

NATIONAL TRANSPORTATION SAFETY BOARD

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



September 30, 2020

MATERIALS LABORATORY FACTUAL REPORT

Report No. 20-053

A. ACCIDENT INFORMATION

Place : Senoia, GA
Date : January 25, 2020
Vehicle : Mustang II Experimental (unregistered)
NTSB No. : ERA20FA086
Investigator : Robert Gretz (AS-ERA)

B. COMPONENTS EXAMINED

Canopy frame pieces and vertical stabilizer with mating fuselage pieces.

C. DETAILS OF THE EXAMINATION

The accident aircraft was performing aerobatic maneuvers when it broke apart in-flight. According to witnesses, the canopy opened and separated from the fuselage and the vertical stabilizer departed the aircraft prior to impact. Several pieces of canopy frame, a portion of the fuselage, and the vertical stabilizer were all submitted to the NTSB Materials Laboratory for examination.

The canopy frame pieces are shown in Figures 1-4. Numerous dents and bends were observed on the canopy pieces. There were separations in the canopy frame near the left aft corner junction and through the horizontal tube near the rear of the frame, as shown in Figures 1 and 2, respectively. The fracture features of both separations were consistent with overstress.

A Mustang II Compendium revised January 3, 2020 outlined, among other items, the placement of gussets in the aft corner junctions of the frame, which were meant to strengthen the canopy framework. As shown in Figure 3, the canopy frame from the accident aircraft did not have gussets in place.

The canopy locking mechanism, shown in Figure 4, was intact, could still be mechanically manipulated, and appeared functional. Figure 5 shows the left and right attachment locations of the forward tube. Yellow arrows point to deformation of the bolt holes in the tube consistent with pull-out of the mating bolts.

The separated vertical stabilizer is shown in Figure 6. A portion of the doubler for the main rib was missing adjacent to a left attachment rivet. A flat area was observed on the fracture surface at the corner of the doubler, as shown in Figure 7. The flat area was

examined using a 5-50x zoom digital microscope. The black dotted line in Figure 8 outlines a thumbnail-shaped pattern observed on the flat area. The thumbnail-shaped pattern was consistent with fatigue cracking emanating from the internal corner of the doubler. Ratchet marks consistent with multiple initiation fatigue cracking were observed along the internal edge of the aft doubler rib. While damage obscured the exact fatigue initiation site, the orientation of the thumbnail-shaped pattern and the location of the ratchet marks indicate the fatigue cracking likely started at the internal corner of the aft doubler rib.

The forward attach point on the vertical stabilizer is shown in Figure 9. The mating bolt was missing when the vertical stabilizer was recovered. Wear was observed on one side of the bolt hole in the attach point, making the hole out of round, as illustrated by the yellow dotted lines. Rolled material was observed on the bottom of the attach point, as indicated by the white arrows. The irregular shape of the bolt hole and the rolled material is constituent with wear that occurred over time. A profile view of the attach point shows it was flat and did not have deformation associated with pull-out of the mating bolt.

The portion of fuselage skin and internal structure submitted for examination is shown in Figure 10. The fracture features on the skin and structural rib pieces of the fuselage were consistent with overstress.

The bolt hole through the rib that mated with the forward attach point of the vertical stabilizer was still attached to the submitted fuselage pieces, as shown in Figure 11. The threads of the bolt hole were examined using a 5-50x zoom digital microscope. Digital microscope images of the threads are shown in Figure 12. The threads had some flattening but were largely intact. Oxidation covered the surfaces of the threads. It could not be determined if the oxidation was a passivation layer formed prior to the accident or was due to exposure of the threads post-accident. No stripping or other thread deformation associated with pull-out of the mating bolt was observed.

Adrienne V. Lamm
Materials Engineer

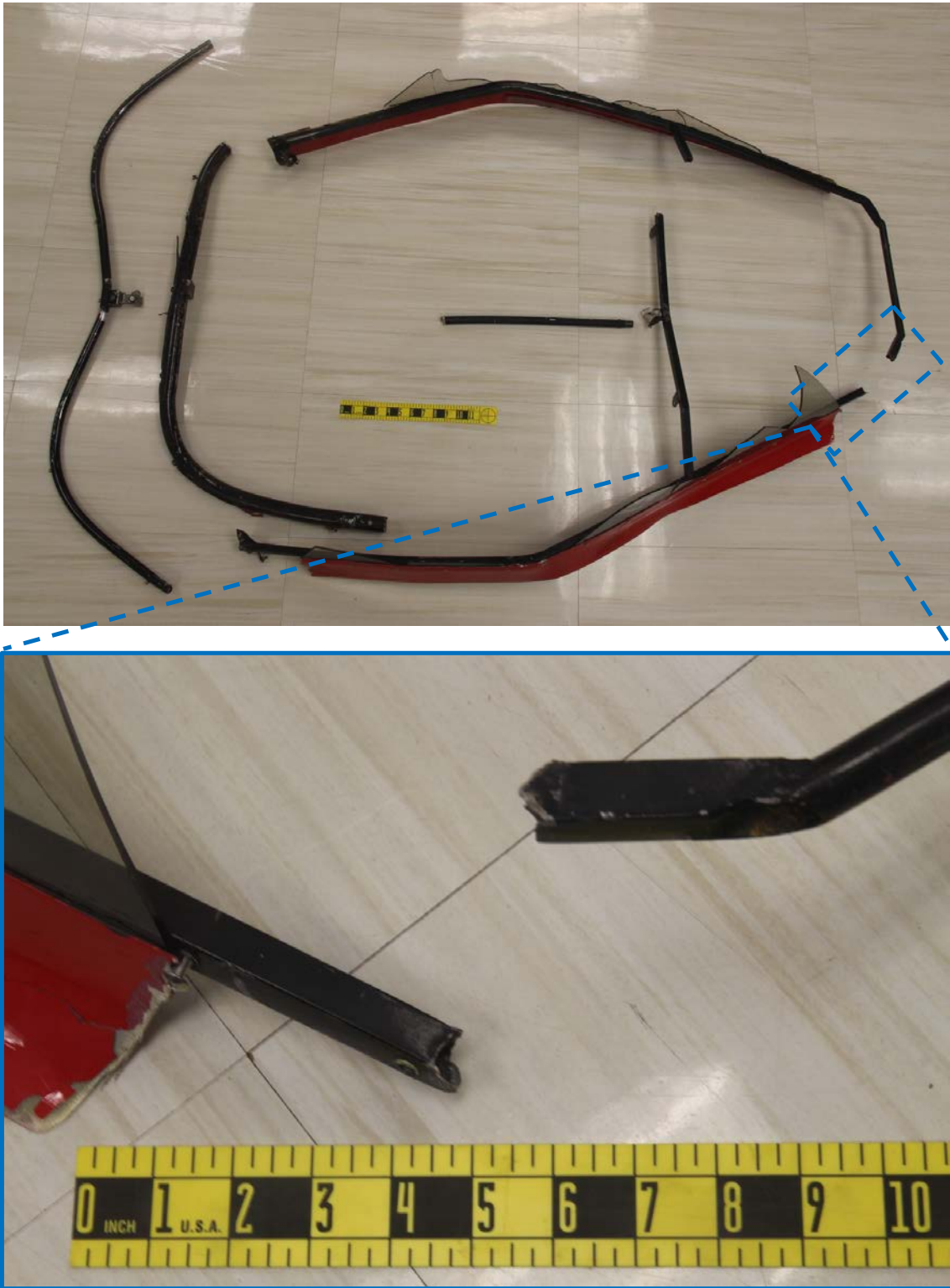


Figure 1: The top shows an overall photo of the canopy frame pieces. The bottom shows a close-up photo of a separation in the canopy frame near the left aft corner junction.

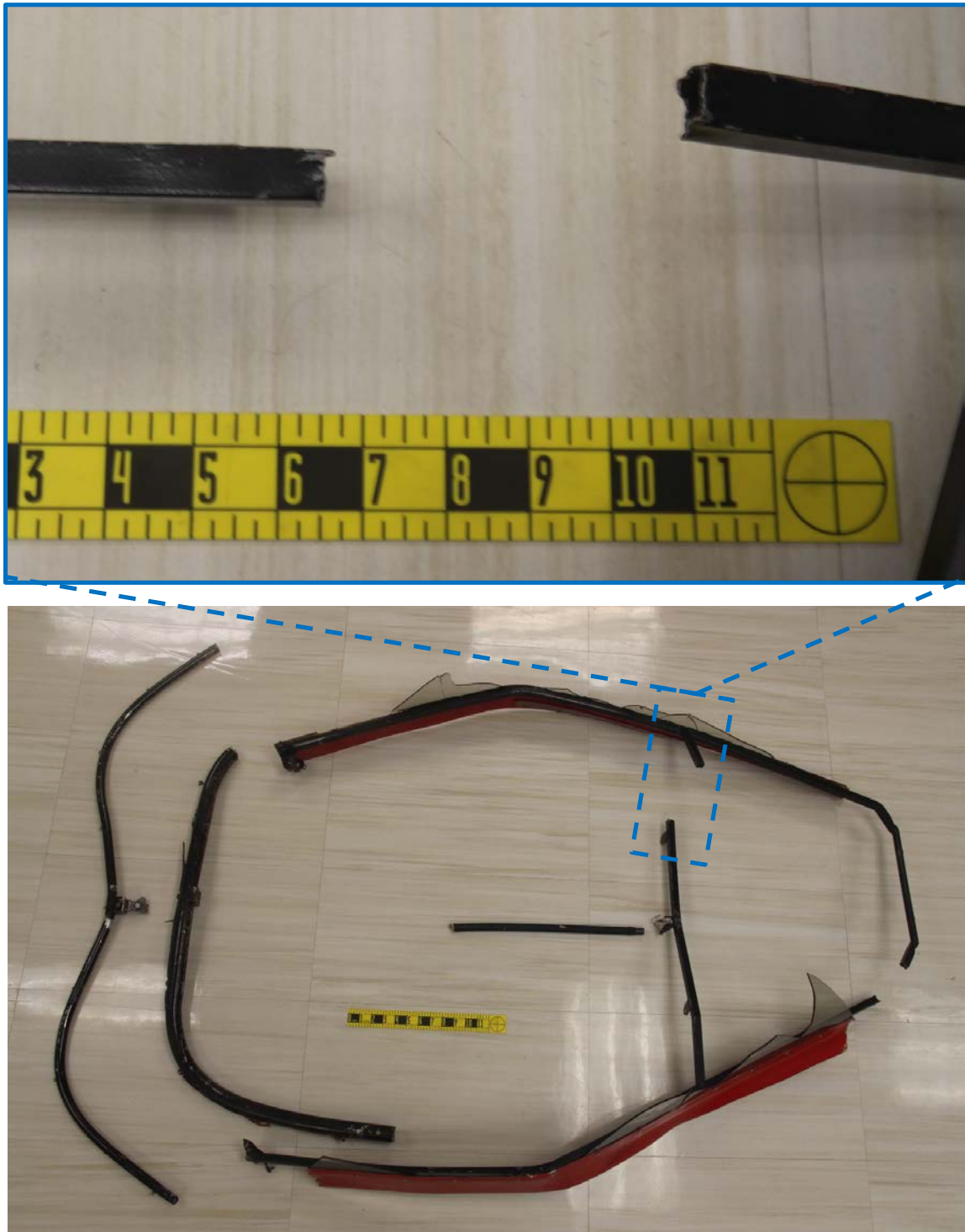


Figure 2: The bottom shows an overall photo of the canopy frame pieces. The top shows a close-up photo of a separation in the canopy frame through the horizontal tube near the rear of the frame.

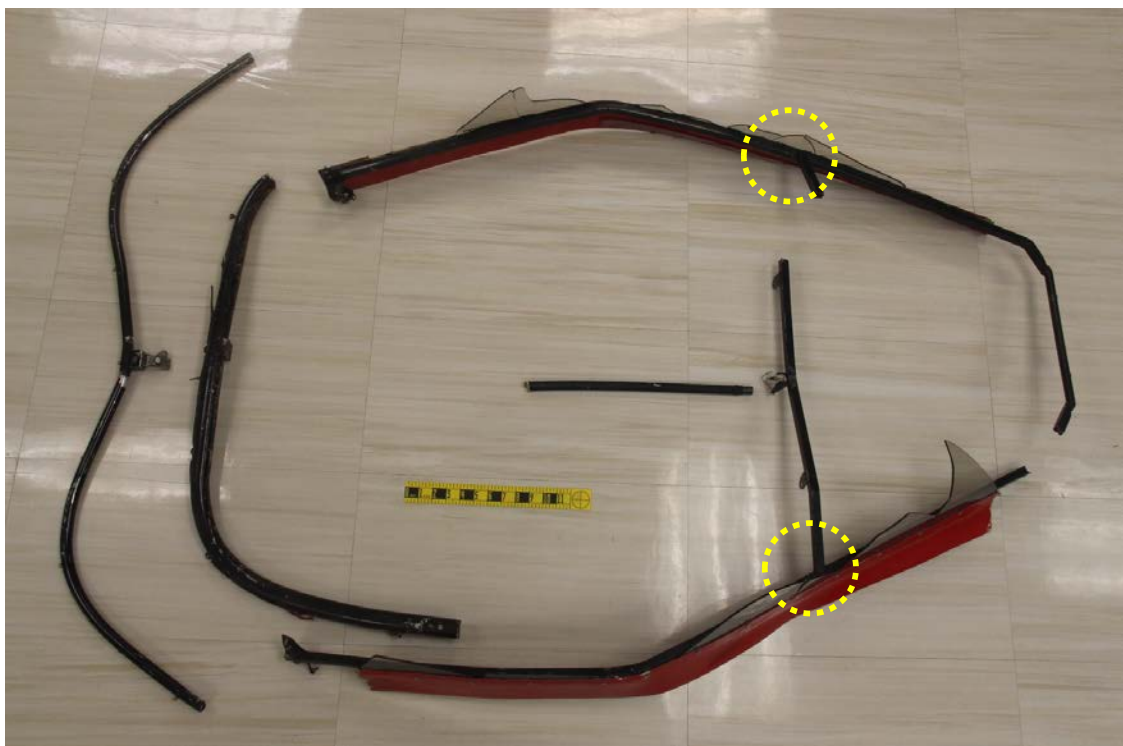
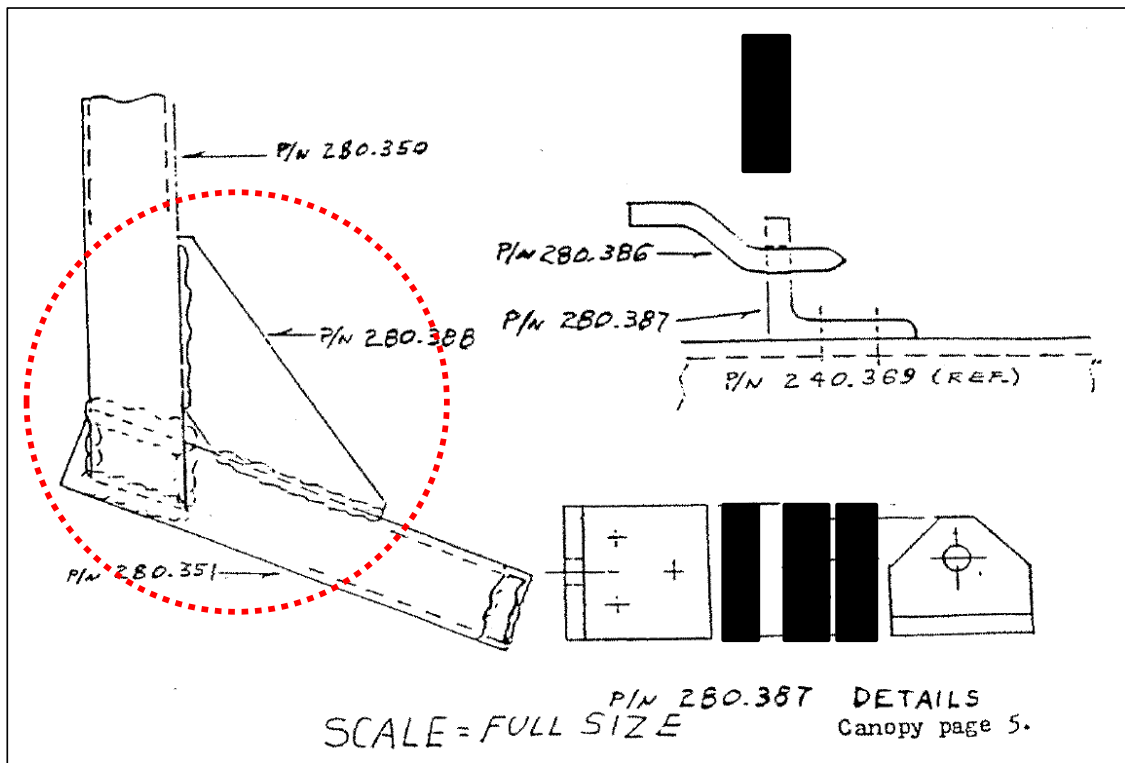


Figure 3: The top image shows a portion of the Mustang II Compendium revised January 3, 2020 with the gusset at the aft junction corners encircled in a red dotted line. The bottom shows an overall photo of the canopy frame pieces, with yellow dotted circles indicating the aft junction corners without gussets installed.



Figure 4: The bottom shows an overall photo of the canopy frame pieces, and the top shows a close-up photo of the canopy locking mechanism.

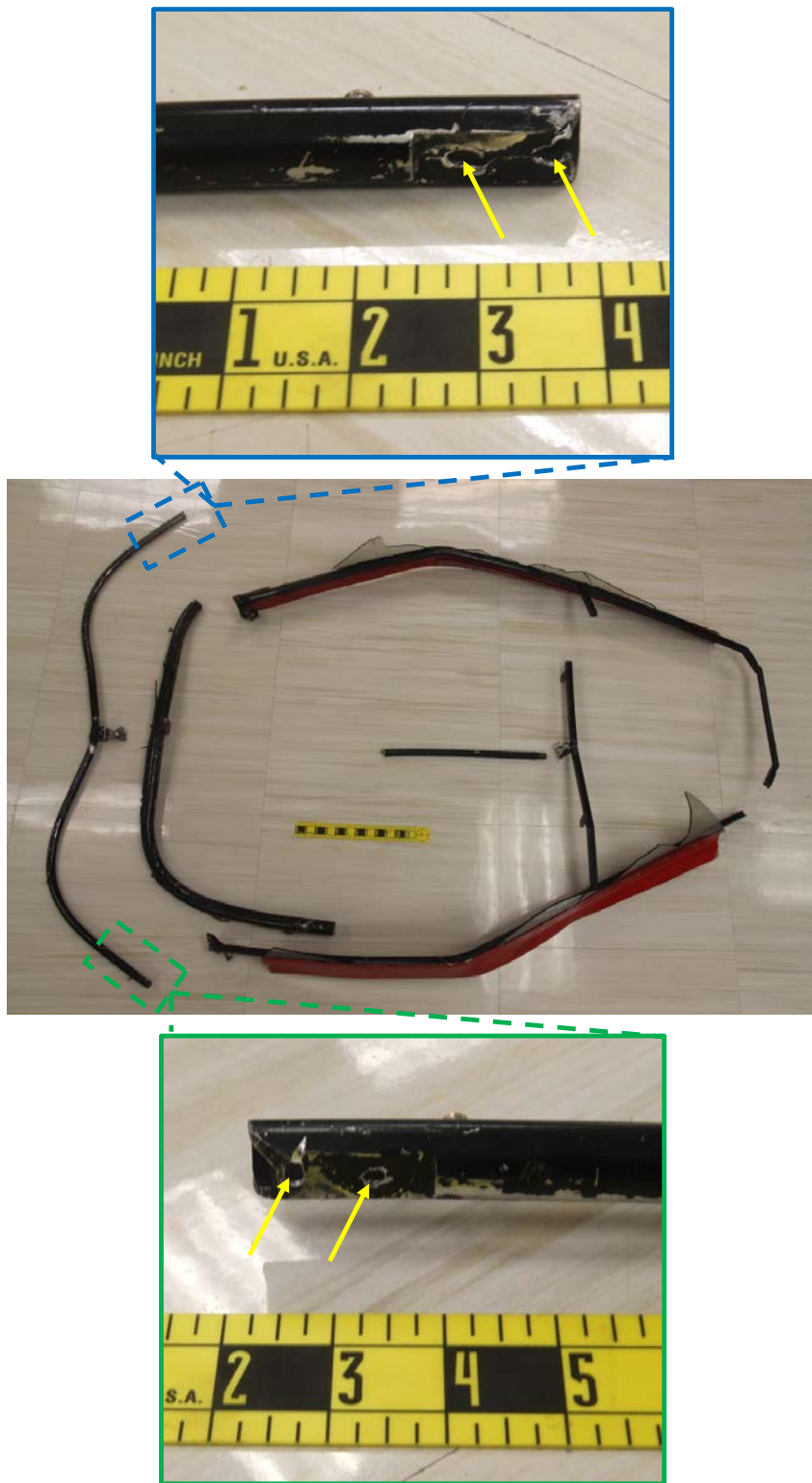


Figure 5: The center shows an overall photo of the canopy frame pieces. The top and bottom photos show the right and left attachment locations, respectively, of the forward tube. Yellow arrows point to deformation of the bolt holes in the tube.



Figure 6: The top shows an overall photo of the separated vertical stabilizer. The bottom photo is a close-up of the left corner of the main rib doubler.



Figure 7: A close-up photo (top) and digital microscope image (bottom) of a flat area on the fracture surface at the corner of the doubler.

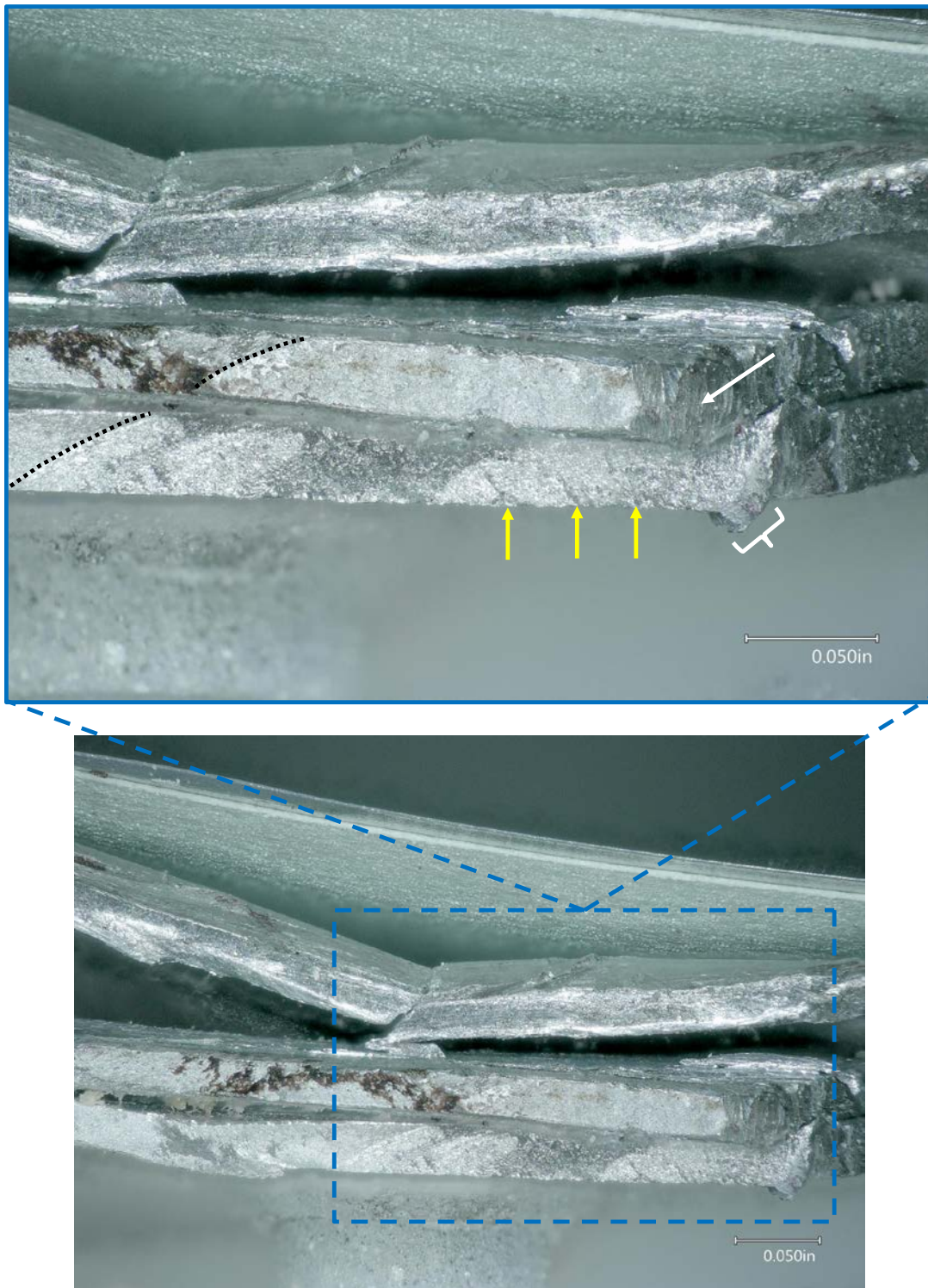


Figure 8: Digital microscope images of the flat area on the fracture surface at the corner of the doubler. The black dotted line outlines the thumbnail-shaped pattern emanating from the doubler corner. The yellow arrows point to ratchet marks along the internal edge of the aft doubler rib. The white bracket and arrow indicate damage obscuring the corners of the doubler ribs.



Figure 9: Close-up photos of the forward attach point (red arrow, top photo) on the vertical stabilizer. The top and bottom of the attach point bolt hole are shown in the center left and right photos, respectively. The yellow dotted lines illustrate a round bolt hole. The white arrows point to rolled material. The bottom photo shows a profile view of the attach point.

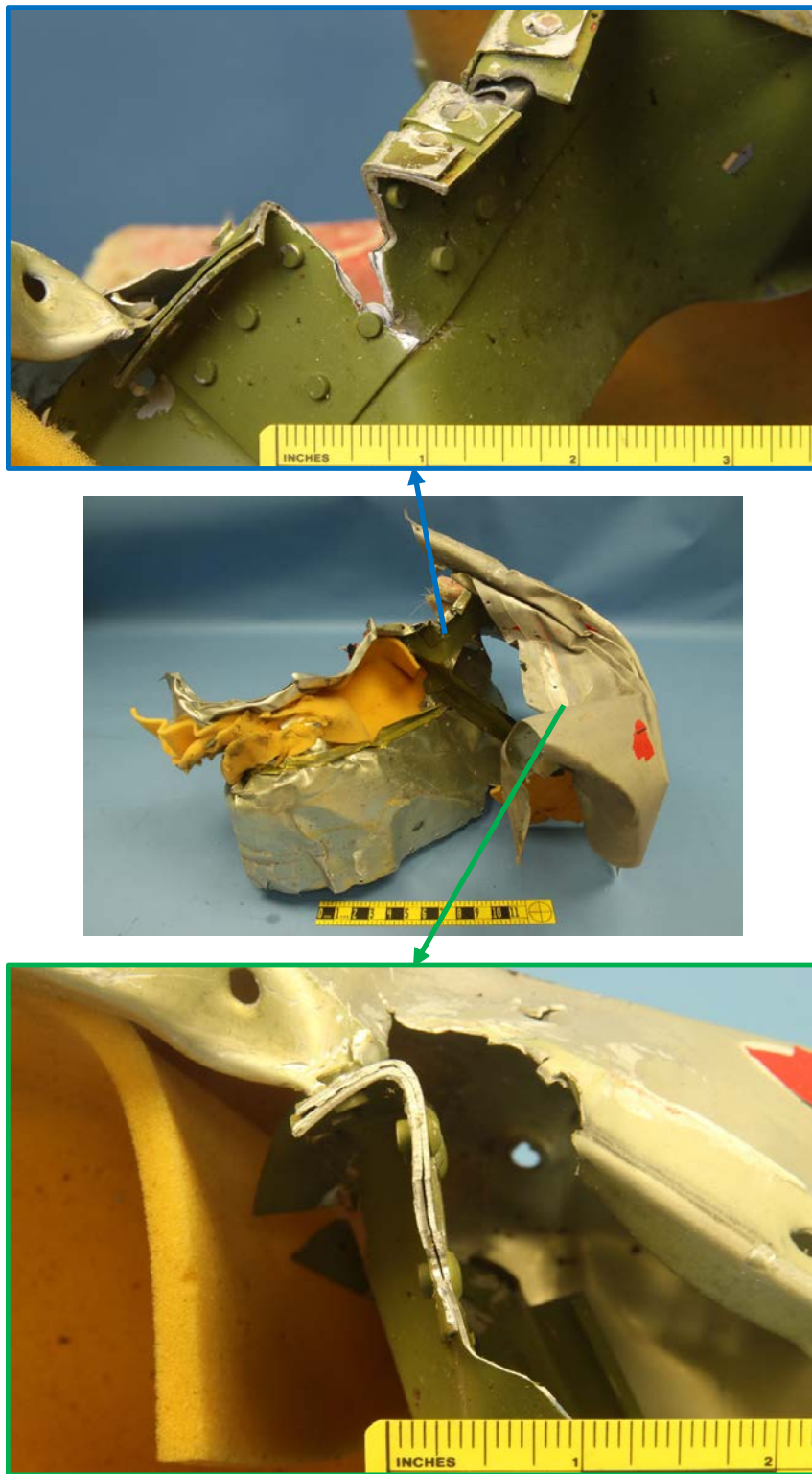


Figure 10: Overall photo of the submitted fuselage piece is shown in the center. The top and bottom photos show some of the fractures in the ribs of the piece.

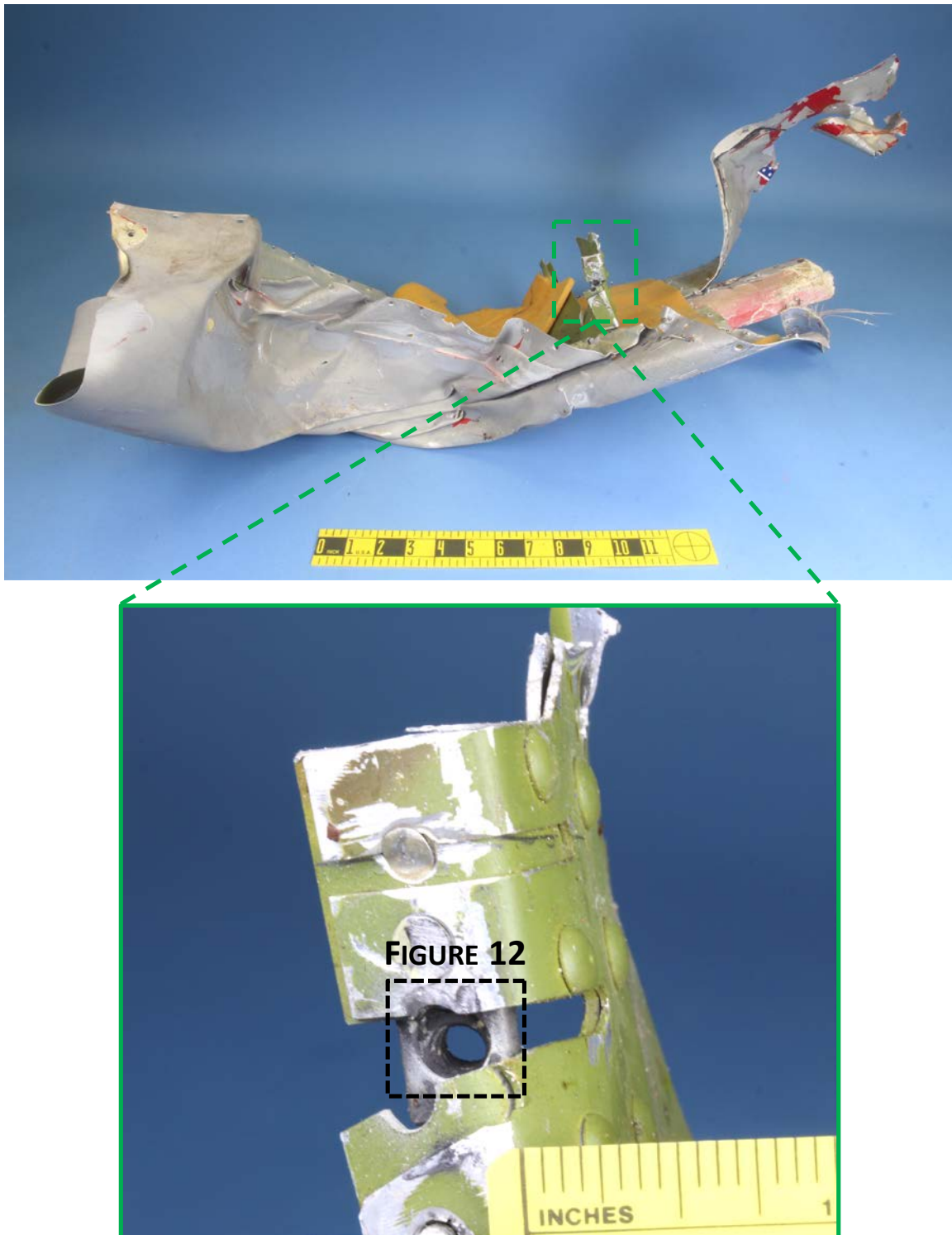


Figure 11: Overall (top) and close-up (bottom) photos of the bolt hole through the rib that mated with the forward attach point of the vertical stabilizer.

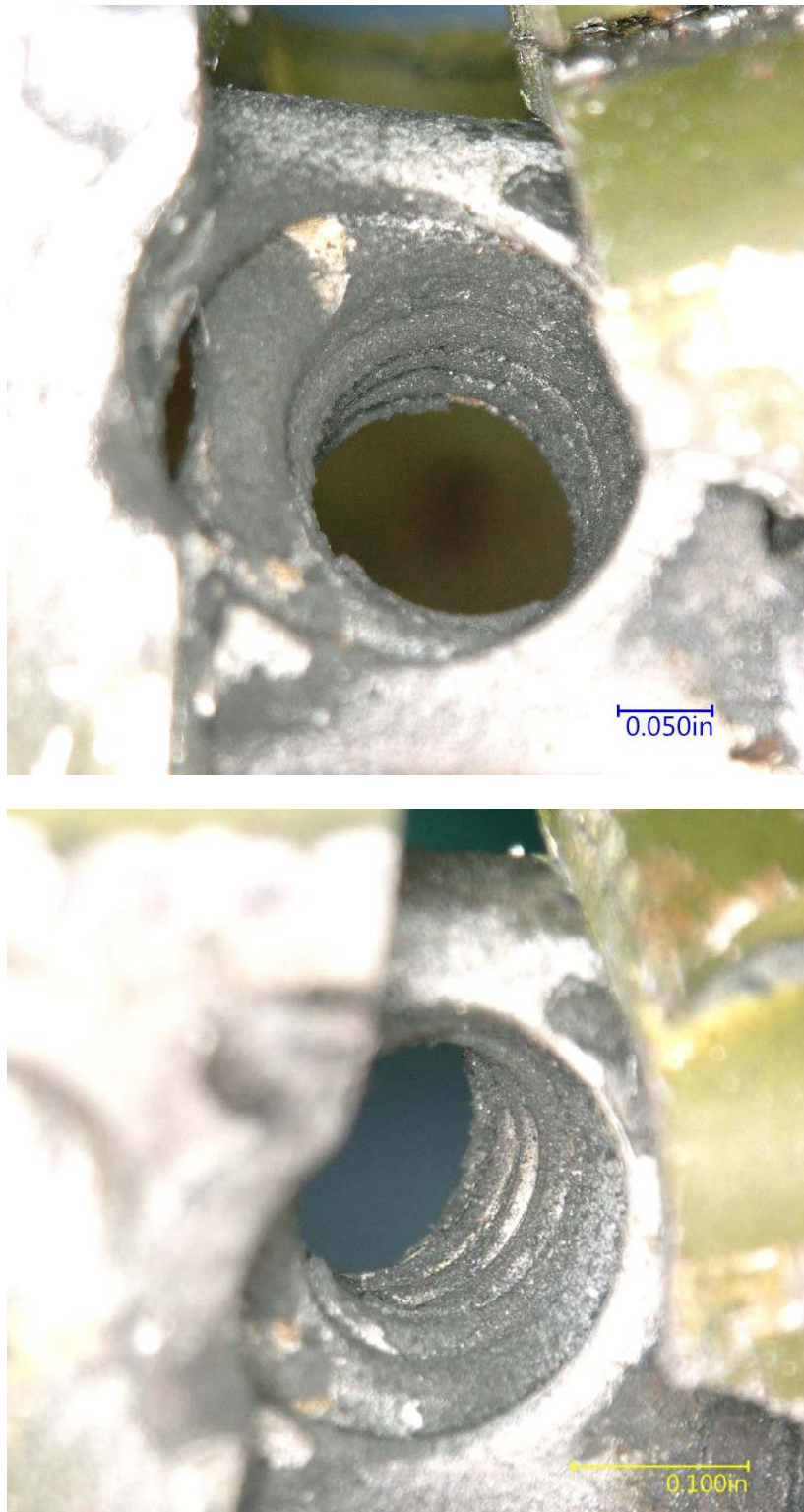


Figure 12: Digital microscope images of the threads in the bolt hole through the rib that mated with the forward attach point of the vertical stabilizer.