

National Transportation Safety Board

Office of Research and Engineering

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WPR23LA278

MATERIALS LABORATORY

Factual Report 24-078

November 13, 2024

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Location: Farmington, Utah
Date: July 19, 2023
Vehicle: Aero AS-355E, N102UM
Investigator: Elliott Simpson

Engine compressor bleed valve assembly from an Allison 250 engine.

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Figure 1 shows a photograph of the as-received parts from the engine compressor bleed valve assembly. The diaphragm contained a circumferential crack that penetrated the sidewall portion, as shown in figures 2 and 3. The diaphragm was specified by Allison as a composite material containing Nomex bidirectional fabric fibers in a matrix of fluorosilicone rubber elastomer. The crack penetrated the fabric fibers and elastomer portions. The length of the crack on the outer surface measured approximately 0.15 inch.

The diaphragm was ultrasonic cleaned with Alconox, a commercial detergent, followed by rinsing in methanol alcohol, and left to dry in air. Scanning electron microscope (SEM) examination of the diaphragm revealed the ends of many fibers were elongated. Several fibers in the area of separation were reduced to nearly a knife edge. Many of fibers exhibited evidence of severe mechanical damage (such as from fracture faces contacting each other). The non-damaged fracture faces of the fibers showed evidence of either a shear fracture, or cup and cone features typical of

overstress separation. Figures 3 through 5 show examples of fiber fractures. The elastomer portion showed no evidence of fatigue cracking.

The gasket (see figure 1) appeared to be made from discontinuous random fibers in a sheet of cardboard-like matrix material that was fractured at two locations. Stereo microscope examination of the gasket revealed the fracture faces of the matrix material were on irregular slant (shear) planes typical of overstress separation.

Submitted by:

Frank Zakar
Sr. Metallurgist

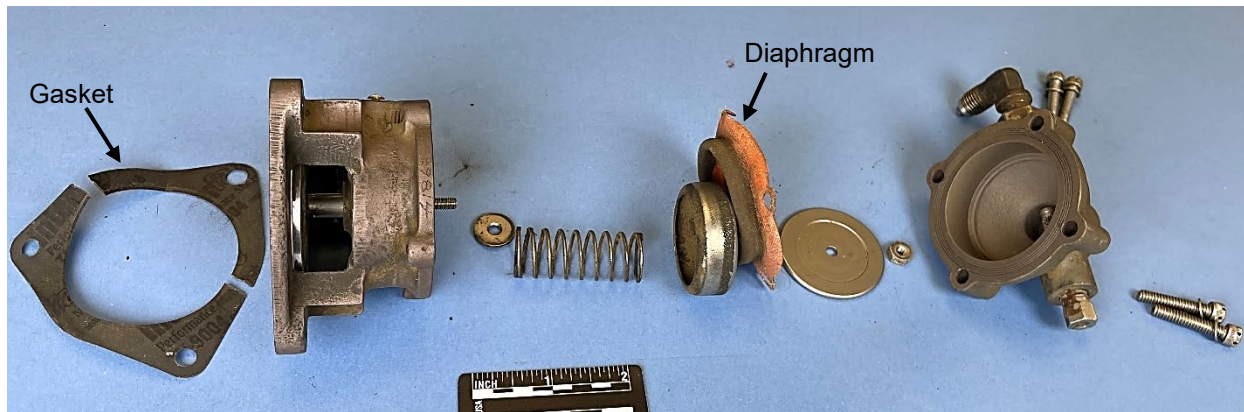


Figure 1. As-received pieces of the engine compressor bleed valve assembly.

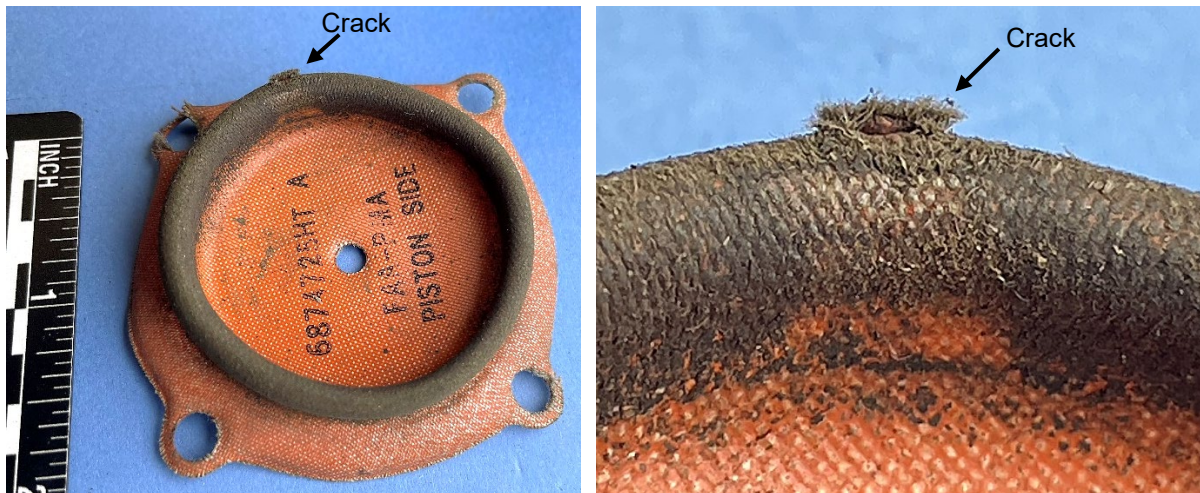


Figure 2. As-received diaphragm with a crack as seen on the outer surface of the sidewall.

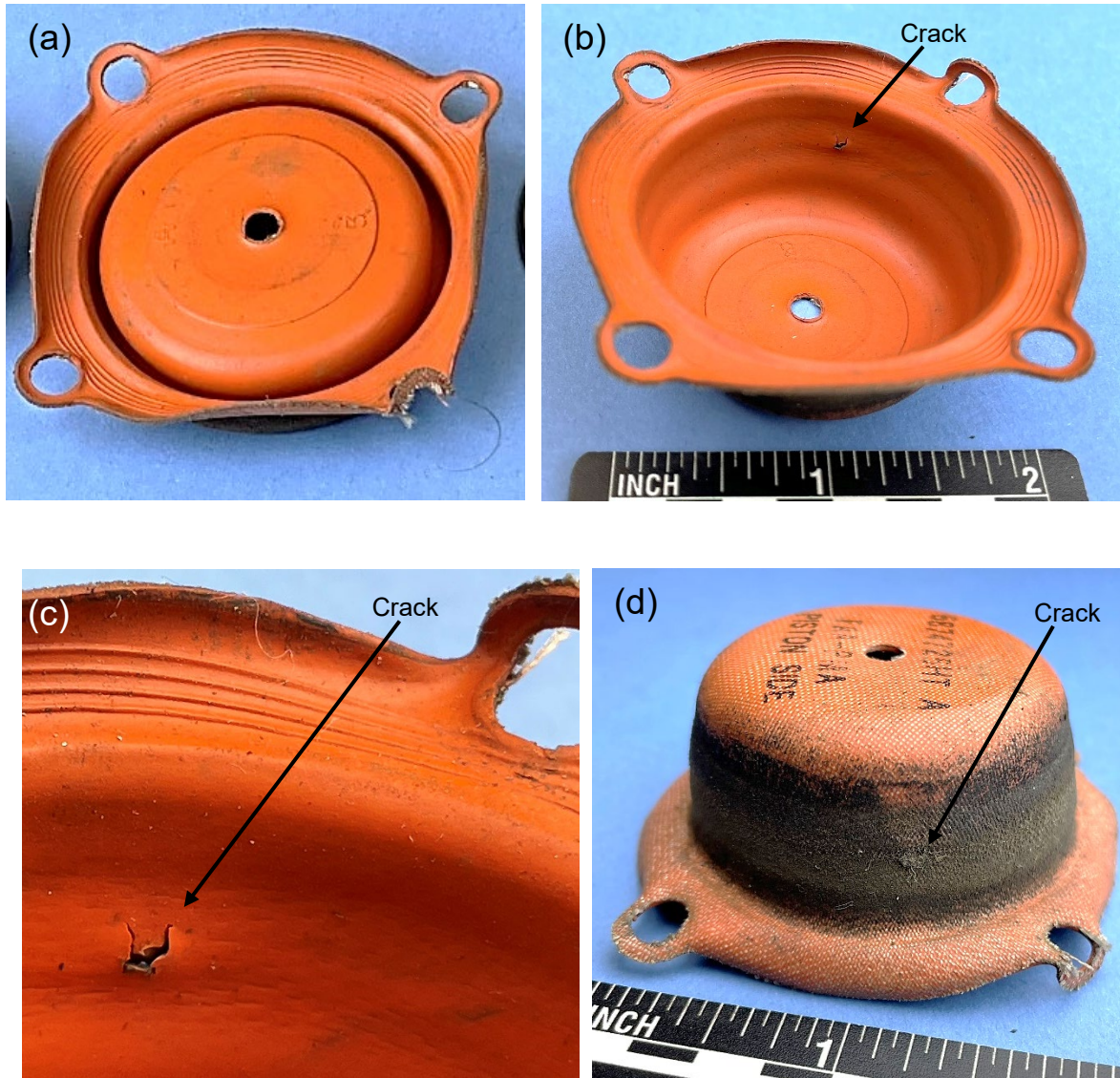


Figure 3. Diaphragm (a) in the as-received condition showing the inner surface of the sidewall ; (b) in the fully stretched condition showing the inner surface of the sidewall and crack; (c) in the fully stretched condition showing a close-up of the crack in the inner surface of the sidewall; (d) in the fully stretched condition showing the outer surface with crack.

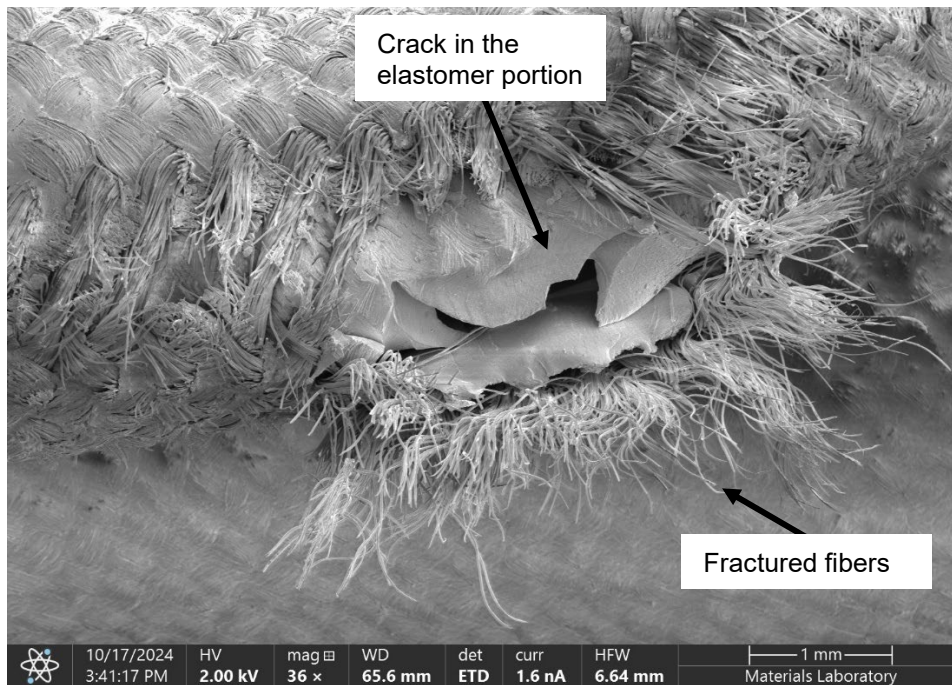


Figure 3. SEM image of the diaphragm showing a crack on the outer surface of the sidewall; after cleaning and before fully stretching out the body of the diaphragm.

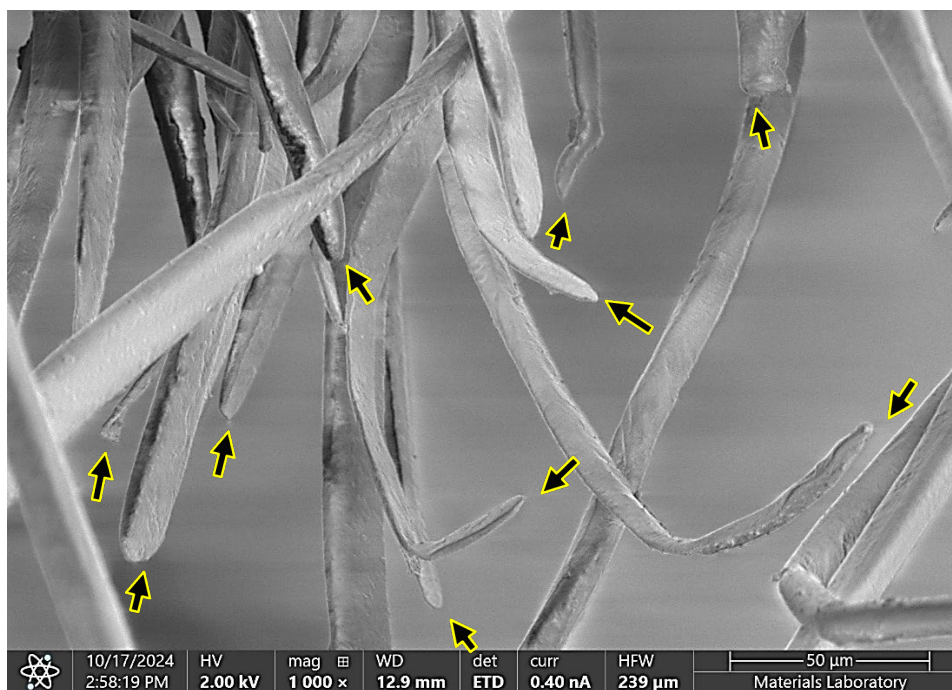


Figure 4. SEM image of the diaphragm in the area of the crack showing the fractured ends of several fibers, indicated by arrows. (1,000X)

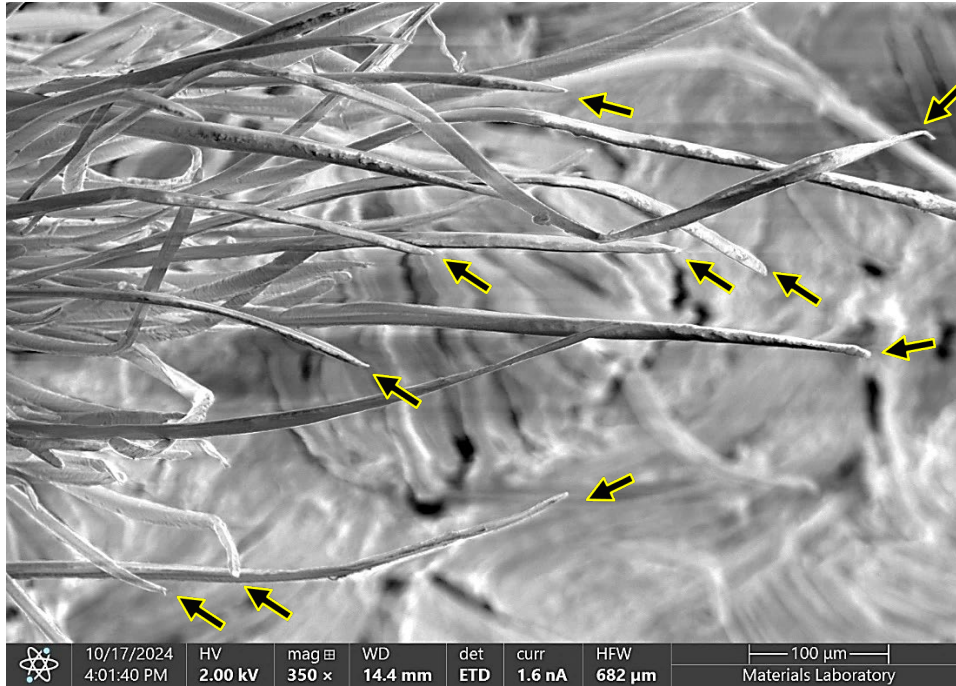
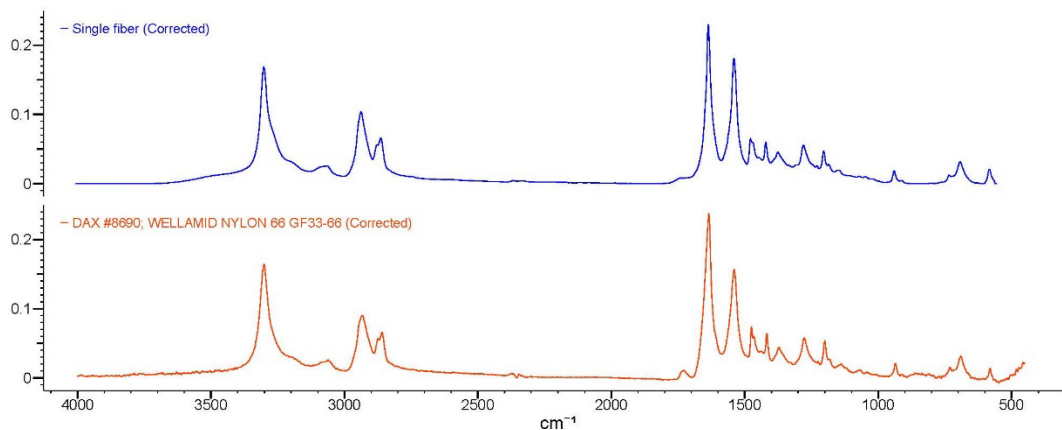
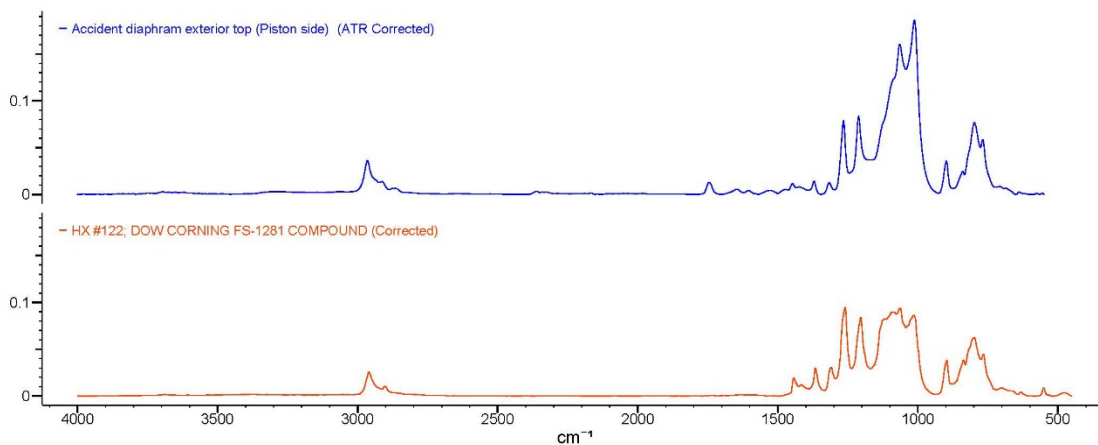


Figure 5. SEM image of the diaphragm in the area of the crack showing the fractured ends of several fibers, indicated by arrows. (350X)

Attachments



Attachment 1. FTIR spectrum of a fractured fiber portion (top) from the diaphragm involved in the accident compared to an FTIR spectrum of Nylon 66 (a polyamide material) from an FTIR reference library (bottom). Both appear similar.



Attachment 2. FTIR spectrum of the flexible elastomer portion (top) from the diaphragm involved in the accident compared to an FTIR spectrum of Dow Corning FS-1281 compound (containing fluorosilicone) from a reference library (bottom). Both share similar peaks.