NATIONAL TRANSPORTATION SAFETY BOARD

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

November 9, 2012

MATERIALS LABORATORY FACTUAL REPORT Report No. 12-001

A. ACCIDENT INFORMATION

Place	:	Milwaukee, Wisconsin
Date	:	June 6, 2011
Vehicle	:	Bombardier CL-600
NTSB No.	:	CEN11IA379
Investigator	:	Ed Malinowski NTSB-CEN

B. COMPONENTS EXAMINED

1) Filters from the hydraulic system, two identified as pressure-side filters, two return-side filters and four drain filters
2) Hydraulic fluid samples from the pressure filter and the return hydraulic filter.

C. DETAILS OF THE EXAMINATION

Eight hydraulic system filters (pressure-side (P/Ns FAA-PMA-WF336733 and 05228-7591357-001), return-side (P/N FAA-PMA-WF336734) and drain (P/N FAA-PMA-WF336732-for silver ended filters and 7913738-5001for purple ended filters), as shown in Figures 1 and 2, were submitted along with hydraulic fluid that was collected with the filters to identify if any contaminant was present.

All of the filters were comprised of an inner metallic perforated tube with two additional types of filtration media laid over the top: an outer layer of stainless steel wire screen; and a filter consisting of several layers of woven fiber mesh located between the tube and the steel mesh. A measurement of the openings in the outer wire screen found the openings to be 166 by 198 micrometers (µm). The inner fiber mesh consisted of irregularly shaped and sized openings with an average opening size between 25 µm to 50 µm. The filter mesh layers for all of the filters were examined under a 5X to 50X stereo zoom-microscope. The examination of the filters revealed no significant particulates within the mesh. Each filter was rinsed with acetone to remove any material trapped within the filter material. The solvent used for each filter was then filtered through a paper filter and the filter paper was air dried. A similar procedure was done on the hydraulic fluid. Each hydraulic fluid sample was placed in a paper filter and

rinsed several times with acetone to remove any traces of hydraulic fluid. The individual filter papers from the filters and the hydraulic fluid samples were examined under a stereomicroscope. Under the stereomicroscope, the filtrate appeared to be a black oily film. The unknown film was examined by scanning electron microscopy (SEM) and quantitative standardless energy dispersive x-ray spectroscopy (EDS) in accordance with ASTM E1508[1]**.** The EDS analysis showed no evidence of metallic particles present in the substance and that the material contained primarily of carbon.

The filtrate from both the fluid and the filters samples was examined using a Fourier Transform Infrared (FTIR) micro-spectrometer with a germanium attenuated total reflectance (ATR) accessory[2] in accordance to ASTM E1252-98 and ASTM E334-01[3]. The spectrometer was used to collect and process infrared wavelength absorbance spectra of each sample[4]. The resulting spectra were not well defined indicating that the substance was possibly a mixture. The spectra obtained from the samples suggested that the material had some characteristic traits of a straight chain, aliphatic hydrocarbon. This was evidenced by the presence of strong characteristic carbon-hydrogen bonding peaks between ~3000 $cm^{-1}$and ~2800 cm^{-1}. Another group of peaks was found between 1300- and 1000 cm^{-1} which is also found in straight chained hydrocarbons as well as a carboxylic compounds (C-O bond), amines (C-N) bond or alkyl halides (C-H_2X). Materials containing these types of bonds are present in aircraft hydraulic systems.

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[1] American Society for Testing Materials E1508 Standard Guide for Quantitative Analysis by Energy-Dispersive Spectroscopy, 2008.
[2] An IR spectrum is created when a molecule converts infrared radiation into molecular vibrations. There are two types of molecular vibrations: stretching and bending. These vibrational movements create bands in a spectrum that occur at specific wavelengths (cm^{-1}). Each wavelength is dependent on a number of factors including the mass of the atoms present, the force constants of the bonds present, and the geometry of the molecule present. Depending on the bonding present, the light will be absorbed, transmitted, or reflected at various wavelengths. From the spectrum produced, information about the bonding present is obtained from the location of group frequency peaks. All molecules have a unique spectrum in IR.
[3] American Society for Testing Materials E1252-98: Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis and American Society for Testing Materials E334-01:Standard Practice for General Techniques for Infrared Microanalysis.
[4] The samples from this aircraft were analyzed using the reflective mode. In reflective mode, the infrared beam is passed through the sample and then reflected off of a reflective IR plate and passed back through the sample where it is detected and analyzed.

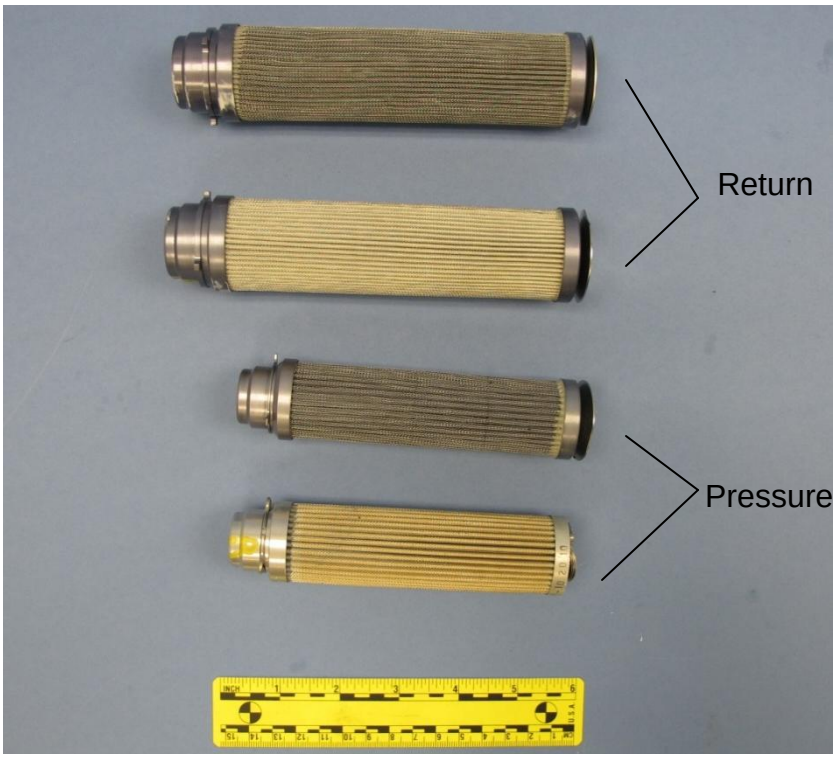

Figure 1. Overall photograph of pressure-side and return-side hydraulic filters.

Figure 2. Overall photograph of submitted drain filters.