital camera designed for capturing video and photos in extreme environments. The camera can record up to 4K video at 60 frames per second, as well as lower-quality recording resolutions at higher frame rates. The camera can also capture still images at a resolution of up to 12 megapixels.

The camera features built-in GPS and Wi-Fi capabilities. Data are saved to an internal microSD card.

2.0 Device Condition

The GoPro HERO7 arrived at the laboratory in good condition with no visible exterior damage. A 64GB microSD card was found intact and seated securely in the memory card slot.

3.0 Device Recording Description

The microSD card from the GoPro HERO7 was successfully imaged and searched forensically for traces of corrupted and unplayable video files. In total, the

microSD card contained 3 photos, in JPEG format, and 45 videos, in LRV¹ and MP4 format.

4.0 Video File Information

All videos and photos contained on the microSD card were reviewed, and a video containing the accident flight departure and impact was identified.

The accident flight video was recorded at a resolution of 3840x2160 pixels and a frame rate of 30 frames per second. An audio track was also recorded from the camera's internal microphone, however, the audio from the occupant's boom microphones was not recorded. The camera was mounted on the airplane's right wing strut, was pointed toward the fuselage of the aircraft, and included a view of both occupants, the engine, and the propeller.

4.1 Video Timing

The video files contained embedded accelerometer and GPS data, including a GPS-synchronized timestamp in coordinated universal time (UTC). The timestamp in UTC was converted to local time, CDT, by subtracting 5 hours. All time referenced in the video summary is CDT. The offset to local time, CDT, is shown below:

$$\text{Video local time, CDT} = \text{video elapsed time} + 17:29:23.685$$

D. VIDEO SUMMARY

In agreement with the Investigator-in-Charge, a summary report was prepared.

The occupants were wearing headsets with boom microphones, however, their dialogue was not audible on the recording because of the ambient engine and wind noise.

The recording began at approximately 17:29:24 CDT and lasted 8 minutes and 51 seconds. When the video began, the airplane was stationary in the water at Minnie Lake in Emily, Minnesota.

Two occupants were visible. The person in the front seat was the pilot flying (PF) and the person in the rear seat was the passenger. The passenger was holding a section of PVC pipe that was to be used to aerially distribute ashes from a recently deceased individual, which remained in his possession for the duration of the flight. The pilot and passenger were wearing a two-point lap seat belt. The passenger was wearing an automatic inflatable life vest. The weather conditions at the time

¹ LRV = low-resolution video format = a video file format used by GoPro for video previews.

appeared clear with no restrictions on visibility and the water on Minnie Lake was calm.

At 17:29:54, the pilot started the engine. The engine started and sounded nominal. The pilot started to water taxi toward the north to the departure point at the northeast corner of Minnie Lake.

At 17:32:56, the airplane reached the northeast corner of Minnie Lake. The pilot made a 180-degree turn and the airplane was now oriented for a departure to the south. As the airplane moved south on the lake, the pilot gestured with his right hand to the passenger in the direction of the takeoff.

At 17:33:22, the engine throttled up and the airplane began to accelerate.² As the airplane gained airspeed, the pilot pushed the control bar to the full forward position.

At 17:33:38, the pilot pulled the control bar toward him, and the airplane became airborne.³ The airplane began to slowly gain altitude over the lake.

At 17:33:55, the airplane was nearing the southern edge of Minnie Lake and was no longer gaining altitude. The pilot was moving the control bar in a counterclockwise direction forward, left, back, and right.

At 17:34:03, the airplane crossed over the southern edge of Minnie Lake and was at an altitude just above the top of the trees. The airplane continued in a southerly direction but was not gaining altitude. The pilot was moving the control bar forward and backward abruptly.

At 17:34:09, the pilot continued to make abrupt control bar inputs as the airplane started to descend and enter a shallow left bank.

At 17:34:12, the left wing clipped the top of a tree, and the airplane entered a left downward spiral.

At 17:34:15, the airplane impacted the tree canopy. The camera continued recording. No further sound from the occupants was noted.

At 17:38:15, the recording ended.

² The airplane started its takeoff roll at latitude 46.7782196 deg, longitude -94.0087132 deg.

³ The airplane became airborne at latitude 46.7766132 deg, longitude -94.0095833 deg. The length of the takeoff roll was approximately 623 feet.

E. SOUND SPECTRUM STUDY

A sound spectrum study was performed on the accident flight audio recovered from the GoPro HERO7 to determine the operating speed of the aircraft's engine before the accident.

The aircraft was equipped with a Rotax 912UL engine, outfitted with a 3-bladed propeller. According to documentation by the engine manufacturer, the engine was rated for a take-off performance of 5,800 RPM and a max continuous performance of 5,500 RPM⁴. Additionally, the engine had a propeller speed reduction gearbox installed with a reduction ratio of 2.27:1.

A three-dimensional spectrogram was generated, as shown in Figure 1, from the audio extracted from the video file from 17:29:30 to 17:34:30. The x-axis represents time in CDT and the y-axis represents sound frequency in Hertz (Hz). The color represents sound intensity, with blue being the lowest intensity sound and red being the highest intensity.

The noise generated by the propeller for this type of engine configuration is generally the strongest at the fundamental blade passage frequency (BPF)⁵. By measuring the BPF from the spectrogram, the RPM of the propeller can be determined using the expression below:

$$RPM_{prop} = BPF \left[\frac{blades}{sec} \right] \times \frac{1}{3} \left[\frac{rev}{blades} \right] \times 60 \left[\frac{sec}{min} \right] \quad (\text{eqn. 1})$$

Next, the relationship between the RPM of the propeller, the RPM of the engine, and the propeller speed reduction gearbox ratio for this engine is shown below:

$$RPM_{engine} = RPM_{prop} \times 2.27 \quad (\text{eqn. 2})$$

The results of the computation of the engine RPM during the taxi and takeoff sequence are provided in Table 1.

Table 1. Computation of engine RPM from accident flight audio.

Time (CDT)	Measured BPF (Hz)	Calculated Engine RPM (RPM)	Phase of accident flight
17:29:55	52	2361	Engine start
17:29:57	63	2860	
17:30:01	67	3042	

⁴ Rotax Engine Type 912 Series Operating Manual, OM-912, rev. 01/01/2023.

⁵ Smith, M. (1989). "Aircraft Noise." Cambridge University Press.

Time (CDT)	Measured BPF (Hz)	Calculated Engine RPM (RPM)	Phase of accident flight
17:30:06	70	3178	Taxi to northeast corner of Minnie Lake
17:30:10	69	3133	
17:30:15	73	3314	
17:30:20	78	3541	
17:30:23	68	3087	
17:30:29	67	3042	
17:30:34	68	3087	
17:30:39	68	3087	
17:30:43	67	3042	
17:30:48	68	3087	
17:30:54	68	3087	
17:31:00	68	3087	
17:31:07	68	3087	
17:31:13	67	3042	
17:31:18	68	3087	
17:31:26	67	3042	
17:31:37	68	3087	
17:31:43	70	3178	Taxi to northeast corner of Minnie Lake
17:31:47	66	2996	
17:31:52	60	2724	
17:31:59	71	3223	
17:32:03	71	3223	
17:32:07	71	3223	
17:32:12	71	3223	
17:32:18	71	3223	
17:32:22	71	3223	
17:32:28	75	3405	
17:32:35	75	3405	
17:32:40	78	3541	
17:32:46	66	2996	
17:32:53	69	3133	
17:33:03	70	3178	180-degree turn for departure to the south
17:33:14	71	3223	
17:33:20	71	3223	
17:33:22	90	4086	Takeoff roll
17:33:23	119	5403	
17:33:25	119	5403	
17:33:28	121	5493	
17:33:31	121	5493	
17:33:35	121	5493	
17:33:38	123	5584	Airborne
17:33:42	123	5584	
17:33:45	121	5493	
17:33:48	121	5493	
17:33:52	121	5493	
17:33:55	123	5584	
17:33:58	123	5584	
17:34:02	122	5539	
17:34:06	122	5539	

Time (CDT)	Measured BPF (Hz)	Calculated Engine RPM (RPM)	Phase of accident flight
17:34:10	121	5493	
17:34:15	112	5085	Impact with trees

The calculated engine RPM during the accident flight's takeoff roll and through the airplane's impact with trees appeared to be consistent with the engine operating at or near its published maximum continuous power setting.

The microSD card also contained video and audio of a previous flight takeoff. Metadata in the video file indicated the previous flight was on October 23, 2021, however, this date could not be independently verified. The previous flight was flown by the same pilot as the accident flight, however, there was no passenger. A similar analysis was performed on the audio from the previous flight takeoff, and it was determined that the calculated engine RPM from the previous flight takeoff appeared to also be consistent with the engine operating at or near its published maximum continuous power setting.

F. GPS DATA SUMMARY

The GoPro HERO7 video contained embedded GPS data including latitude, longitude, and GPS altitude. Figure 2 is a Google Earth overlay of the embedded GPS data extracted from the accident flight video. The weather and lighting conditions shown in the Google Earth overlay are not necessarily representative of the conditions at the time of the accident.

The data used to generate Figure 2 are provided in comma-separated values (CSV) format as Attachment 1 to this report.

Submitted by:

Kyle Garner
Sr. Aerospace Engineer – Recorder Specialist

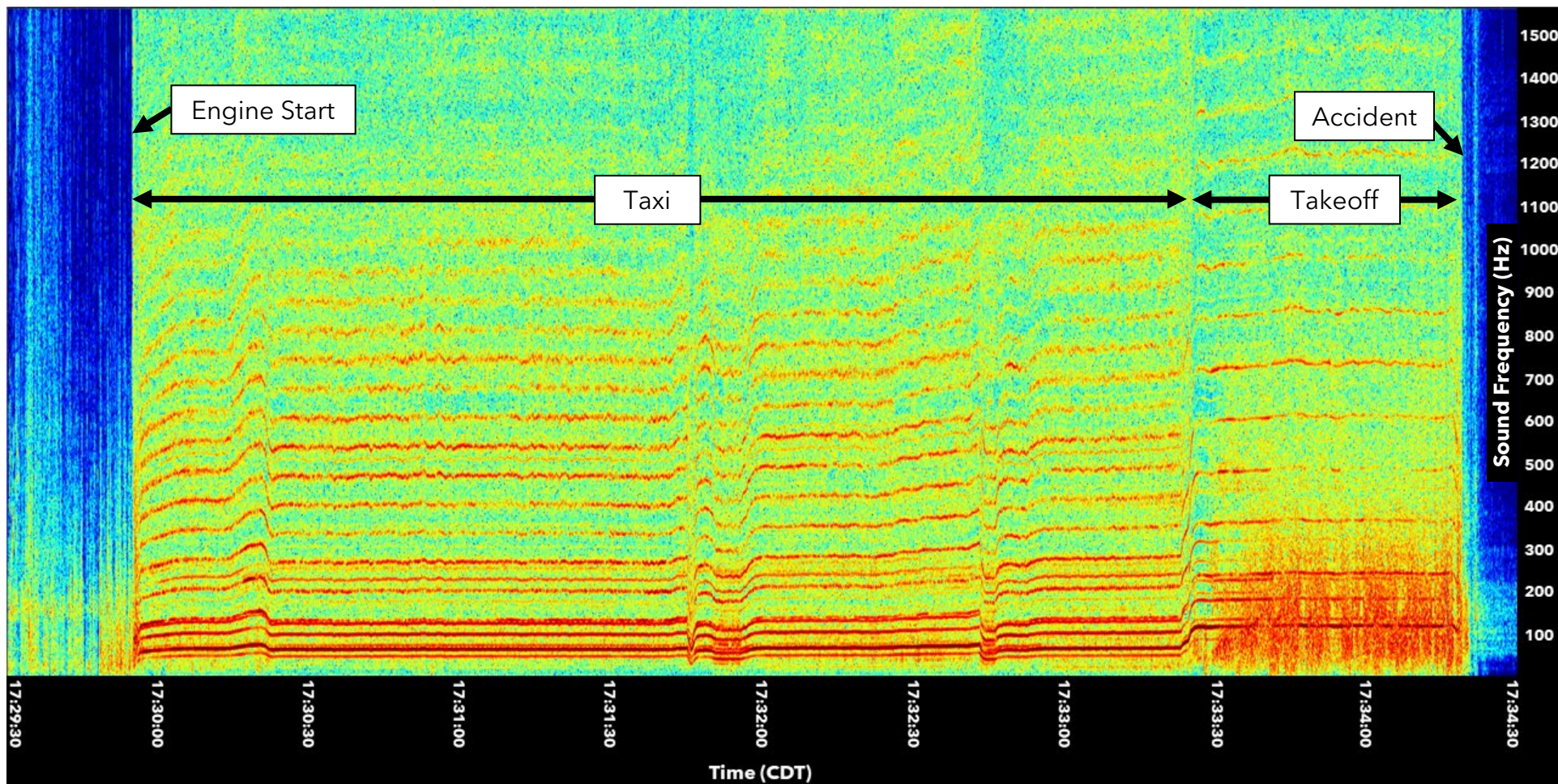


Figure 1. 3D spectrogram of audio - 17:29:30 to 17:34:30 CDT.

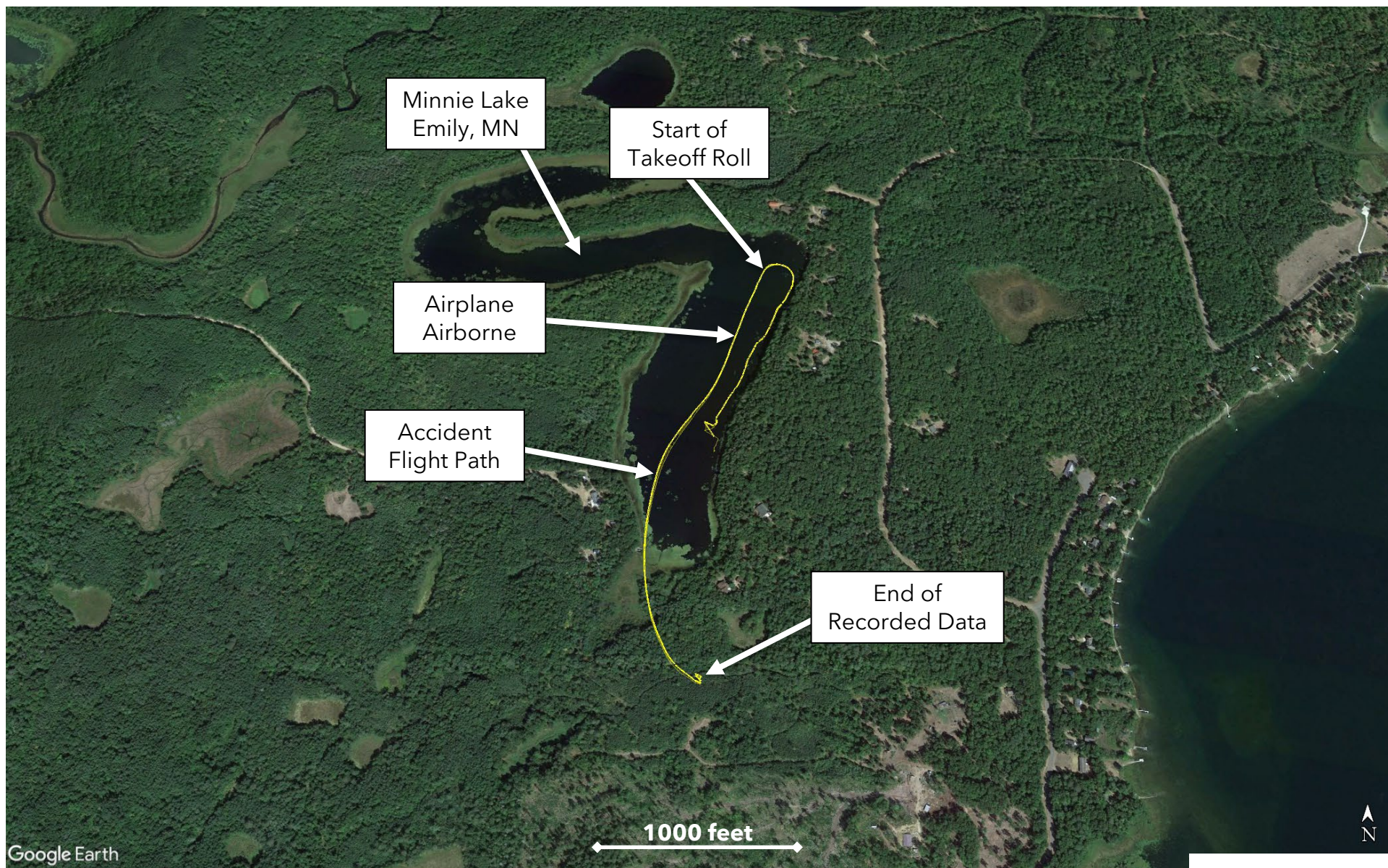


Figure 2. Overview of GPS data recovered from GoPro HERO7 for the accident flight.