# NATIONAL TRANSPORTATION SAFETY BOARD

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

September 14, 2021

MATERIALS LABORATORY FACTUAL REPORT Report No. 21-066

## A. ACCIDENT INFORMATION

| | | |
|---|---|---|
| Place | : | York, Pennsylvania |
| Date | : | December 30, 2020 |
| Vehicle | : | Piper PA-46R-350T, N463ST |
| NTSB No. | : | ERA21LA238 |
| Investigator | : | Ralph Hicks, AS-ERA |

## B. COMPONENTS EXAMINED

Engine mount.

## C. DETAILS OF THE EXAMINATION

An overall view of the lower side of the submitted engine mount as received is shown in figure 1, and closer views of the nose landing gear (NLG) actuator attachment feet are shown in figures 1 (lower image) and 2. On the left side, several tubes near the NLG actuator attachment foot were bent and had been cut, and one tube was fractured near its weld to the attachment foot. On the right side, the NLG attachment foot was fractured at the toe of the support tube welds on the upper and forward sides of the foot and through the lower support tube on the underside of the foot. Portions of the fracture around the right attachment foot were covered with resolidified metal deposits.

Paint and primer had been removed from areas around the NLG actuator attachment feet, exposing the underlying metal surface mostly on the forward and lower sides around the welds. A translucent brown coating was observed covering the exposed metal, primer, and paint around the NLG actuator attachment feet. Engine mount inspections described in Piper Service Bulletin (SB) 1103F[1] require removal of coatings on the NLG actuator attachment feet and 1 to 3 inches of the adjacent tubes to conduct fluorescent penetrant inspections for cracks. If no crack indications are found, SB 1103F states the area where paint was removed is to be cleaned and coated with Dinitrol/Ardrox AV8 followed by Dinitrol/Ardrox AV30 corrosion prevention compound.

A close view of the forward face of the left NLG actuator attachment foot is shown in figure 3. The tube welded to the forward face was fractured adjacent to the weld. The fracture surface appeared light gray and was on slant angles, features consistent with ductile overstress fracture.

[1] Service Bulletin 1103F, *Engine Mount Inspection*, Piper Aircraft, Inc., Vero Beach, Florida (September 1, 2015).

Close views of the right NLG actuator attachment foot are shown in figures 4 and 5. Deposits of resolidified pools of molten metal were observed on the upper side shown in figure 4 and on the interior surface shown in figure 5. The areas around the deposits were tinted brown and black consistent with local heating produced by a welding process. The crack in the foot was gaped open, and weld metal deposits spanned and filled the space between the crack faces. Smaller beads of resolidified metal consistent with weld spatter were observed fused to adjacent surfaces, including exposed crack faces.

To facilitate a closer examination of the NLG actuator attachment feet, the engine mount tubes were cut several inches away from the feet to separate the feet from the remainder engine mount. The feet were soaked in mineral spirits, and surfaces were lightly brushed with a soft-bristle brush to remove the corrosion prevention compound. Views of the attachment feet after cleaning with mineral spirits are shown in figures 6 and 7. The cleaned surfaces were examined using an optical stereomicroscope, and crack indications were observed at the toe of the weld on the left foot as indicated with brackets in figure 6.

The attachment bolt shank extending from the right NLG actuator attachment foot was placed in a vice, and the weld deposits were fractured by hand forces applied to the attached structural tube segments. Most of the fracture surfaces were obscured or obliterated by the post-fracture weld process or heavy recontact damage. However, an area of relatively flat fracture features in planes perpendicular to the forward surface and separated by ratchet marks[2] were observed on the forward side of the right NLG actuator attachment foot, features consistent with fatigue fracture. The fracture surface was covered with oxidation. To further examine the fracture surface, the foot piece was immersed in Evapo-Rust[3] for approximately 20 minutes followed by lightly brushing the surface with a soft-bristle brush. The resulting fracture surface on the forward side of the right NLG actuator attachment foot is shown in figure 8. Curving crack arrest lines consistent with a fatigue fracture were observed. The fatigue initiated from multiple origins at the forward side of the foot as indicated with a bracket in figure 8.

Matthew R. Fox, Ph.D.
Senior Materials Engineer

[2] A ratchet mark is a small step in the fracture surface formed when two adjacent fatigue cracks originate on slightly offset planes.
[3] Evapo-Rust is manufactured by Harris International Laboratories, Springdale, Arkansas.

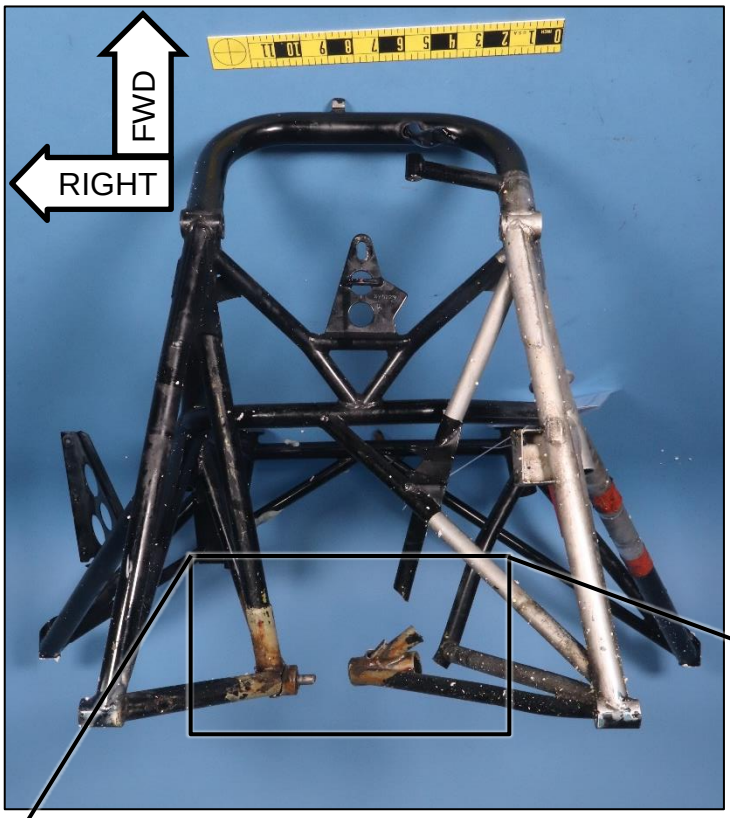


Figure 1. Overall view of the lower side of the engine mount (left) with a closer view of the NLG actuator attachment feet (below).


Figure 2. NLG actuator attachment feet as viewed from above.


Figure 3. Left NLG actuator attachment foot as viewed looking aft.

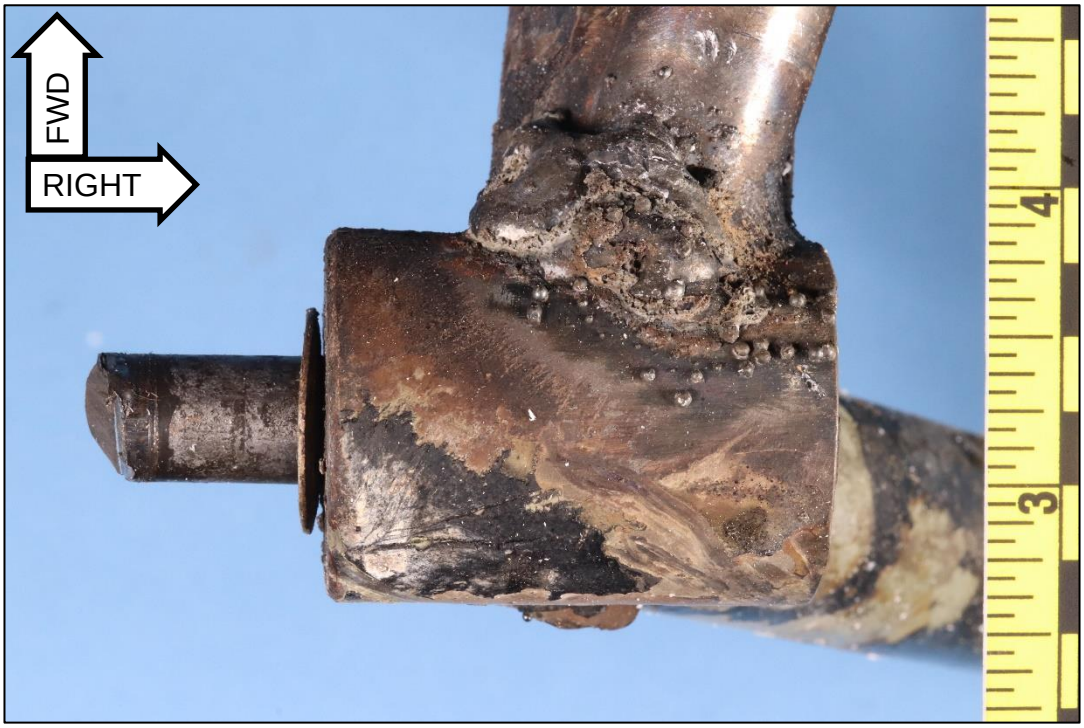


Figure 4. Upper side of the right NLG actuator attachment foot.

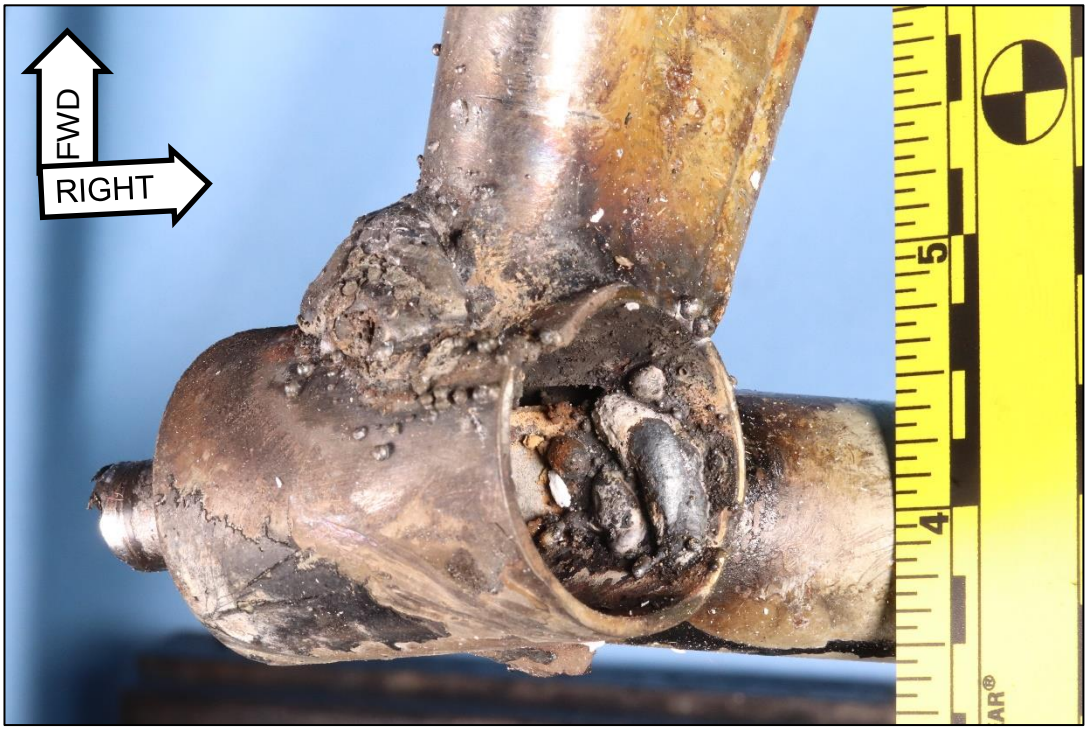


Figure 5. Oblique view showing the upper and interior surfaces of the right NLG actuator attachment foot.

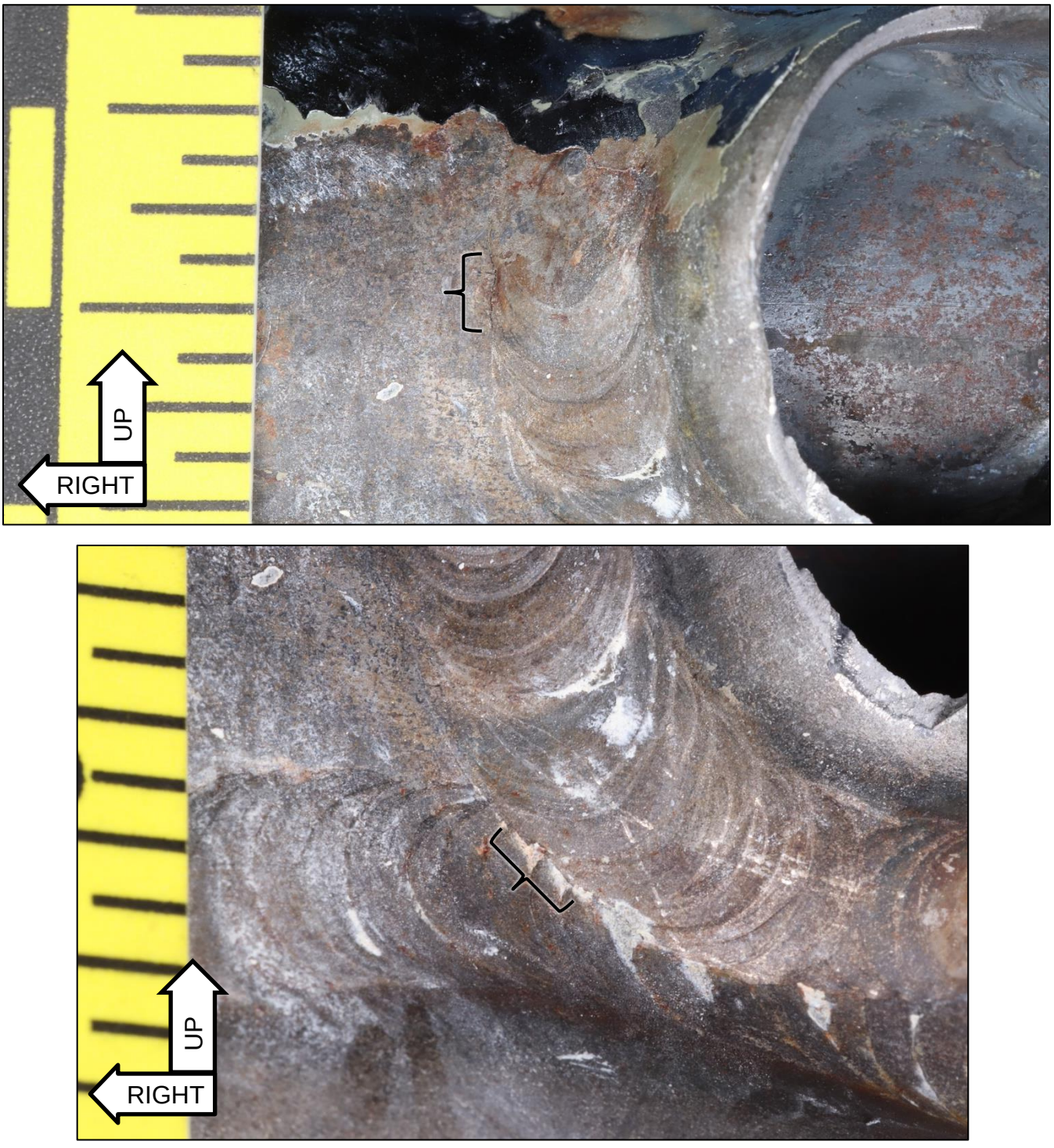


Figure 6. Forward face of the left NLG actuator attachment foot after cleaning with mineral spirits showing crack indications at the weld toe (locations marked with unlabeled brackets) as detected using an optical stereomicroscope.

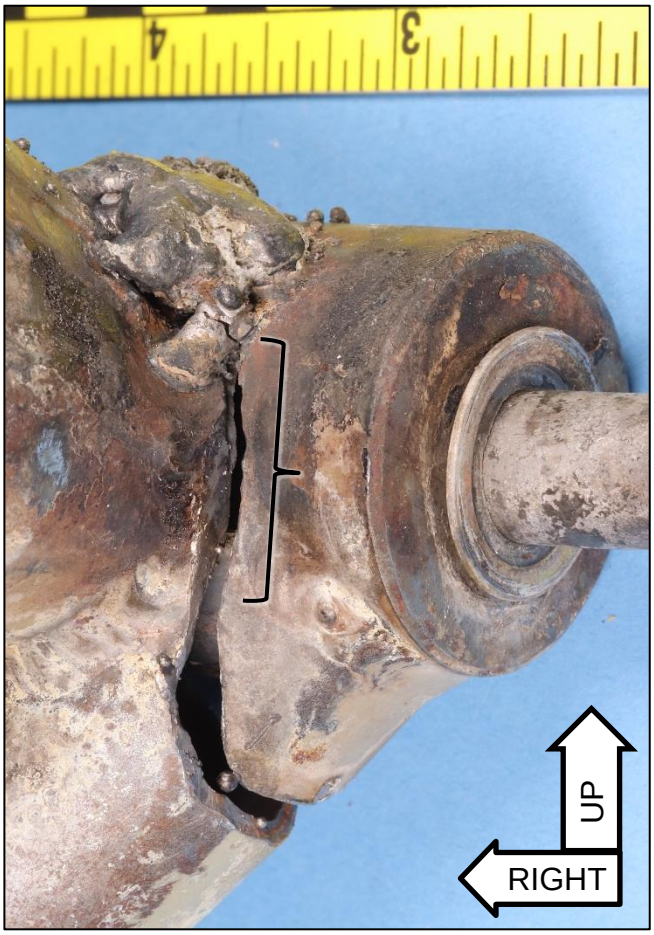


Figure 7. Right NLG actuator attachment foot after cleaning with mineral spirits as viewed looking aft. An unlabeled bracket indicates the fracture surface shown in figure 8.

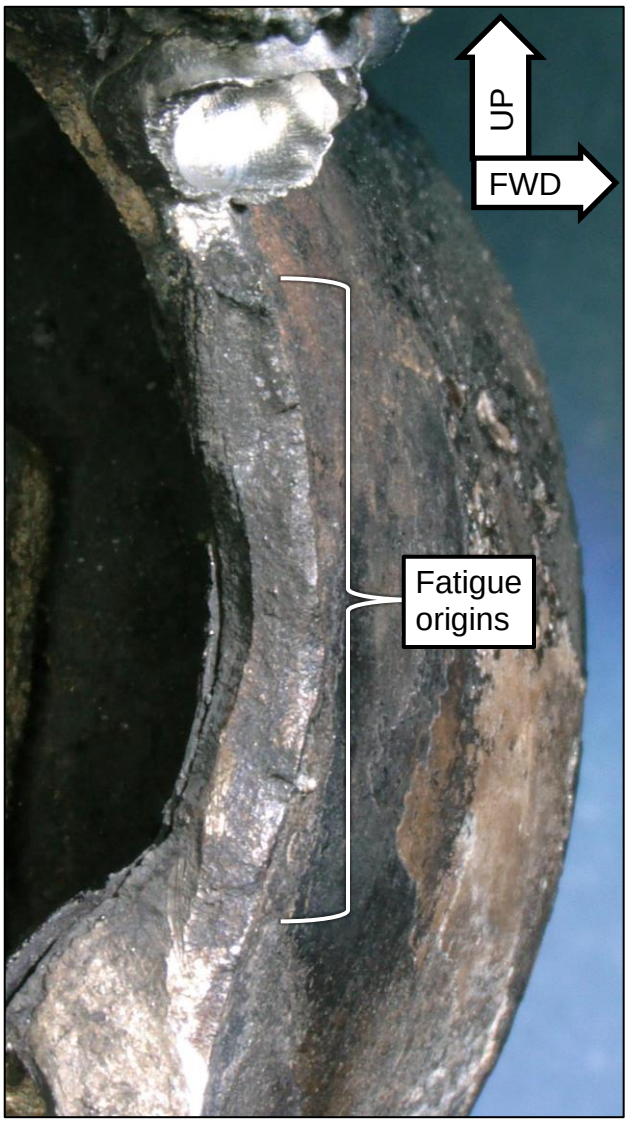


Figure 8. Fracture surface on the forward side of the right NLG actuator attachment foot after cleaning and oxide removal.