Sikorsky Aircraft Corporation
6900 Main Street • P.O. Box 9729
Stratford, Connecticut 06615-9129
(203) 386-4000

Sikorsky
A United Technologies Company

December 02, 2010

Mr. James Struhsaker
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594

PSL-106-2010

Dear Mr. Struhsaker:

Sikorsky Aircraft would like to present the Board Members with an Executive Summary of our position on the August 5, 2008 accident near Weaverville, CA (LAX08PA259), prior to the Probable Cause Hearing next Tuesday.

Attached, please find our Executive Summary. Please provide this information to the Board Members on our behalf.

Please feel free to contact me with any questions you may have.

Very truly yours,

SIKORSKY AIRCRAFT CORPORATION

[redacted]

Christopher Lowenstein

Chief of Aircraft Safety Investigation

cc: T. Haueter

enc: **Sikorsky Aircraft Comments to NTSB (four pages)**

S-61N Fatal Accident; Weaverville, CA; LAX08PA259

The Accident: On August 5, 2008; a Carson S-61N Fire King aircraft (N612AZ) with 13 aboard crashed in the Shasta/Trinity National Forest while transporting firefighters in an active fire. The crash and subsequent fire destroyed the aircraft and resulted in the deaths of the pilot, the safety crewmember,[1] and seven firefighters; and serious injuries to the copilot and three firefighters. The National Transportation Safety Board (NTSB) led the investigation, with assistance from the FAA, the US Forest Service (USFS), Sikorsky Aircraft (Sikorsky), General Electric (GE), Columbia Helicopters (Columbia), and Carson Helicopters (Carson).

Planning: During the NTSB-led accident investigation, it was soon determined that the flight crew was using incorrect performance charts in the Carson Rotorcraft Flight Manual Supplements (RFMS #8). Pages labeled as "5 Minute Power" (a normal take-off power) actually contained the performance data for "2½ Minute Power" (a substantially higher emergency-only, single-engine power). This led the flight crew to develop their flight plan for more lifting capability than actually existed. (For the accident conditions, this difference in lift was approximately 1200-1250 lb)

When asked how the 5 Minute Power charts had been replaced by the 2½ Minute Power charts, Carson representatives denied knowledge. However, more than two years prior to the accident, Carson had petitioned the USFS to allow the routine use of *those exact* 2½ Minute Power charts for routine mission performance planning. That request was rejected by the USFS after consultation with the FAA, Sikorsky, and GE.[2]

After the accident, those particular 'modified' charts were found in *both* Carson's proposal to the USFS *and* in Carson's own Flight Manuals – but were *NOT* found in the RFMS version submitted to the FAA Airworthiness Certification Office for approval.

Carson's main rotor performance data was also found to be incorrect. Sikorsky/USN flight test data, obtained under carefully measured ambient conditions, with real-time telemetry, resulted in measured hover performance that was lower than predicted by Carson's RFMS #8 performance charts. For the accident conditions, Sikorsky determined that the performance discrepancy was about 575 lbs.[3] The NTSB has conducted a comprehensive hover performance study, using Sikorsky, USN, and Carson data.[4] The NTSB's evaluation of Carson's own flight data indicated about 400 lbs less performance than would be calculated from RFMS #8.[5]

Weight Issues: Early in the investigation, the NTSB Operations Group was unable to accurately determine the pre-accident weight of the aircraft based on Carson's incomplete and conflicting records. It was later determined that Carson had incorrectly reported the weight data for USFS-contracted aircraft. The Operations Group investigation of 11 Carson aircraft determined that eight showed weight differences between the left and right main gear of exactly 80 lbs, that four aircraft weighed within ±2 lbs of each other, and that some weights were recorded in tenths of a pound when using a scale with only 'whole-pound' precision.[6]

---

1 The 'safety crewmember' was a USFS inspector pilot acting in a safety capacity after the completion of the flight evaluation. http://www.ntsb.gov/Dockets/Aviation/LAX08PA259/426753.pdf ; Operations Group Chairman's Report; p. 10.

2 http://www.ntsb.gov/Dockets/Aviation/LAX08PA259/432022.pdf ; Operations; Attachment 101 – USFS Letter to Carson.

3 http://www.ntsb.gov/Dockets/Aviation/LAX08PA259/454337.pdf ; Hover Study Addendum #2, Table 3.

4 NTSB Hover Study Addendum #2; *Op. Cit.*

5 The 'Whipple' test was conducted by Carson in an attempt to demonstrate the aircraft's performance at the accident conditions. It was designed as a spot-check, was not performed under controlled conditions, and utilized no flight test instrumentation.

6 Operations Group Chairman's Report; *Op. Cit.*; pp. 24-44. It should be noted that these S-61 aircraft were at least 35 years old and had substantially different histories, prior configurations, etc. It should be noted that even consecutive new UH-60M Black Hawks off the production line are not as consistent in weight.

Carson initially denied misreporting these weights,[7] but later admitted that the accident aircraft exceeded the Chart C weight by 1042 lbs.[8] (The Operations Group determined it was 1437 lbs overweight). Further investigation revealed that Carson did not accurately maintain the configuration control of the aircraft, as is required by FAA regulations. The accident aircraft had been weighed numerous times, with inconsistent results.

The USFS terminated its contracts with Carson on February 18, 2009.[9] The *termination for cause* letter documented that three helicopters were overweight, and that two of those helicopters were in further default, because they could not meet their contract performance specifications. Further, all five helicopters under contract were found to be in violation of both the USFS contract and 14 CFR 91.9; based on the use of improper performance charts.

FCU Issue: Throughout the investigation, Carson has diverted attention away from the weight and performance issues by claiming that contamination of the fuel control unit (FCU) was the cause of the accident. There is no physical evidence of such, and it is conclusively disproven by analysis of the cockpit voice recorder (CVR) sound-spectrum data. That data shows both engines and the rotor accelerating simultaneously in all three takeoffs from the accident site.

Columbia Helicopters' submission clearly illustrated this finding by overlaying CVR transcript excerpts, the CVR sound-spectrum data, and their comments regarding engine performance.[10] This study provides a visual and easily understood explanation demonstrating that the engines were operating normally. It shows the crew exceeding engine core (N_G) redlines on both engines at a point where rejecting the takeoff would still be possible. The data shows that the engines were actually producing *above-specification* power.[11] It further shows that the rotor decay rate agrees well with Carson's Whipple Test (on an aircraft with two similarly tuned *above-specification* engines) until the aircraft began striking trees which removed additional energy from the rotor system.

Columbia's analysis of the CVR data established that the torque callout during the takeoff corresponds to a power being generated that is *above-specification*, which negates Carson's proposed theory of 'correct N_G with low torque' on one engine. Note that it is thermodynamically *impossible* to have *both* simultaneous and parallel engine core (N_G) acceleration *and* low torque on one engine.

Had there been a FCU contamination issue, as Carson has proposed, the affected engine's acceleration schedule would have been slowed, causing the other engine to momentarily assume more load; thus requiring an increase in the N_G speed, which would have been observed as divergences in the sound-spectrum data. This was not the case, since both engines smoothly accelerated together, exceeding their redline limits, and proceeded to their topping limits (to within 0.3% of the previous day's recorded topping numbers). This *measured data* from all three takeoffs, including the accident departure, indicated two healthy engines and FCUs, exhibiting a normal acceleration schedule, *and* producing *above-specification* power.[12] [13]

---

[7] http://www.ntsb.gov/Dockets/Aviation/LAX08PA259/431820.pdf ; Carson's attorney's letter to USFS, dated 17 Oct 2008.

[8] http://www.ntsb.gov/Dockets/Aviation/LAX08PA259/432026.pdf ; Carson email admitting aircraft was 1042 lbs overweight.

[9] http://www.fs.fed.us/im/foia/frequent/Carson/2_18_09_termination_letter_9340.pdf ; USFS Termination for Cause Letter, 2/18/09.

[10] http://www.ntsb.gov/Dockets/Aviation/LAX08PA259/452036.pdf ; Columbia Submission to NTSB, dated 10/06/10.

[11] Engines are rated to produce certain specification power. The Power Available charts give data for a '*minimum spec*' engine. Sikorsky and the USFS consider *above-spec* engines to provide additional safety margin only. Carson's flight crew used the *above-spec* data for planning purposes, which is in contravention of USFS guidance. See http://www.ntsb.gov/Dockets/Aviation/LAX08PA259/432015.pdf.

[12] Operations Group Chairman's Report; *Op. Cit.*; Figure 6, p. 23.

[13] http://www.ntsb.gov/Dockets/Aviation/LAX08PA259/440051.pdf ; GE Power Study, Figure 3, p. 5.

With proper performance planning and incorporation of appropriate safety margins, the topping limit should NEVER be approached in routine flight operations. The 'topping limit' is the point at which the engine is producing as much power as thermodynamically possible. The fuel control (throttle) is 'wide open'. FAA regulations *prohibit dual-engine operation beyond the 100% N_G redline* limit, which was exceeded during both prior takeoffs from the accident site, as well as during the accident takeoff itself.

It was also observed that there is no mention on the cockpit voice recorder by either pilot (or by the USFS Inspector Pilot) that redlines were being exceeded on all three accident site takeoffs. Acceptance of such parameters may indicate that these redline exceedances had become 'normalized' and a routine part of their operational 'culture'.

FCU History: During the investigation, Carson has stated that they were aware that FCU contamination had been cited as an issue in the *Hayes II* incident.[14] The *Hayes II* incident, however, was associated with an engine that was *slow to accelerate* following an unrelated in-flight shutdown of the other engine. There was NO power *loss* from the engine, which had a contaminated FCU. Further, in the *Hayes II* incident, the TSB identified:

- The engine had been intentionally rigged to a lower performance level to match a poorer performing engine *and*
- Several other FCU problems, including a misrigged stator vane actuator, unrelated to contamination.

Fuel Filtration: Sikorsky Aircraft issued an ASB recommending use of the 10 micron airframe filter in January 2010. This was prompted by a letter from GE to Sikorsky in June 2006 recommending its use. Selection and qualification of the filter had already been in progress for several months prior to the accident. GE had stated that contamination could result in fluctuations or delayed accelerations (again, which were not seen in the sound-spectrum data). Further, more than two years prior to the accident, Carson had requested and received permission from Sikorsky to install the 10 micron filter in its S-61 fleet. Carson later ordered a large quantity of 10 micron filters from Falls Filtration Technology (under an FAA PMA approval).[15]

Columbia Helicopters has stated[16] that contamination of an FCU will typically result in either:

1. A slow acceleration of longer than 9 seconds (not evident in the sound-spectrum data) or
2. A fluctuation of N_G speed (not evident in the sound-spectrum data)

Further, Columbia Helicopters did not concur with Carson's allegations that fiberglass contamination is a widespread issue. The Airworthiness Group determined[17] that some contamination (mostly fine metal) was found (as expected) in the filter areas of about 25% of non-routine FCU overhauls. Widespread debris was found in about 2% of non-routine FCU overhauls. None of the 215 evaluated work orders described the contamination as fiberglass.

The airframe filter is only one of three separate 40 micron filters used to purify the fuel before it enters the FCU. The airframe filter is the first, the centrifugal fuel purifier is second, and finally the fuel control unit, designed and manufactured by Hamilton Sundstrand, which uses its own 40 micron filter. Military H-3 aircraft (similar to civil S-61s) have been equipped with a 10 micron airframe fuel filter for about 40 years. Despite Carson's allegations, Sikorsky has not received any customer complaints regarding fuel contamination from either military or from civil operators of the H-3/S-61 aircraft.

[14] http://www.tsb.gc.ca/eng/rapports-reports/aviation/2002/a02p0320/a02p0320.asp ;TSB-Canada Aviation Report, commonly known as *Hayes II.*

[15] NTSB email dated 28 July 2010, including PO 2071366 from Carson to Camar for 10 micron filters, qty 100, dated 10/28/07. Carson has stated to the NTSB that they were unaware these filters were the 10 micron filtration level vice the 40 micron level.

[16] http://www.ntsb.gov/Dockets/Aviation/LAX08PA259/452374.pdf ; Airworthiness Group Chairman's Report; Addendum 4, p. 2.

[17] *Ibid.*; p. 3.

The 40 micron airframe filters were damaged in the post-crash fire and no judgment could be made on their level of contamination, however, the airframe filter is equipped with an automatic differential pressure/bypass indicator to advise the pilots that the filter is in or is about to enter bypass. There was no mention of any bypass indications by the pilots.

The investigation evaluated the FCU 40 micron filters in the NTSB Materials Lab. A visual inspection in accordance with the maintenance manual showed only about 10-50% of the filter screen holes were clogged.[18] Up to 70% blockage of the filter is allowed.[19]

Simulations: Sikorsky Aircraft performed hundreds of man-hours of computer simulation work as directed by the NTSB to evaluate the predicted performance of the accident aircraft under different conditions. Sikorsky Handling Qualities Engineering has refined these simulations over a period of nine months in close cooperation with the NTSB's Performance Group Chairman.

The final GenHel product (Revision 13; runs *c* and *d*)[20] with input parameters established by the NTSB, takes into account all of the known factors affecting the aircraft's performance, including the most accurate modeling of the aircraft's available power, based on GE's engine performance calculations, the most accurate aircraft configuration including the Fire King external tank, all aspects of vertical drag, the ground effect contribution to power required, and the corrected performance of the composite main rotor blades. The simulation illustrates that the aircraft would strike the tree within 6 feet of where it actually did (bracketing the impact height based on two different ambient temperatures).

Conclusions: The cause factors of this accident can be described by six separate and distinct actions:

1. Carson's improper provision of the 2½ min OEI power charts to the crew for planning
2. Carson's improper use of *above-specification* engine power data for planning
3. Carson's improper maintenance of weight records of the aircraft
4. Carson's incorrect power-required performance charts
5. The flight crew's failure to account for the weight of the USFS Inspector Pilot, *and*
6. The flight crew's failure to reject *all three* H-44 takeoffs when the crew predicted a large power margin and yet found themselves exceeding redline limitations prior to the takeoff commit point; *or*
   The flight crew's failure to properly evaluate actual hover performance vs. expected hover performance prior to committing to a horizontal departure with obstructions in the flight path.

Using the proper USFS planning performance margins with Carson's RFMS #8 data (maximum weight of 17,000 lb) would have resulted in a *+11% safety margin* above HOGE.[21]

Since the accident aircraft exceeded redlines during the first two takeoffs, the flight crew should have noted that either the performance planning or the actual aircraft performance was incorrect. All three takeoffs from the accident site should have been rejected prior to exceeding the N_G redlines, which would have prevented this accident.

The combination of inaccurate charts and inaccurate weights led the flight crew to improperly plan for these three flights. The flight crew's failure to detect the discrepancy between predicted and observed aircraft performance; and subsequent failure to reject each takeoff eventually led to the aircraft's accident on the third improper takeoff from the H-44 site.

---

[18] http://www.ntsb.gov/Dockets/Aviation/LAX08PA259/430172.pdf ; Materials Lab Report 08-121; pp. 3, 8.

[19] http://www.ntsb.gov/Dockets/Aviation/LAX08PA259/426650.pdf ; Airworthiness Group Chairman's Report; p. 60.

[20] NTSB Hover Study Addendum #2; *Op. Cit.*; Figures 9c and 9d.

[21] http://www.ntsb.gov/Dockets/Aviation/LAX08PA259/443215.pdf ; NTSB Hover Performance Study; Errata 1, p. 9.