

NATIONAL TRANSPORTATION SAFETY BOARD

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



month/day/year

MATERIALS LABORATORY FIRE FACTUAL REPORT

Report No. 14-059

A. ACCIDENT INFORMATION

Place : Wapakoneta, Ohio
Date : March 8, 2014
Vehicle : Cessna 310
NTSB No. : CEN14LA159
Investigator : Courtney Liedler
AS-CEN

B. ACCIDENT SUMMARY

On March 8, 2014, about 1120 eastern standard time (EST), a Cessna 310Q, N69980, experienced fire in the nose compartment while taxiing to the ramp at Auglaize County Neil Armstrong Airport (AXV) in Wapakoneta, Ohio. The airplane was substantially damaged. The pilot and two passengers on-board were not injured. The personal flight was operated under the provisions of 14 Code of Federal Regulations Part 91. Visual meteorological conditions prevailed for the flight, and an instrument flight plan had been filed. The flight originated from Akron-Canton Airport (CAK) in Akron, Ohio.

According to the pilot, the flight was uneventful. As he stopped the airplane on the ramp to park at AXV, a "puff of smoke" came from below the instrument panel. The pilot immediately shut down the electrical system believing it may have been the source of the smoke but the smoke continued to increase. He completed the airplane shutdown checklist, then he and the passengers exited the airplane. The pilot stated he could hear fire in the nose and saw the paint on the nose compartment beginning to discolor. He removed the nose access panel and extinguished the fire with a carbon dioxide fire extinguisher.

C. WRECKAGE EXAMINATION

The accident aircraft is shown in Figure 1. The aircraft was intact and the fire damage was limited to the nose compartment and the lower forward portion of the instrument panels and cockpit. The exterior damage was located on the upper portion and right side of the nose compartment. The upper section of fuselage exhibited large areas of thermal discoloration of the exterior paint as well as bubbling and peeling of the outer layers of the paint as shown in Figures 2-4. This damage continued down the right side of the nose compartment. The lower right exhaust louvers and the fuselage skin near the heater exhaust exhibited sooting and some thermal discoloration as shown in Figure 5-7.

The interior of the nose compartment was heavily sooted and exhibited thermal damage particularly in the area of the cabin heater, which was located on the rear right side of the nose compartment. The left side of the compartment is shown in Figure 8 and the right side is shown in Figure 9. The left side of the compartment was heavily sooted with some generalized melting and sagging of wire insulation. On the right side, nonmetallic components (such as wire insulation, tubing and ducts) adjacent to the heater showed melting and thermal discoloration. Several rubber components of the heater assembly were missing and presumed destroyed by the fire. The exterior of the heater and adjacent metallic assembly components were sooted and had evidence of thermal discoloration. During the removal of the heater assembly from the aircraft, the heater assembly drain line was found to be blocked as shown in Figure 10. There was limited fire damage to the cabin. There was some thermal discoloration of the floor on the right side of the cockpit as shown in Figure 11.

The heater installed in the accident aircraft was a Southwind 8240E. The heater after removal is shown in Figure 12. According to the aircraft logs and manufacturer information, this heater was installed at the time of the accident aircraft's manufacture and overhauled in 1997. A pressure decay test was done on the combustion chamber in 2003. The current owner had used the heater several times including the day of the accident.

D. LABORATORY EXAMINATION

Several components were removed from the aircraft and sent to the Materials Laboratory for further examination. The components included the cabin heater assembly including the vent and drain lines, the heater fuel pump box and the light bulb from the heater annunciator light.

The exterior case of the heater was removed during the examination as shown in Figure 13. No anomalies were initially found during the removal. A pressure test of the combustion chamber and associated heat exchanger muff was then performed. Four separate leaks were found. One leak was found in the igniter plug port weld as shown in Figure 14. One leak was found in the heat muff end weld, as shown in Figure 15. Two leaks were found in the welds that attach the combustion chamber to the heat exchanger muff as shown in Figure 16. One of those leaks had a visible crack as shown in Figure 17.

The blocked drain line was examined. It was determined that the material in the drain line was densely packed from the open (drain) end to the end fitting as shown in Figure 18. Approximately 0.4 grams of material was removed from the drain line using a thin wooden scraper. The material was brownish gray in color and had a powdery consistency as shown in Figure 18. A sample of the material removed from the drain line was examined using a Fourier Transform Infrared (FTIR) spectrometer with a diamond

attenuated total reflectance (ATR) accessory¹ in accordance to ASTM E1252-98 and ASTM E334-01². The spectrometer was used to collect and process infrared wavelength absorbance spectrum of the sample³. The spectral pattern was similar with an amine carboxylate. The spectrum of the unknown material was processed through a spectral library search engine. The search found several matches to the unknown material. The matches were materials used as surfactants often used as fuel additives (mostly corrosion inhibitors, detergents, antioxidants and emulsifiers) in aviation fuels. A solid powdery residue, similar in appearance to the blockage material, recovered from the inside of the heat exchanger was also examined by FTIR. The spectrum from this material had no significant spectral patterns indicating that little or no organic material was present.

The blockage material sample was then analyzed by scanning electron microscopy (SEM) and quantitative standardless energy dispersive x-ray spectroscopy (EDS) in accordance with ASTM E1508⁴. The EDS analysis showed the presence of carbon (C), aluminum (Al), oxygen (O), and lead (Pb). These constituents are consistent with lead oxide and aluminum oxides often found in aviation fuel combustion byproduct and other materials found within the aircraft engine compartment and fuel system. The EDS spectrum of material from the drain line was compared to material found in the heat exchanger and the two materials were found to be of similar composition.

There was evidence of fuel leakage in the fuel pump box as shown in Figure 20. There were evaporation marks where the fuel accumulated and the evaporated off leaving behind the nonvolatile residue. There were several bands of evaporation marks consistent with multiple evaporation cycles. Because the fuel pump box had visible thermal discoloration, indicating that the fuel pump had been exposed to heat, pressure testing of the fuel pump was not done due to the inability to recreate a pre-accident condition for the fuel pump.

¹ 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. Infrared spectra can help in identifying the chemical composition and/or bonding present in an unknown molecule. The spectrometer emits a broad band of infrared light through the specimen.

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. Most spectra contain additional "fingerprint" peaks that are unique to a particular molecular structure. All molecules have a unique spectrum in IR.

² 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.

³ 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.

⁴ American Society for Testing Materials E1508 Standard Guide for Quantitative Analysis by Energy-Dispersive Spectroscopy, 2008.

The filament in the heater annunciator light was examined by x-ray. No anomalies were found and the filament was unstretched and intact as shown in Figure 21.

Nancy B. McAtee
Fire and Explosion Specialist



Figure 1. Overall photograph of accident aircraft.



Figure 2. Photograph of exterior of nose compartment.



Figure 3. Close-up photograph of upper nose fuselage skin.



Figure 4. Close-up photograph of upper nose fuselage skin facing forward.



Figure 5. Close-up photograph of cabin heater exhaust and drain.

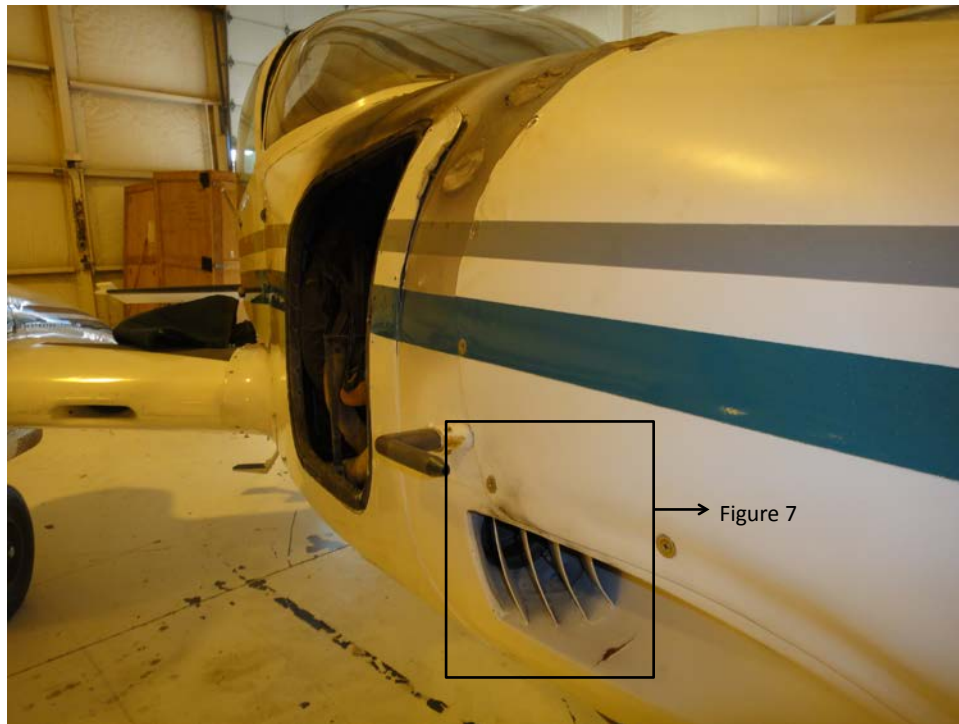


Figure 6. Photograph of right side of nose compartment with exhaust louver.



Figure 7. Close-up of sooting on lower right exhaust louver.



Figure 8. Photograph of the left side interior of the nose compartment.

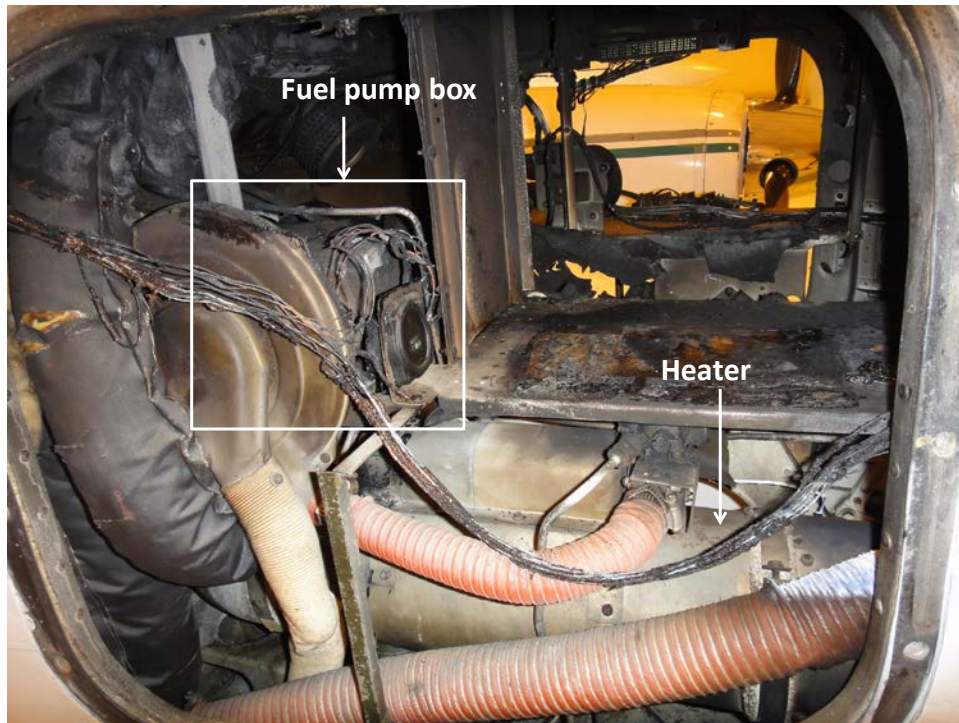


Figure 9. Photograph of the right side interior of the nose compartment.



Figure 10. Close-up photograph of the end of the heater drain line.



Figure 11. Photograph of cockpit floor with carpeting removed.

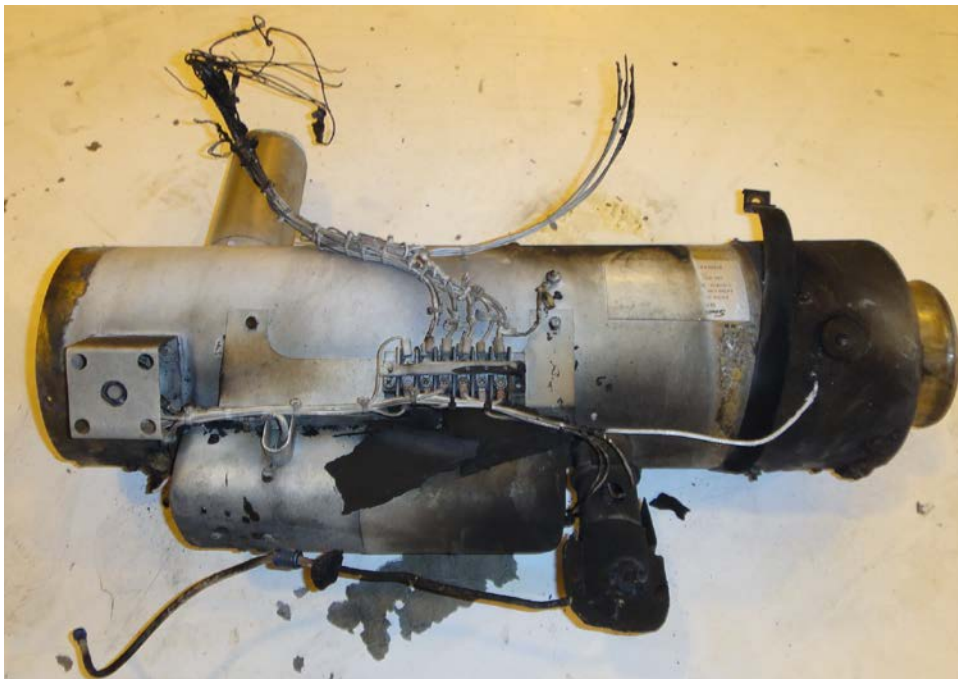


Figure 12. Close-up photograph of cabin heater after removal from accident aircraft.



Figure 13. Photograph of cabin heater with outer cover removed.

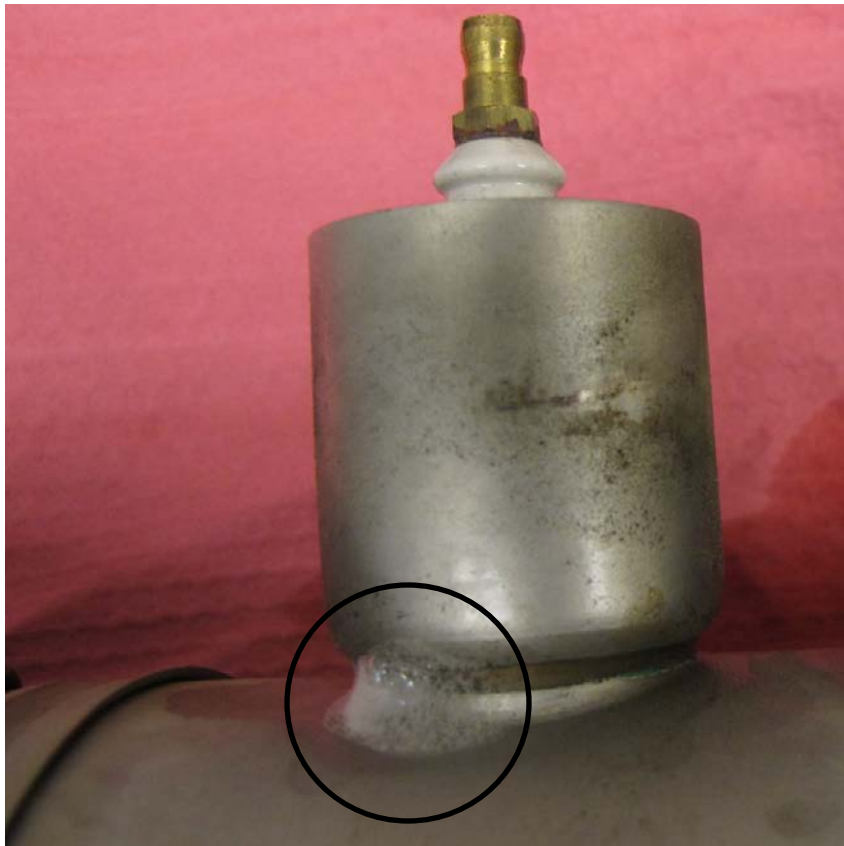


Figure 14. Photograph of leak in igniter plug port weld. The leak (circled in black) is made visible by the bubbling leak detector liquid.



Figure 15. Photograph of leak in heat muff end weld. The leak (circled in black) is made visible by the bubbling leak detector liquid.



Figure 16. Photograph of leaks in combustion chamber-heat muff weld. One leak was made visible by the bubbling leak detector liquid.

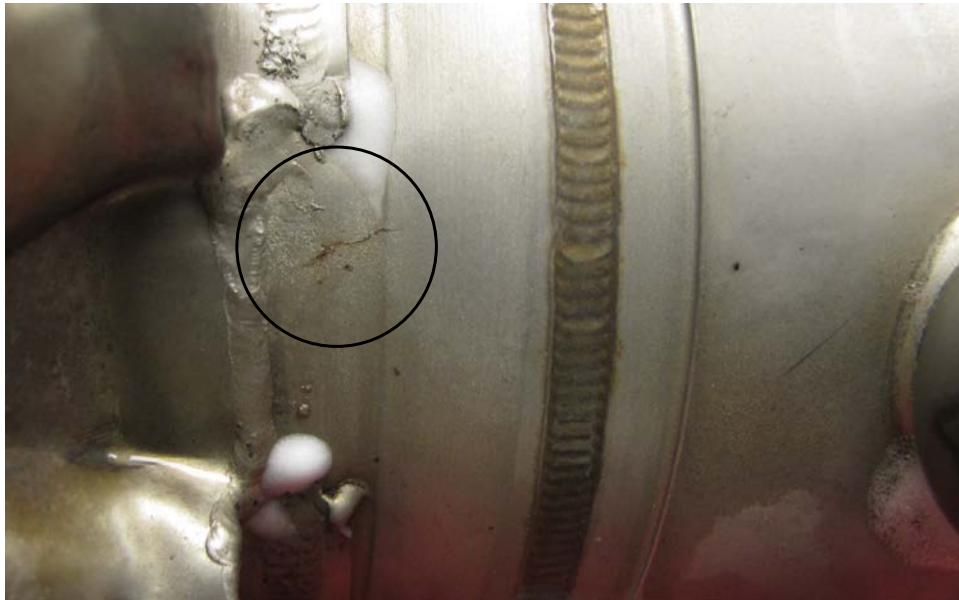


Figure 17. Photograph of visible crack in combustion chamber-heater muff weld (highlighted by black circle).



Figure 18. Close-up photograph of fitting end of cabin heater drain line (opposite end of line in Photograph 10).



Figure 19. Photograph of material removed from cabin heater drain line.

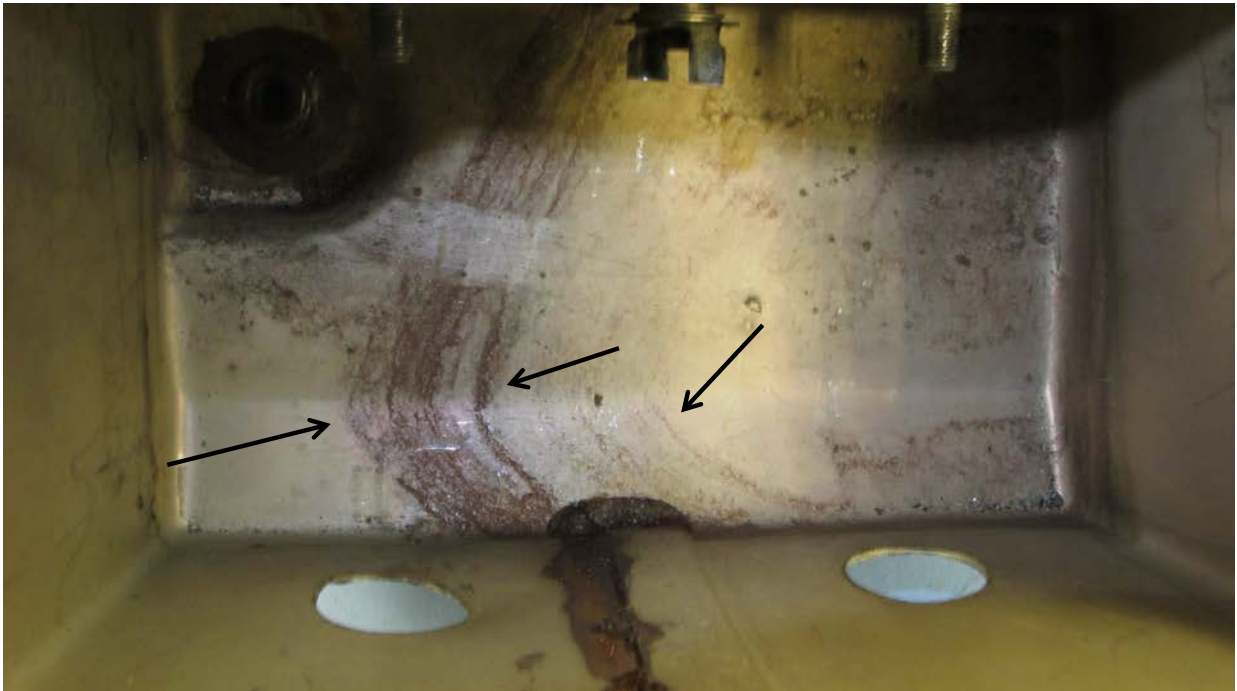


Figure 20. Interior of cabin heater fuel pump box. Evaporation lines are marked with black arrows.

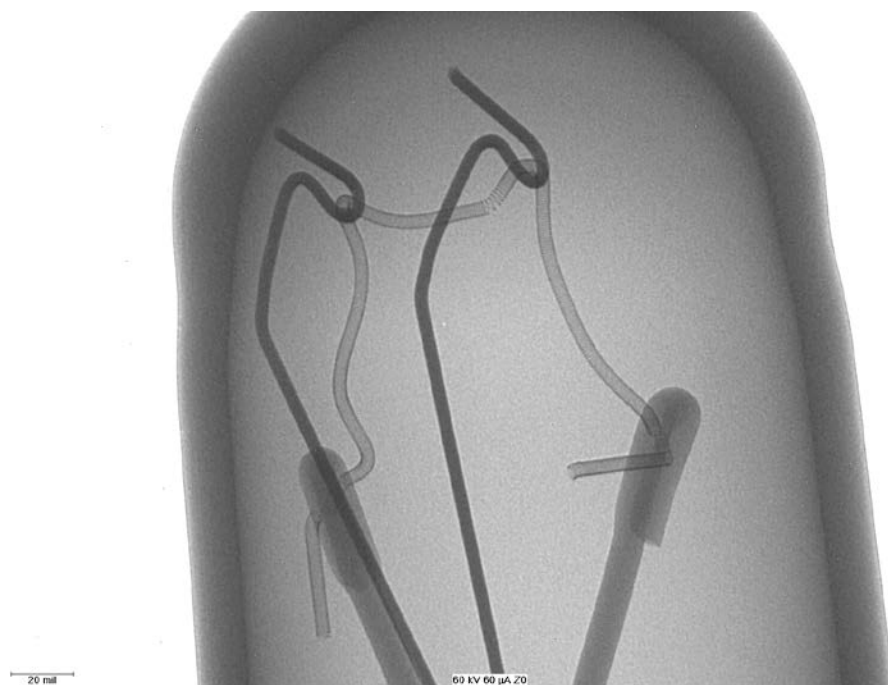


Figure 21. Radiograph of cabin heater light bulb filament.