NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

May 21, 2009

Sound Spectrum Study Cockpit Voice Recorder - 12

Group Chairman's Report
By James Cash

A. EVENT

Location:	Weaverville California
Date:	August 5, 2008, 1941 PDT
Aircraft:	Sikorsky S-61N, N612AZ
Operator:	Carson Helicopters, Helitanker 766
NTSB Number:	LAX08PA259

B. GROUP

A sound spectrum group was convened on August 27, 2008.

Chairman:	James Cash National Transportation Safety Board
Member:	Robert L. Drake Air Safety Investigator Federal Aviation Administration
Member:	Stuart K. Drost Lead Acoustics Engineer Sikorsky Aircraft
Member:	Steve Metheny Executive Vice-President Carson Helicopters, Inc.
Member:	John M. Harris Chief pilot Carson Helicopters, Inc.

Member: David Gridley
Flight Safety Investigator
GE Aviation

C. SUMMARY

On August 5, 2008, about 1941 Pacific daylight time, a Sikorsky S-61N helicopter, N612AZ, crashed during takeoff near Weaverville, California. The airline transport pilot and eight passengers were killed; the commercial copilot and three passengers were seriously injured. The helicopter was destroyed by impact forces and a post crash fire. The helicopter was being operated under contract to the U.S. Forest Service by Carson Helicopter Services, Inc., as a public use flight. Visual meteorological conditions prevailed at the time of the accident, and a visual flight rules flight plan had been filed.

A solid-state combination flight data (FDR) and cockpit voice (CVR) recorder was sent to the National Transportation Safety Board's Laboratory for readout. The sound spectrum group was convened on August 27, 2008 to examine the engine and rotor sounds found on the aircraft's CVR recording.

D. DETAILS OF INVESTIGATION

On August 9, 2008, the NTSB Vehicle Recorder Division's Laboratory received the following recorder:

Recorder Manufacturer/Model: **Penny & Giles MPFR**
Recorder Serial Number: **unknown**

Details of Investigation

On August 27, 2008 a sound spectrum group was convened to examine the accident aircraft's CVR recording. The 2-hour recording was examined to document significant rotor system and engine sounds that could be heard during the flights. During the 2-hour recording the aircraft made several takeoffs and landings. Specifically there were two previous successful takeoffs and one wave-off from remote landing site H44, the accident takeoff attempt from H44, three successful takeoffs from remote landing site H36 and a successful takeoff from the Trinity base helipad. All of the takeoffs from H44, including the wave-off were examined as well as all of the takeoffs from H36 and the takeoff, landing and shutdown at Trinity Base were examined and plotted.

The audio sounds recorded on the cockpit area microphone channel of the CVR (CAM) recording were digitized and examined using a software frequency analysis program to document the sounds. Sound signatures were identified on the audio recording that corresponds to the rotational frequencies of the "gas producing" N_G compressor of the engine. In addition to the N_G turbine sound signatures, several tones were identified that could be associated with the rotation of the main rotor system of the helicopter. Using conversion documentation supplied by the helicopter's manufacturer the recorded sounds were converted from the recorded frequencies to engineering units. The following conversions from measured frequency to engineering units were used:

For engine conversion: Engine frequency of 438.33 Hz equals 100% N_G speed
For rotor conversion: Planetary mesh frequency of 663.1 Hz equals 100% rotor speed

The speed of the main rotor system was measured by identifying the planetary gear mesh sound signature. This meshing of the gears produces a sound signature of 663.1 Hz at 100% rotor speed. The planetary gear sound signature is very loud and quite pronounced on the CAM channel of the CVR (see chart 1).

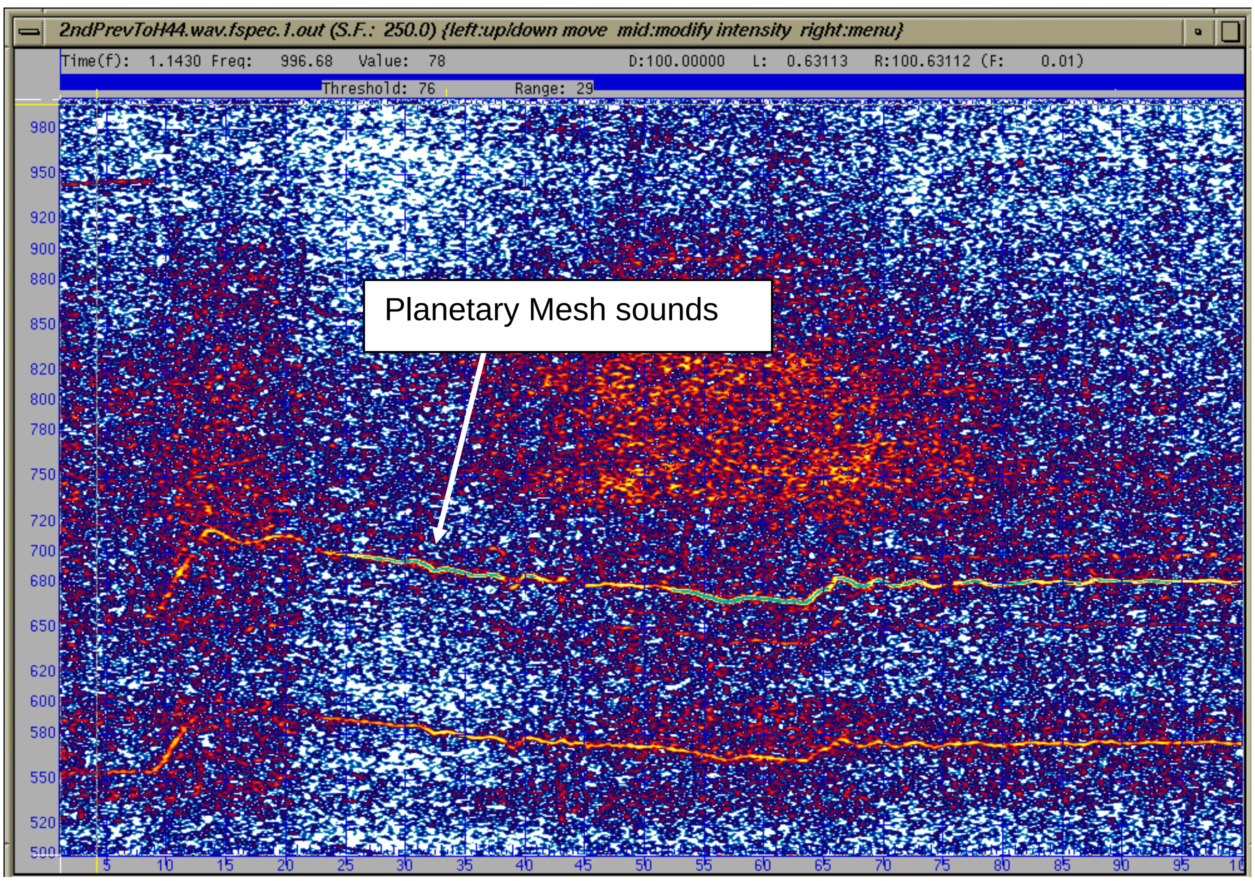

Chart 1

Chart 1 is a three-dimension presentation of the time, frequency and energy contained in the various signals. This spectrogram or "voice print" depicts time in seconds along the bottom axis of the chart. Frequency in hertz is presented along the vertical axis. Energy is presented by the different colors associated with the signals. The colors range from the darker blue-green colors that represent low energy signals to the lighter reds and yellows that represent higher energy signals.

A similar planetary gear mesh trace was identified for each of the takeoffs. The data was converted from measured frequency to rotor system rotation in % RPM.

A similar operation was conducted to measure and calculate the N_G rotational speeds for each of the aircraft's engines. The rotating gas generator of the engine produces noise at the fundamental (primary) frequency and at integer multiples or harmonics of that frequency. The sixth harmonic of the engines produced the most identifiable sound signature during all of the takeoffs. (See chart 2)

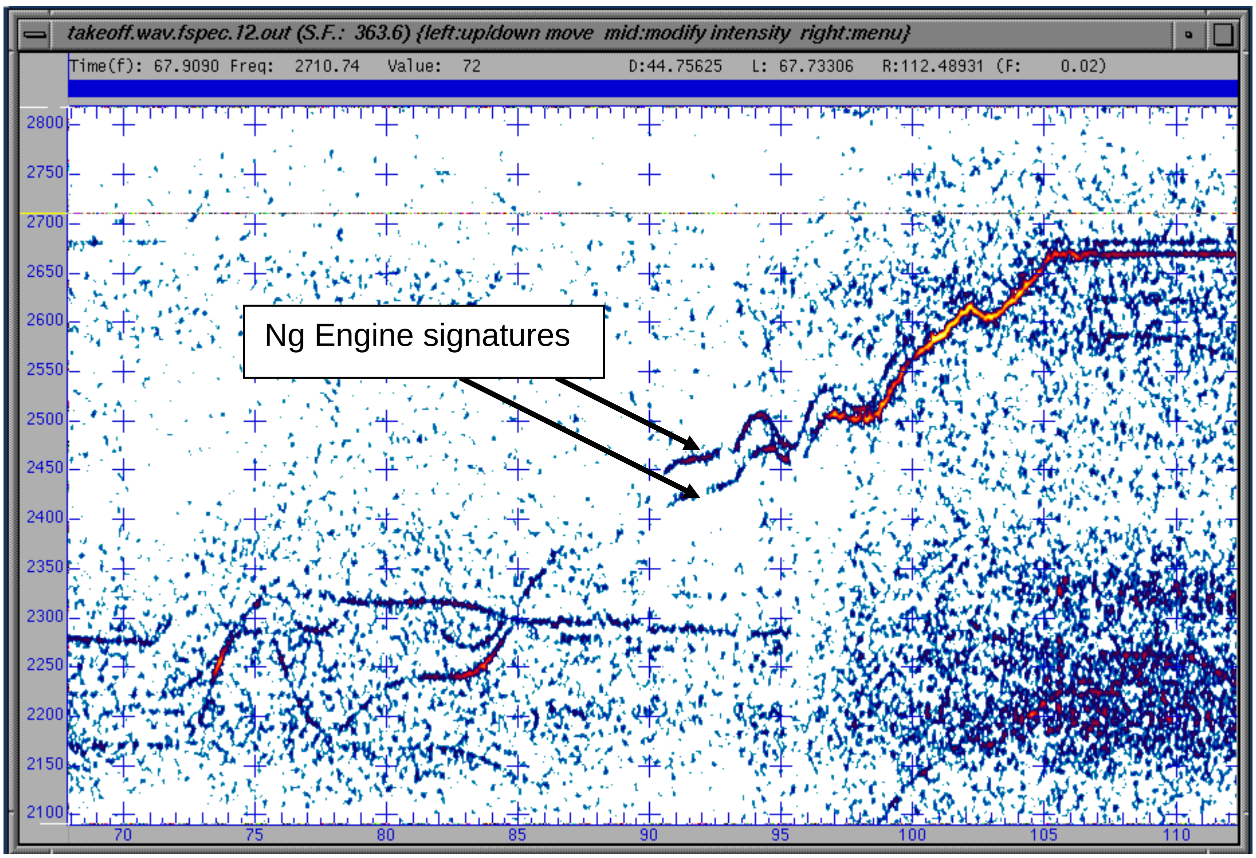

Chart 2

It can be seen from chart 2 that a sound signature can be identified for each of the aircraft's engines. This trace represents the 6^{th} harmonic of the rotating N_G turbine of the engine. A similar trace was generated for each of the 3 H44 takeoffs, the one wave-off from H44 as well as the 3 takeoffs from H36 and the landing and takeoff from Trinity base.

Charts 3-14 depict the data obtained by converting the sound signatures from the spectrogram plots to rotational speeds in percent for both the gas generators of the aircraft's engines and for the main rotor system speed for each of the takeoffs and one landing. Unless noted otherwise, the times shown on the plots were obtained from the CVR transcript and are expressed in local pacific daylight time.

Attachment #1 contains the data in comma separated variable (csv) format that was used to create plots 3-11.

Note: It was not possible to determine which of the aircraft's engines produced what sound trace on the various takeoffs and landings; therefore the engine traces depicted on the charts are labeled as engine A and engine B.

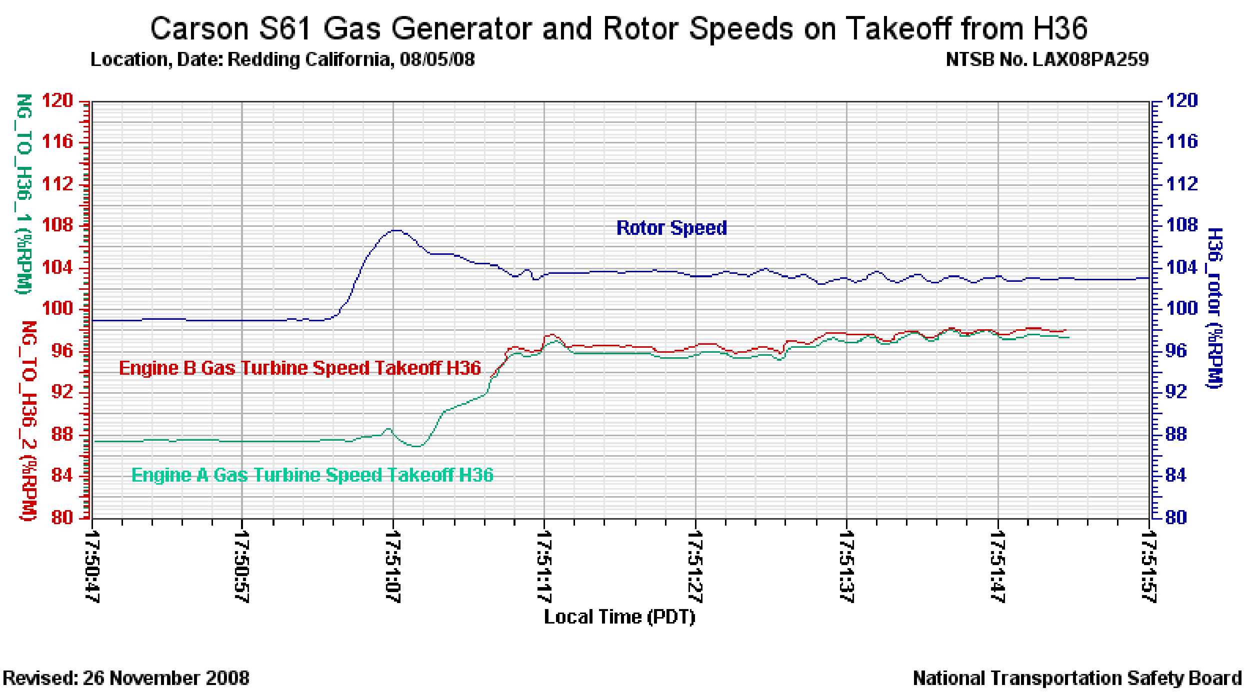

Chart 3 Takeoff from H36

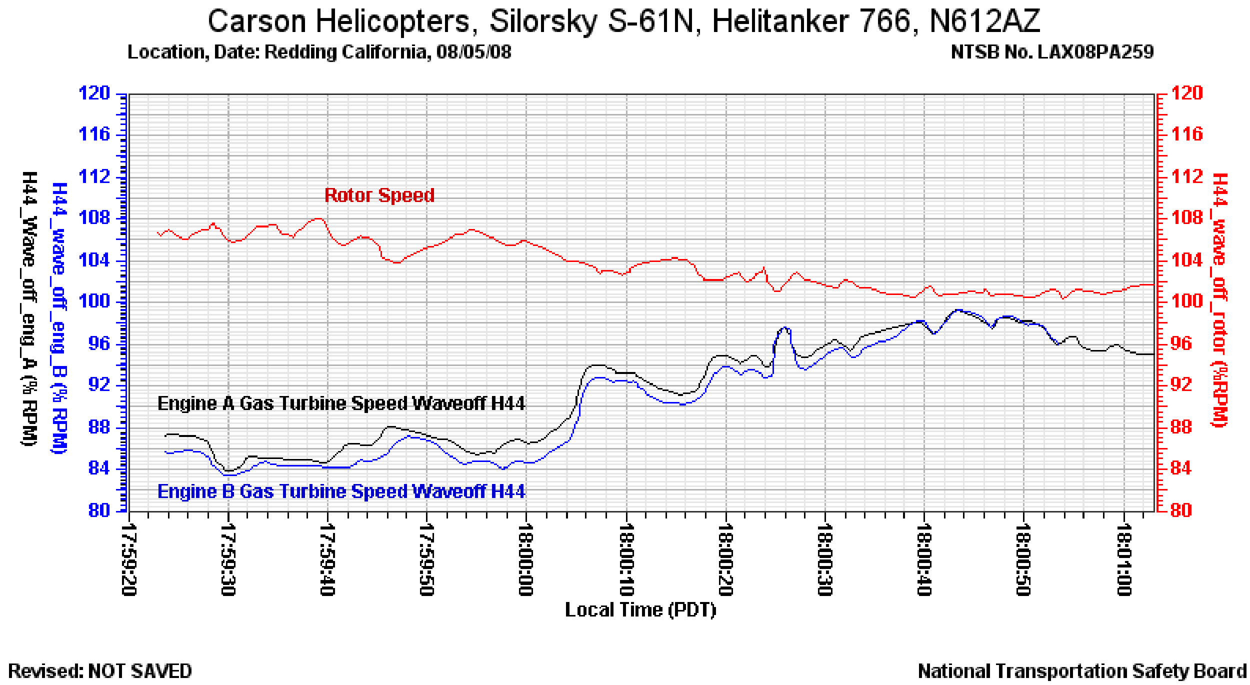

Chart 4 Wave off from H44

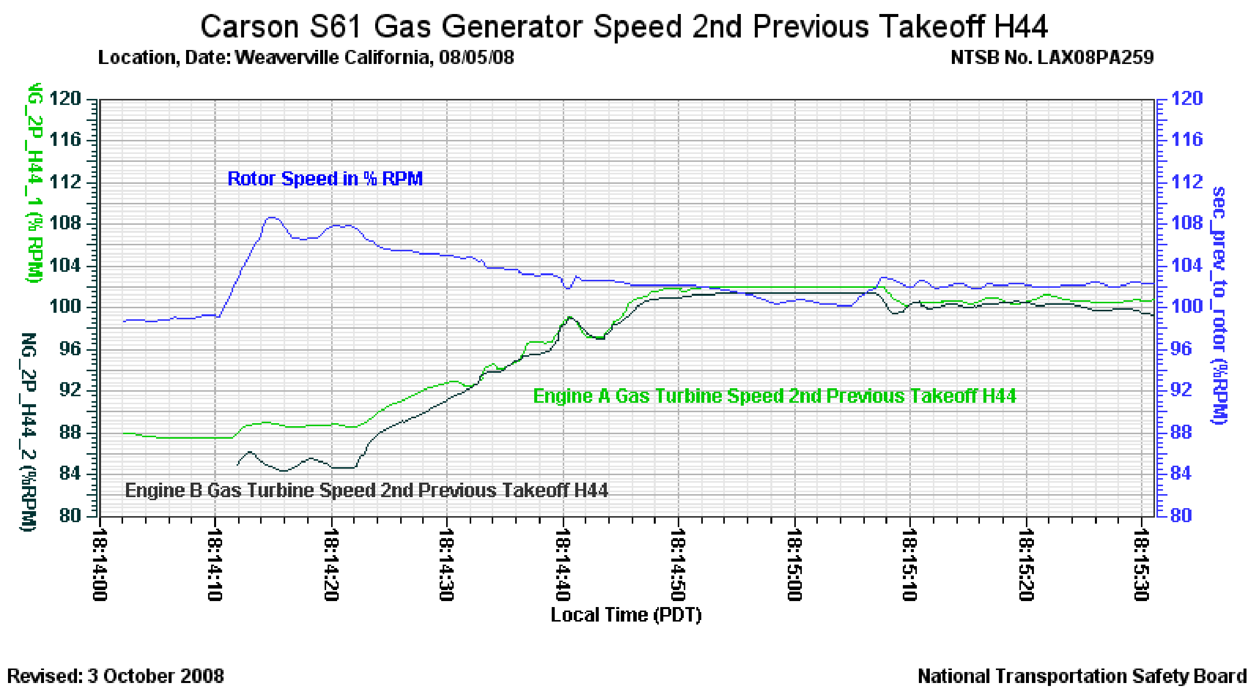

Chart 5 1st Takeoff from H44

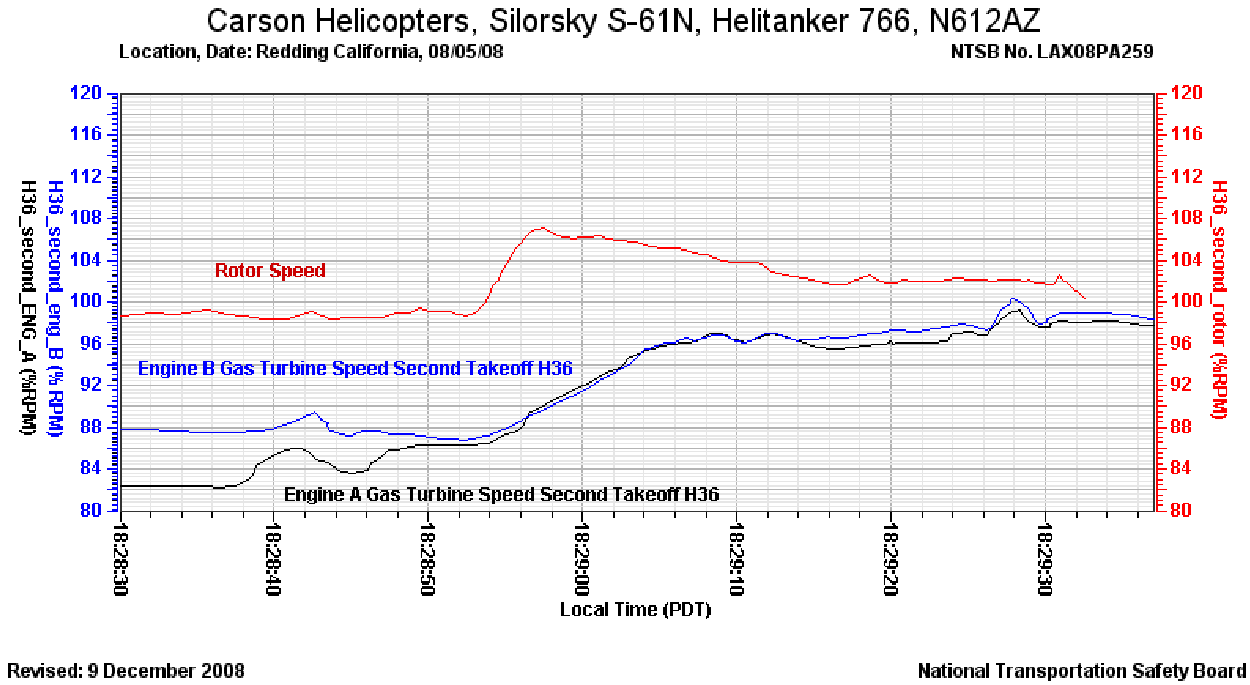

Chart 6 2nd Takeoff from H36

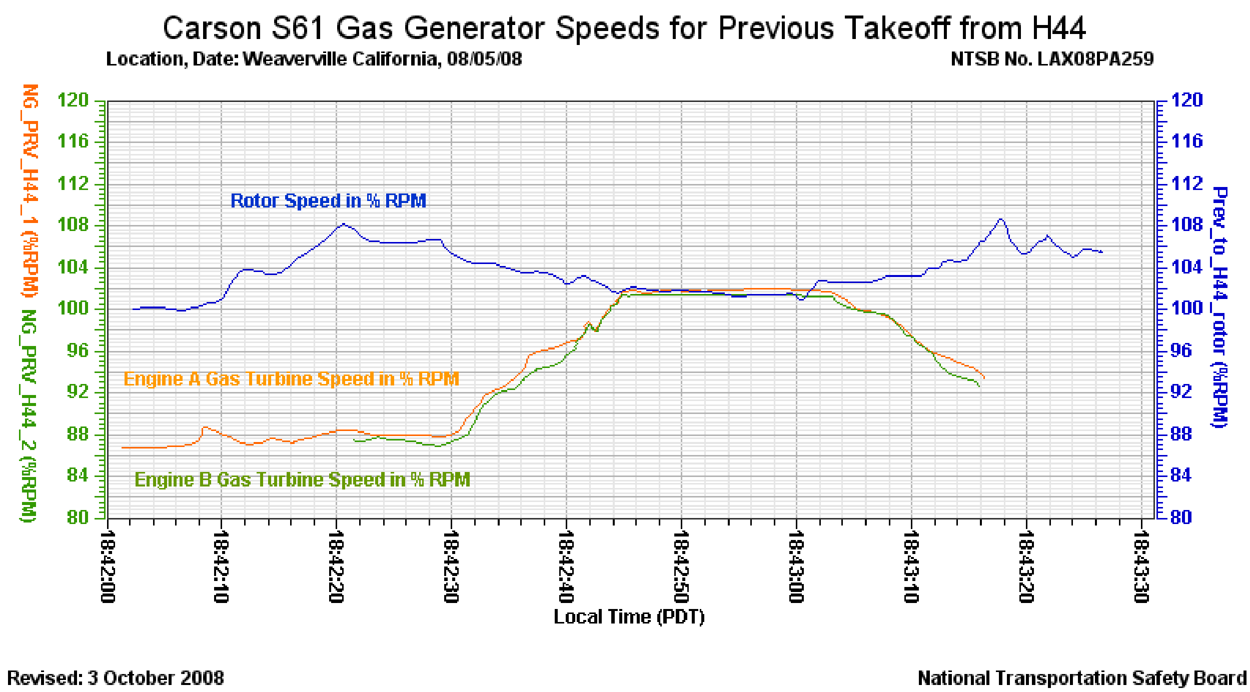

Chart 7 2nd Takeoff from H44

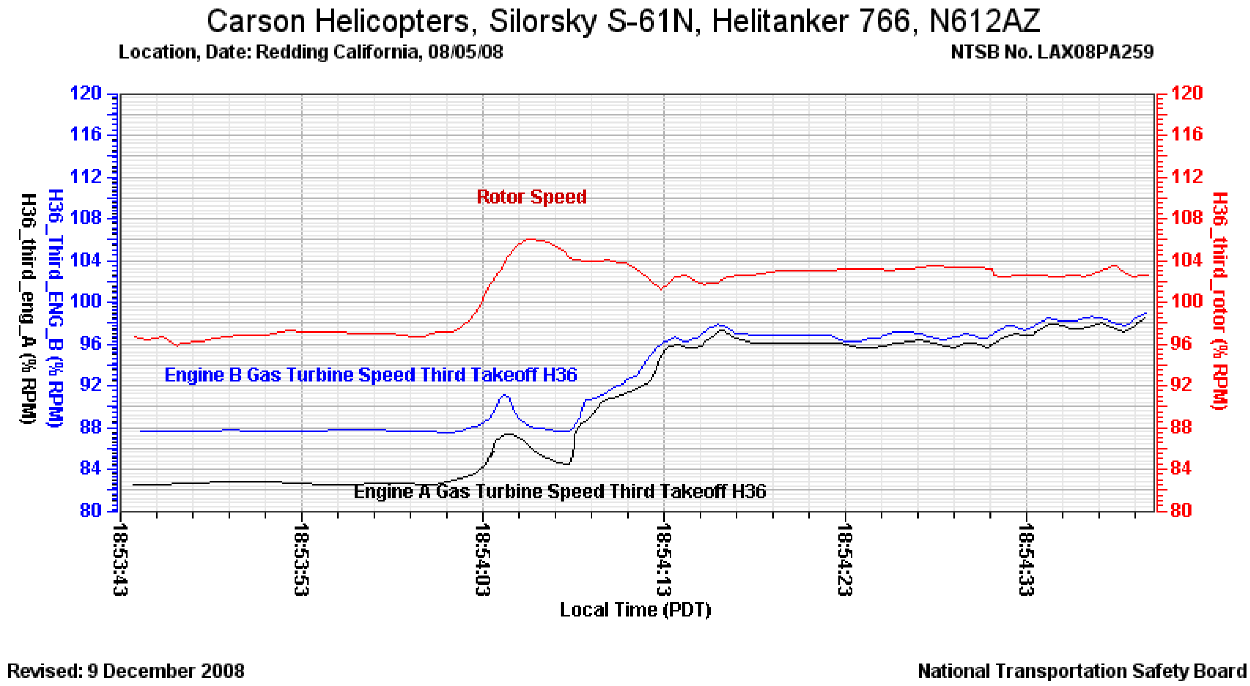

Chart 8   3rd Takeoff from H36

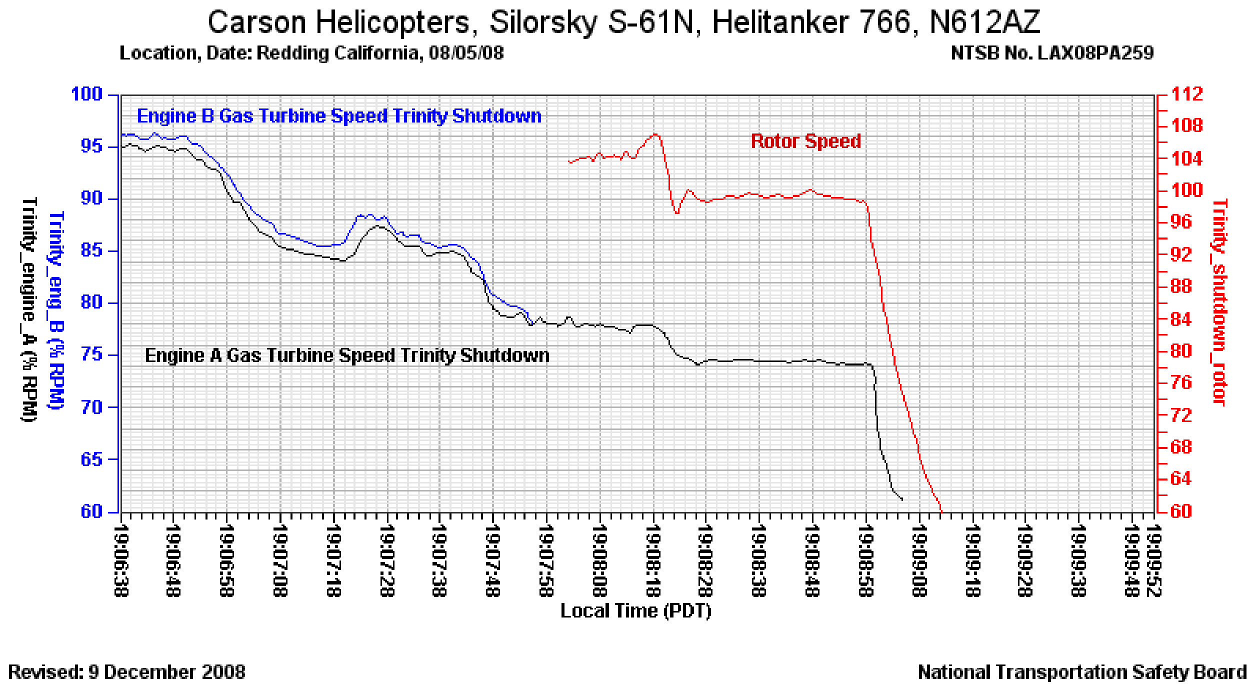

Chart 9 Landing and engine shutdown at Trinity Base

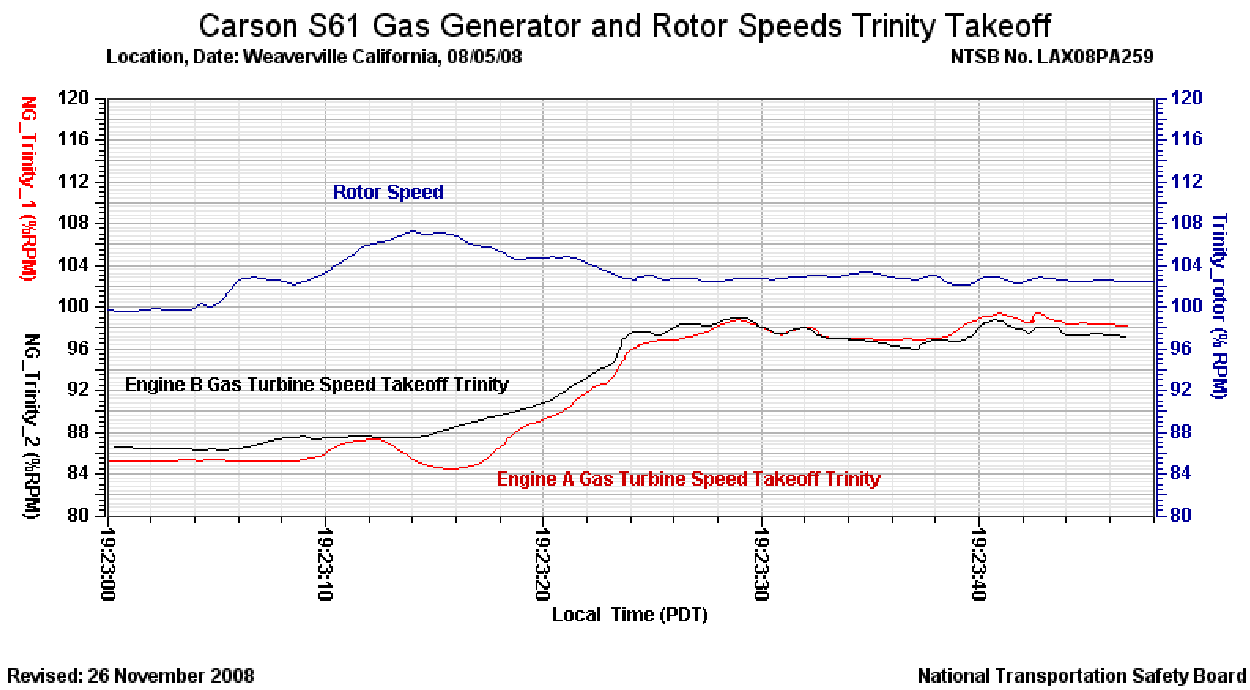

Chart 10 Takeoff from Trinity Base

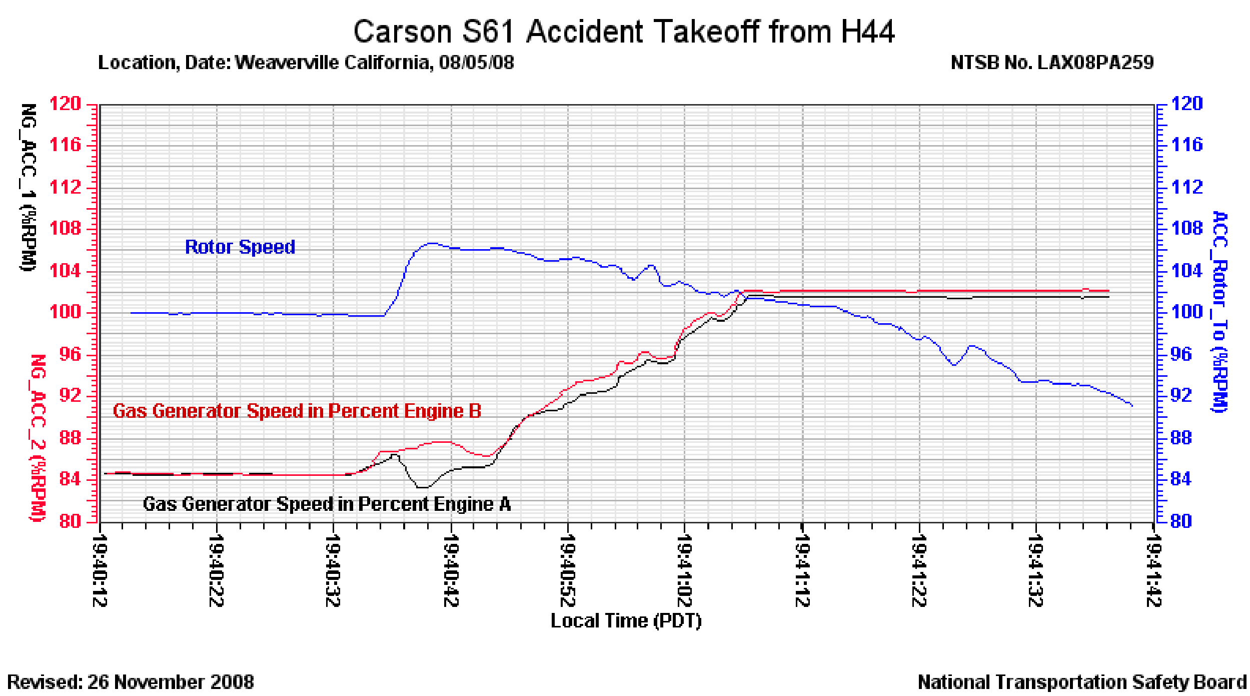

Chart 11 Accident Takeoff from H44

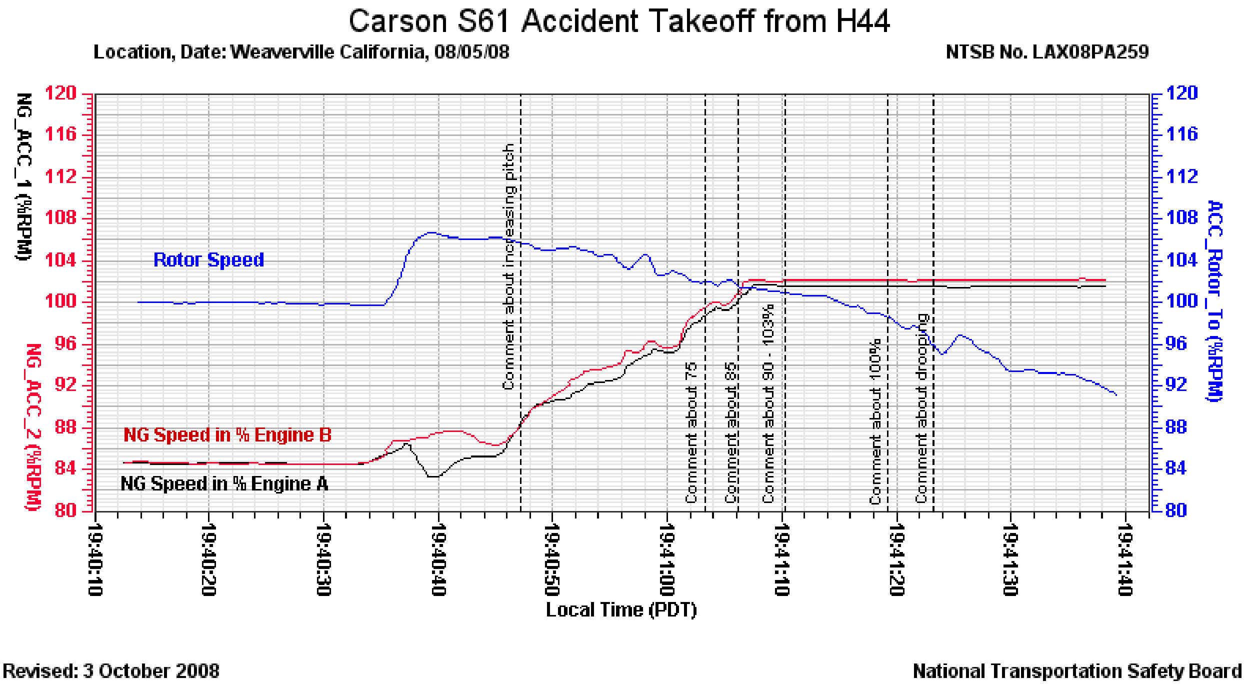

Chart 12 Accident Takeoff from H44 with selected CVR notations

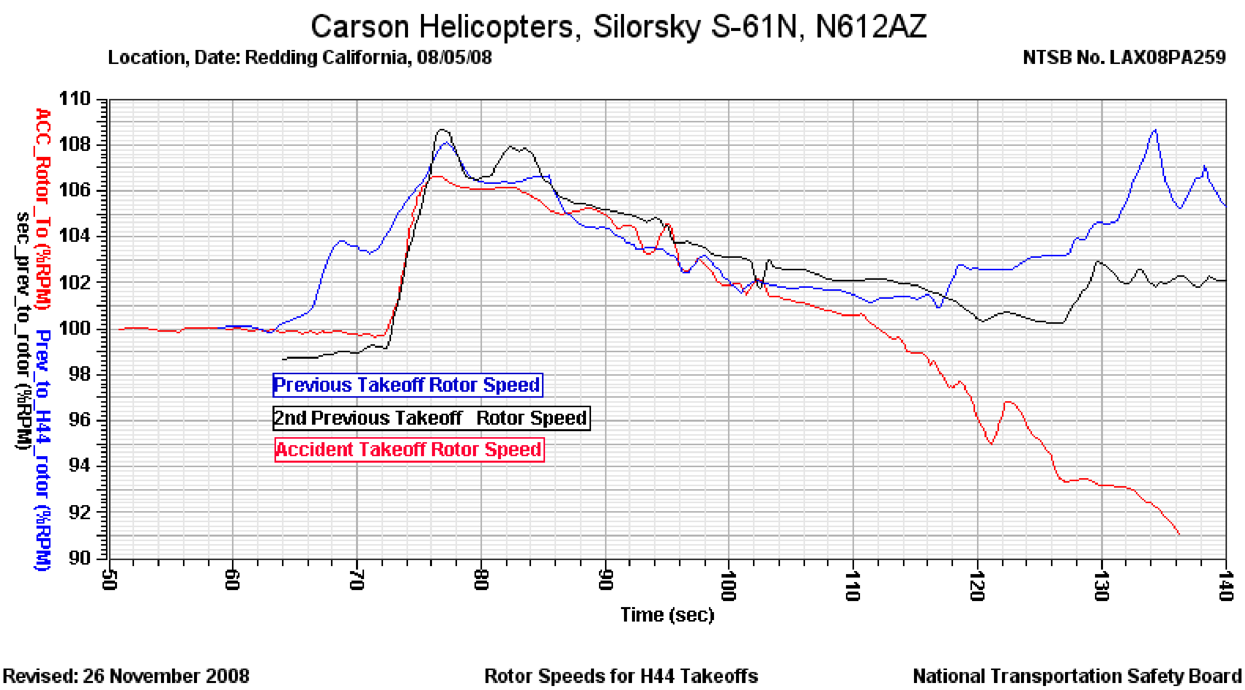

Chart 13 Main Rotor Speed Comparison of H44 Takeoffs
(Time is shown in elapsed seconds)

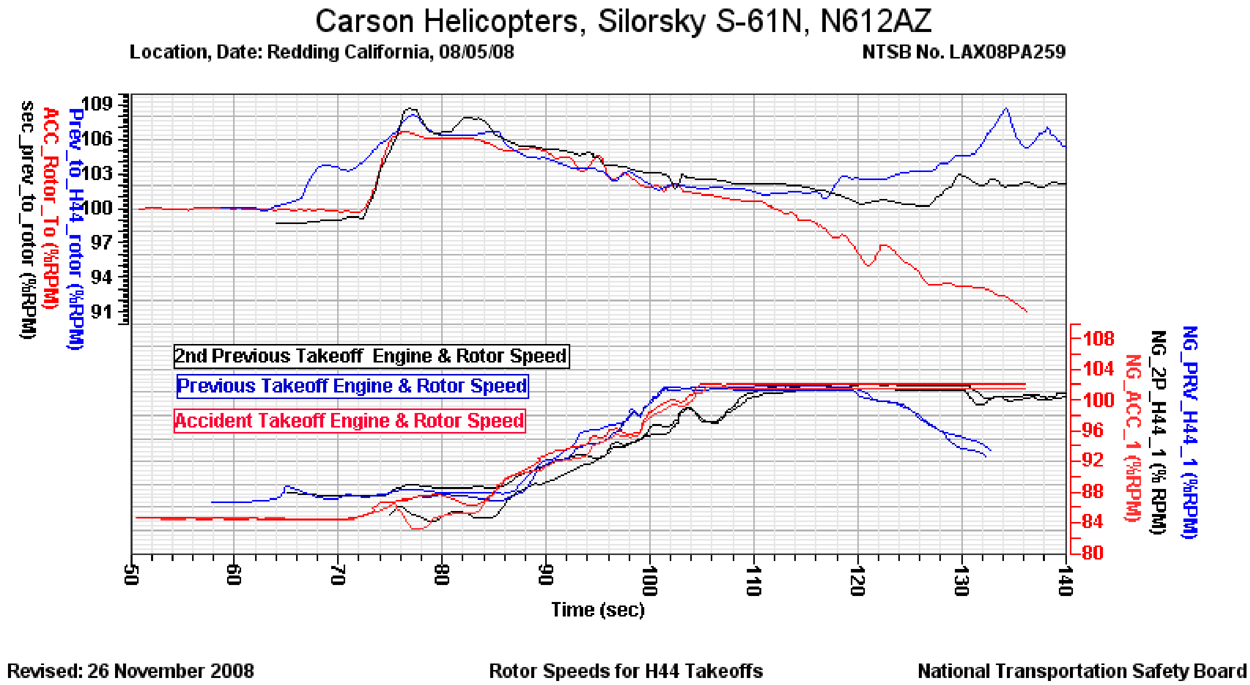

Chart 14 Main Rotor Speed and N_G Speed Comparison for H44 Takeoffs
(Time is shown in elapsed seconds)

James Cash
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