

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Washington, D.C. 20594

December 3, 2018

Video Study

**NTSB Case Number:
ANC18FA055**

A. ACCIDENT

Location: Willow, Alaska
Date: July 18, 2018
Time: 1900 Alaska Daylight Time
Aircraft: De Havilland DHC-2 (Beaver)

B. AUTHOR

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NTSB

C. ACCIDENT SUMMARY

On July 18, 2018, about 1900 Alaska daylight time, a float-equipped De Havilland DHC-2 (Beaver) airplane, N9878R, impacted tree-covered terrain following a loss of control during the initial climb from the Willow Seaplane Base, Willow, Alaska. Of the three people on board, the airline transport pilot died at the scene and the two passengers received serious injuries. The airplane was destroyed by a postcrash fire. The airplane was registered to Laughlin Acquisitions, LLC and operated by Alaska Skyways, Inc., dba Regal Air, as a Title 14 Code of Federal Regulations Part 135 visual flight rules on-demand passenger flight. Visual meteorological conditions prevailed and company flight following procedures were in effect. The accident flight originated from the Willow Seaplane Base about 1900 and was destined for a remote, unnamed lake about 61 miles northwest of Willow.

D. DETAILS OF INVESTIGATION

The goal of this study was estimating the speed, the altitude, the engine speed and the flap position of the airplane based on a video. The video was recorded by a security camera installed on a porch door of a residential building, facing the back yard. The speed and the altitude of the airplane were estimated based on the visual information

in the video file. The engine speed was estimated based on the audio information in the video file.

Estimating Airplane Speed and Altitude

The video was recorded with a Nest Cam Outdoor security camera. It had 1280x720 resolution and an average frame rate of 14.2 fps. The frame rate was not constant. The video duration was about 303 seconds during which most frames were spaced by 0.0667 seconds, corresponding to a frame rate of 15 fps. However, a significant number of frame spacings were 0.0333 seconds or 0.1333 seconds, corresponding to frame rates of 30 fps and 7.5 fps, respectively.

Parts of the accident airplane were visible in the video between video times 111.5 seconds and 114.1 seconds. The left float entered the field of view at time 111.5 seconds. The tail was still visible at time 113.2 seconds just before it disappeared behind trees. At time 114.1 seconds, the tail was seen for the last time when it reappeared in a gap between tree branches. Only between time 112.3 seconds and time 112.9 seconds were most of the fuselage and at least one wing visible in the video.



Figure 1. Segment from a Video Frame that Shows the Airplane

Figure 1 shows a 480x200 pixel segment from a video frame that shows the accident airplane. That video frame was recorded at time 112.5 seconds. When the airplane was visible in the video, it was approximately in front of the camera and was moving approximately parallel to the image plane of the camera. This simplified the speed estimation because the known total length of the DHC-2 floatplane, 32.75 feet, could be used for estimating its flown distance between video frames. Since the time between video frames was known because the frame times were known, speed could be estimated by dividing a flown distance by the time it took to fly that distance. The speed was estimated between several pairs of video frames and the estimated speed was 56 ± 3 knots.

The known length of the DHC-2 was also used for estimating its altitude. When it appeared first in the video, its altitude was about 115 feet above the crash location. It impacted the ground 3.5 seconds later. During these 3.5 seconds, the airplane had a large and increasing left-wing-down bank angle. This bank angle, visible in Figure 1, indicates that the airplane was in a left turn when it was recorded by the camera. It is estimated that the bank angle was about 25° at time 112.5 seconds, corresponding to Figure 1, and was increasing rapidly. At time 114.1 seconds, the bank angle was close to 90° .

Airplane Flap Position

The airplane had a large left-wing-down bank angle and the camera was looking from the left. Consequently, the video recorded only views of the top side of the wings. The resolution of the video was not sufficiently high to allow estimation of the position of the flaps based on such views.

Estimating Airplane Engine Speed

The video included an audio channel that was sampled at 16 kHz. It was used for estimating the engine speed via spectral analysis of the sound. Figure 2 shows the sound intensity signal during a 20 second period. The dotted red line indicates the time of ground impact, at 115.0 seconds. Based on the figure, it was assumed that the airplane was closest to the camera between time 110 seconds and time 112 seconds, when the sound intensity was highest.

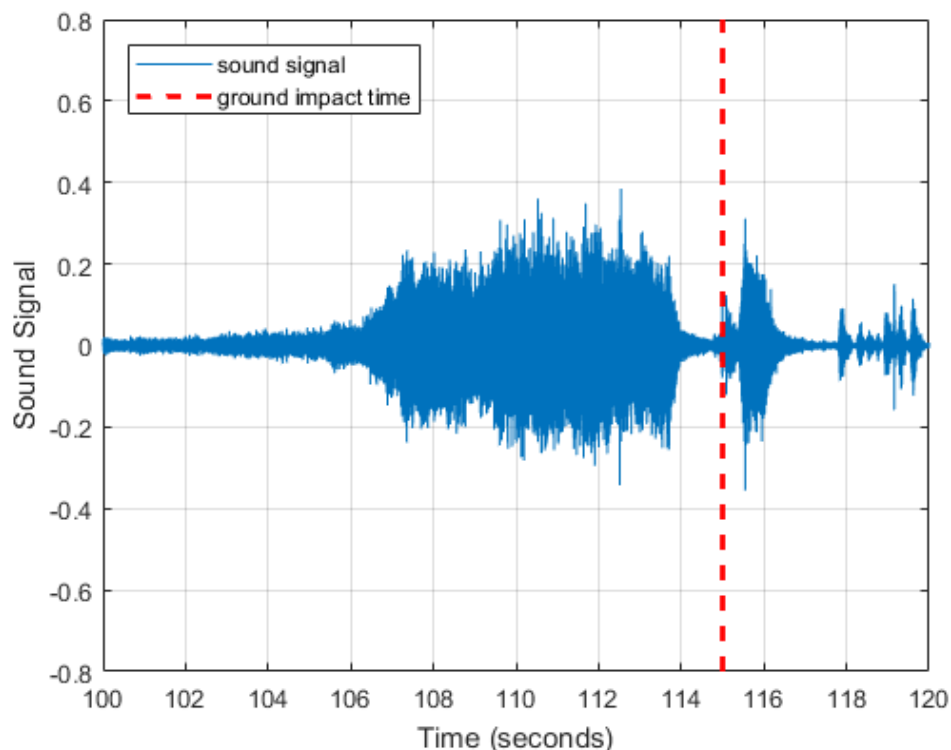


Figure 2. Sound Signal Recorded by the Camera Microphone

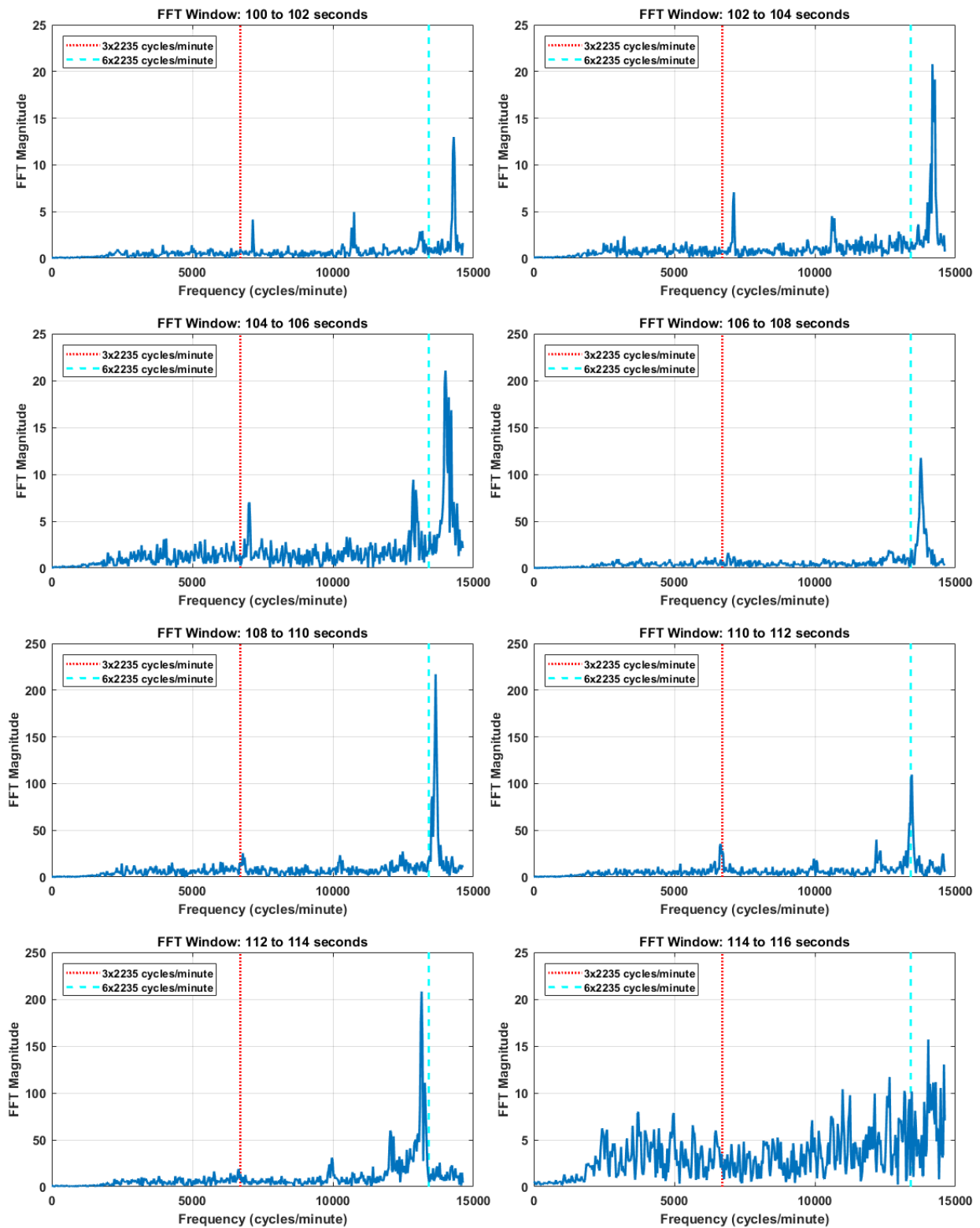


Figure 3. Airplane Propeller Sound Spectrum Plots

The spectrum was computed with a 32,768-point FFT (Fast Fourier Transform) algorithm. Figure 3 shows eight spectra, each computed over a two-seconds long signal segment. Since there was no FFT averaging or segment overlap, the eight segments cover $8 \times 2 = 16$ seconds of signal, from video time 100 seconds to video time 116 seconds.

The airplane approached the camera from the right and was last seen in the video moving left of the camera, toward the ground impact location. This resulted in a Doppler frequency shift of the recorded sound. As the airplane was approaching the camera, the recorded frequency was higher than the sound frequency generated by the propeller. As the airplane was moving away from the camera, the recorded frequency was lower than the sound frequency generated by the propeller.

Since it was assumed above that the airplane was closest to the camera between time 110 seconds and time 112 seconds, the Doppler frequency shift should be close to zero in that time interval. This fact was used for estimating the RPM of the engine. Since the propeller had three blades, the expected dominant spectral peak was at three times the engine RPM. The second harmonic, at about six times the engine RPM, turned out to have higher energy content than the first harmonic and was also used for engine speed estimation.

There are two vertical lines superimposed on each spectrum plot in Figure 3. The dotted red line is at frequency $3 \times 2235 = 6705$ cycles/minute. The broken cyan line is at $6 \times 2235 = 13,410$ cycles/minute. These two lines are at the frequencies of the first and the second harmonic peak in the spectrum plot corresponding to the time interval between 110 seconds and 112 seconds, where the Doppler shift is expected to be close to zero because the airplane was closest to the camera microphone. Therefore, the engine rotational speed is estimated to be 2235 RPM.

Figure 3 shows that before time 110 seconds, the spectral peaks are at frequencies higher than 6705 cycles/minute and 13,410 cycles/minute due to the Doppler effect. Past time 112 seconds, spectral peaks are at frequencies lower than 6705 cycles/minute and 13,410 cycles/minute. The wide frequency content of the spectrum between time 114 seconds and 116 seconds is due to the sound generated by the ground impact at time 115.0 seconds.

E. CONCLUSIONS

Video recorded by a security camera was used for estimating the speed, the altitude and the engine speed of an airplane that crashed shortly after takeoff. The speed about three seconds before ground impact was estimated as 56 ± 3 knots. The altitude at that time was about 115 feet above the crash location. The engine speed was estimated via spectrum analysis of the sound channel in the video. It was estimated as a constant 2235 RPM up to the time of ground impact. The video did not include information that could be used for estimating the position of the flaps.