NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

August 8, 2013.

MATERIALS LABORATORY FACTUAL REPORT Report No. 13-054

A. ACCIDENT INFORMATION

Place:	East Moriches, New York.
Date:	October 20, 2012.
Vehicle:	Swift Museum Foundation, Inc. GC-1A, N80823.
NTSB No.:	ERA13FA032.
Investigator:	Tim Monville.

B. COMPONENTS EXAMINED

Left exhaust assembly.

C. DETAILS OF THE EXAMINATION

The left exhaust assembly submitted for examination is illustrated in Figure 1 with the #2 exhaust outlet, normally attached to the #2 cylinder exhaust port, the flange, normally bolted to a similar flange on the left muffler, and the clamp, normally retaining the left manifold to the exhaust outlet identified. The left exhaust assembly had been cut at the #1 exhaust pipe that is normally located under the engine and is similarly attached to the #1 cylinder exhaust port. The #1 exhaust pipe had also been deformed inwards at the location indicated by the identifying red arrow. The individual pieces of the left manifold are identified as the #2 exhaust pipe, the left exhaust pipe and the #1 exhaust pipe. The forward (FWD) direction, as installed on the engine, is also indicated. The white arrow indicates the cut end of the #1 exhaust pipe and the yellow arrow indicates the fractured end of the left exhaust pipe. The blue arrow indicates the fractured end of a portion of the left exhaust pipe still attached to the flange. Cylinders #3 and #4 have a separate exhaust arrangement where the #4 exhaust pipe is routed forward and under the engine, attached to and parallel to the #1 exhaust pipe, to join the #3 exhaust pipe and both exhaust through the right muffler.

The left side of the engine is illustrated in Figure 2 with the forward direction indicated and the left exhaust components identified as in Figure 1. The yellow and blue arrows indicate the fractures similarly indicated in Figure 1. Figure 2 illustrates the flange with the portion of the left exhaust pipe still bolted to the left muffler. Although the clamp was fractured, it was retained in the vicinity of its original location by other engine components.

Examination of the left exhaust revealed two welded patch repairs where the #1 exhaust pipe joins the #2 exhaust pipe and a fracture on the upper side immediately forward of the patches. A view of the left side of the repairs indicated by the brown arrows in Figures 1 and 2 is illustrated in Figure 3 with the forward direction indicated. The patch identified as "A" was found to be almost circumferential with a small gap located on the underside. The patch identified as "B" was mostly located on the left side, between the purple arrow in Figure 3 and in the right image in Figure 5. The patch welds had a rough uneven lumpy appearance with areas of undercutting but did not display any indications of escaping exhaust gasses. The red arrow in Figure 3 indicates the left tip of a fracture that extended to the right, over the top of the manifold, to the red arrow in Figure 4 and along the forward edge of the weld indicated by the yellow arrow. The white arrow in Figure 3 indicates where the #2 exhaust pipe was now located under the fractured edge of the weld joining it to the left exhaust pipe.

The right side of the patch repairs is illustrated in Figure 4 with the forward direction indicated and patch "A" identified. The patch welds had a rough uneven lumpy appearance with areas of undercutting but did not display any indications of escaping exhaust gasses. The white arrow indicates a previous weld that had been partially obscured by the patch weld indicated by the yellow arrow. The red arrow indicates the right tip of the fracture indicated by the red arrow in Figure 3.

Examination of the patch repairs on the underside of the manifold revealed a third patch. The repair patches are illustrated in the left image in Figure 5 and identified as "A" and "B", as in Figures 3 and 4, and the third patch, located mostly below the ends of patch "A", is identified as "C". The forward direction is indicated. The red arrow indicates the tip of the crack similarly indicated in Figure 3 and the white arrow indicates the weld similarly indicated in Figure 4. The green arrow indicates the original weld that joins the #1 exhaust pipe to the #2 exhaust pipe. The patch repair welds still displayed the rough uneven lumpy appearance illustrated.

The patch repairs on the upper side of the manifold are illustrated in the right image in Figure 5 and identified as "A" and "B" as in Figures 3 and 4. The forward direction is indicated. The patch repair welds still displayed the rough uneven lumpy appearance illustrated. The white arrow indicates the weld similarly indicated in the left image and in Figure 4, and the red arrows indicate the fracture tips similarly indicated in Figures 3 and 4. The blue arrows indicate cracks that were a continuation of the fractures indicated by the red arrows and had propagated along both sides of the original weld indicated by the green arrow. The yellow arrow indicates a weld on top of the weld indicated by the green arrow. The upper side, looking aft, is illustrated in Figure 6 with patch "A" identified. The green arrow, as in Figure 5, indicates the original weld and blue arrows indicate the cracks on both sides of the weld. The white arrow indicated the weld similarly indicated in the right image in Figure 5 and the yellow arrows indicate the exposed uniform pipe thickness.

Examination of the manifold also revealed the compression buckle indicated by the purple arrow in Figure 1, the normal location for the clamp.

The flange identified in Figure 1 is normally part of the exhaust assembly and bolted to the muffler as illustrated in Figure 2. A side view of the fractures indicated by the yellow and blue arrows in Figure 1 are illustrated in the left image in Figure 7 with mating features indicated by the yellow and blue arrows. The left exhaust pipe, the ball joint and the flange are identified and the forward direction is indicated. The ball joint allows for any misalignment between the exhaust pipe and the muffler. The white arrow indicates the rearward deformation of the flange at the mounting hole indicated by the purple arrow and the green arrow indicates a crack in the lip of the flange that normally conforms to the ball joint. The exhaust pipe is welded to the ball joint and the weld was found on the ball joint portion. The weld was also found to be circular. The weld within the red box is illustrated in the right image in Figure 7 with a blue arrow indicating the fracture as in the left image. The examination revealed that the weld consisted of the three identified beads that are divided by the red dashed lines.

Examination of the rear end of the exhaust pipe revealed the fracture face and deformation of the pipe illustrated in Figure 8. Examination of the fracture face indicated by the yellow arrows revealed a rough grainy surface, consistent with an overload event, on a uniform pipe thickness that was measured at 0.027-0.025-inch thick. The exhaust outlet was extracted from the exhaust pipe and the pipe thickness was found to be uniform and was measured at 0.029-0.028-inch. The thickness of the cut end of the #1 exhaust pipe indicated by the white arrow in Figure 1 was found to be uniform and measured at 0.029-0.025-inch.

XRF analysis[1] was performed on the exhaust assembly and the analyzer matched the exhaust pipes, the exhaust outlet, the exhaust outlet's flange, the ball joint and the flange to a stainless steel designated as type 321. The analyzer matched patches "A", "B" and "C" to stainless steels designated as type 303 or type 304. The analyzer also indicated that the welds were stainless steel but could not match it to any particular type.

Derek Nash
Mechanical Engineer

[1] Using a Thermo Scientific Niton XL3t-980 x-ray fluorescence (XRF) alloy analyzer.

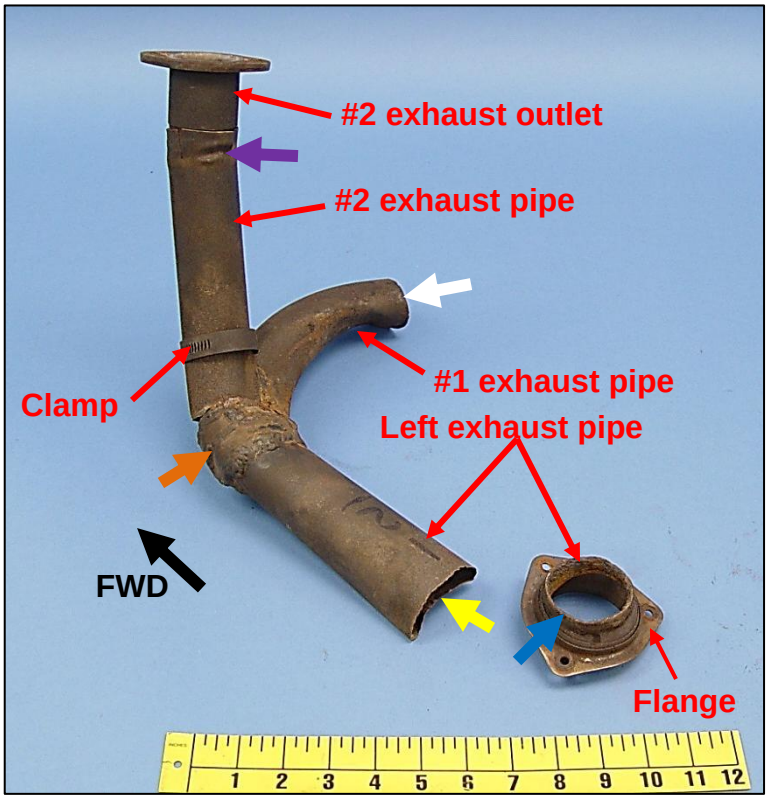


Figure 1. The left exhaust assembly received for examination.

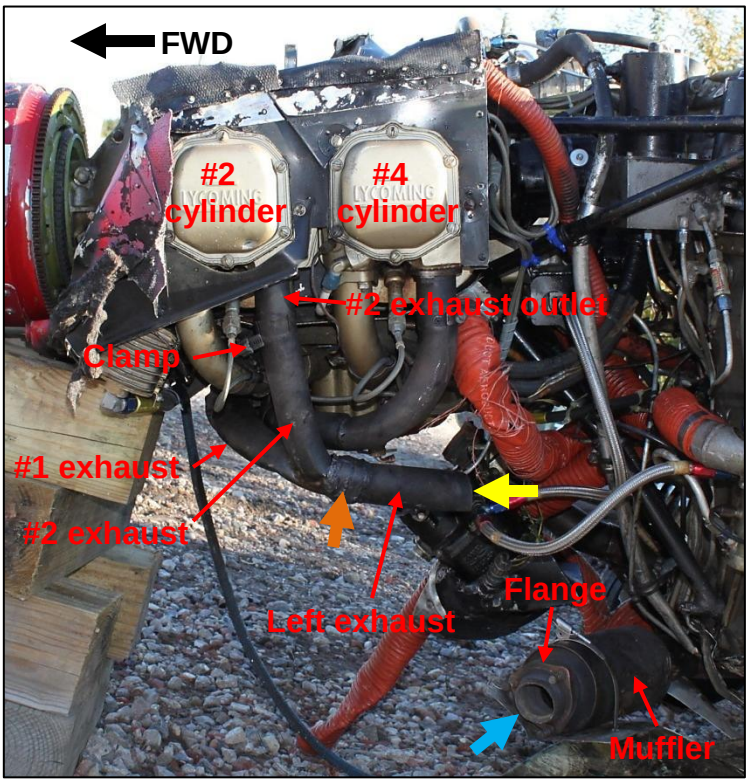


Figure 2. The left side of the engine with the left exhaust components in Figure 1 indicated and identified.

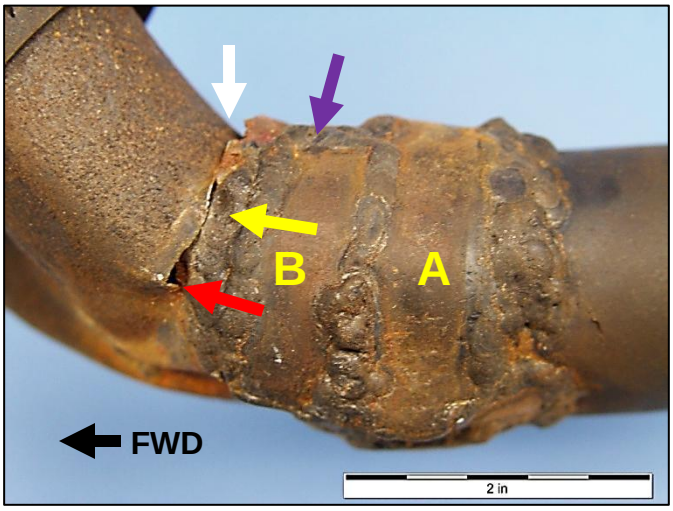


Figure 3. The left side of the left exhaust repair indicated by the brown arrow in Figure 1.

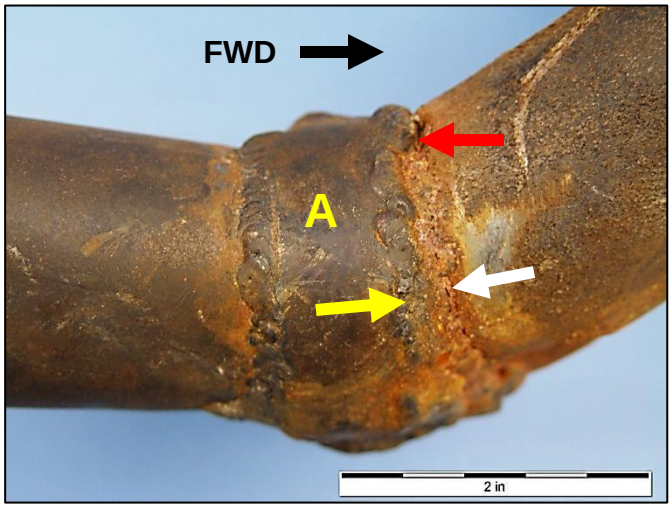
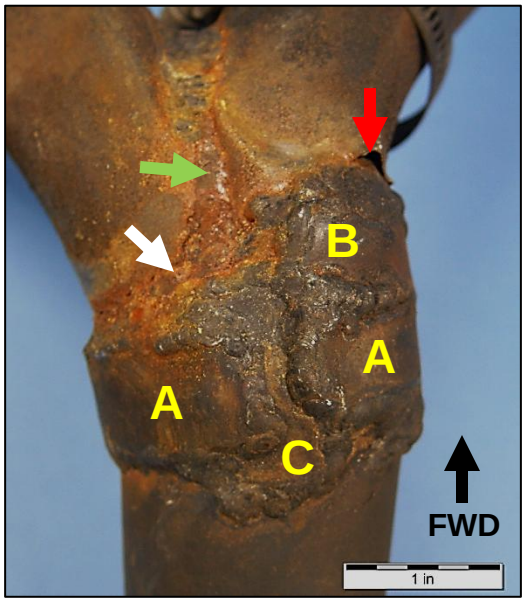


Figure 4. The right side of the left exhaust repair illustrated in Figure 3.



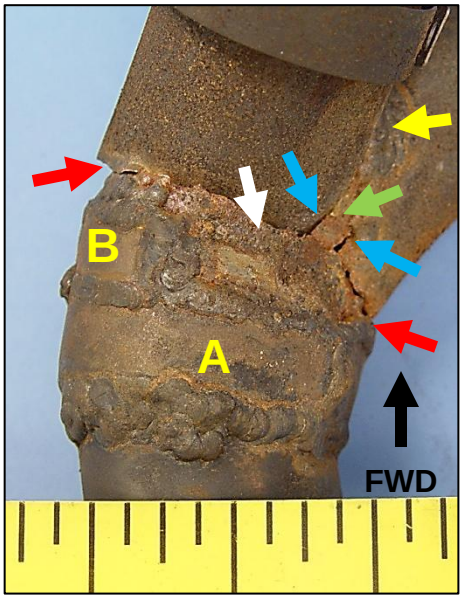


Figure 5. The underside (left) and upper side (right) of the left exhaust repair illustrated in Figure 3.

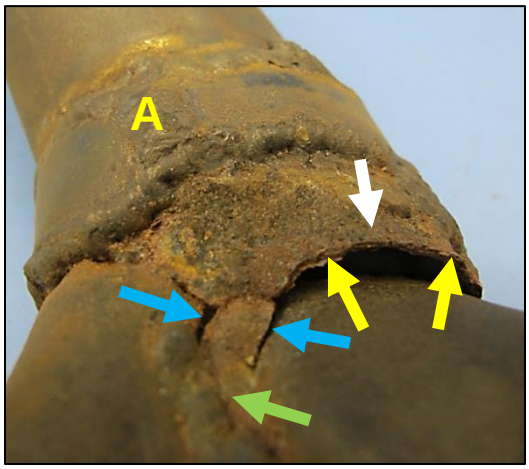
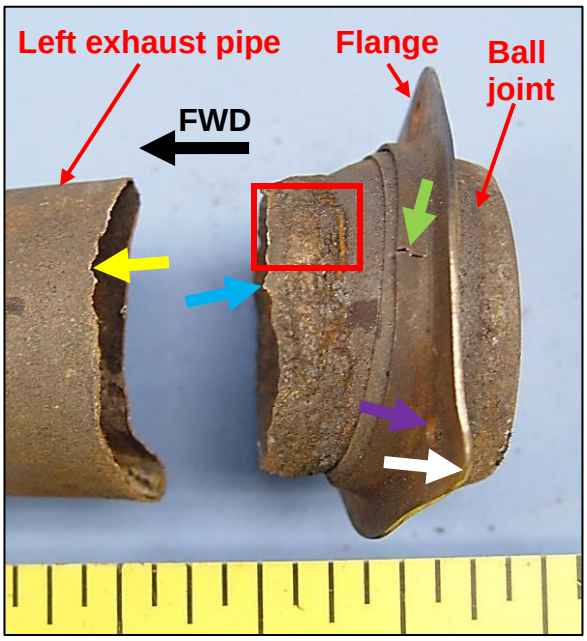


Figure 6. The upper side of the left exhaust repair, looking aft.



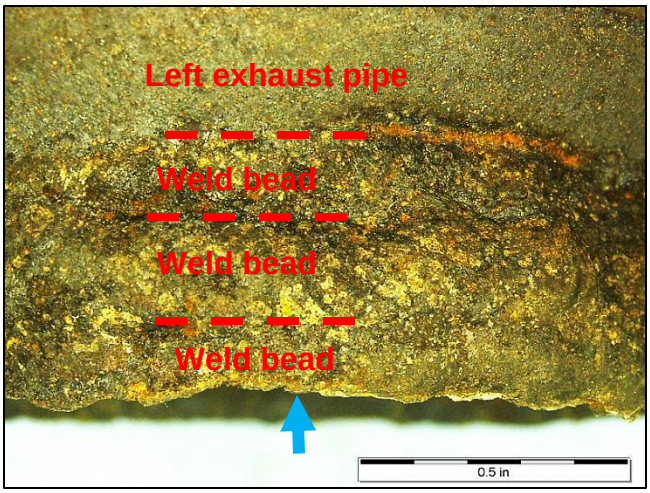


Figure 7. The mating fractures indicated by the yellow and blue arrows in Figures 1 and 2 (left) and the weld in the red box (right).

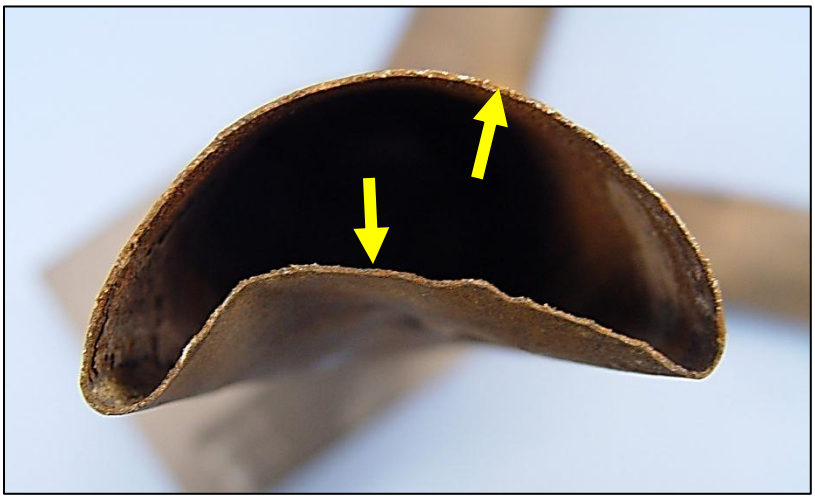


Figure 8. The fracture face indicated by the yellow arrow in Figures 1, 2 and 7.