

NATIONAL TRANSPORTATION SAFETY BOARD

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

September 25, 2020

Sound Spectrum Study

**NTSB Case Number:
WPR20LA258**

A. ACCIDENT

Location: Hanna, Utah
Date: August 7, 2020
Time: 1145 mountain daylight time (MDT)
Aircraft: Cessna T210M

B. AUTHOR

Dan T. Horak
NTSB

C. ACCIDENT SUMMARY

On August 7, 2020, about 1145 mountain daylight time, a Cessna T210M airplane, N761RG, was substantially damaged when it was involved in an accident near Hanna, Utah. The private pilot and one passenger were seriously injured, and four other passengers had minor injuries. The airplane was operated as a Title 14 Code of Federal Regulations Part 91 personal flight.

D. DETAILS OF INVESTIGATION

The goal of this investigation was estimating the engine speed based on the sound channel in a video recorded by an iPhone 11 Pro phone that was inside the airplane. The video lasted about 84 seconds, it had 568x320 resolution, and the sound was recorded at the rate of 44100 samples per second.

The sound channel was downsampled by a factor of two and its spectrum was analyzed with a Fast Fourier Transform (FFT) algorithm of size 32768. The processing window was 1.49 seconds wide and frequency resolution was 40 cycles/minute.

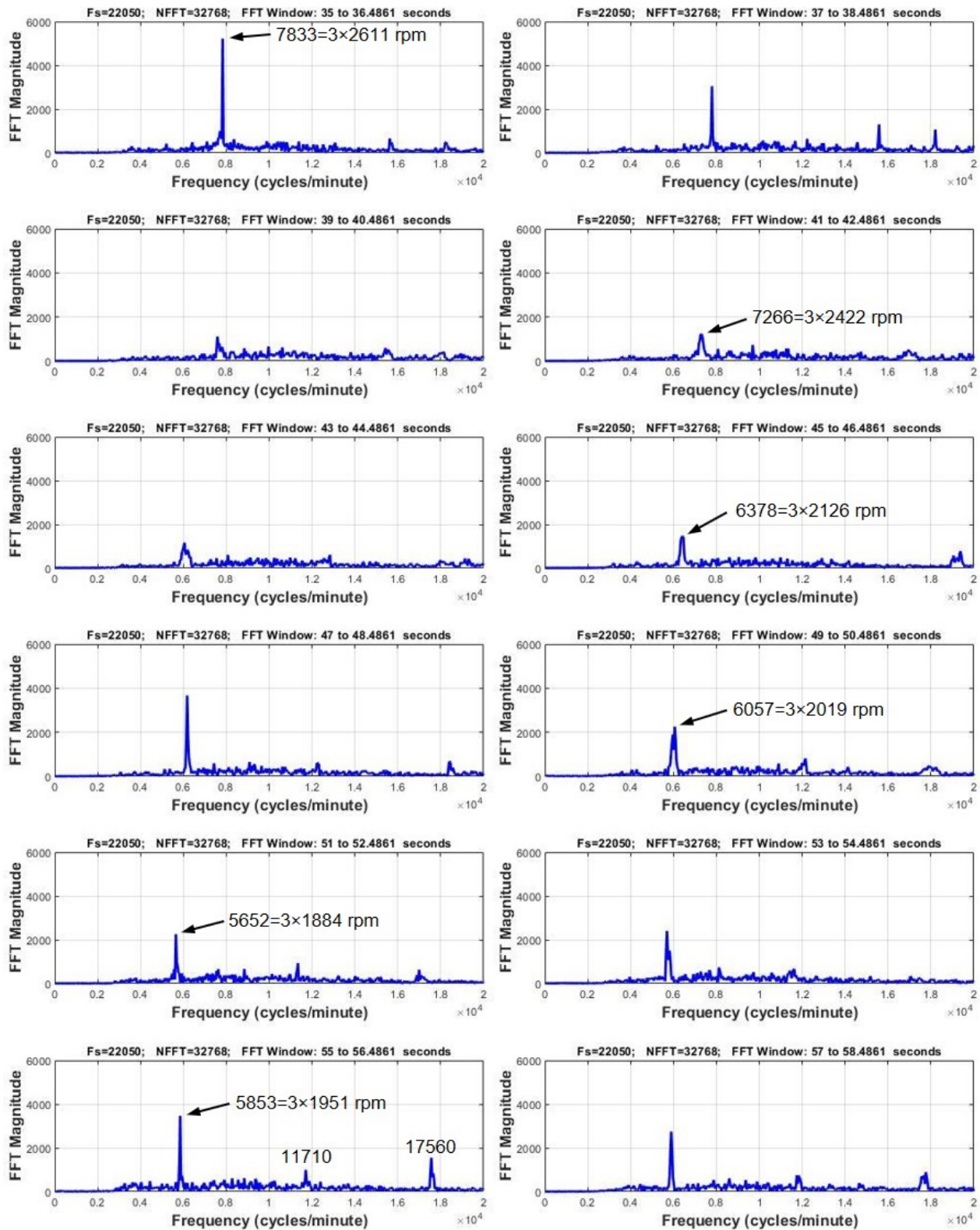


Figure 1. Sound Spectra between Time 35 seconds and Time 57 seconds

Figure 1 shows 12 spectra computed in windows that started at times 35 seconds through 57 seconds into the video, in 2-second increments. At time 35 seconds, the large spectral peak is at 7833 cpm (cycles/minute). Since the propeller had three blades, the estimated engine speed is $7833/3=2611$ rpm, close to the engine rated speed of 2700 rpm. It is possible that the recorded sound included a contribution from the sound generated inside the 6-cylinder Continental TSIO-520 engine.

Figure 1 shows that the engine speed was decreasing past time 35 seconds, going as low as 1884 rpm at time 51 seconds. Some of the spectra show small spectral peaks at the harmonics of the estimated engine speed, as marked on the spectrum starting at time 55 seconds.

The spectrum analysis that is illustrated in Figure 1 was performed for FFT analysis windows that started from video time 1 second to video time 81 seconds, in 2-second increments. The estimated engine speed is shown in Figure 2.

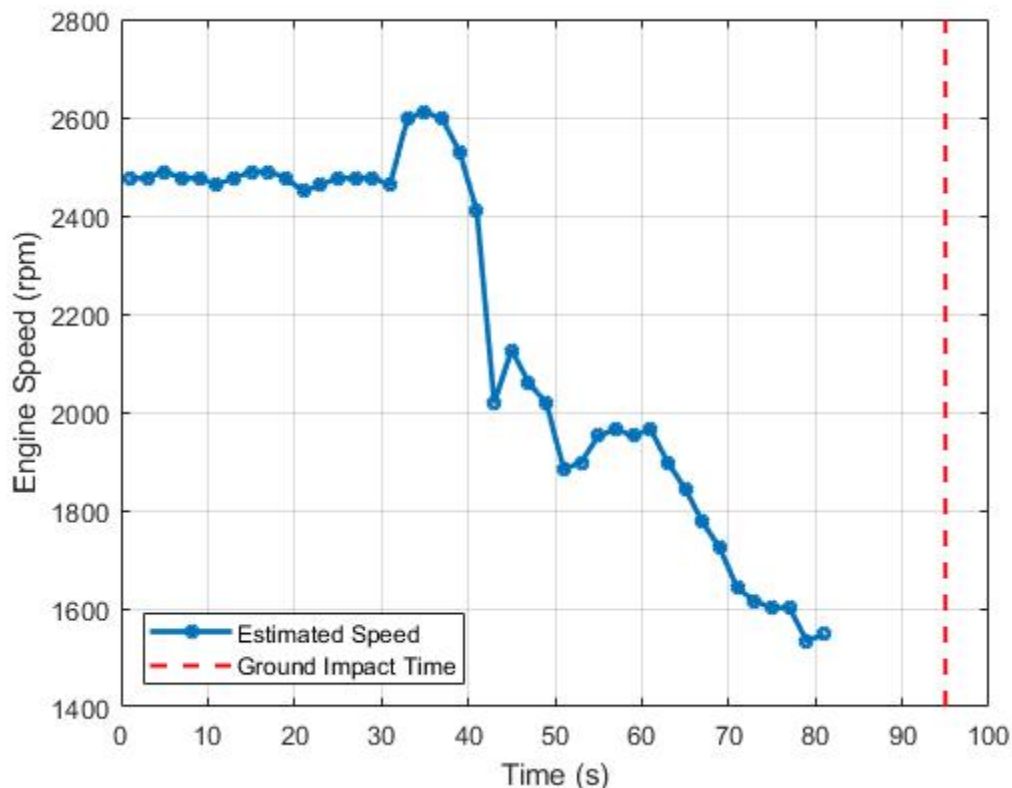


Figure 2. Estimated Engine Speed

The figure shows an approximately constant engine speed of about 2500 rpm for about 30 seconds, followed by an increase toward 2600 rpm for about 10 seconds. Between 41 seconds and 43 seconds, the speed decreased by about 400 rpm, from about 2400 rpm to about 2000 rpm. At the last time where analysis was performed, in a time window between 81 seconds and 82.49 seconds, the engine speed was down to 1550 rpm.

Both time-domain analysis and spectral analysis were performed in an attempt to determine if the engine speed decrease past time 41 seconds was due to a complete lack of combustion or if the engine continued operating but at a reduced speed. It was concluded that the information in the video sound channel is insufficient to make such determination.

E. CONCLUSIONS

The engine speed of an airplane that suffered damage during landing was estimated based on the sound channel in a video recorded by a phone in the airplane.