

NATIONAL TRANSPORTATION SAFETY BOARD

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



March 10, 2017

MATERIALS LABORATORY FACTUAL REPORT

Report No. 17-024

A. ACCIDENT INFORMATION

Place : Brunswick, North Carolina
Date : June 10, 2016
Vehicle : WSK PZL MIELEC M-18A Agriculture Airplane, N2283M
NTSB No. : ERA16LA209
Investigator : Daniel Boggs ASI-ERA

B. COMPONENTS EXAMINED

Main spar outboard wing fitting; one bolt that fractured at the threaded portion; three aileron attachment rod assemblies; main spar top rail (upper cap) that fractured along a row of rivets; rear spar hinge assembly, all from the right wing.

C. DETAILS OF THE EXAMINATION

Figure 1 shows a photograph of the as-received pieces from the right wing.

Main Spar Outboard Wing Fitting and Fractured Bolt

The main spar outboard wing fitting contained two arms. The fitting fractured at the two arms, in the areas indicated by arrows "S" in figure 1. Each arm contained six bolt holes. The fracture in the upper arm intersected the first hole at the inboard end. The fracture in the lower arm intersected the second hole from the inboard end. Bench binocular microscope of the fractured arms revealed the lower fracture faces contained fatigue cracks that emanated from the bore of the hole on diametrically opposite sides of each hole, in the areas indicated by brackets "O" in figure 2. Figure 3 shows a photograph of the lower fracture face. The fatigue crack in the lower face of the fracture emanated from multiple origins along the entire length of the bolt hole, areas indicated by brackets "O" in figure 3. Fatigue propagation on each side of the hole was through approximately 90% of the wall and terminated in the areas indicated by dashed lines in figure 3.

Figure 4 shows a photograph of the upper fracture face. The upper fracture face contained similar fatigue cracks with the exception that the fatigue origin areas emanated from the lower corner of the hole (see figure 4). The fatigue crack in the upper fracture face exhibited better defined fatigue fracture features, than those on the lower fracture face. According to the engineering drawing number D.22.200.36.1 for the fitting, the fitting is specified to be made from "30HGSA" low alloy high strength steel, heat treated to a tensile strength between 110 and 130 Kg/mm². This converts to between 156,456 and

184,903 pounds per square inch (psi). Rockwell hardness testing of the fitting produced an average hardness reading of 36 HRC, which converts to an ultimate tensile strength of approximately 161,000 psi.¹ The converted tensile strength was within the tensile strength range specified for the fitting.

The shank portion from the fracture bolt was inserted by hand into the third hole from the inboard end. The shank portion of the bolt fitted snugly into the hole. The fracture intersected the root thread portion of the bolt. The fracture face of the bolt contained fatigue cracks that emanated from multiple origins all around the root portion. Fatigue propagation was toward the center of the bolt and extended through approximately 95 percent (%) of the bolt cross section.

Three Aileron Attachment Rod Assemblies

The right wing contained an inboard, middle (mid), and an outboard aileron attachment rod assembly. The outboard attachment rod contained a circumferential fracture in the main tube portion. The assembly contains two arm portions that were welded to the main tube portion. The fracture intersected the welds at the base of the two arms, indicated by arrows "X" in figures 1 and 5. The fracture intersected the aft edges of the welds (intersection between the weld and main tube portion). Bench binocular microscope examination of the forward face of the main tube fracture revealed a fatigue cracks emanated from the outer surface of the main tube, at the aft edges of the welds, in the areas indicated by bracket "O" in figure 6. Fatigue propagation was through approximately 50% of the wall and terminated in the areas indicated by a dashed line in figure 6. The fatigue crack extended around approximately 30% of the tube circumference.

The inboard and mid aileron attachment rod assemblies were intact. Both assemblies contained cracks in the white paint layer and in the same respective locations as the fatigue cracks in the outboard assembly. The paint was removed with a commercial paint stripper from the weld areas of the intact assemblies. Bench binocular microscope examination of both intact assemblies after paint stripping revealed presence of intermittent cracks on the outer surface of the welds in the same respective location as the fracture on the outboard assembly. Figure 7 shows a close-up photograph of several intermittent cracks at the aft edges of the weld, after the paint was removed from the inboard rod assembly. A saw cut was made through the main tube portion of the two intact assemblies in the areas approximately 0.2 inch aft of the crack locations. Examination of the inner face of the main tube portion for both intact assemblies revealed the intermittent cracks did not extend through the wall.

¹ Conversion per ASTM A370, Mechanical Test Methods and Definitions of Mechanical Testing of Steel Products

Main Spar Top Rail

The main spar top rail (upper cap) fractured along a row of rivets, in the area between unmarked arrows in figure 1. The fracture face contained no evidence of a fatigue crack.

Rear Spar Hinge Assembly

The rear spar hinge assembly contained a plate portion and ear portions on each side of the plate. The plate portions contained a ball insert. The ball insert portion and ear portions have a hole for an attachment bolt. An attachment bolt is specified to be inserted through the holes. The rear spar hinge assembly was submitted without the attachment bolt (bolt is presumed missing). The plate portion was cut in the area indicated by arrow "E" in figure 1. The ear portions were disassembled from the wing. Detailed examination of the bore for all the holes revealed they contained evidence of dark brown oxide consistent with iron oxide. Each ear portion contained bending deformation that was away from the center plate portion.

With respect to all the fatigue fracture regions I this report, the areas outside of the fatigue regions exhibited a rough texture on a slant plane consistent with an overstress separation.

Frank Zakar
Senior Metallurgist

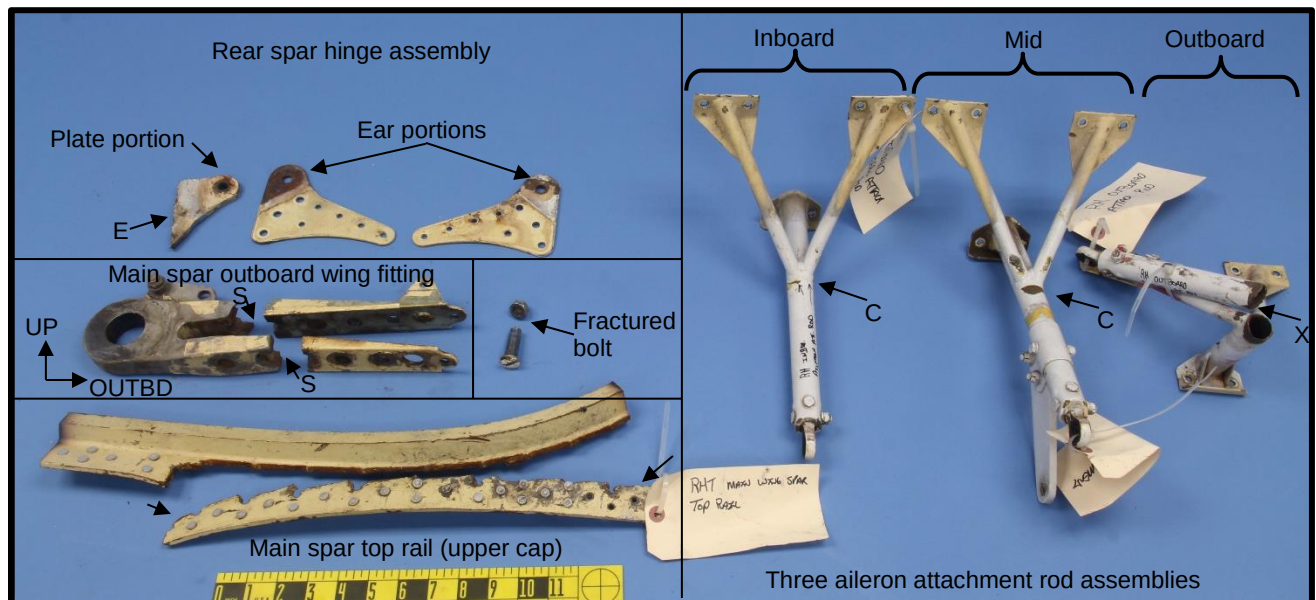


Figure 1. As-received photograph of the main spar outboard wing fitting that fractured at the upper and lower arms; one bolt that fractured at the threaded portion; three aileron attachment rod assemblies (one is fractured at the rod portion in area indicated by arrow "X", and the other two contained a crack in same respective locations indicated by arrows "C"); main spar top rail (upper cap) that fractured along a row of rivets; rear spar hinge assembly. All pieces are from the right wing.

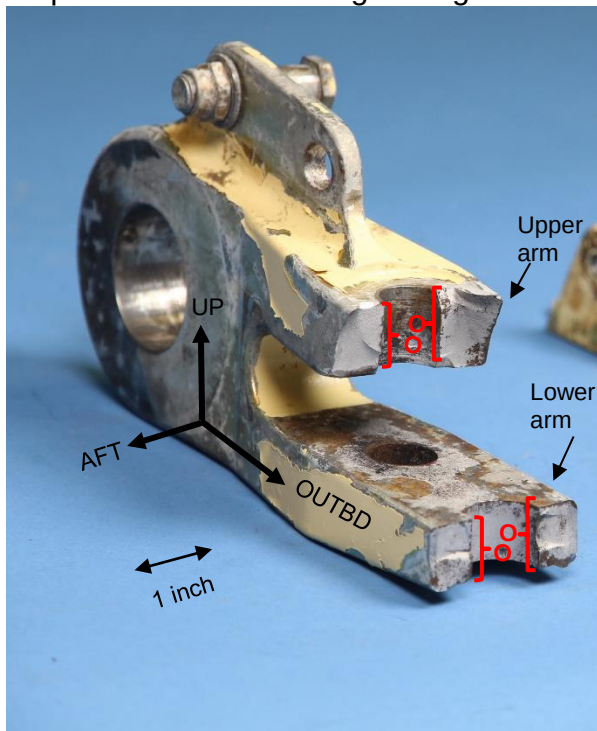


Figure 2. Photograph of the as-received main spar outboard wing fitting that fractured at the upper and lower arms in the area indicated by arrows "S" in figure 1, showing the inboard face of the fracture.

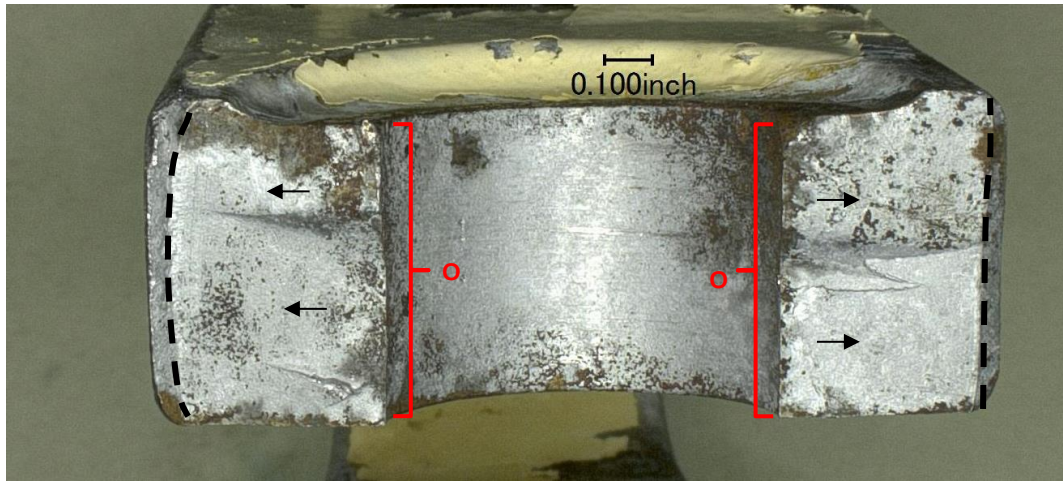


Figure 3. Photograph of the main spar outboard wing fitting showing the lower arm outboard face of the fracture. Fatigue cracking emanated from the bore of the hole in the areas indicated by bracket "O".

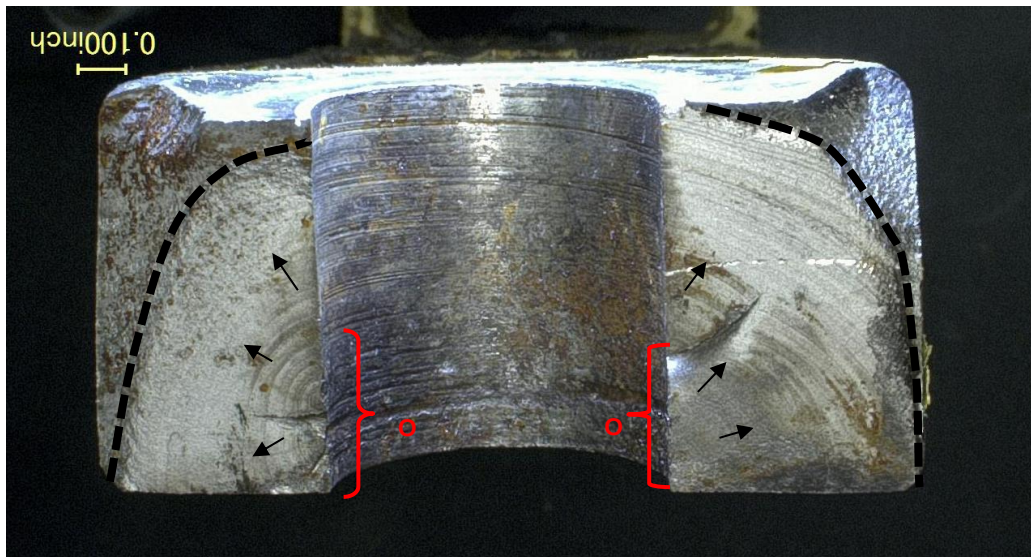


Figure 4. Photograph of the main spar outboard wing fitting showing the upper arm outboard face of the fracture. Fatigue cracking emanated from the lower corner of the hole in the areas indicated by bracket "O".

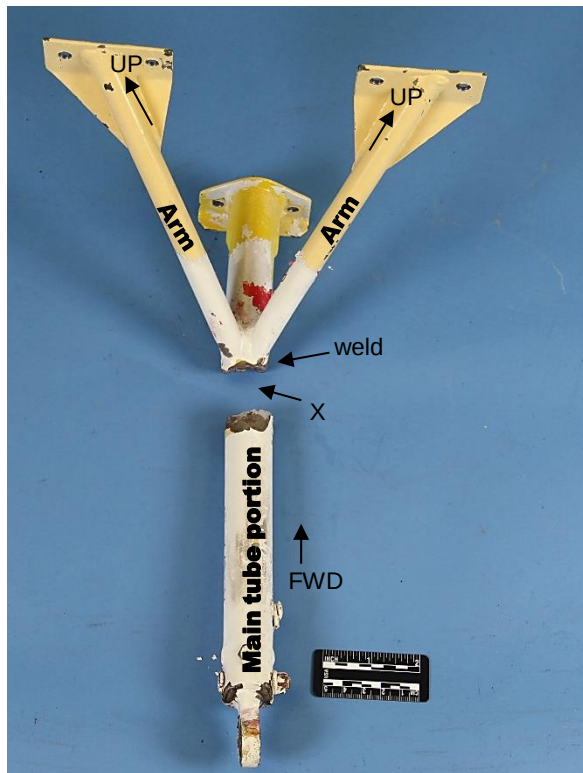


Figure 5. Photograph of the aileron attachment rod assembly that fractured in the tube portion in the area indicated by arrow "X" in figure 1.

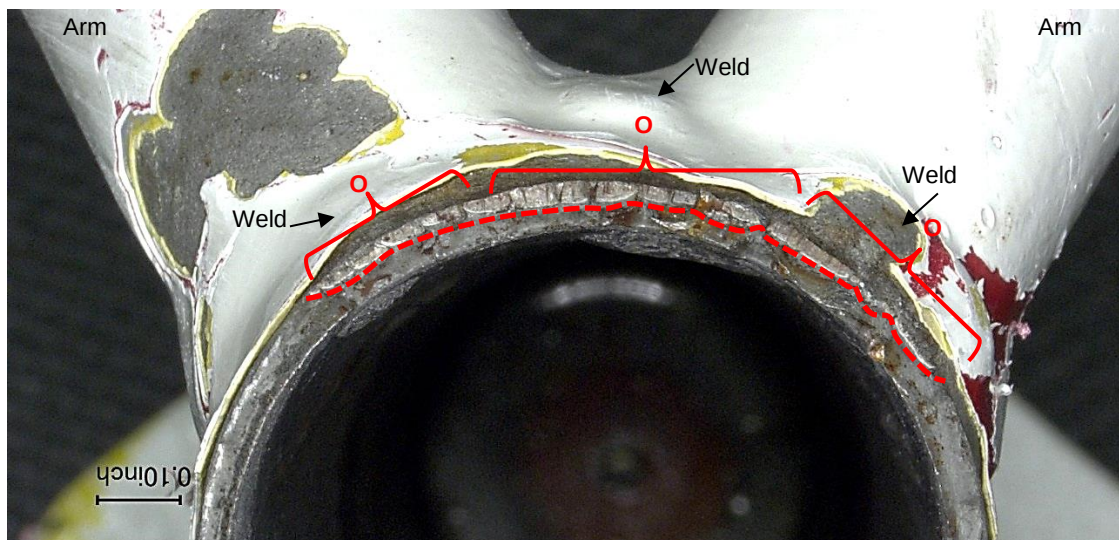


Figure 6. Forward face of the fractured aileron attachment rod assembly showing fatigue cracks that emanated from the outer surface in the areas indicated by brackets "O".

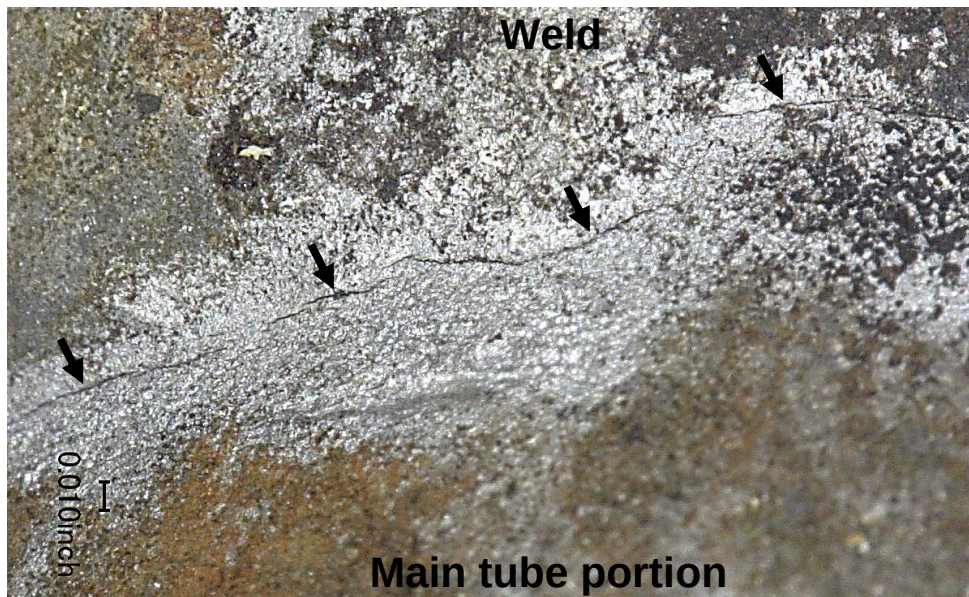


Figure 7. Close-up photograph of the aileron attachment rod assembly showing intermittent cracks in the area along the aft edge of the weld in the areas indicated by arrows.