

National Transportation Safety Board

Office of Research and Engineering

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ATC RECORDING SOUND SPECTRUM

Specialist's Study

November 14, 2025

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A. ACCIDENT

Location: Clearwater, FL
Date: February 1, 2024
Time: 1907 eastern standard time
Airplane: Beech V35B, N6659L

B. ATC RECORDING SOUND SPECTRUM SPECIALIST

Specialist Charles Cates
Mechanical Engineer/Recorder Specialist
National Transportation Safety Board (NTSB)

C. DETAILS OF THE INVESTIGATION

The focus of this sound spectrum investigation was on identification of sounds which may be related to the operation of the engine on the Beech V35B aircraft. The aircraft was equipped with a Continental Motors, Inc. IO-520-BB horizontally opposed six-cylinder engine rated for 285 horsepower at 2700 rpm. The engine was directly driving a McCauley 3A32C76-S-M constant-speed three-bladed propeller.

The Airplane Flight Manual (AFM) recommends an engine power setting for takeoff of 2700 rpm, cruise climb of 2500 rpm, and contains cruise performance charts with engine operation at 2500, 2300, and 2100 rpm. Propeller fundamental frequency and harmonics for these speeds are given in Table 1.

Engine/Prop Speed (rpm)	2700	2500	2300	2100
Prop Fundamental Frequency (Hz)	135	125	115	105
Prop 2nd Harmonic Frequency (Hz)	270	250	230	210
Prop 3rd Harmonic Frequency (Hz)	405	375	345	315
Prop 4th Harmonic Frequency (Hz)	540	500	460	420
Prop 5th Harmonic Frequency (Hz)	675	625	575	525
Prop 6th Harmonic Frequency (Hz)	810	750	690	630
Prop 7th Harmonic Frequency (Hz)	945	875	805	735
Prop 8th Harmonic Frequency (Hz)	1080	1000	920	840
Prop 9th Harmonic Frequency (Hz)	1215	1125	1035	945

Table 1. Listing of propeller frequencies and harmonics at AFM suggested engine speeds.

The Investigator-In-Charge (IIC) provided the NTSB Vehicle Recorder Division's Audio Laboratory with files of the ATC audio communications from Tampa Arrival and Departure control positions on the night of the crash. A partial transcript of

communications between N6659L and air traffic controllers is available in this docket.¹ The ATC audio recordings were encoded at a sample rate of 8 kHz.

To determine engine RPM operation, the study focused on portions of the recording where the pilot was transmitting on the radio by holding the mic key but not speaking. (Voice signatures tend to dominate recorded ATC audio and obscure background sounds.) Three transmissions were found to have enough non-voice transmission time to isolate propeller or engine sounds. Table 2 lists the transmissions used for the study.

UTC Time	Controller Position	Communication
2347:55	East Arrival Departure	direct clearwater at five thousand five niner lima.
0005:51	West Arrival Departure	coming to Albert Whitted I can't see the other airport.
0006:15	West Arrival Departure	I'm losing engine.

Table 2. Communications used for sound spectrum study.

To isolate frequencies in the signal, a fast Fourier transform (FFT) algorithm was used on the slices of audio containing no voice data to convert the signal from the time domain to the frequency domain. A FFT size of 4096 bins was used, giving a frequency resolution of 1.95 Hz. Figures 1, 2, and 3 show the FFT during the period of non-voice transmission time of each transmission. The FFT focuses on the region of 50 Hz-2 kHz.

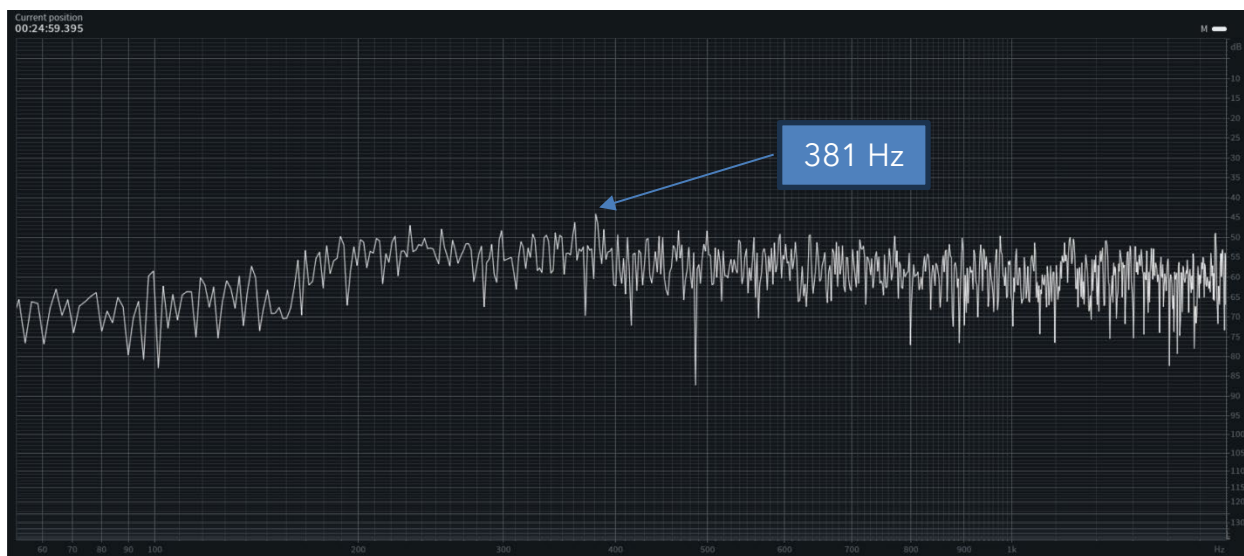


Figure 1. FFT of non-voice transmission time from transmission at 2347:55 UTC.

¹ See docket item entitled "NTSB Prepared Partial Transcription of Communications".

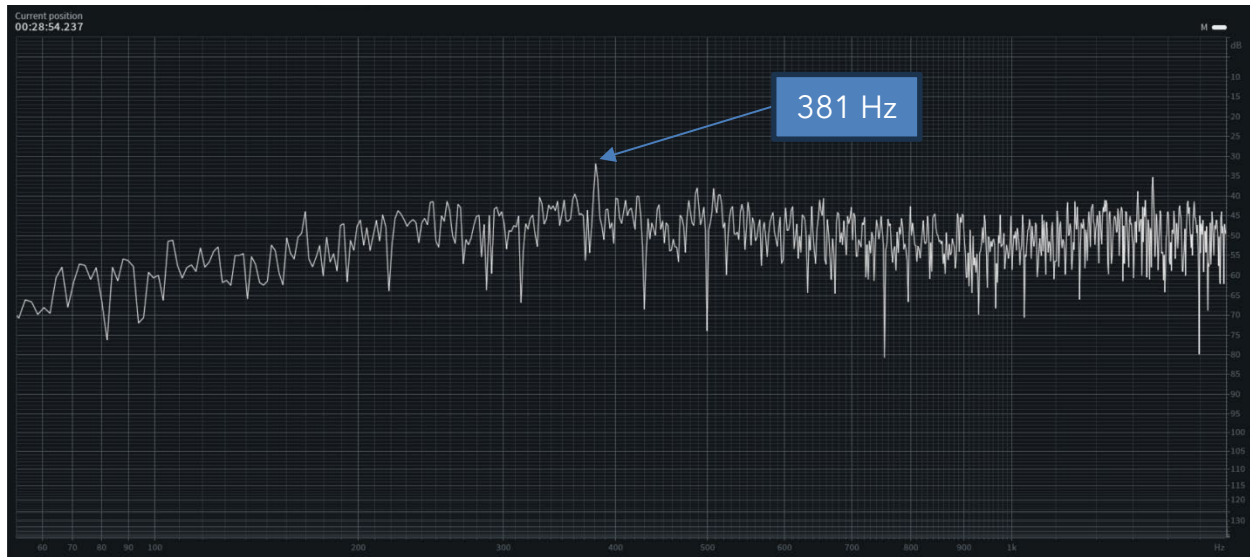


Figure 2. FFT of non-voice transmission time from transmission at 0005:51 UTC.

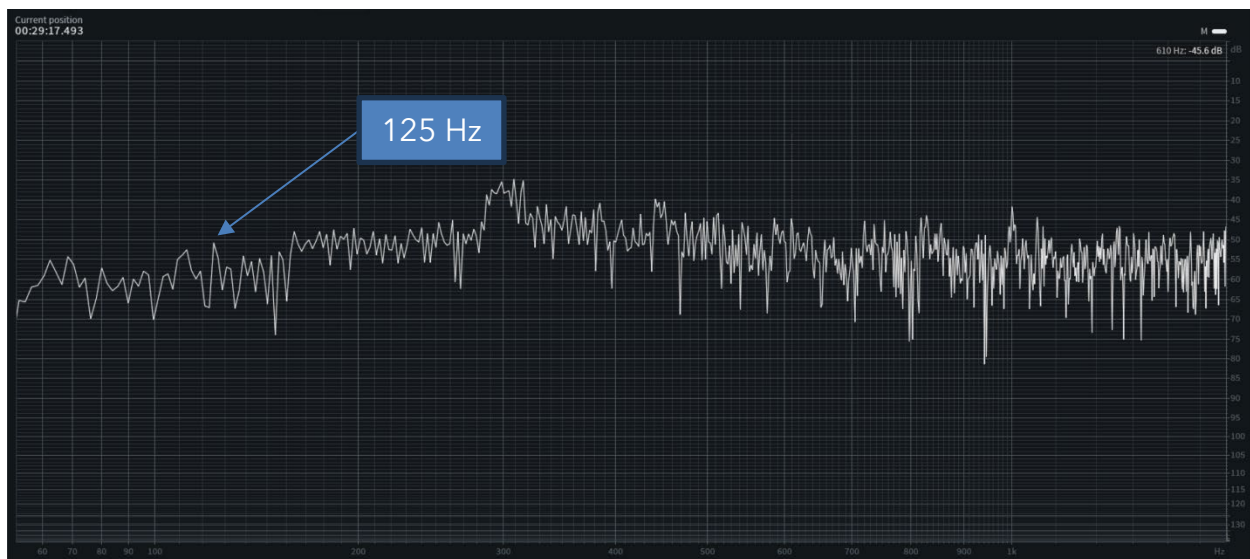


Figure 3. FFT of non-voice transmission time from transmission at 0006:15 UTC.

As a FFT is a snapshot in time of a transient signal, moving sidebands and other noise are expected features in the frequency domain. In the above figures, the fundamental tones annotated on the plots are the most consistent peaks in the transient data, and therefore are the most likely to be associated with the propeller.

Knowing the frequency and harmonic order and number of blades of the propeller allows for the calculation of propeller rpm as follows:

$$n_{prop} = \left(\frac{f / \text{harmonic order}}{n \text{ blades}} \right) \times 60$$

The FFT during the period of non-voice transmission time in figures 1 and 2 showed a peak in noise intensity at about 381 Hz. It is likely that this peak corresponds to the third harmonic of the propeller fundamental tone, thus allowing for a calculation of propeller speed of about 2540 rpm.

Figure 3 did not show a strong corresponding tone in the third harmonic range, however in the lower frequencies there was a peak in noise intensity at about 125 Hz, which likely corresponds to the propeller fundamental tone with the propeller turning at about 2,500 rpm².

Submitted by:

Charles Cates
Mechanical Engineer/Recorder Specialist

² Measured acoustic levels from a propeller have been shown to change with angle of attack, with the largest changes in the higher harmonics. See for example Ramani Mani, "The Radiation of Sound From a Propeller at Angle of Attack", NASA report number CR-4264.