

NATIONAL TRANSPORTATION SAFETY BOARD

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



June 16, 2020

MATERIALS LABORATORY FACTUAL REPORT

Report No. 20-025

A. ACCIDENT INFORMATION

Place : Seldovia, Alaska
Date : July 19, 2019
Vehicle : de Havilland DHC-2 Mk. I, N68083
NTSB No. : ANC19FA035
Investigator : Brice Banning, AS-ANC

B. COMPONENTS EXAMINED

Float struts and flying wire attachment straps, fittings, and hardware.

C. DETAILS OF THE EXAMINATION

Overall views of the submitted components are shown in figure 1. The components were from an Aerocet Model 5850 float assembly installed on the accident airplane. Two struts from the left side were submitted as shown in the upper photograph in figure 1, and attachment straps and fittings for all four streamline cables (flying wires) were submitted as shown in the lower image in figure 1. Attach hardware for the two left flying wire attachment fittings were also included as shown in figure 1. The left middle strut was fractured at the lower end of the strut, and the left rear strut was fractured at both the upper and lower ends of the strut. The left forward flying wire fitting and the right rear flying wire strap were also fractured.

As installed on a de Havilland DHC-2 Mk. I, the Aerocet Model 5850 floats are connected to the fuselage with 6 struts and 4 flying wires. The struts are configured with 3 along each side of the fuselage and are tubes with an aerodynamic cross-section having straps bolted to each end for attaching the strut to clevis fittings that are in turn attached to the fuselage at the upper end or float at the lower end. The flying wires form a crossing pattern with the lower end of each wire connected to a float on one side of the airplane and the upper end connected to the fuselage on the opposite side of the airplane. Clevis fittings connect the lower ends of the flying wires to the floats at locations just inboard of the strut lower attachment locations, and dogbone-shaped straps connect the upper ends of the flying wires to the fuselage at the upper strut attachment locations. The two forward flying wires are connected to the float and fuselage at points associated with the middle strut attachments, and the two rear flying wires are attached at points associated with the rear strut attachments.

Both straps at the lower end of the left middle strut were fractured as shown in figure 2. The fracture surfaces had rough matte-gray features consistent with ductile overstress fracture. The overall deformation pattern associated with the fracture was consistent with a tension load with some torsion. An area of contact damage was present at the lower forward end face of the aerodynamic tube section as indicated in the lower image in figure 2.

The upper end of the left middle strut was intact and remained attached to the upper clevis fitting as shown in figure 3. The upper end of the aerodynamic tube section was deformed near the aft end of the strut as indicated with an unlabeled arrow in figure 3. The deformation corresponded to contact with the lower aft corner of the clevis fitting consistent with the fitting rotating about the strap attachment bolt axis to contact the upper end face of the strut tube section.

The lower end of the left rear strut is shown in figure 4. The inboard strap was bent inboard and downward, and the lower clevis fitting remained attached to the inboard strap. The outboard strap was fractured and had rough, matte gray features consistent with ductile overstress fracture. The outboard strap adjacent to the fracture was also bent downward and inboard consistent with an overall load causing the strut to bend downward and inboard relative to the clevis fitting.

Both straps at the upper end of the left rear strut were fractured as shown in figure 5. The upper clevis fitting for the rear strut was received with attachment hardware as shown in the upper image in figure 5, and a mating piece of the outboard strap is also shown. Fracture features for the straps were rough and matte gray consistent with ductile overstress fracture. Both straps were also bent upward and outboard adjacent to the fracture as shown in the lower image in figure 5. Evidence of contact damage was observed on the end face of the tubular strut section forward of the straps.

In the flying wire assemblies, fractures occurred in components associated with the two flying wires attached to the left float. In the assembly for the rear flying wire attached to the left float, the fracture occurred in the strap at the right rear fuselage attachment. A close view of the strap fracture features is shown in figure 6. The fracture features had a rough matte gray appearance consistent with ductile overstress fracture.

Close views of the fitting at the left rear flying wire float attachment location (float end of the flying wire with the fractured strap) are shown in figure 7. The hole where the flying wire attached to the clevis fitting was elongated as indicated in the right image in figure 7. The flying wire attachment hole diameter measured 0.4315 inch parallel to the flying wire axis and 0.3810 perpendicular to the flying wire axis. According to an engineering drawing for the fittings, the specified diameter was 0.375 inch to 0.377 inch. Tension cracks were observed in the paint around the elongated hole consistent with overstress deformation. The bolt for attaching the clevis end of the fitting to the float (hardware shown in figure 1) had a bent shank. The paint on the fitting was mostly intact, but some relatively small areas of corrosion and missing paint were observed around the flying wire attachment hole.

On the outboard side of the left rear flying wire fitting, a curved area of contact damage was observed on the outboard side of the clevis as indicated in figure 7. The damage was consistent with contact with the attachment hardware at the lower end of the left rear strut as the upper end of the left rear strut rotated downward and inboard onto the flying wire fitting located just inboard of the strut attachment.

The left front flying wire fitting was fractured at the flying wire attachment lobe as shown in figure 8. The hole for the attachment was elongated, and tension cracks were observed in the paint next to the elongated hole consistent with overload deformation of the hole. The attachment bolt at the clevis end of the fitting was also bent (see figure 1) consistent with overload deformation.

Overall, the fractures had rough, matte gray features consistent with ductile overstress fracture. Sliding contact marks consistent with contact with the flying wire attachment bolt were observed on the vertical portion of the lug fracture as indicated in figure 9. The horizontal portion of the fracture (see figure 8) was free of post-fracture contact with the attachment bolt, but the forward edge of the fracture was smeared consistent with a bending fracture secondary to the vertical fracture. The inboard surface of the lug adjacent to the vertical fracture near the attachment hole had missing and bubbled paint, and the exposed surface was corroded and bulging slightly consistent with exfoliation corrosion.

The vertical fracture surface of the left front flying wire fitting was cleaned by submerging the fitting in acetone while cleaning using an ultrasonic cleaner. The cleaned fitting was then examined using a scanning electron microscope (SEM). Relatively small areas of the fracture surface had intergranular fracture features consistent with exfoliation corrosion. Both areas of corrosion were located at the inboard side of the fracture adjacent to the attachment bolt hole and near the upper edge of the lug as indicated in figure 9. The remainder of the fracture surface had dimple features such as the typical SEM image shown in figure 9 consistent with ductile overstress fracture. No evidence of a progressive crack growth mechanism such as fatigue was observed outside of the areas of corrosion.

The right forward and right rear flying wire fittings were cleaned using acetone and a soft-bristle brush, and the cleaned fittings are shown in figures 10 and 11. The area in and around the flying wire attachment holes had a corroded appearance, particularly on the inboard sides shown in figures 10 and 11, and paint around the attachment holes was blistered. The flying wire attachment hole diameters were measured in the loading and transverse directions, and the hole in the forward fitting was slightly elongated (0.3795 inch diameter) in the loading direction relative to the transverse direction (0.3765 inch diameter). The flying wire attachment hole in the right rear fitting measured 0.3765 inch in both the loading and transverse directions.

The intact holes in the straps connecting the flying wires to the fuselage were relatively free of visible deformation or signs of corrosion. Attachment holes in the straps at the fuselage end of the flying wires were measured, and results are listed in table 1.

According to engineering drawings for the straps, the diameter of the fuselage attachment holes are specified to be 0.625 inch to 0.627 inch, and the flying wire attachment holes are specified to be 0.375 inch to 0.377 inch.

Table 1. Flying Wire Strap Hole Diameter Measurements

Strap Location	Attachment	Diameter parallel to flying wire axis (inch)	Diameter transverse to flying wire axis (inch)
Right front	Fuselage	0.6265	0.6260
Right front	Flying wire	0.3760	0.3765
Left front	Fuselage	0.6260	0.6260
Left front	Flying wire	0.3760	0.3760
Right rear	Fuselage	0.6305	0.6290
Right rear	Flying wire	Fractured	Fractured
Left rear	Fuselage	0.6280	0.6275
Left rear	Flying wire	0.3785	0.3775

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Senior Materials Engineer

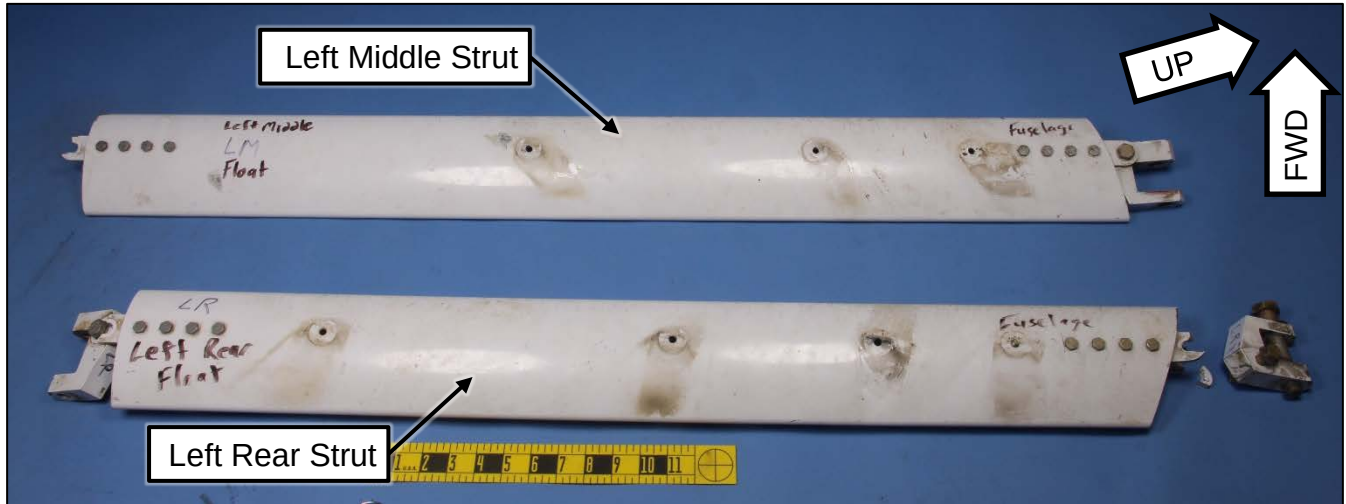


Figure 1. Overall view of the submitted left middle and left rear struts with attachment fittings and hardware (upper image) and flying wire attachment straps and fittings with attachment hardware for the lower left fittings (lower image).

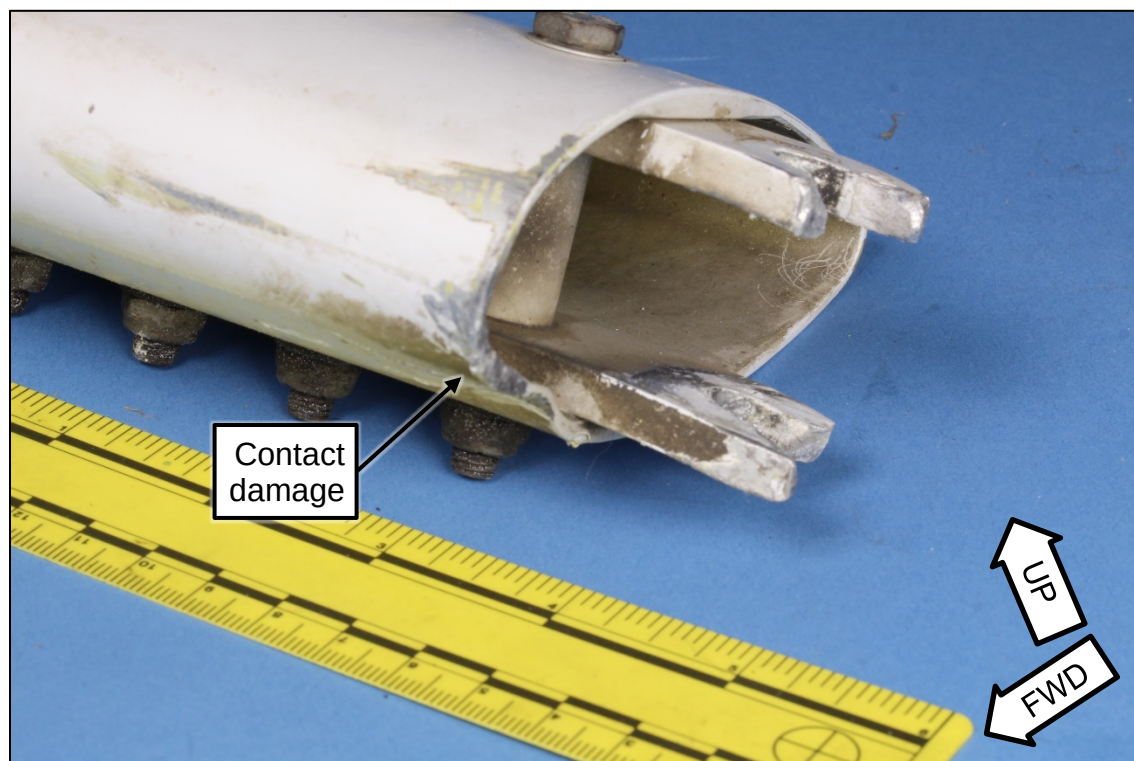
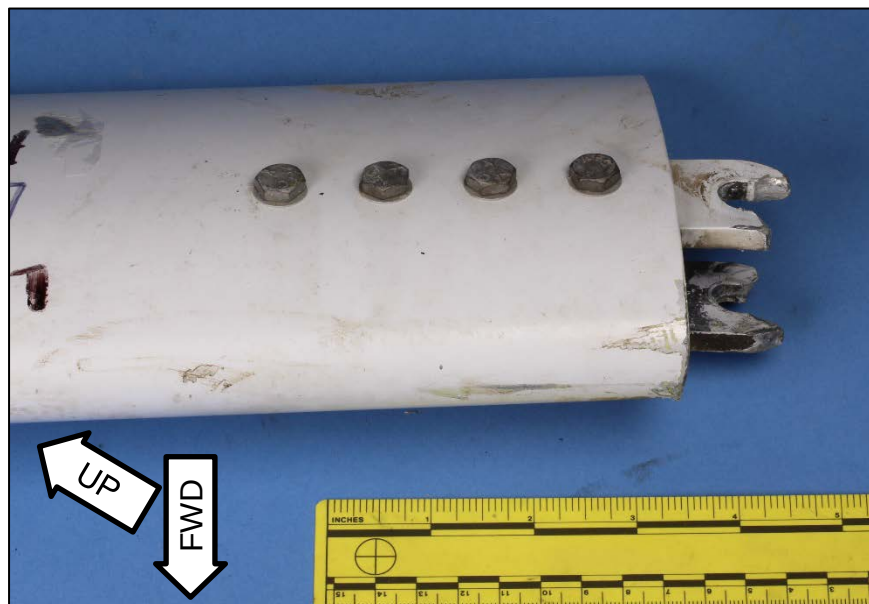


Figure 2. Views of the strap fractures at the lower end of the left middle strut. Contact damage was observed on the forward end face of the strut as indicated.



Figure 3. Intact upper end of the left middle strut. An unlabeled arrow indicates damage corresponding to contact between the strut and the aft corner of the clevis fitting.



Figure 4. Lower end of the left rear strut. The inboard strap was bent downward, and the outboard strap was fractured.

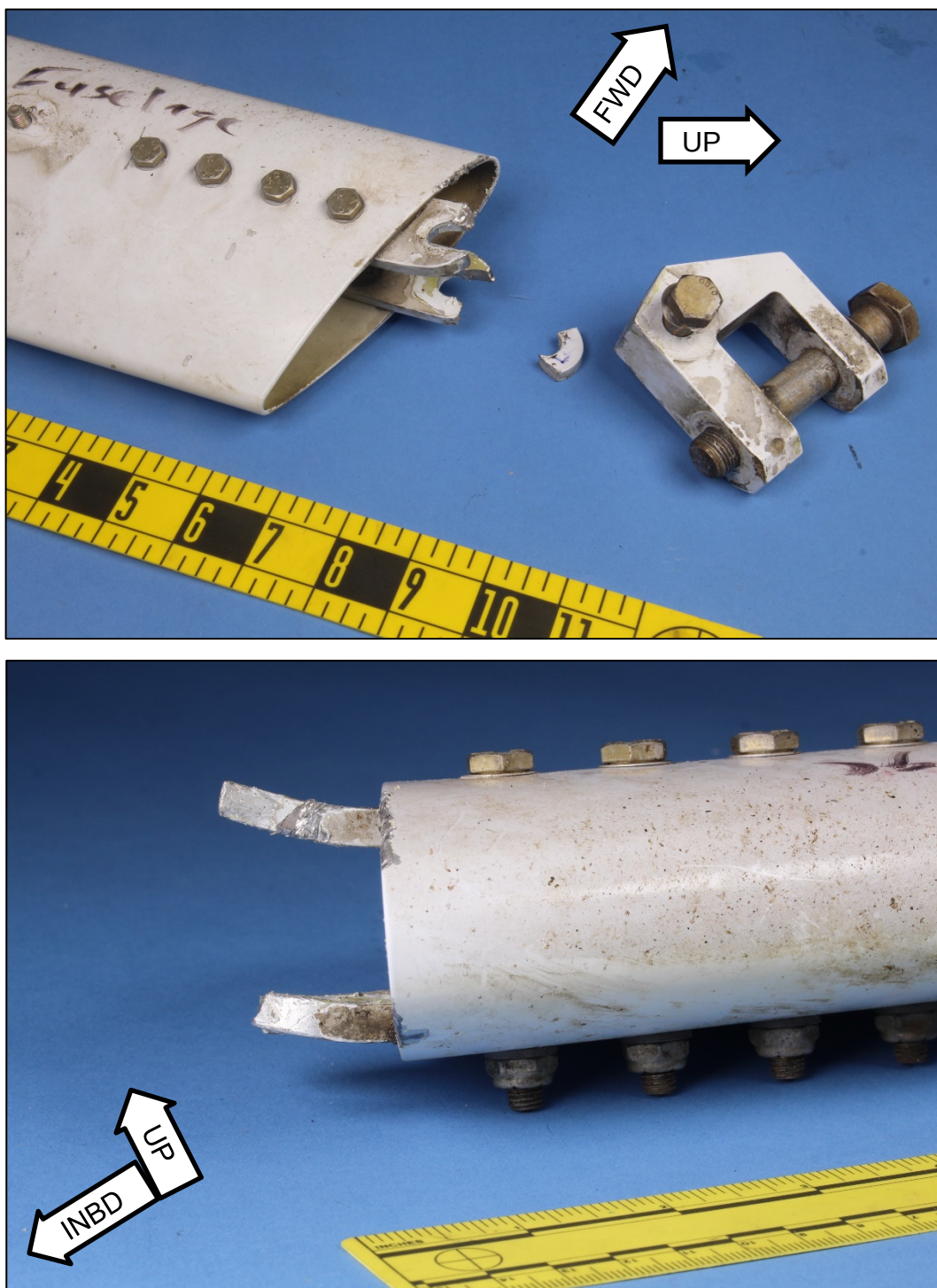


Figure 5. Views of the upper end of the left rear strut. The corresponding fitting with mating strap piece is shown in the upper image, and upward bending deformation of the straps is shown in the lower image.



Figure 6. Fractured end of the right rear flying wire attachment strap.

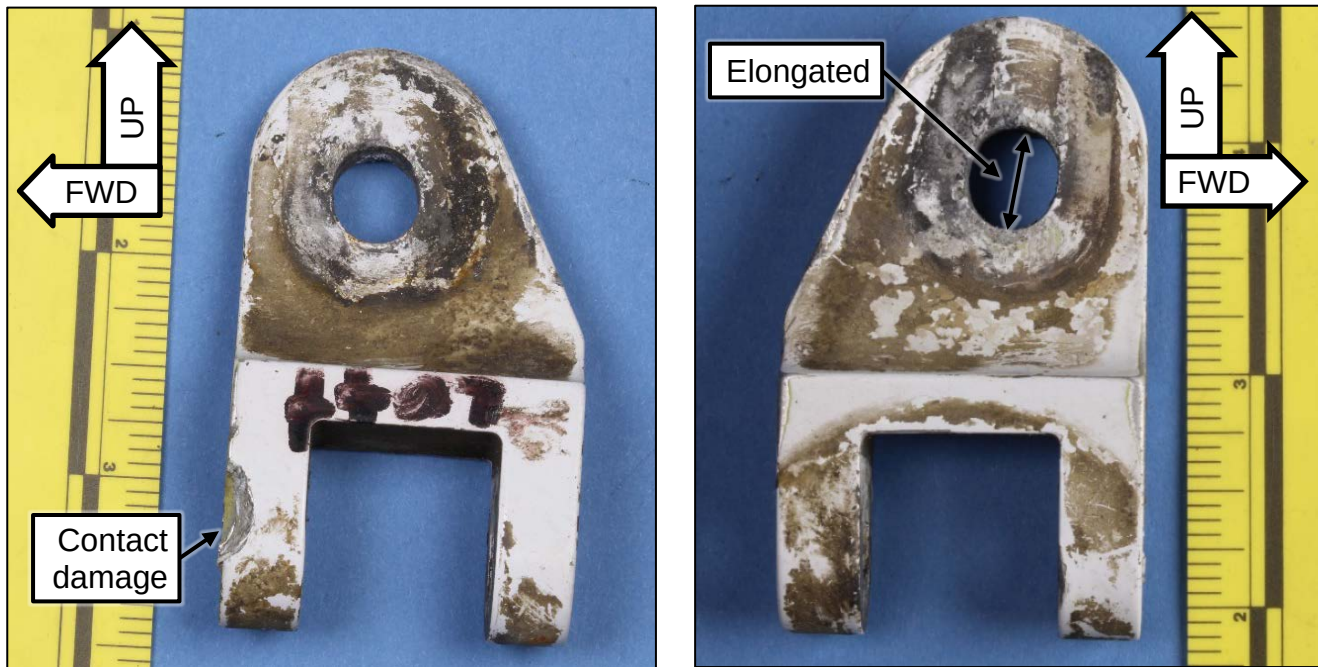


Figure 7. Photographs of the left rear flying wire attachment fitting showing the outboard (left image) and inboard (right image) sides of the fitting. The flying wire attachment hole was elongated, and some corrosion was observed around the flying wire attachment hole. Contact damage corresponding to strut attachment hardware was observed on the outboard front corner of the clevis front lug as shown.

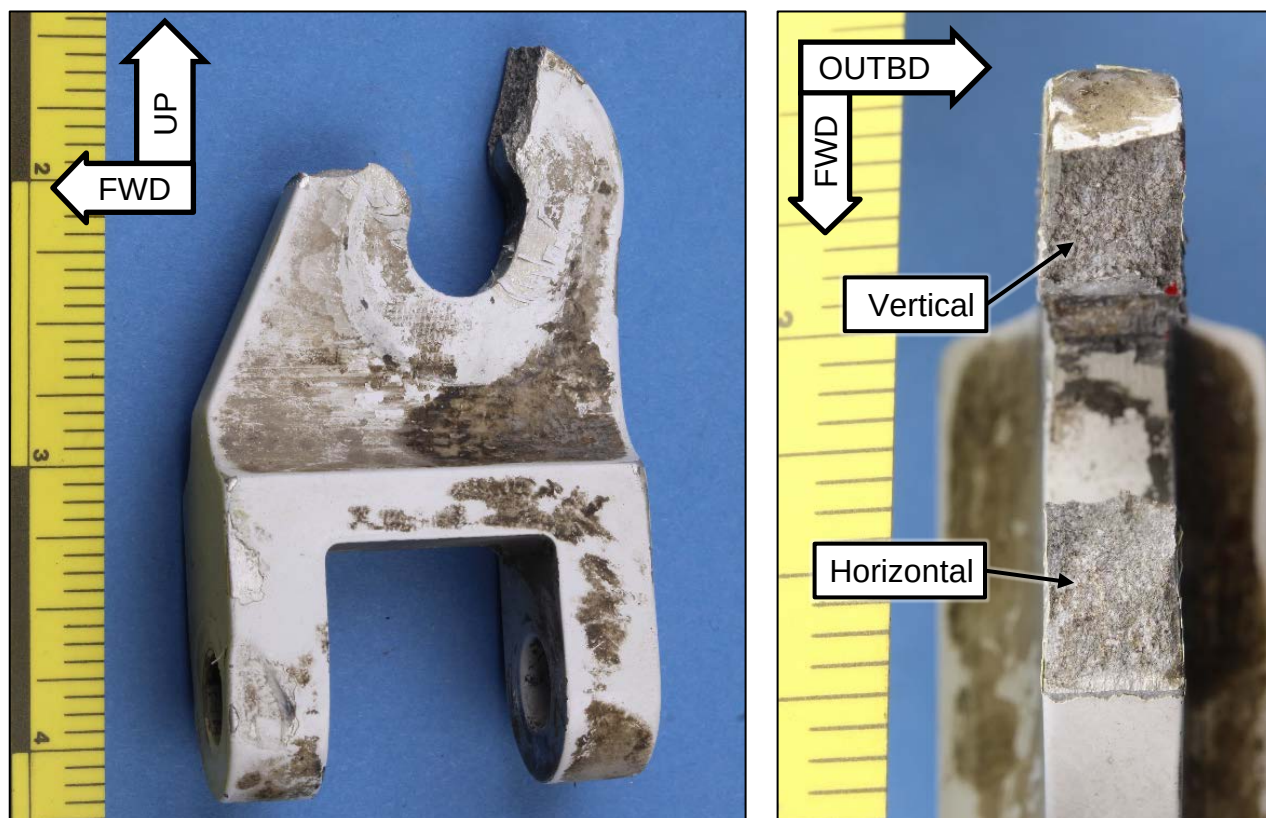


Figure 8. Left forward flying wire attachment fitting. An overall view of the outboard side is shown in the left image, and a view of the fracture surfaces are shown in the right image.

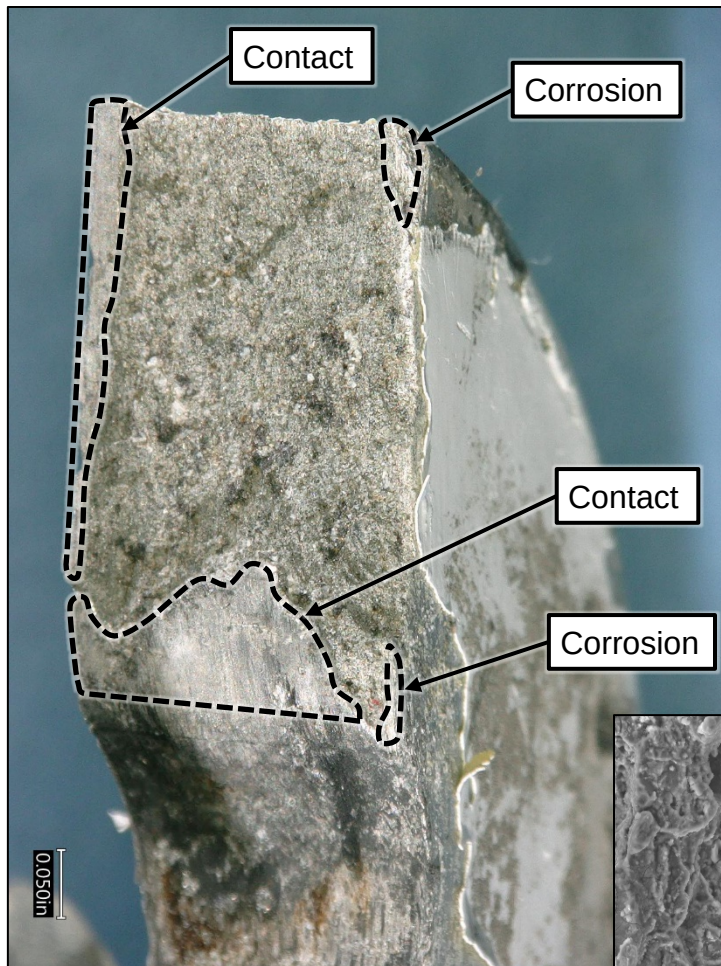
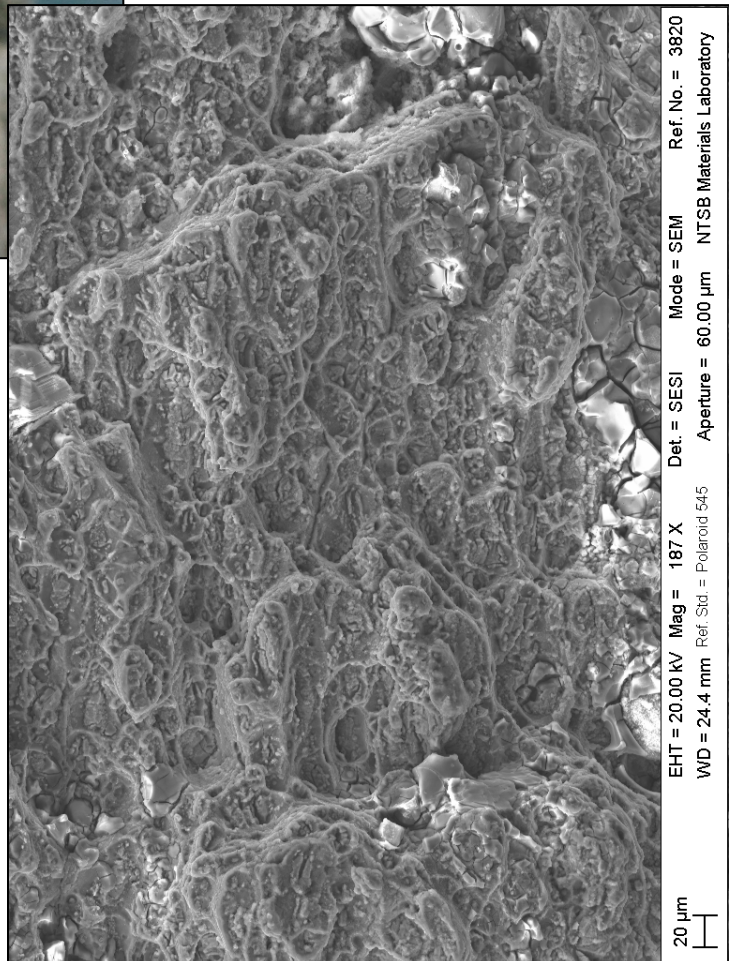
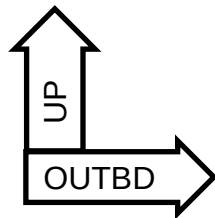


Figure 9. Optical image (left) and SEM image (below) of the vertical fracture surface on the left forward flying wire attachment fitting. Dashed lines in the optical image indicate areas of exfoliation corrosion and areas of sliding contact damage in the fracture plane.



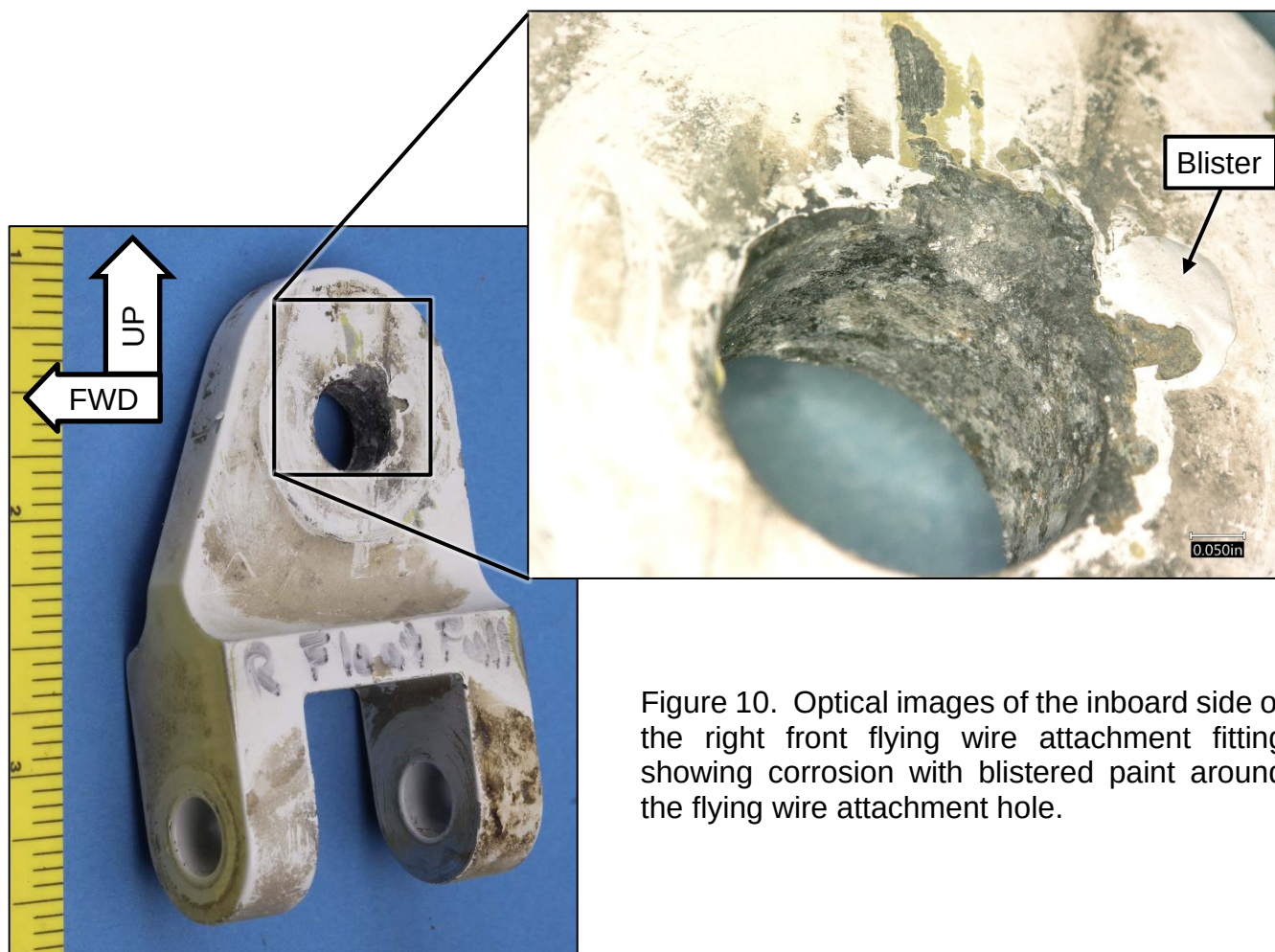


Figure 10. Optical images of the inboard side of the right front flying wire attachment fitting showing corrosion with blistered paint around the flying wire attachment hole.

Figure 11. Optical image of the inboard side of the right rear lower flying wire attachment fitting showing corrosion with blistered paint around the flying wire attachment hole.

