

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594



April 6, 2018

MATERIALS LABORATORY FACTUAL REPORT

Report No. 18-022

A. ACCIDENT INFORMATION

Place : Alapaha, Georgia
Date : September 16, 2016
Vehicle : Cessna A188A
NTSB No. : ERA16FA315
Investigator : Adam Gerhardt

B. COMPONENTS EXAMINED

Two (2) fuel hoses; throttle-body fuel screen

C. DETAILS OF THE EXAMINATION

Two black hoses were submitted to the laboratory for examination. The hoses were submitted to determine what material the hoses were made from and if that material was compatible with 100LL aviation gasoline. The hoses were labeled Hose #1 (the original hose used by the aircraft owner used for fueling, approximately a year old at the time of the accident) and Hose #2 (a new extension added to the existing hose just prior to the accident). Photographs of the hoses are shown in Figures 1 and 2.

Hose #1 was a 0.75-inch diameter, black polymeric hose, approximately 12 feet in length. A manufacturer's identification (FILLRITE ID FUEL TRANSFER HOSE WITH STATIC WIRE MADE IN THE USA 02314C) was visible in regularly spaced intervals on the exterior. The hose comprised of a black polymeric material with an embedded metal wire mesh for static protection. Hose #1 was noticeably faded in color when compared to Hose #2. There was no obvious visible damage.

Hose #2 was a 0.75-inch diameter, black polymeric hose, approximately 20 in length. No lettering or identification markings were present on the exterior. Hose #2 comprised of a black polymeric outer layer and a braided steel inner layer. Springs were installed inside the hose at each of the connector ends to prevent hose kinking.

Samples from both hoses were examined to identify the hose material. The samples were examined using a Fourier Transform Infrared (FTIR) micro-spectrometer with a silicon attenuated total reflectance (ATR) accessory in accordance to ASTM E1252-98 (American Society for Testing Materials E1252-98: *Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis*). The spectrometer was used to collect and process infrared wavelength absorbance spectra of the unknown material.

The Hose #1 and Hose #2 sample spectra had several similar peaks indicating that the two hose materials were the same material. That material contained the following combination of spectral peaks corresponding to particular functional groups found within molecular structure of the material. The presence of a strong doublet peak between $\sim 2900\text{ cm}^{-1}$ and $\sim 2850\text{ cm}^{-1}$ is indicative of a carbon-hydrogen (C-H) single stretching bond. The presence of a doublet peak ~ 2360 and 2340 cm^{-1} is indicative of a carbon-carbon (C-C) group (most likely in the form of elemental carbon or carbon black). It can also indicate the presence of a triple bonded carbon-nitrogen ($\text{C}\equiv\text{N}$) group. The presence of a single peak $\sim 1450\text{ cm}^{-1}$ is indicative of a carbon-hydrogen₂ (C-H_2) bending bond. The presence of a single peak $\sim 960\text{ cm}^{-1}$ is indicative of a carbon-hydrogen₃ (C-H_3) bending bond. This combination of functional groups is consistent with a straight-chained hydrocarbon with an attached nitrile group. A spectral library search was performed on both hose sample spectra. The search found a very strong match to acrylonitrile/butadiene copolymer (n-butyl rubber or nitrile rubber) for both hoses. Based on the visual examination and the FTIR analysis, the hose material for both hoses was consistent with carbon black-filled nitrile rubber¹.

The throttle-body fuel screen was submitted to the Materials Laboratory for examination as shown in Figure 3. The finger screen was located on the bottom of the throttle body as shown in Figure 4. The thumbscrew holding the finger screen in place was removed. The screw is shown in Figure 5. The screen was torn away from the screw and the orifice was filled with a brown powdery debris. The remains of the finger screen and the thumbscrew are shown in Figure 6.

The debris was a brown crystalline powder. A close-up photograph of the debris is shown in Figure 7. The debris was analyzed using a handheld x-ray fluorescence (XRF) alloy analyzer. The analysis found the debris consistent of silicon (Si), titanium (Ti), chromium (Cr), iron (Fe), copper (Cu), zinc (Zn) and lead (Pb). Silicon is present in soil. The other materials can also be found in soil as well as material found in an airplane's fuel system.

A sample of the debris in the fuel screen was examined to identify the material. The samples were examined using a Fourier Transform Infrared (FTIR) spectrometer with a diamond attenuated total reflectance (ATR) accessory in accordance to ASTM E1252-98 (American Society for Testing Materials E1252-98: *Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis*).

The debris sample spectrum contained the following combination of spectral peaks corresponding to particular functional groups found within molecular structure of this material. The presence of a strong doublet peak between $\sim 2900\text{ cm}^{-1}$ and $\sim 2850\text{ cm}^{-1}$ is indicative of a carbon-hydrogen (C-H) single stretching bond. The presence of a strong single peak $\sim 1700\text{ cm}^{-1}$ is indicative of a carbon-oxygen double bond ($\text{C}=\text{O}$) bond. The presence of a single peak $\sim 1400\text{ cm}^{-1}$ is indicative of a carbon-hydrogen₂ (C-H_2) bending bond. The presence of a single peak $\sim 1340\text{ cm}^{-1}$ is indicative of a carbon-hydrogen₃ (C-H_3) bending bond. The presence of a single peak $\sim 1250\text{ cm}^{-1}$ is indicative of a carbon-oxygen (C-O) bond. The presence of a single peak $\sim 700\text{ cm}^{-1}$ is indicative of multiple carbon-

¹ Nitrile rubber is a compatible hose material for use with gasoline.

hydrogen₂ (C-H₂) bending bonds. This combination of functional groups is consistent with a carboxylic acid. A spectral library search was performed on the debris sample spectrum. The search did not find an exact match, but the spectrum had similarities to several emulsifiers and anti-corrosion products. These types of materials are often present in aviation fuel.

Based on the visual examination and the XRF and FTIR analyses, the debris found in the finger screen was consistent with soil that had come in contact with aviation fuel.

Nancy B McAtee
Chemist



Figure 1. Overall photograph of Hose #1.



Figure 2. Overall photograph of Hose #2.

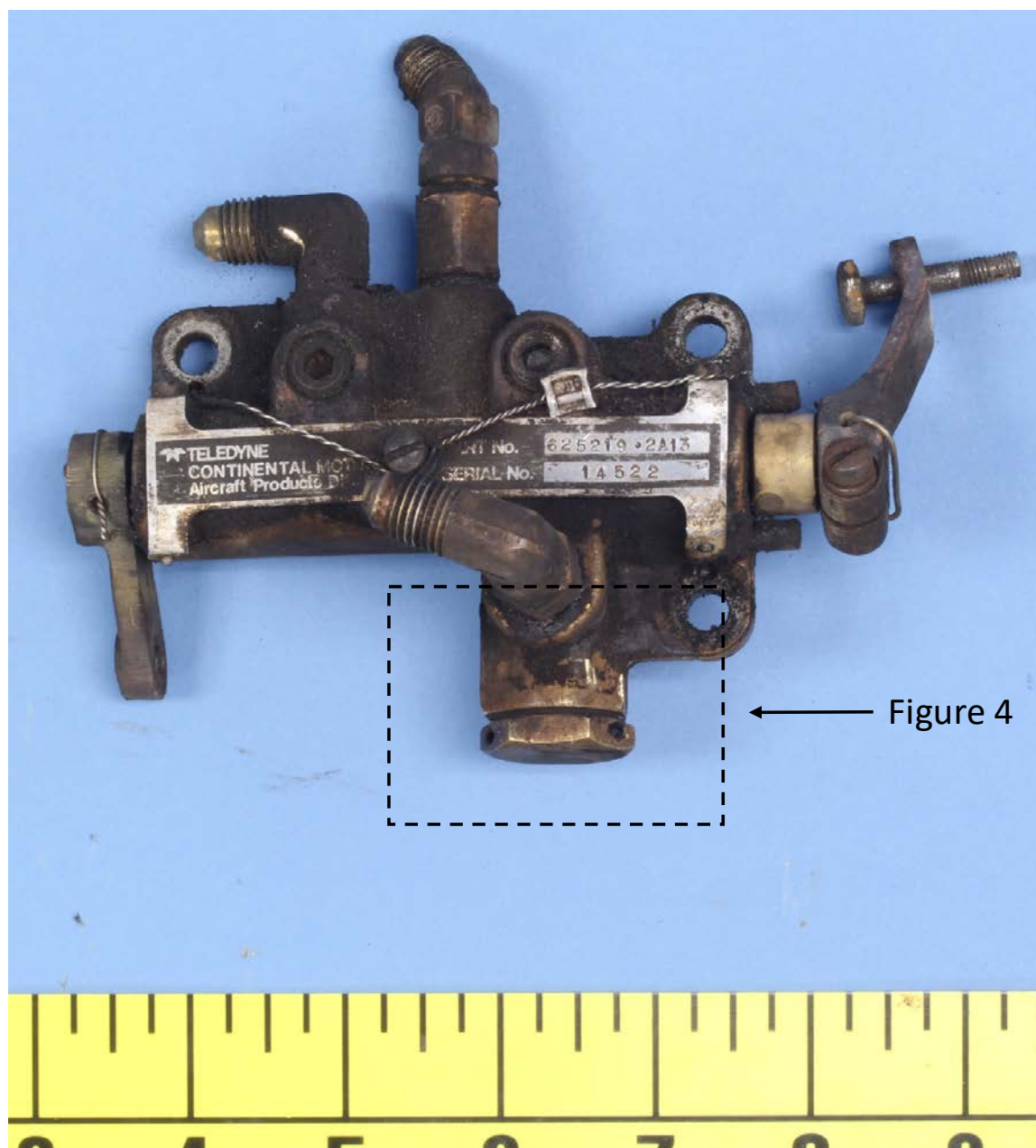


Figure 3. Overall photograph of the throttle-body fuel filter.



Figure 4. Close-up photograph of torn fuel screen in throttle-body.



Figure 5. Close-up photograph of underside of fuel screen thumbscrew.



Figure 6. Photograph of thumbscrew and remnants of fuel screen.



Figure 7. Close-up photograph of debris found in fuel screen.