

NATIONAL TRANSPORTATION SAFETY BOARD

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



April 12, 2016

MATERIALS LABORATORY FACTUAL REPORT

Report No. 16-032

A. ACCIDENT INFORMATION

Place : Okeechobee, Florida
Date : November 6, 2015
Vehicle : Zenith CH701, N56553
NTSB No. : ERA16FA033
Investigator : Luke Schiada, AS-ERA

B. COMPONENTS EXAMINED

Front and Rear Struts from Left and Right Wings.

C. DETAILS OF THE EXAMINATION

The as-received components of the right and left wing strut assemblies are displayed in figure 1. The complete lengths of the left wing struts were received along with the fuselage attachment cluster, as shown in the upper view of figure 1. The front strut was separated into three pieces and the rear strut was in two pieces. Each with the inboard pieces still bolted to the fuselage cluster. All but the inboard ends of the right wing struts were received as shown in the lower view of figure 1. Both the forward and aft struts were fractured at the inboard ends and saw cut (for shipping) near the middles.

The strut pieces had been exposed to fire and the exterior paint was charred and missing in some locations. When handled, copious quantities of corrosion deposits would exit the open areas of all the struts.

The aircraft wing strut assemblies are each (left and right) composed of two long strut tubes (front and rear) connected to the fuselage at the inboard (lower) ends and to the wing spars at the outboard (upper) end. The engineering drawing¹, see upper view of figure 2, describes the front and rear struts as "one piece, 4130N² seamless tubes, 1.125" OD x .035" " of different lengths. Bent "U" plates, also 4130N, are welded into the open each ends for attaching to the fuselage and wing.

Visual examinations of the struts found each to be manufactured from two pieces of tubing welded together within a surrounding sleeve as shown in the lower left views of figure 2. Further, the as-built tube end construction details differed from the drawing. On the received struts the tube ends were shaped and welded to form closed tube ends, see middle right image of figure 2.. The drawing shows the attaching plates welded into round open tube ends.

¹ Zenith Aircraft Co. part number 7-V-10 4th edition, 09/2001.

² 4130N denotes normalized AISI 4130 alloy steel.

The left wing struts were separated at multiple locations. The front strut had parted through the tube section near the inboard attachment plate and again near mid-span, see separation notations in figure 1. At the inboard end the "U" plate remained bolted to the fuselage cluster with a short length of tube attached, as shown in figure 3. The mid-span separation was located just inboard of the connecting sleeve as shown in figure 4. The lower tube section was also perforated at two location below the mid-span separation. The larger perforation is visible in the both views of figure 4.

Visual and magnified optical examination found that the wall thickness of the forward tube of the left wing had been reduced to knife edges by internal corrosion at both separations. The outboard portion of the lower separation is displayed in figure 5.

To explore the extent of corrosion, the forward strut of the left wing was longitudinally sectioned on a roughly horizontal plane and opened adjacent to both separations, as shown in the upper view of figure 6. The lower views display the severe internal corrosion at and for significant lengths beyond the separations.

The engineer drawing indicates the nominal specified wall thickness as 0.035 inch. The upper two views of figure 7 show the corrosion and knife edges on either side of the lower separation. Measurements determined that the wall loss due to the corrosion was highly variable with location. The lower views of figure 7 show remaining wall thickness along the tube section of the strut. Significant wall loss was confined to the immediate area of the separation. While at the aft side of the strut more than 1/3 of the wall was lost for several inches outboard from the separation. Figure 8 shows the wall loss on a transverse cross section of the strut tube about 5 inches above the lower separation.

The right wing struts were separated at the inboard ends and bent and deformed in several locations, shown again at the top of figure 9. Magnified optical examinations found the separation to be consistent with overstress fractures after significant bending / buckling deformation. Close examination uncovered areas of thin wall at both strut separations. Longitudinal sectioning of the aft strut at the separation revealed significant internal corrosion and localized wall loss at portions of the separation.

Further examinations uncovered three areas of internal corrosion of the aft tube. One area was at the bend / buckle just outboard of the separation and shown in the lower view of figure 9. Small perforation were visible in the deformed area. Longitudinal sectioning revealed severe internal corrosion of one side of the tube wall. The corrosion removed an estimated 25% of the wall. A second area of internal corrosion was evidenced by three perforations of the wall at the attachment point for the jury struts, shown in the upper image of figure 10.. The third area was at the outboard end adjacent to the "U" plate attachment as shown in the lower view of figure 10.

Joe Epperson
Senior Metallurgist

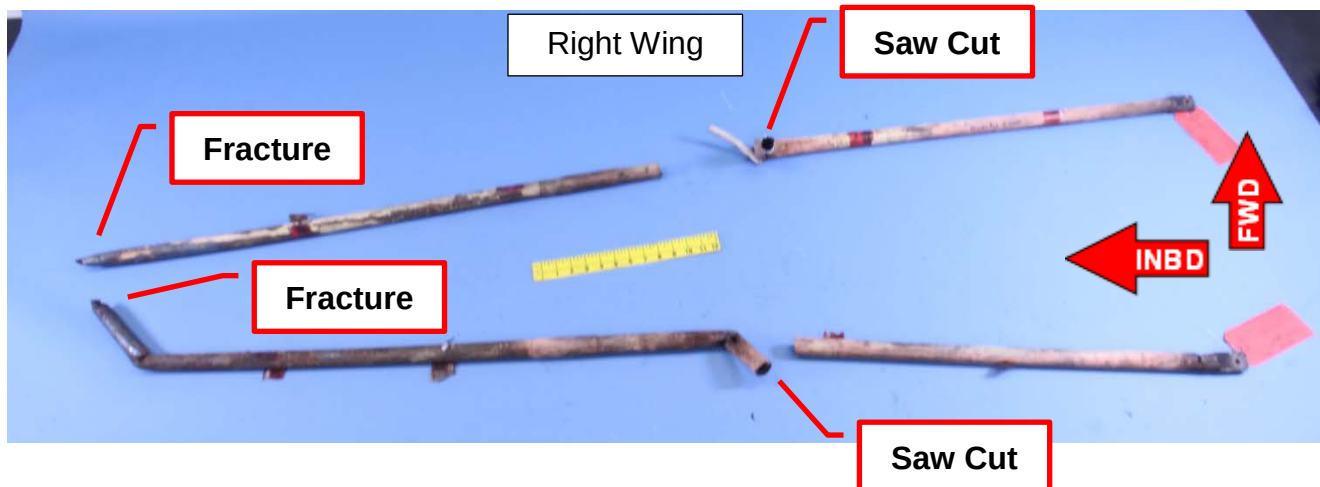
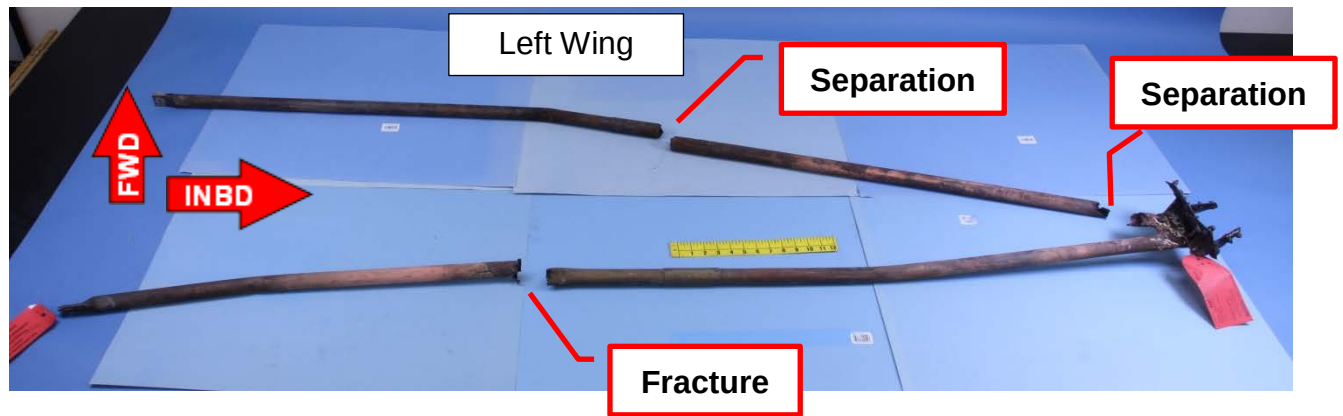


Figure 1. Overall view of the as-received pieces of the left and right wing struts with separation and fracture locations denoted.

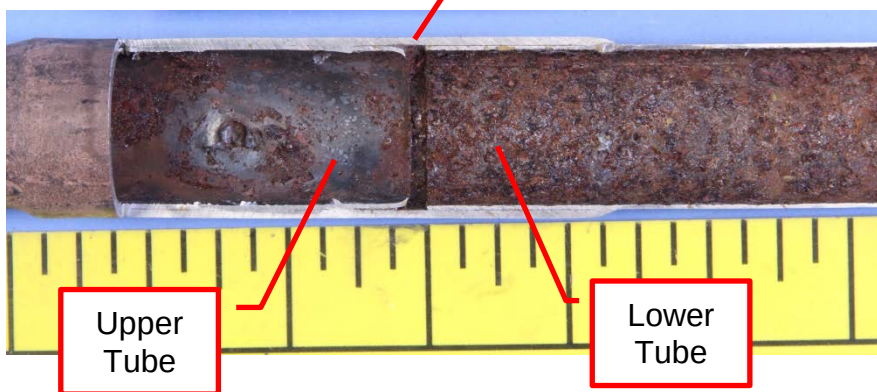
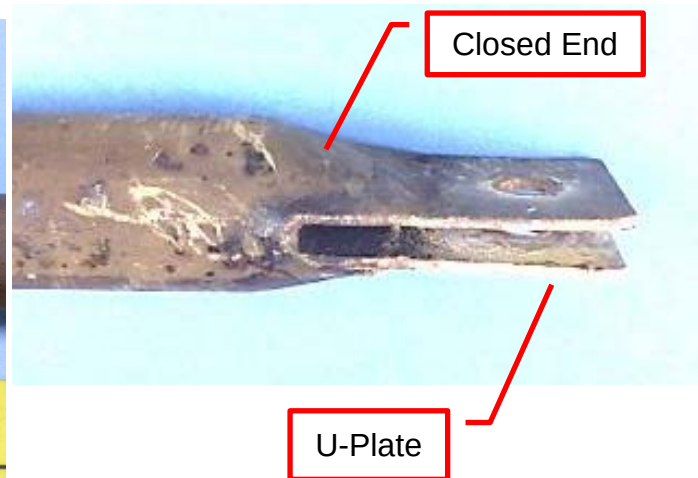
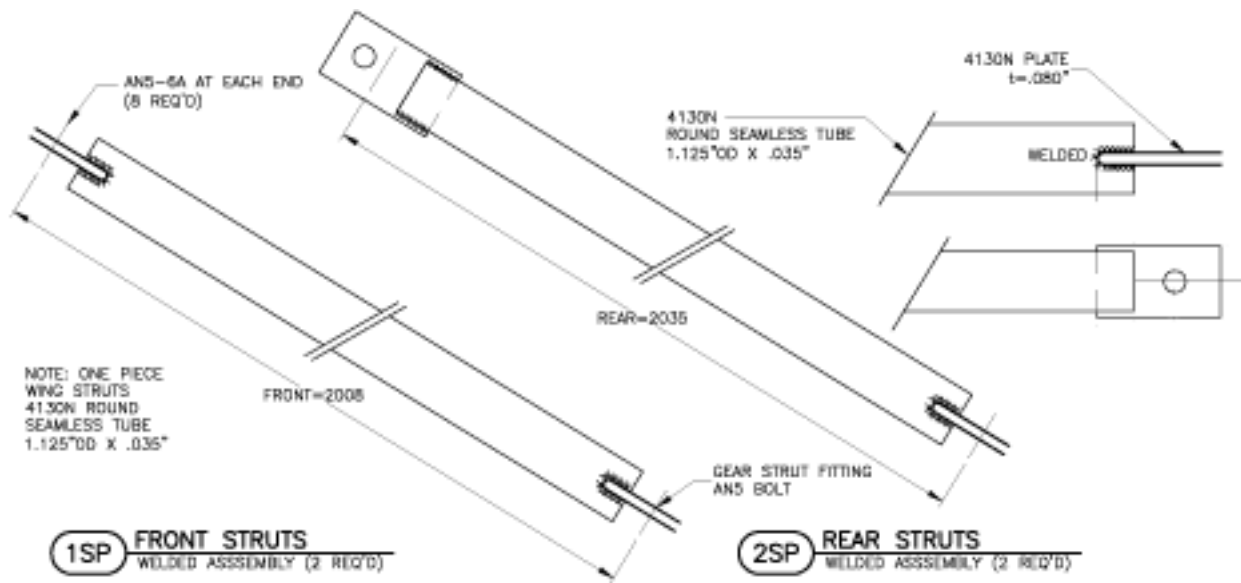


Figure 2. Details of construction as shown on a sample engineering drawing of the struts (top). Images at left show the two piece and sleeve construction of the tubes. Image above shows the as-manufactured closed end tube detail compared to the open ended tube detail shown in the drawing.

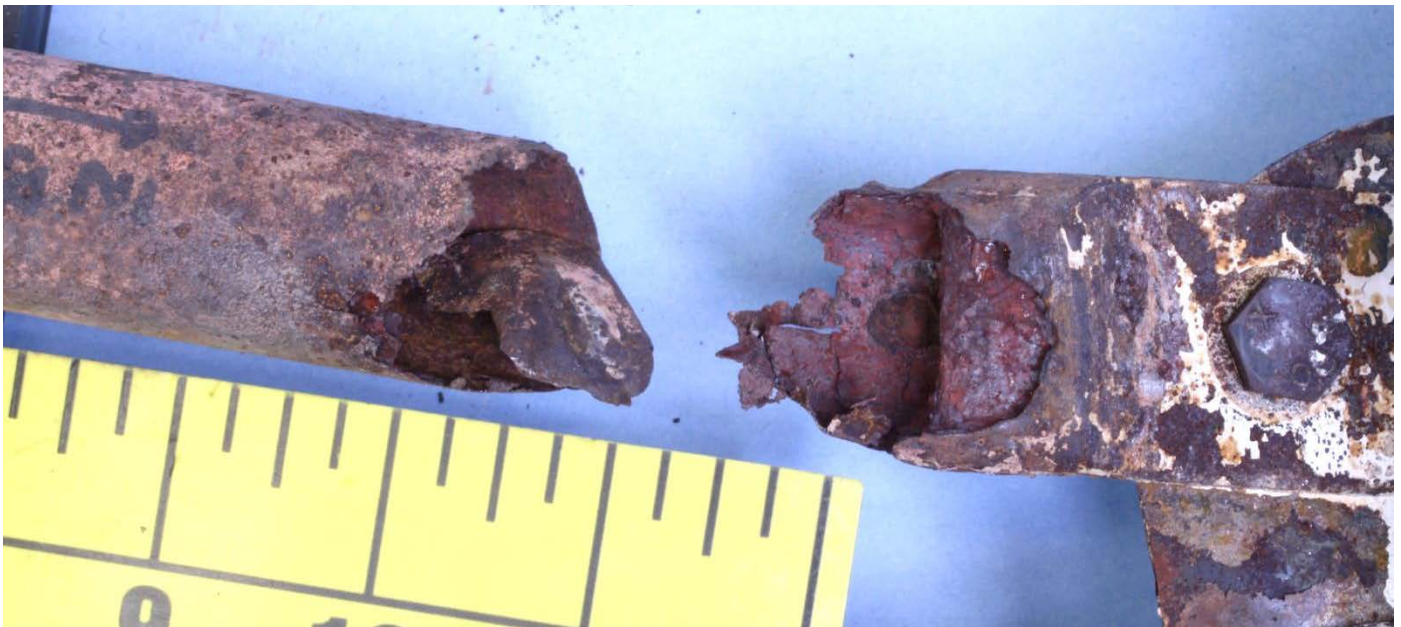
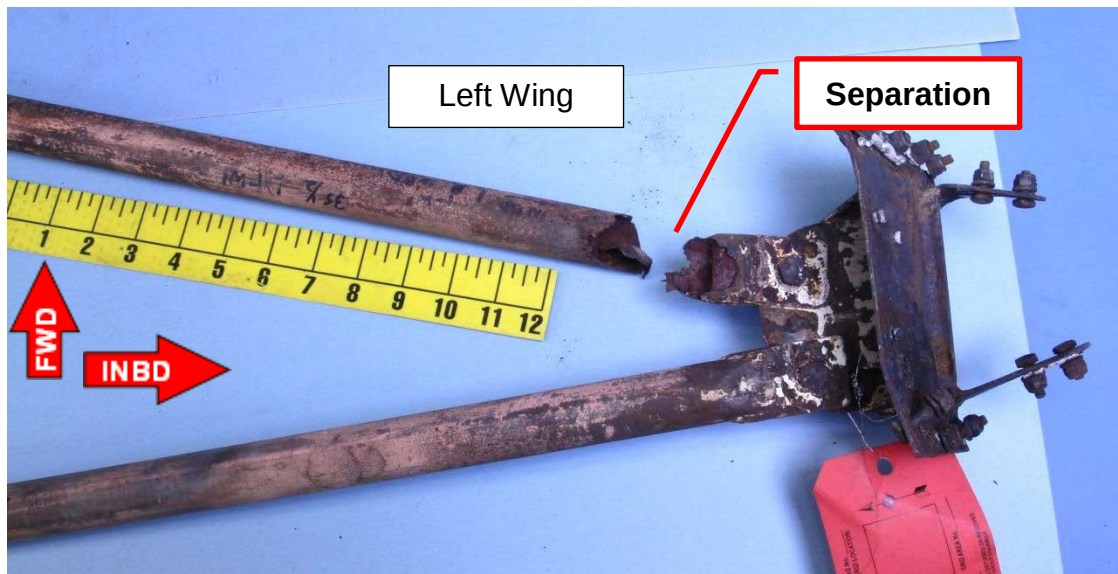


Figure 3. Views of the inboard separation area of the left wing forward strut exhibiting severe and extensive internal corrosion of the strut tube at the separation location.

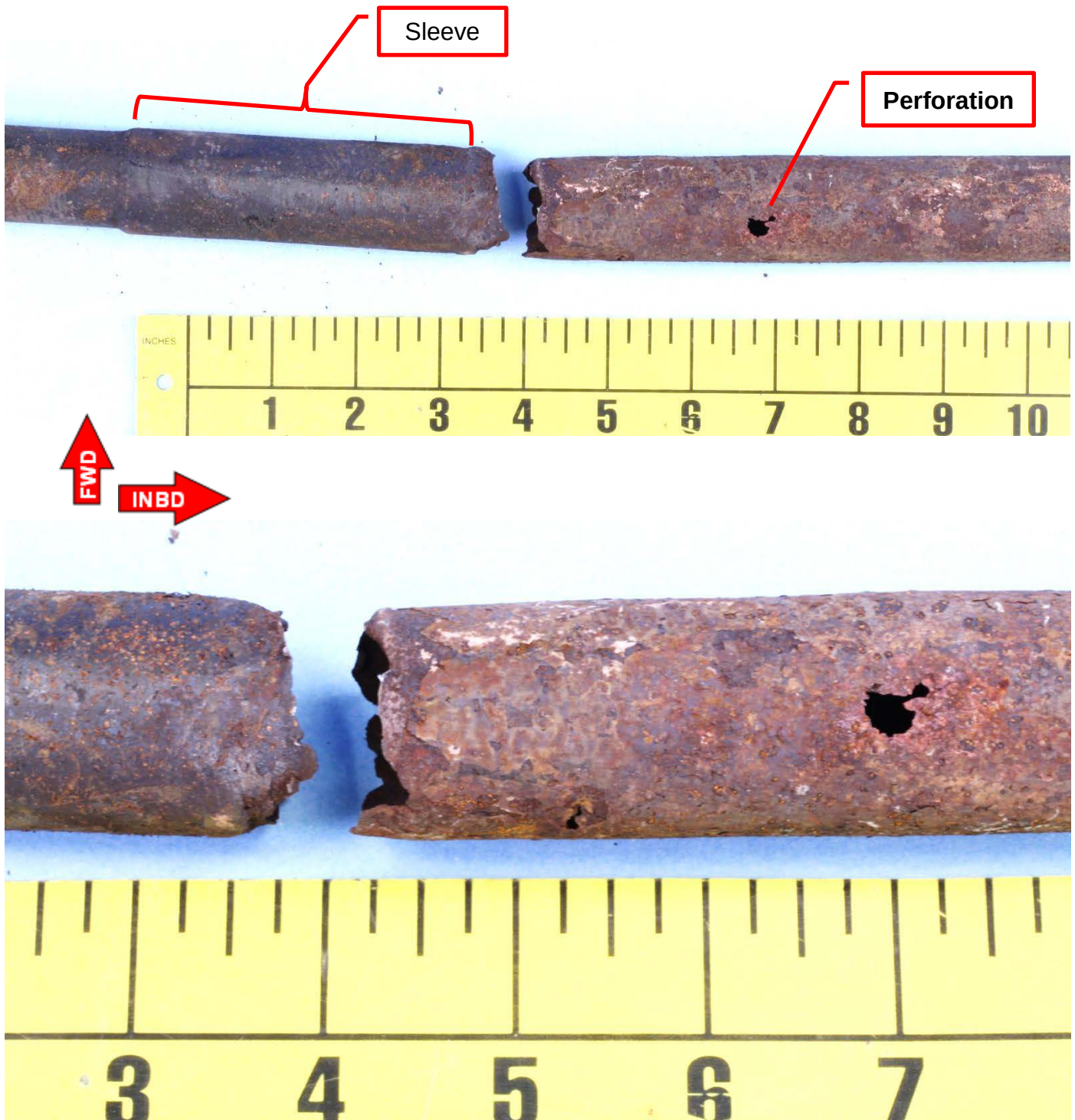


Figure 4. Two views of the mid-span separation area just inboard of the assembly sleeve. Also note the nearby corrosion perforation of the lower strut tube.



Figure 5. Two views of the left wing forward strut tube separation showing the severe corrosion thinning of the tube wall at the separation.





Figure 6. Views of the inboard section of the left wing forward strut after the mid-span (left) and lower (right) separation locations have been longitudinally sectioned (upper image). Middle image shows the inboard separation in cross section with significant wall loss. Boxed areas of image are displayed in figure 7. Lower image show wall loss adjacent to the mid-span separation.

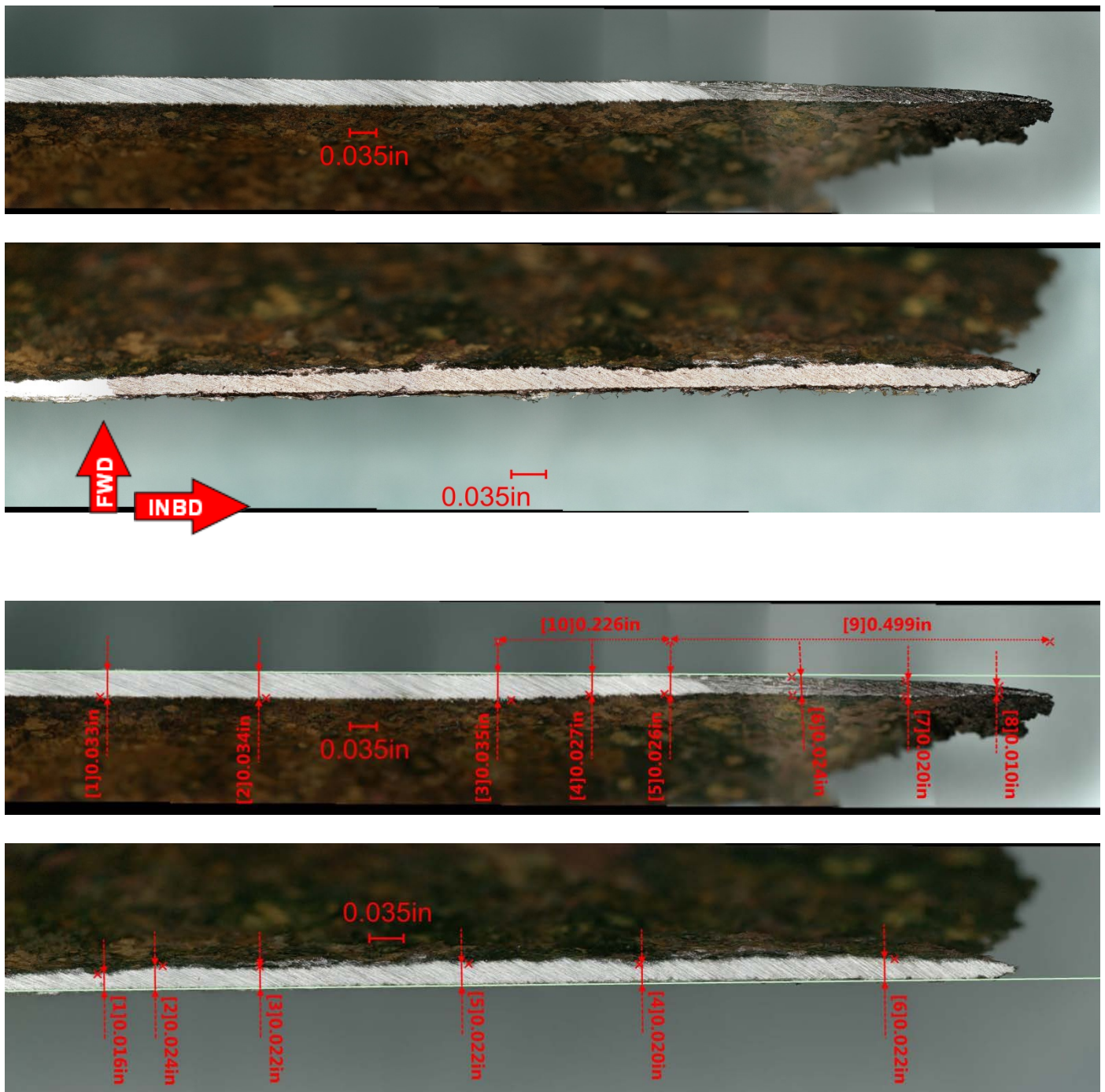


Figure 7. Upper two images show the wall adjacent to the lower separation of the left wing forward strut with the knife edge separation at right. Lower two images show the same area with wall thickness measurements superimposed.

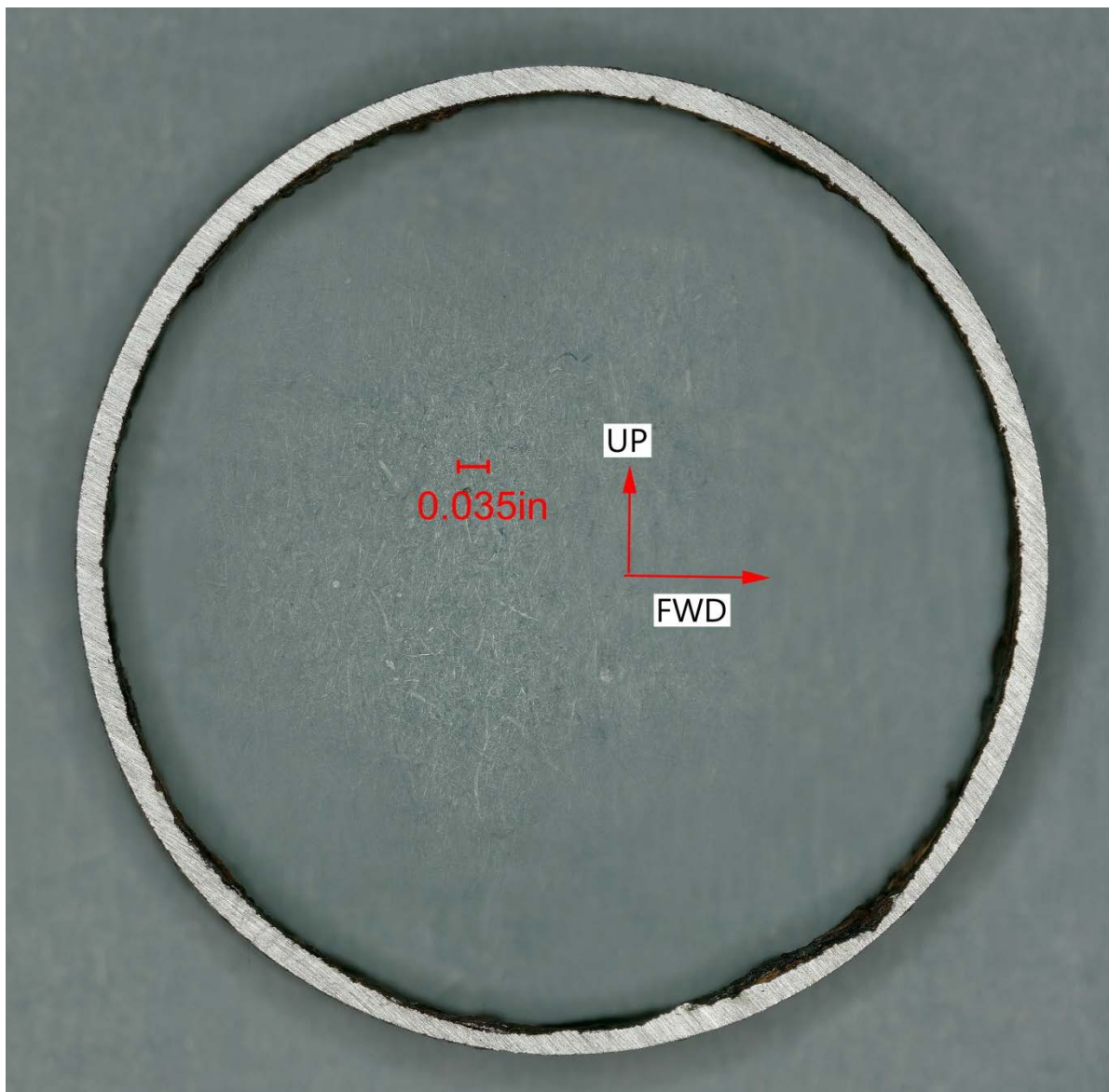


Figure 8. Cross section of the left wing forward strut lower tube showing the corrosion reduced wall thickness in the lower half.



Figure 9. At top an overall view of the as-received pieces of the right wing strut. Red boxed area shown in middle view. Yellow boxed areas shown in figure 10. Middle view shows the internal corrosion at the inboard fracture and adjacent buckle. View at left shows closer view of the cross section at the buckle area with severe wall loss from internal corrosion.

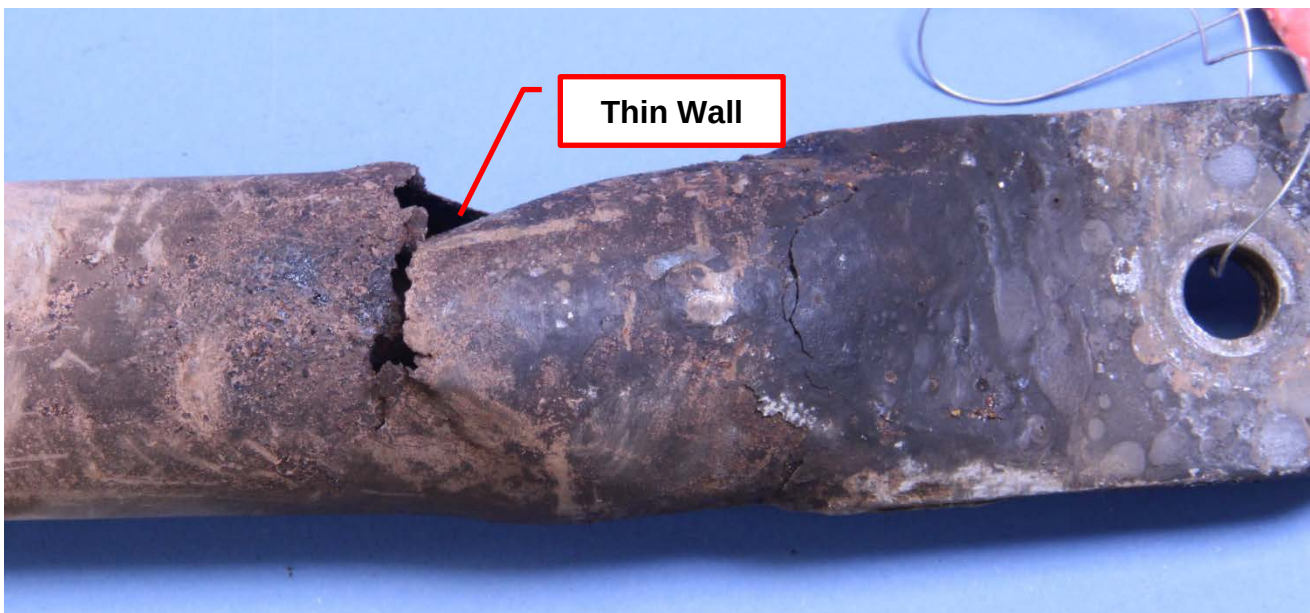
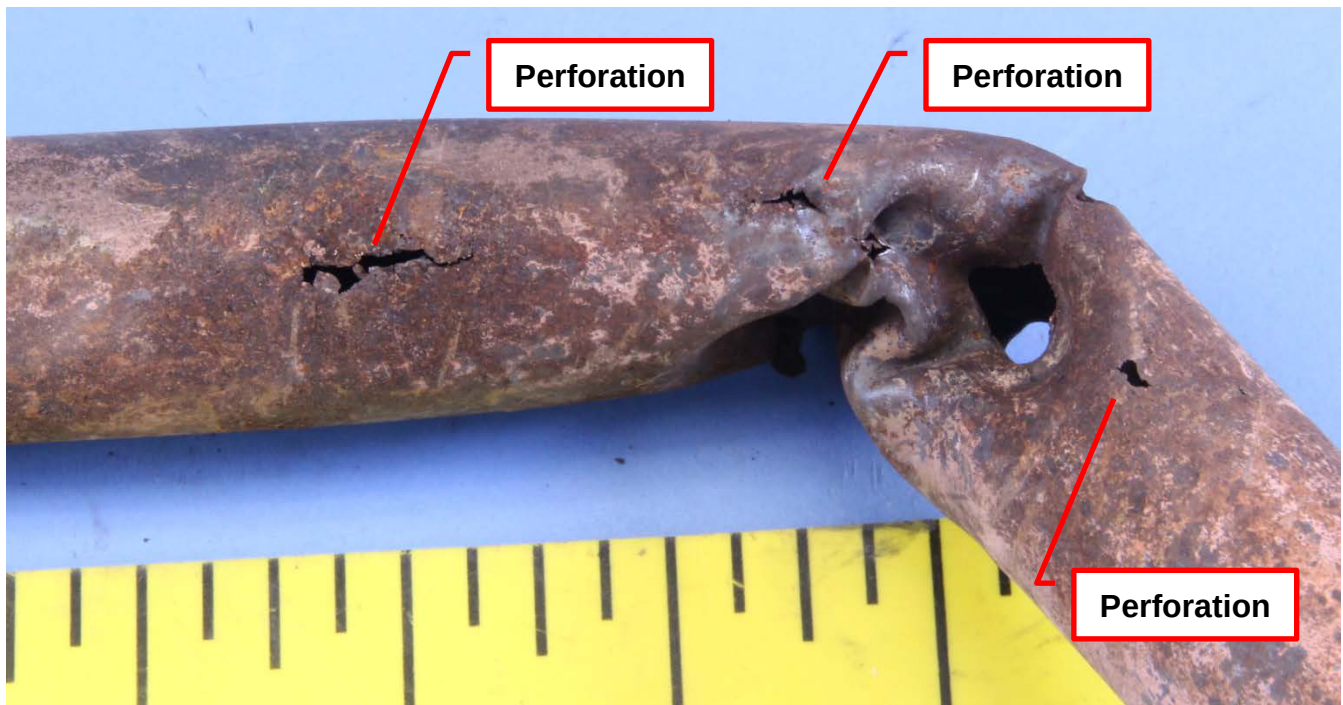


Figure 10. Yellow boxed areas from upper view of figure 9. Upper view shows perforations mid-span. Lower view shows this wall area at deformation near upper end of strut.