

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



WPR24FA056

MATERIALS LABORATORY

Factual Report 24-085

June 11, 2025

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A. ACCIDENT INFORMATION

Location: Corona, California
Date: December 16, 2023
Vehicle: David B Lunn Vans RV8
Investigator: Zoe Keliher, AS-WPR

B. COMPONENTS EXAMINED

Fuel tank pickup, fuel selector, 40-micron filter element, electric fuel pump housing, firewall elbow fitting, 10-micron filter housing and element, engine driven fuel pump, fuel flow transducer, fuel injector servo filter

C. EXAMINATION PARTICIPANTS

Specialist Michael Meadows
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Specialist Nancy McAtee
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D. DETAILS OF THE EXAMINATION

The NTSB materials laboratory received several components from the fuel system of a homebuilt Vans RV-8 equipped with a Lycoming IO-360-C1C fuel injected engine. The components had been exposed to a post-crash fire.

The components had been received disassembled and labeled as indicated in figure 1, relative to the direction of fuel flow. Closer images of each component are shown in subsequent figures.

Figure 2 shows a portion of a fuel tank pickup with a finger screen attached as received. A deposit consistent with molten and resolidified metal was observed on the end of the screen. The tube was deformed and fractured just above the 90° bend, consistent with overstress separation.

Figure 3 shows a photograph of the fuel selector as received. Closer views of the indicated areas are shown in subsequent figures. A deposit of white material was observed on the inner surface of the exposed straight run end of the T-shaped fitting as shown in figure 4. A glossy variegated-tan and bubbled material was adhered to the inner surface of the branch of the T-shaped fitting as shown in figure 5. This material was removed with metallic tweezers and is shown from opposite sides in the right images. Chemical analysis was performed on the white and tan materials and results are detailed later in this report.

Figure 6 shows a view of the 40-micron fuel filter as received which had a brownish appearance.

Figure 7 shows a view of the exterior surface of the electric fuel pump housing which was covered by black soot deposits. Interior views of the electric fuel pump are shown in the subsequent figures. A solid white, slightly glossy piece of material was observed between two curved plate magnets. A distinct groove was observed along the length of the piece and rounded amorphous mounds protruded around the corners of the plate magnets as shown more closely in figures 8 and 9. The overall appearance was consistent with molded and melted plastic. The white piece of material was extracted for chemical analysis, results of which are detailed later in this report.

Figure 10 shows a view of connected fittings, which made up the 90° firewall elbow, arranged in series with a disassembled filter housing and a pleated 10-micron filter, as received. The exterior surfaces of these components (except the pleated filter element) were covered by black soot deposits. Closer views of each end of the firewall elbow fittings are shown in figure 11, where a tan and bubbled material was observed adhered to the inner surface of the fittings. A sample of this material was extracted from the fittings for chemical analysis, results of which are detailed later in this report.

Figure 12 shows interior views of the filter housing shown in figure 10. A hard, shiny off-white and bubbled material was observed adhered to areas of the internal surface of the housing. A white plastic ring was present on one side of the filter housing, visible in the right image. Closer views of each side of the 10-micron filter element are shown in figure 13. A similar off-white material was visible between filter pleats as indicated by yellow arrows. Samples of the off-white material were extracted from the filter housing and element for chemical analysis, results of which are detailed later in this report.

Figure 14 shows a photograph of the disassembled engine driven fuel pump, as received. A hard, glossy white material was observed in the fuel chambers of the pump as shown more closely in figures 15 - 17. A sample of this white material was extracted from the fuel pump for chemical analysis, results of which are detailed later in this report.

As a test to assess flow between the fuel chambers, the inlet chamber was filled with water, which slowly dripped through the check valve to the opposite chamber under gravitational force. When the opposite chamber (reference figure 16) was filled with water, it slowly dripped back into the inlet chamber under gravitational force with no appreciable water observed flowing to the outlet chamber. When blown with compressed air from the outlet chamber side, small bubbles were observed emanating from around the outlet check valve in the opposite side chamber,

consistent with small open pathways through the valves, with more significant flow observed on the inlet valve side.

Figure 18 shows a view of the fuel flow transducer with cover removed and inlet/outlet fittings as received. Black soot deposits were observed on exposed outer surfaces. A white material, similar in appearance to that observed in the engine driven fuel pump, was observed inside the transducer, and pooled on the inner surfaces of the inlet and outlet fittings. The black wheel component inside the transducer was entangled in and partially covered by the white material and could not be rotated by hand. A closer view of the white material observed inside the transducer is shown in figure 19. A sample of this white material was extracted from the transducer for chemical analysis, results of which are detailed later in this report.

Figure 20 shows a view of the fuel injector servo filter and fitting as received. The wrench flats of the end fitting were covered with black soot deposits, a blue elastomeric O-ring was present on the filter side of the fitting, and a smaller black elastomeric O-ring was present around the filter at the base of the fitting. A hard white material similar to that observed in the engine driven fuel pump and the fuel flow transducer appeared to fill and protrude from the screen filter element. Figure 21 shows a view looking down into the open end of the fitting, toward the filter, showing similar white material obstructing the interior of the fitting. A sample of this white material was extracted from the servo filter for chemical analysis, results of which are detailed later in this report.

a. CHEMICAL ANALYSIS RESULTS

Specimens were extracted from the fuel system components either with metallic tweezers or by cutting/shaving with a scalpel blade to collect a sample. The specimens were consistent with organic/polymeric materials and were subjected to Fourier Transform Infrared (FTIR) Spectroscopy. The resulting spectra identified multiple chemistries of materials present. Specimens taken from the fuel selector were consistent with polyimide or polyacrylic based polymers. The specimen taken from the electric fuel pump was consistent with a nylon-based material. The specimens acquired from the firewall elbow fitting, 10-micron filter screen/housing, engine driven fuel pump, transducer, and servo filter were most consistent with polyvinyl chloride or polyvinyl acetate-based polymers or co-polymers. The specimen acquired from the 10-micron filter screen exhibited a spectrum consistent with a mixture of the polyimide, polyacrylic, poly vinyl chloride, and poly vinyl acetate chemistries.

A sample of the white material extracted from the engine driven fuel pump was subjected to a temperature of approximately 100° C (212° F). After a brief exposure to elevated temperature, the material underwent a softening process and became sticky, resembling the consistency of a melted marshmallow. Over time at elevated temperature, the material began to turn off-white to light brown in color but remained soft and sticky. Upon removing the heat source, the material returned to a

hardened physical state. This behavior is consistent with thermoplastic polymer material behavior at elevated temperatures, and inconsistent with thermoset or chemically cured polymeric material behavior.

b. MATERIAL COMPARISON

Several materials that were reported to have been used during the aircraft build were identified for chemical composition comparison to the unknown materials observed in the fuel system components as detailed above. These materials were:

1. PRC-Desoto: P/S 890 Class B - a two-part polysulfide-based aircraft fuel tank sealant
2. The Flamemaster Corporation: Chem Seal: CS 3204 - a two-part polysulfide-based aircraft fuel tank sealant
3. Bill Hirsch Auto Parts Inc.: Alcohol Resistant Gas Tank Sealer - a one-part white liquid designed to coat the interior of automotive fuel tanks to seal pinhole leaks and prevent rusting upon drying¹
4. Axalta: Corlar® 13580S™ - a three-part epoxy-based primer for aircraft exteriors
5. Axalta: Imron® AF400™ - a two-part polyurethane-based topcoat for aircraft exteriors

The materials identified in the fuel system components were inconsistent with polysulfide, epoxy, and polyurethane chemistries. According to the safety data sheet (SDS), the Bill Hirsch Auto Parts: Alcohol resistant gas tank sealer contains predominantly solvents (xylenes, acetone, and ethylbenzene), VMCH resin - CAS# 9005-09-8 (15 - 25% by weight), and titanium dioxide (up to 10% by weight).² The composition of VMCH resin was consistent with the materials identified in the firewall elbow fitting, 10-micron filter screen/housing, engine driven fuel pump, fuel flow transducer, and fuel injector servo filter.³

Submitted by:

Michael Meadows
Materials Engineer

¹ Bill Hirsch Auto Parts Inc. (Parsippany, New Jersey): <https://www.hirschauto.com/ALCOHOL-RESISTANT-GAS-TANK-SEALER/productinfo/GTS/QUART/>

² The SDS was obtained from https://www.aircraftspruce.com/P/N_09-03477. The Chemical Abstracts Service (CAS) assigns unique identification numbers (CAS#) to every chemical substance described in open scientific literature in the United States.

³ VMCH Resin (CAS 9005-09-8) is a high molecular weight vinyl chloride/vinyl acetate/maleic acid terpolymer with a melting point of 100°C and a specific density of 1.35 at 20°C. Source: Alfa Chemistry (Holbrook, New York).

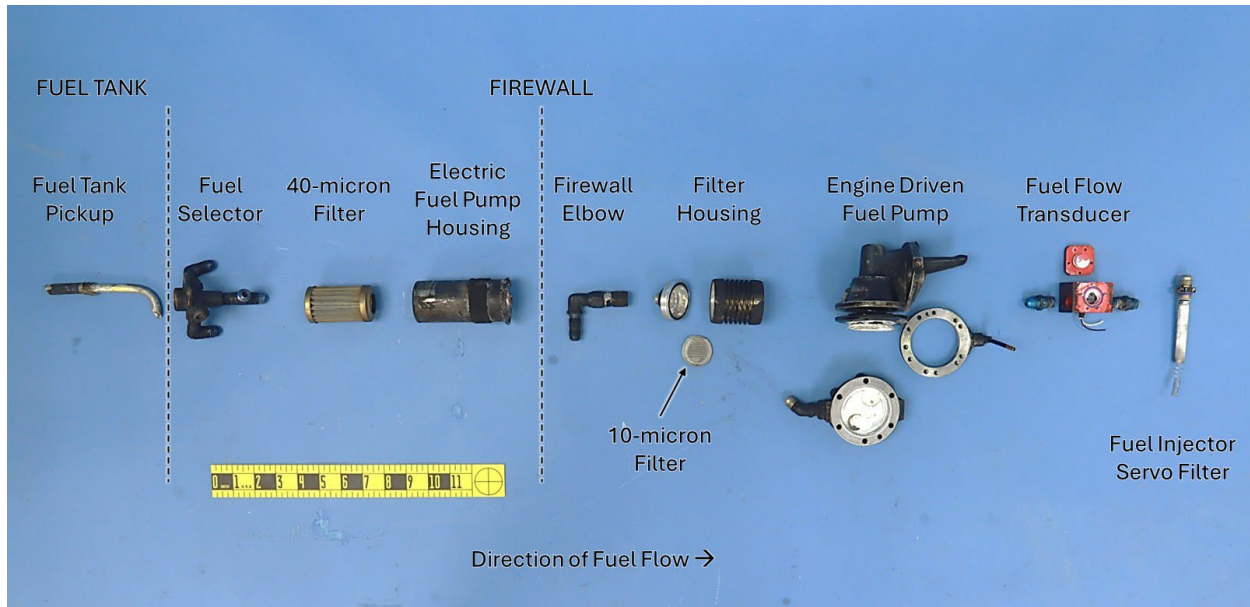


Figure 1. Photograph of as received fuel system components placed in series relative to the direction of fuel flow and the position of the firewall.



Figure 2. Photograph of the fuel tank pickup with attached screen which was fractured above the tubing bend. A deposit of molten metal was observed at the end of the screen.

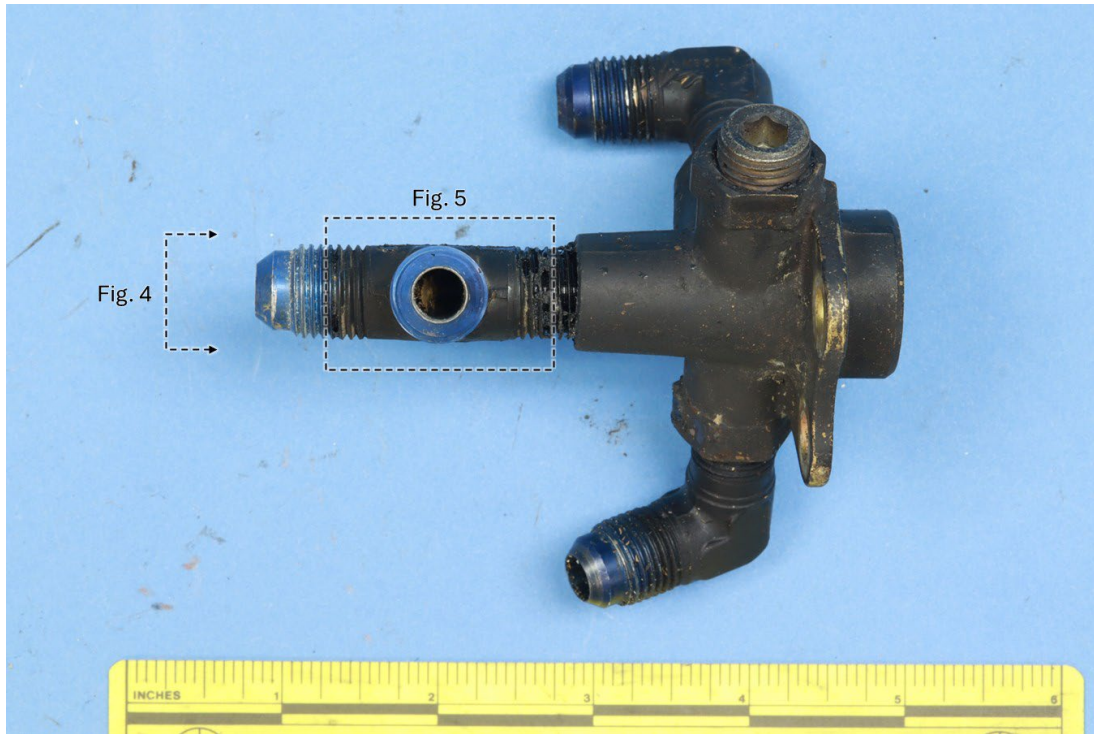


Figure 3. Photograph of the fuel selector. Closer views of the indicated areas are shown in subsequent figures.



Figure 4. Closer view of the fuel selector fitting indicated in figure 3 where a white material deposit was observed on the inner surface of the fitting.

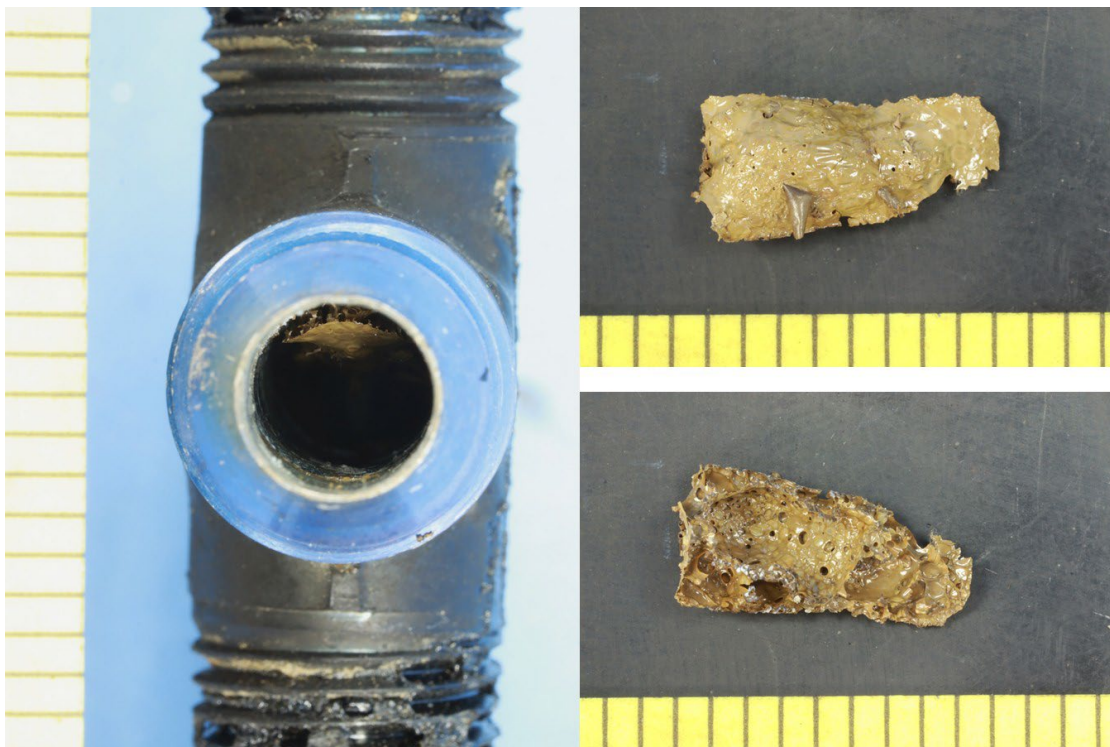


Figure 5. Closer view of the fuel selector fitting indicated in figure 3 where a tan material was observed on the inner surface of the fitting. The right images show opposite sides of the tan material after extraction from the fitting.



Figure 6. Photograph of the 40-micron fuel filter element.



Figure 7. Photograph of the exterior of the electric fuel pump housing. Black soot deposits were observed covering the outer surface.



Figure 8. Photograph of one end of the electric fuel pump housing where a white material was observed inside the housing.



Figure 9. Photograph looking axially through the electric fuel pump housing showing another view of the white material observed between two curved plate magnets in the housing.



Figure 10. Photograph of the firewall elbow placed in series relative to the 10-micron fuel filter housing (disassembled) and the pleated filter element.



Figure 11. Closer views of each end of the firewall elbow fittings where tan material deposits were observed on the inner surfaces of the fittings.



Figure 12. Photographs of the interior surfaces of the 10-micron fuel filter housing where off-white material deposits were observed.



Figure 13. Photographs of each side of the 10-micron filter element where off-white material deposits were observed between filter pleats, examples of which are indicated by yellow arrows.



Figure 14. Photograph of the disassembled engine driven fuel pump.

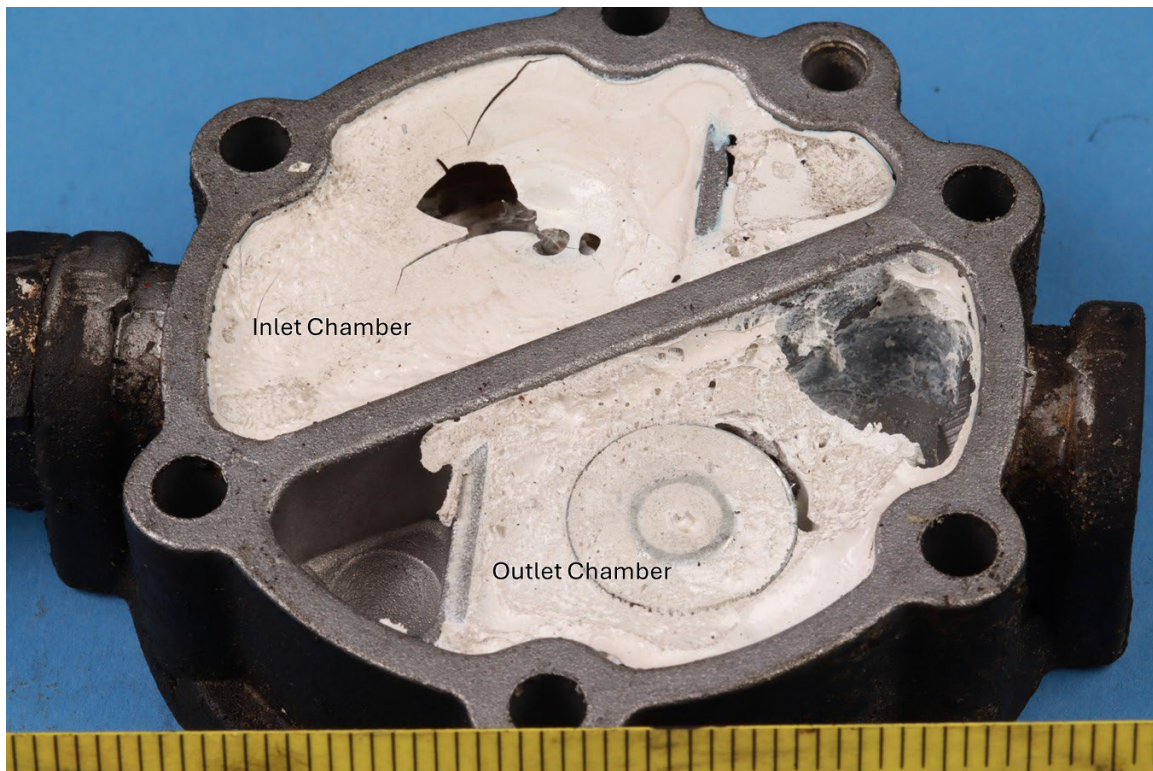


Figure 15. Closer view of the base of the engine driven fuel pump where a white material was observed filling the inlet and outlet chambers.

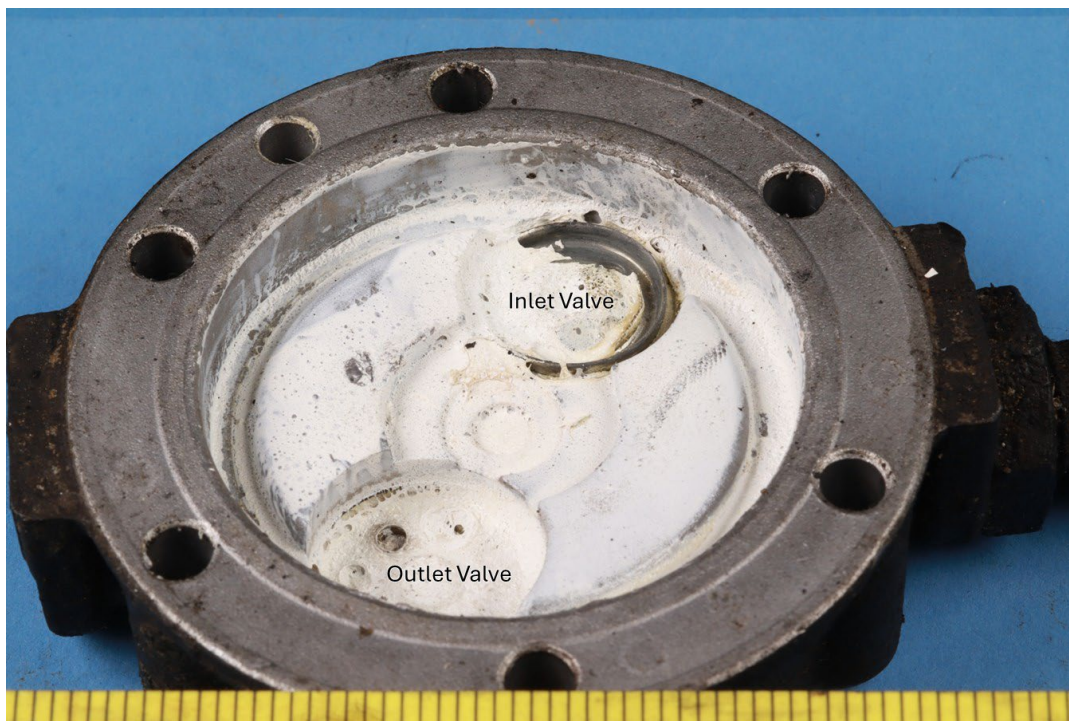


Figure 16. Closer view of the opposite side of the base of the engine driven fuel pump shown in the previous figure. A similar white material was observed in this chamber and surrounding the valves.



Figure 17. Photograph of the fuel pump body with the diaphragm seals as viewed from the pumping chamber side. A similar white material was observed covering the pumping chamber components.

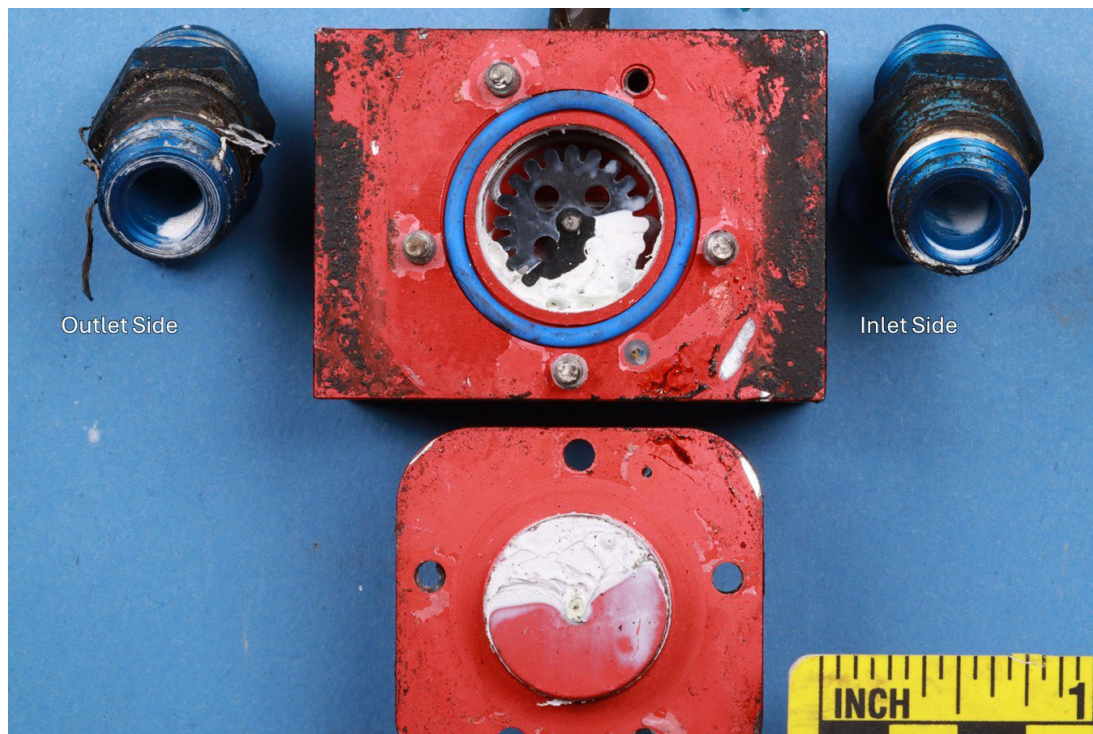


Figure 18. Photograph of the fuel flow transducer with cover plate removed and inlet/outlet fittings (disassembled). A white material was observed inside the transducer and on the inner surfaces of the fittings.



Figure 19. A closer view of the interior of the fuel flow transducer shown in the previous figure showing a black wheel component entangled in a white material.



Figure 20. Photograph of the fuel injector servo filter where a white material was observed on and protruding from the filter screen element.



Figure 21. A view looking into the fitting of the servo filter element where a white material obstructed the interior of the fitting.