

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



ERA24LA333

MATERIALS LABORATORY

Factual Report 25-001

February 3, 2025

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A. ACCIDENT INFORMATION

Location: Egg Harbor City, NJ
Date: July 31, 2024
Vehicle: Cirrus SR20 (N124RR)
Investigator: Aaron McCarter

B. COMPONENTS EXAMINED

The halves of a butterfly valve that had been the alternate air valve in an engine induction housing. Also included were two screws that had held the valve in place in the induction housing and a piece of rubber that had been between the two halves as assembled.

C. EXAMINATION PARTICIPANTS

Specialist Brian Fuchs, Ph. D.
National Transportation Safety Board
Washington, D.C.

D. DETAILS OF THE EXAMINATION

The pieces of the valve as received are shown in Figures 1 and 2. One half of the valve contained four fractured rivets embedded into the surface. These fracture surfaces were visible on the interior of the valve. All the broken rivets protruded approximately 0.11 inch above the interior face, as measured with digital calipers. One rivet head remained attached to the other half of the valve. Later cleaning of the valve caused the rivet head to detach, and it was found that the fracture surface was approximately level with the exterior surface of the valve.

The valve halves were cleaned in an ultrasound bath with acetone. Examination of the rivet fracture surfaces under an optical stereoscope showed striations on all four surfaces, interspersed with shiny planes consistent with rubbing or contact post-fracture. The rivets were arbitrarily labeled 1 through 4 (as displayed in Figure 3) and were examined using a field-emission scanning electron microscope (SEM).

Secondary electron (SE) micrographs of the rivets are shown in Figures 4 - 7. All four fracture surfaces showed striations consistent with fatigue crack propagation alongside small areas of ductile dimples consistent with final overstress failure. Rivets 1, 2, and 3 also showed ratchet marks, indicating multiple cracks originating from the outer edge of the rivet. The fracture surface features, including the location and shape of the ductile dimpling surfaces were consistent with bending or torsion-bending stresses on the rivets.

The assembly screws were cleaned in an ultrasound bath with acetone and examined for thread damage. Smearing and blunting consistent with contact damage were noted on the final two threads of each screw (Figure 8).

Submitted by:

Brian Fuchs, Ph. D.
Materials Engineer

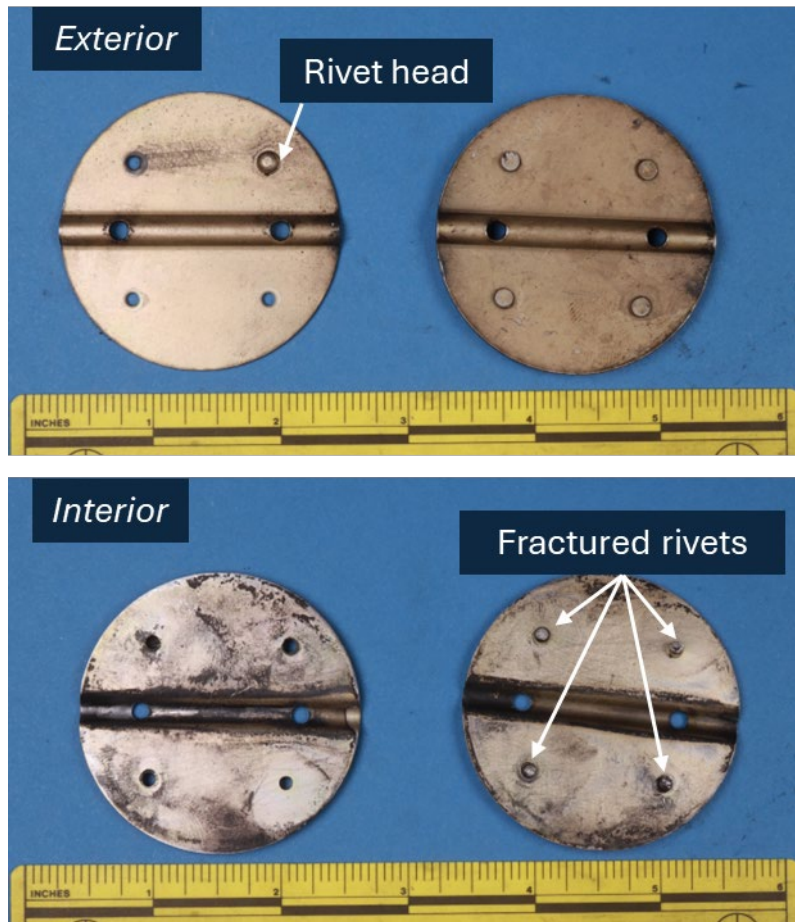


Figure 1. Metal halves of the butterfly valve as received. (Top) Outer surfaces. (Bottom) Inner surfaces.

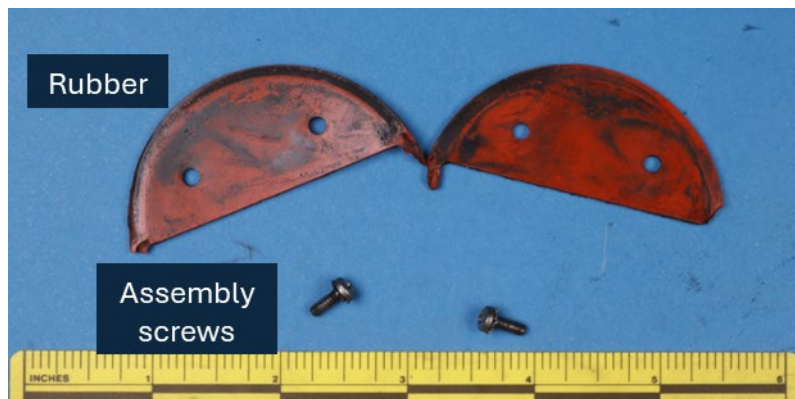


Figure 2. Rubber padding and screws from the butterfly valve as received.

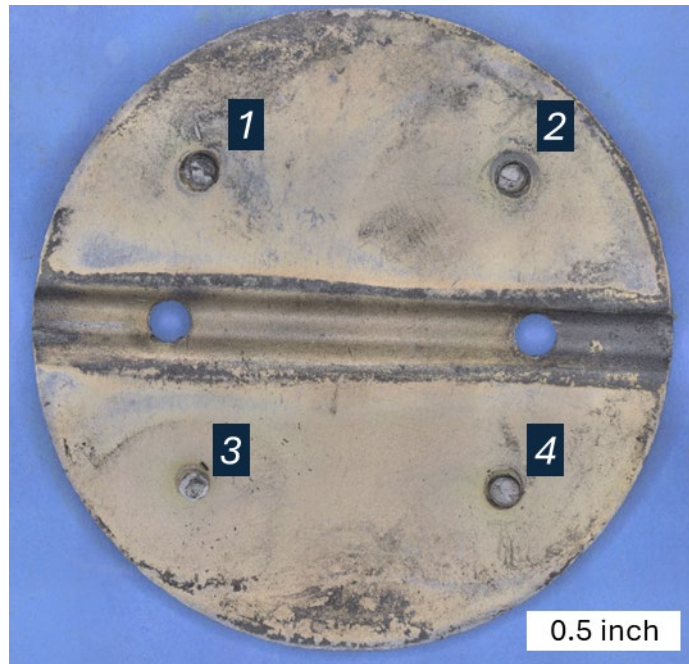


Figure 3. Valve and rivet fracture surfaces after cleaning with acetone.

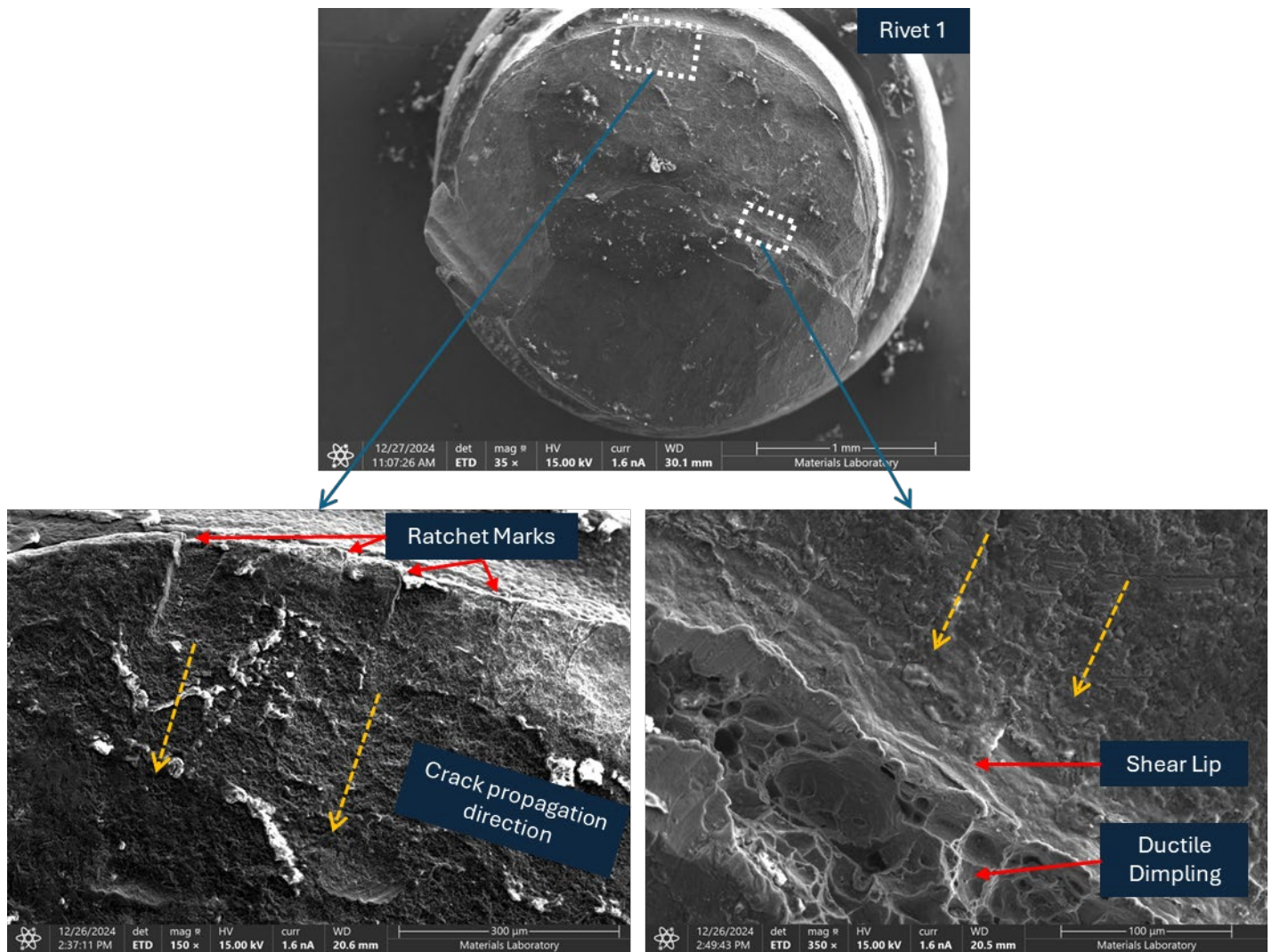


Figure 4. (Top) SE micrograph of the Rivet 1 fracture surface. (Bottom left) Ratchet marks on the outer edge of the fracture surface. Striations indicate the direction of crack propagation towards the center of the rivet. (Bottom right) The boundary between crack progression striations and the ductile dimpling consistent with overload failure.

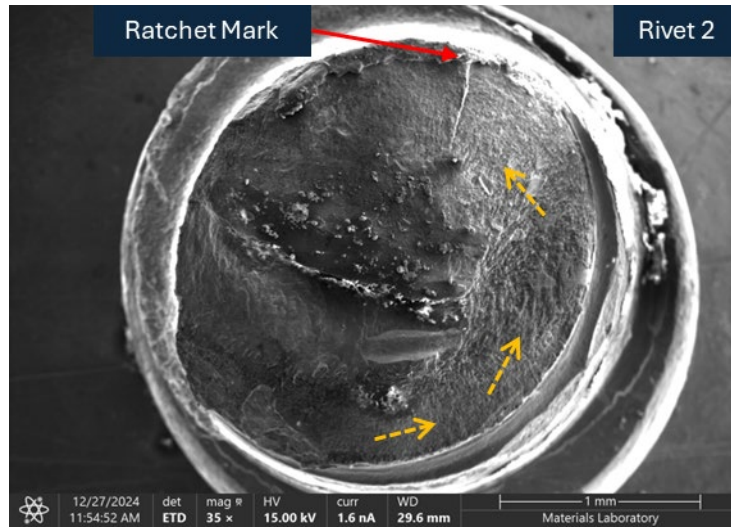


Figure 5. Crack progression striations and ratchet marks visible on Rivet 2. Orange lines indicate the direction of crack progression.

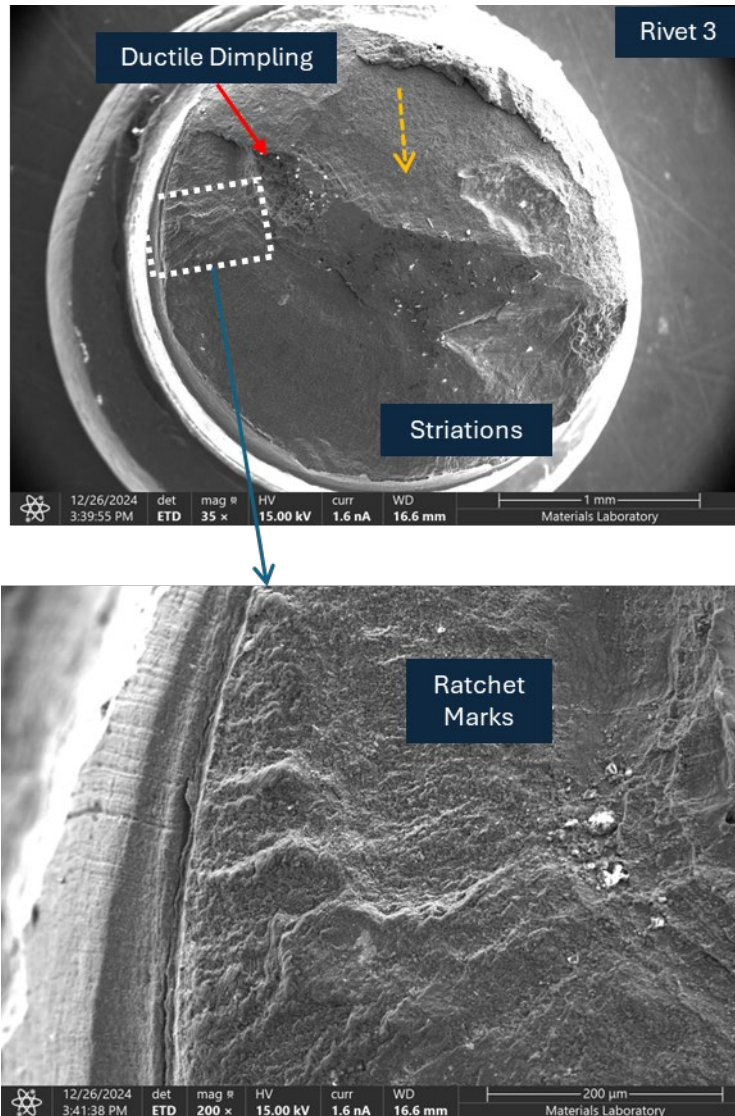


Figure 6. (Top) Crack progression striations progressing from the outer edges of Rivet 3. Ductile dimpling was observed near the center of the rivet. Orange lines indicate the direction of crack progression. (Bottom) Ratchet marks on the outside edge of the fracture surface.

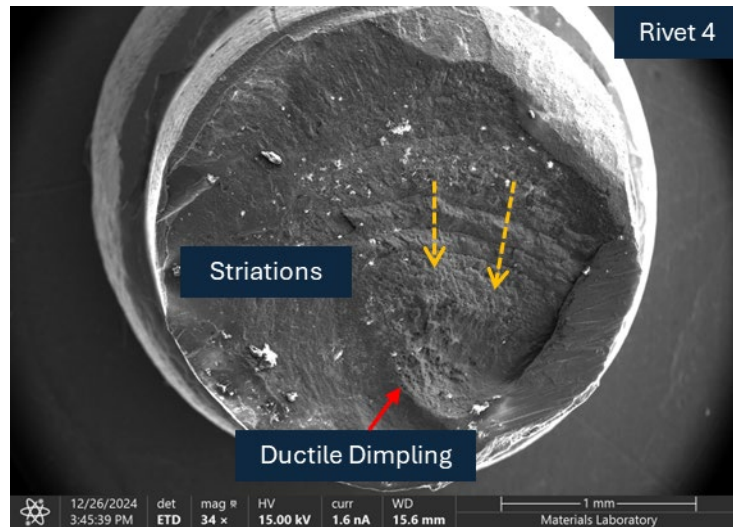


Figure 7. Crack progression striations on the fracture surface of rivet 4, consistent with torsion-bending fatigue. Orange lines indicate the direction of crack progression.

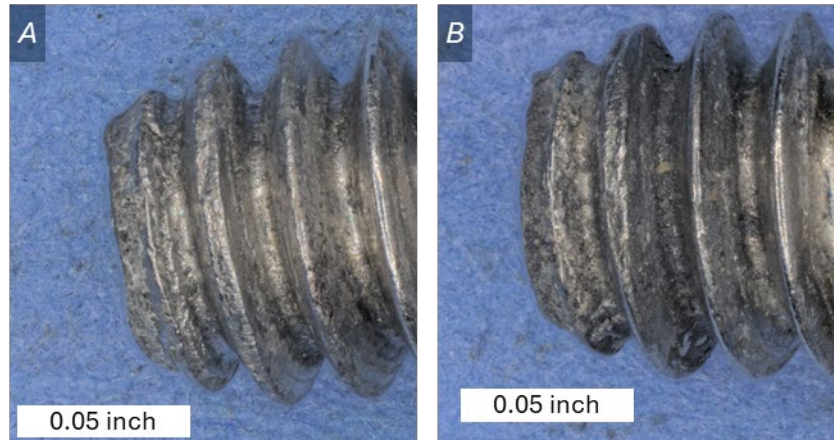
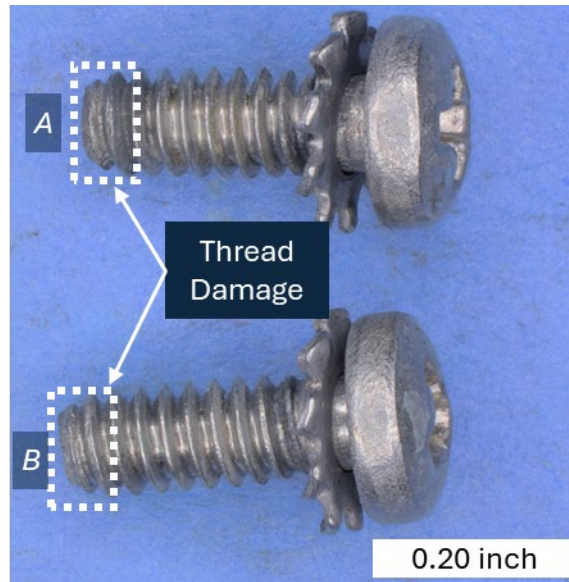


Figure 8. (Top) The final two threads in both screws were damaged. (Bottom images) close-up of the damage areas labeled in the top images. The crests of the final two threads show smearing damage.