

**NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594**

January 22, 2010

Addendum 1 to:

Airworthiness Group Chairman's Factual Report

Of September 10, 2009

NTSB ID No.: LAX08PA259

A. ACCIDENT:

Location: Weaverville, California
Date: August 05, 2008
Time: About 7:41 PM Pacific Daylight Time (PDT)
Aircraft: Sikorsky S-61N Helicopter

B. SUMMARY

This addendum to the factual report contains the documentation of the examination, testing and disassembly of three fuel control units (FCUs). Two FCUs were obtained from a Croman SH-3H helicopter that was involved in an accident and one FCU was obtained from an S-61N helicopter that experienced a loss of engine power during approach and landed uneventfully. All three FCUs were examined at the Columbia Helicopters, Inc., (Columbia) facility located in Aurora, Oregon under NTSB supervision.

C. DETAILS OF THE INVESTIGATION:

C.1 Examination of FCUs from the SH-3H Helicopter:

C.1.1 Event Description:

On July 17, 2009, about 1530 Pacific daylight time, a Croman SH-3H, N613CK, collided with a tank near Willow Creek, California. The United States Forest Service (USFS) was operating the public-use helicopter under the provisions of 14 Code of Federal Regulations (CFR) Part 133. (Reference NTSB No. WPR09TA353).

Even though the engines were not reported as losing power during the accident, the NTSB requested that the FCUs be removed from the helicopter and examined. The left engine's FCU was identified with P/N 788226-1, model number JFC26-5 and serial number 72476M. The right engine's FCU was identified with P/N 788226-1, model

number JFC26.5 and serial number 68032M. As witnessed by a representative from the Forest Service, the left and right engine FCUs were removed on August 11, 2009 at West Coast Turbine Ltd, located in Richmond, BC Canada. To maintain chain of custody, the FCUs were placed in shipping containers, secured and sent to the NTSB for storage. Just prior to the examination, the shipping containers with the FCUs were sent to the Portland, Oregon Federal Aviation Administration (FAA) and secured.

A team of investigators convened in Aurora, Oregon at Columbia Helicopters, Inc (Columbia) facility on December 2 and 3, 2009 to examine and test the left and right engine FCUs. Representatives from Columbia performed the examination and testing of the FCU under the supervision of the NTSB and witnessed by representatives from Croman Corporation, and the USDA Forest Service. A representative from the Portland, Oregon FAA delivered the shipping containers with the FCUs to the investigation team.

C.1.2 FCU Serial Number 72476M (Left Engine) Examination:

According to the operator, the FCU having serial number 72476M was last overhauled 1103.2 flight hours prior to the event.

C.1.2.1 Main Fuel Control Filter Inspection – Prior to Functional Testing:

The filter comprises a two-section screen-type 40-micron filter (a main screen and a servo screen), a cylinder, and a spring loaded bypass valve.

The main fuel control filter was removed and inspected prior to functional testing the unit on Columbia's test bench. Visual inspection of the filter assembly revealed a foreign particle located behind the filter bypass valve seat and several particles resting on the filter body (main screen element). Other than these particles, the filter visually appeared unrestricted and free of debris. NTSB Materials Laboratory metallurgical examination¹ revealed that the particle located behind the filter bypass valve seat had material properties consistent with aluminum, and its dimensional characteristics were approximately 30 x 30 microns. Examination also revealed that one of the particles resting on the filters main screen (red on one side and gray on the other²) had material properties consistent with chlorinated plastic such as polyvinyl chloride (PVC), and its dimensional characteristics were approximately 675 x 330 microns. The other particles resting on the filter body had material properties consistent with aluminum alloy, with dimensional characteristics ranging from approximately 300 to 1900 microns.

C.1.2.2 Fuel Sample Obtained Prior to Functional Testing:

The throttle valve end cap was removed and a fuel sample was taken. Visual inspection of the sample revealed that in addition to the fuel, the sample contained foreign

¹ Reference sample 2A in the NTSB Materials Laboratory Factual Report number 10-002 in the Safety Board's public docket for accident, WPR09TA353

² Reference sample 1A in the NTSB Materials Laboratory Factual Report number 10-002 in the Safety Board's public docket for accident, WPR09TA353

material. NTSB Materials Laboratory metallurgical examination³ revealed that the particles contained in the fuel sample ranged in size from 18 to 380 micron's with material characteristics consistent with carbon and lead.

C.1.2.3 Functional Testing:

Results from functional testing revealed that the unit was capable of supplying sufficient fuel to its respective engine during the accident flight. Manipulation of fuel flow changes using N_F RPM showed normal pressure regulator valve (PRV) operation. The PRV smoothly followed all fuel flow changes.

C.1.2.4 Post Test Inspection/Disassembly:

The FCU was removed from the fuel test bench and the team conducted a post-test visual inspection of the fuel control filter and the PRV assembly. Inspection of the filter assembly revealed one small particle (red on both sides) on the main filter screen (the particle had not made its way past the filter). No anomalies were observed with the PRV assembly (piston and sleeve); its piston operated smoothly within its sleeve using slight hand pressure. NTSB Materials Laboratory metallurgical examination⁴ of the particle revealed that its material properties were consistent with aluminum alloy. The particle was found to be approximately 100 X 90 micron's in size.

C.1.3 Examination of the Right Engine FCU:

According to the operator, FCU (S/N 68032M) was last overhauled 169.1 flight hours prior to the event.

C.1.3.1 Main Fuel Control Filter Inspection – Prior to Functional Testing:

The main fuel control filter was removed and inspected prior to functional testing the unit on Columbia's test bench. The filter appeared unrestricted, however, visual inspection revealed two particles located on the main filter screen. NTSB Materials Laboratory metallurgical examination⁵ revealed that one particle contained material properties consistent with stainless steel with dimensional characteristics of approximately 260 x 180 microns, and the other particle contained material properties consistent with Chromium and having dimensional characteristics of approximately 100 x 70 microns.

Due to the lack of fuel remaining in the FCU, a fuel sample was not taken.

³ Reference sample 4A and 4B in the NTSB Materials Laboratory Factual Report number 10-002 in the Safety Board's public docket for accident, WPR09TA353

⁴ Reference sample 3A in the NTSB Materials Laboratory Factual Report number 10-002 in the Safety Board's public docket for accident, WPR09TA353

⁵ Reference sample 5A and 5B in the NTSB Materials Laboratory Factual Report number 10-002 in the Safety Board's public docket for accident, WPR09TA353

C.1.3.2 Functional Testing:

Results from functional testing revealed that the unit was capable of supplying sufficient fuel to its respective engine during the accident flight. Manipulation of fuel flow changes using N_F RPM showed normal pressure regulator valve (PRV) operation. The PRV smoothly followed all fuel flow changes.

C.1.3.3 Post Test Inspection/Disassembly:

A post-test visual inspection of the fuel control filter revealed no anomalies or debris. The PRV piston operated smoothly within its sleeve using slight hand pressure. Upon removal of the PRV, a small particle located on the outboard side of the diaphragm was found. NTSB Materials Laboratory metallurgical X-ray energy dispersive spectroscopy (EDS) analysis of the particles revealed that it was organic having dimensional characteristics of approximately 30 x 20 microns.⁶

C.2 Examination of the FCU from a Sikorsky S-61N Helicopter:

C.2.1 Event Description:

The operator reported that on normal approach, the pilot lowered the collective to about 20% torque, and then reduced the rotor RPM to 103% N_R . Immediately, the torque output for the left engine dropped to about 10%, N_G dropped to about 52%, and the T_5 increased to about 750 degrees C. An uneventful landing was made.

The FCU having P/N 725725-5 with serial number of 29172 was submitted, by the operator, to Columbia Helicopters Inc for examination. A review of the operator's maintenance records revealed that Columbia Helicopters Inc. had overhauled the FCU on March 25, 2009.

C.2.2 Examination of the Left Engine FCU:

A team of investigators convened in Aurora, Oregon at Columbia's facility on December 2 and 3, 2009 to examine and test the left engine FCU. Representatives from Columbia performed the examination and testing of the FCU under the supervision of the NTSB and witnessed by representatives from the helicopter operator.

Visual inspection of the as received FCU (S/N 29172) revealed that the fuel filter and element were not present within the FCU; however, the filter bypass valve remained installed. According to the operator, they removed the filter assembly prior to delivering the FCU to Columbia. Inspection of the filter housing revealed a single particle resting on

⁶ Reference sample 7A in the NTSB Materials Laboratory Factual Report number 10-002 in the Safety Board's public docket for accident, WPR09TA353.

the housing wall. Examination of the particle by the NTSB Materials Laboratory revealed that it was non-metallic with dimensional characteristics of 150 x 80 micron's⁷.

Because the main filter was not present and debris larger than 40 micron (filter size) was found, the team agreed that the FCU should not be installed and functionally tested on Columbia's fuel test bench due to the potential of contaminating their equipment. The team agreed that the FCU should be disassembled and inspected for additional contamination.

C.2.2.1 PRV Examination/Inspection:

Inspection revealed that the PRV piston was stuck within its sleeve assembly. After applying hand pressure to the piston, it moved, but remained sticky. The PRV assembly was removed and sent to the NTSB Materials Laboratory for examination.

NTSB examination of the sleeve portion of the PRV assembly, before the spool was disassembled from the sleeve, revealed that the outer wall of the sleeve contained a particle, which was embedded between the rubber O-ring and the housing near the bore at the metering end. X-ray energy dispersive spectroscopy (EDS) analysis of the particle produced a spectrum that contained a major elemental peak of aluminum, and minor elemental peaks of silicon, magnesium, iron, copper, carbon, and oxygen, consistent with an aluminum alloy. The particle was found to be approximately 1800 X 500 micron's in size⁸.

Examination of the spool after it was removed from the sleeve revealed that the first circumferential groove contained one narrow particle, which was red on one side and white on the other side. EDS spectrum of this particle revealed that its material properties were consistent with chlorinated plastic such as polyvinyl chloride. Additional particles were found within the other three circumferential grooves. The particles ranged in size from 10 to 1400 microns and had material characteristics consistent with organic material, aluminum alloy, stainless steel, nickel, copper, and cadmium⁹.

C.2.2.2 Fuel samples:

Fuel samples were obtained from the throttle valve end cap, lead lag servo end cap, and T2 servo end cap. Visual examination of the fuel samples under a microscope revealed small particles contained within the fuel. The particles were collected and sent to the NTSB for examination.

⁷ Reference NTSB Materials Laboratory Factual Report number 09-094, sample number 11. This report is located in the Safety Board's public docket for accident ENG09SA023.

⁸ Reference NTSB Materials Laboratory Factual Report number 09-094, sample number 1. This report is located in the Safety Board's public docket for accident ENG09SA023.

⁹ Reference NTSB Materials Laboratory Factual Report number 09-094, samples number 2 through 8. This report is located in the Safety Board's public docket for accident ENG09SA023.

NTSB examination of the particles contained in the fuel samples revealed that the particles ranged in size from 20 to 2300 microns and had material characteristics consistent with organic material and Cadmium¹⁰.

C.2.2.3 Internal Contamination:

An internal inspection of the FCU revealed a sliver of contamination on the 3D cam. NTSB examination of the particle revealed that it had the dimensional characteristics of 180 x 2300 microns and material characteristics consistent with chlorinated plastic such as polyvinyl chloride¹¹.

Mike Hauf
Airworthiness Group Chairman

¹⁰ Reference NTSB Materials Laboratory Factual Report number 09-094, samples number 12 through 14. This report is located in the Safety Board's public docket for accident ENG09SA023.

¹¹ Reference NTSB Materials Laboratory Factual Report number 09-094, sample number 9. This report is located in the Safety Board's public docket for accident ENG09SA023.