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

November 20, 2017

MATERIALS LABORATORY FACTUAL REPORT Report No. 17-081

A. ACCIDENT INFORMATION

Place	:	Medford, New Jersey
Date	:	September 8, 2017
Vehicle	:	Schweizer 269C1, N204HF
NTSB No.	:	ERA17FA317
Investigator	:	Brian Rayner, ASI-ERA

B. COMPONENTS EXAMINED

Collective Throttle Control System with Throttle Cable, Linkage and Carburetor.

C. DETAILS OF THE EXAMINATION

The as-received components are displayed in figure 1. The collective and throttle assembly with throttle cable are in the upper view. The right collective lever was bent upward with mechanical damage and denting at the fulcrum of the bend and the throttle cable was bent and distorted as shown. The carburetor linkage is displayed in the middle view with the support structure for the bellcrank assembly fractured and the tie rod separated. The throttle arm side of the carburetor is shown below.

1. Tie Rod

The bellcrank and tie rod assemblies are displayed in the upper view of figure 2. The tie rod assembly was received separated at the threaded joint. The components were unbolted from the carburetor throttle arm and the throttle cable prior to receipt in the materials laboratory. The tie rod assembly consisted of an internally threaded rod attached to the bellcrank and an externally threaded rod end bearing and jam nut attached to the throttle arm. The tie rod was separated at the threaded joint between the two pieces. The rod end was received with the jam nut at the location shown. This was reported to be the location found at the accident scene.

Magnified examinations of the bearing threads uncovered mechanical damage to the three end threads boxed area in the middle view and shown at higher magnification in the lower view of figure 2. The damage was consistent with thread to thread wear. The wear showed a distinct pattern with material removed (red arrows) from the bearing side flanks of the lower threads (as shown) and the opposite flanks (bellcrank side) of the upper threads.

Visual examination of the internal threads in the rod revealed cellulose material imbedded into the threads. After brush cleaning, damage was visible to the three end threads as shown in the upper view of figure 3. The damage left the thread flanks pock marked and reduced in size consistent with vibratory thread to thread wear. These three threads correspond to the three worn threads on the bearing fitting. Threads further inside the rod were bright and shiny and undamaged.

The end of the rod was abrasively cut on a vertical plane to reveal the damaged threads as shown in the lower view of figure 3. Magnified examinations of the damaged threads showed a similar pattern of wear to the bearing threads. For half of the rod circumference the wear (red arrows) was on one flank of the threads and on the opposite flank on the other half of the circumference.

The pattern of thread wear was consistent with bending contact with the mating threads of the bearing and rod. The remaining threads on the bearing were relatively undamaged and without clearly define contact patterns.

The engineering drawing, 269A8416, and maintenance documents[1] both specify the eye to eye center length of the tie rod assembly as 4.97 inch +/- 0.02 inch. This length is depicted in the upper view of figure 4 and results in about 16 or 17 engaged threads. When the tie rod is installed on the throttle arm and the bellcrank, the rod and bearing cannot rotate relative to each other. The as-received position of the jam nut was about two threads past the end of the rod when at about 4.97 inches, as shown.

The thread wear found on both the bearing and rod however was consistent with about three threads engaged between the two components. This is depicted in the lower view of figure 4 and results in a tie rod length of about 5.5 inches or about 0.5 inch longer than specified.

Examinations of the jam nut uncovered an arc of wear damage to the bellcrank side washer face as shown in the two views of figure 5. The arc of wear covered about 217 degrees of the nut adjacent to the internal nut threads. A similar arc of wear was found on the end of the rod. The size and location of the wear on the nut corresponds to the size and location of a wear pattern found on the end of the rod as shown in figure 6.

2. Throttle Cable

The as-received throttle control cable assembly is shown in the upper view of figure 7. The assembly was deformed and kinked as shown with both support tubes separated from their respective swivel fittings. The carburetor side cable end, that connects to the bellcrank, was bent more than 90 degrees and the stranded inner cable was kinked and bent about 90 degrees, yellow box upper view. The exposed strands of the cable were spread apart (bird caged), as shown in the lower view of figure 7. The cable assembly was labeled “McFarlane custom Lot# 45481”. It was reported to be a copy of the original assembly p/n 269A8410.

[1] Model 269C-1 Basic HMI paragraph 4-6 e, 13 Dec 2004.

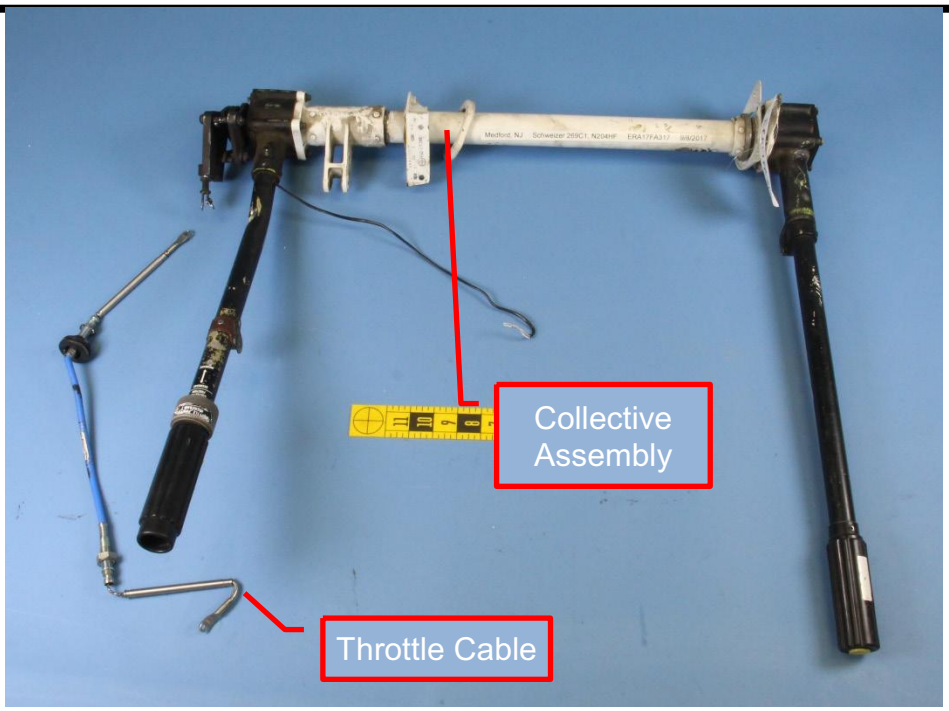
To accurately measure the cable length, it was suspended from a fixture and stretched with 100 pounds from of the carburetor end. The Cablecraft engineering drawing[2] for the throttle cable, 580-704, lists an eye to eye length of 27.12 inches for a 269A8410-11 part number cable. Measurements of the received cable were about 27.12 inches. Other dimensions on the cable appeared to meet the drawing requirements.

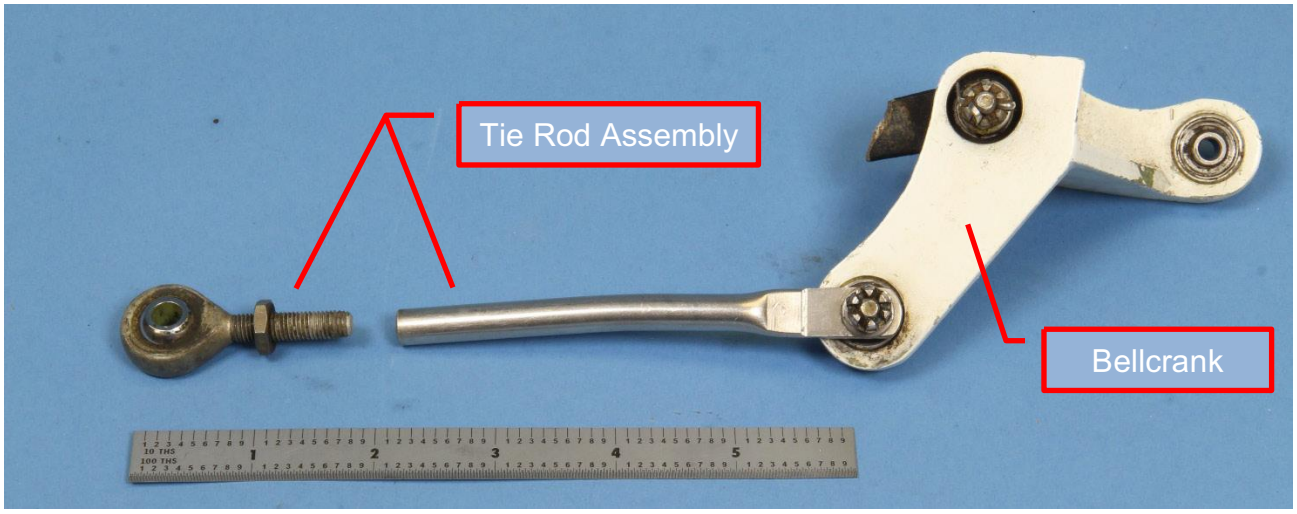
3. Carburetor

The carburetor is displayed in the upper view of figure 8 with the bellcrank and tie rod pieces positioned in their approximate original positions. The mounting structure for the bellcrank was fractured and deformed. The inlet and outlet flanges of the carburetor were also distorted and fractured. The throttle arm and idle stop screw appeared intact and undistorted. The maintenance documents indicated that with the throttle arm at idle (against the stop) The arm should be at approximately 17 degrees from vertical. The angle of the arm was photographically measured using three different reference lines on the carburetor. All three measurements were within 1 degree of 17 as depicted in the lower view of figure 8.

Joe Epperson, FASM
Senior Metallurgist

[2] The Hughes Tool drawing 269A8410 lists Cablecraft 580-704-026 as the approved souse of supply.





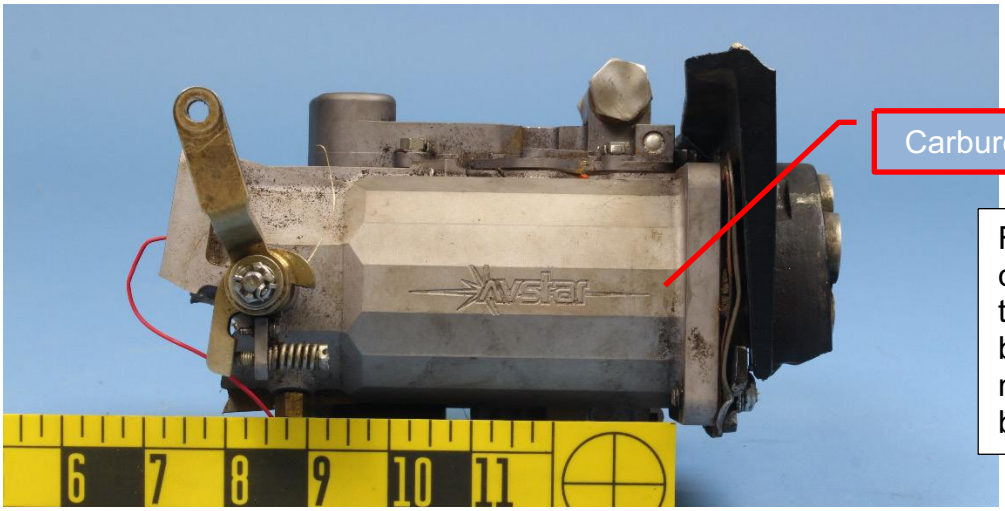
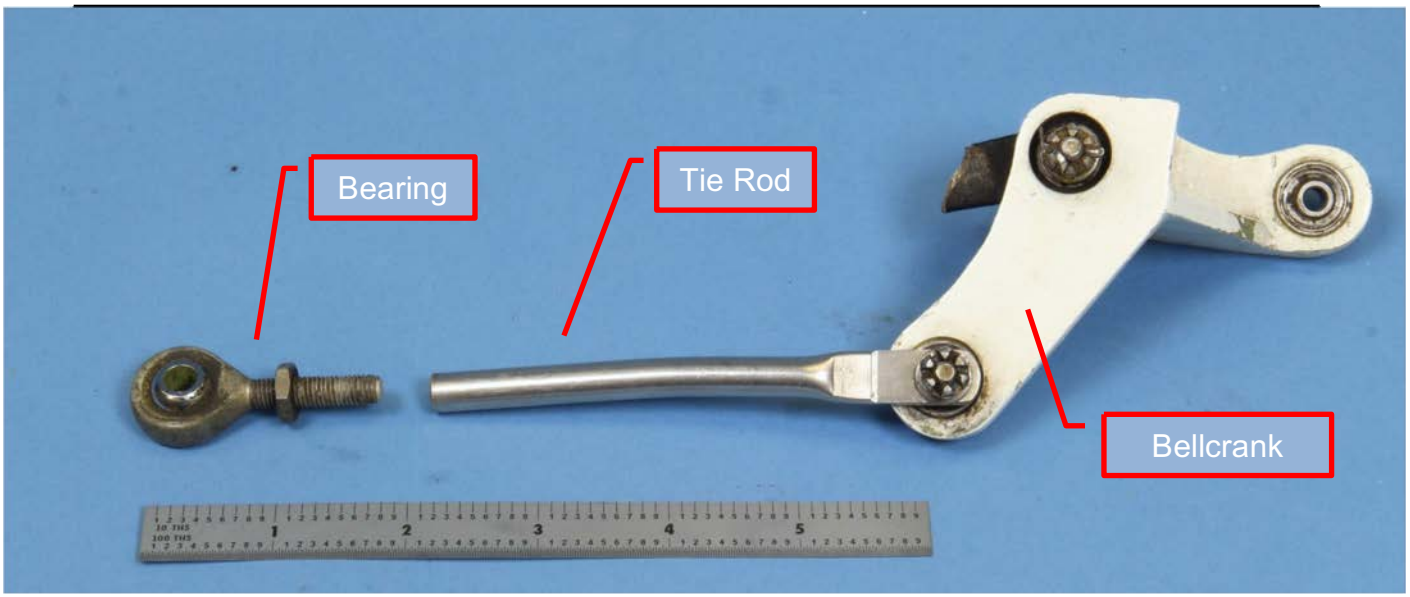


Figure 1. The as-received components, collective and throttle cable at top, the bellcrank and tie rod in the middle and the carburetor below.



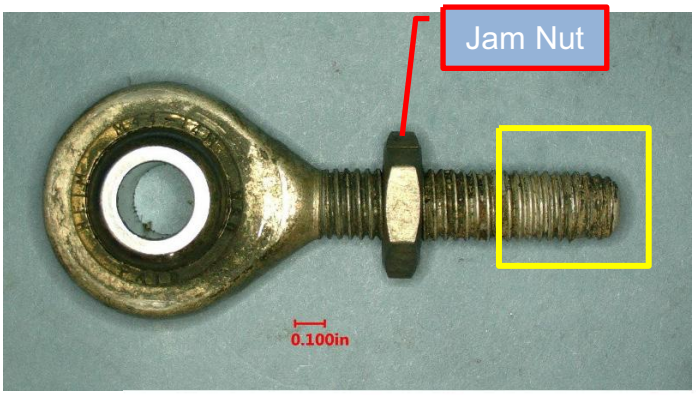
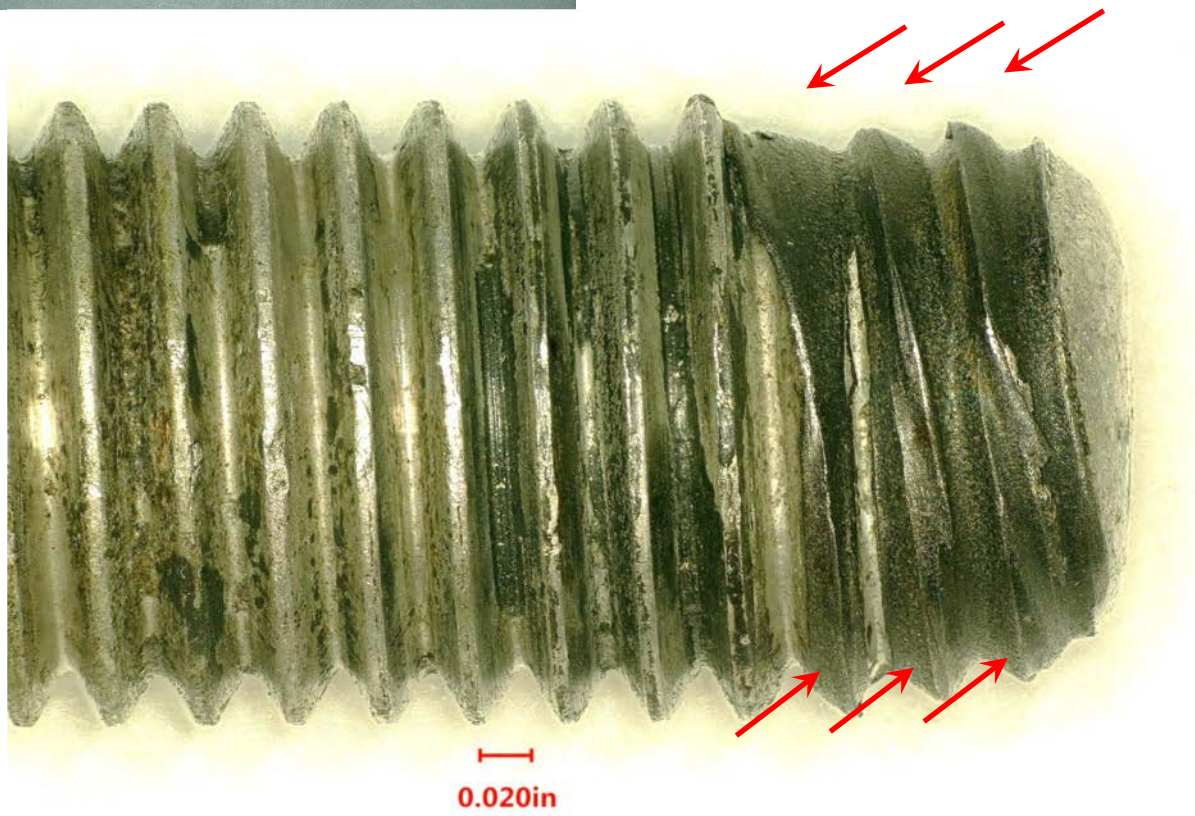


Figure 2. The carburetor throttle linkage with separated tie rod assembly at top. Left view shows the rod end bearing with thread damage. The boxed area is displayed below at higher magnification showing the pattern of wear (red arrows) damage.



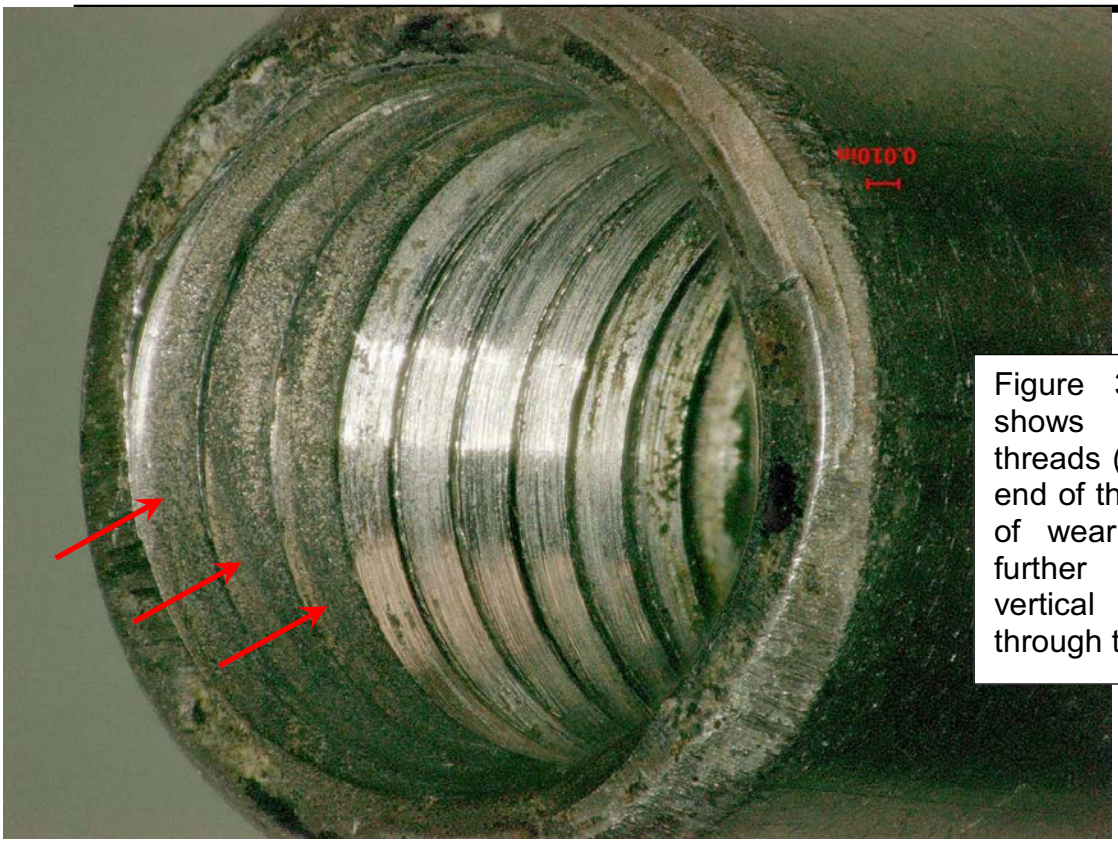
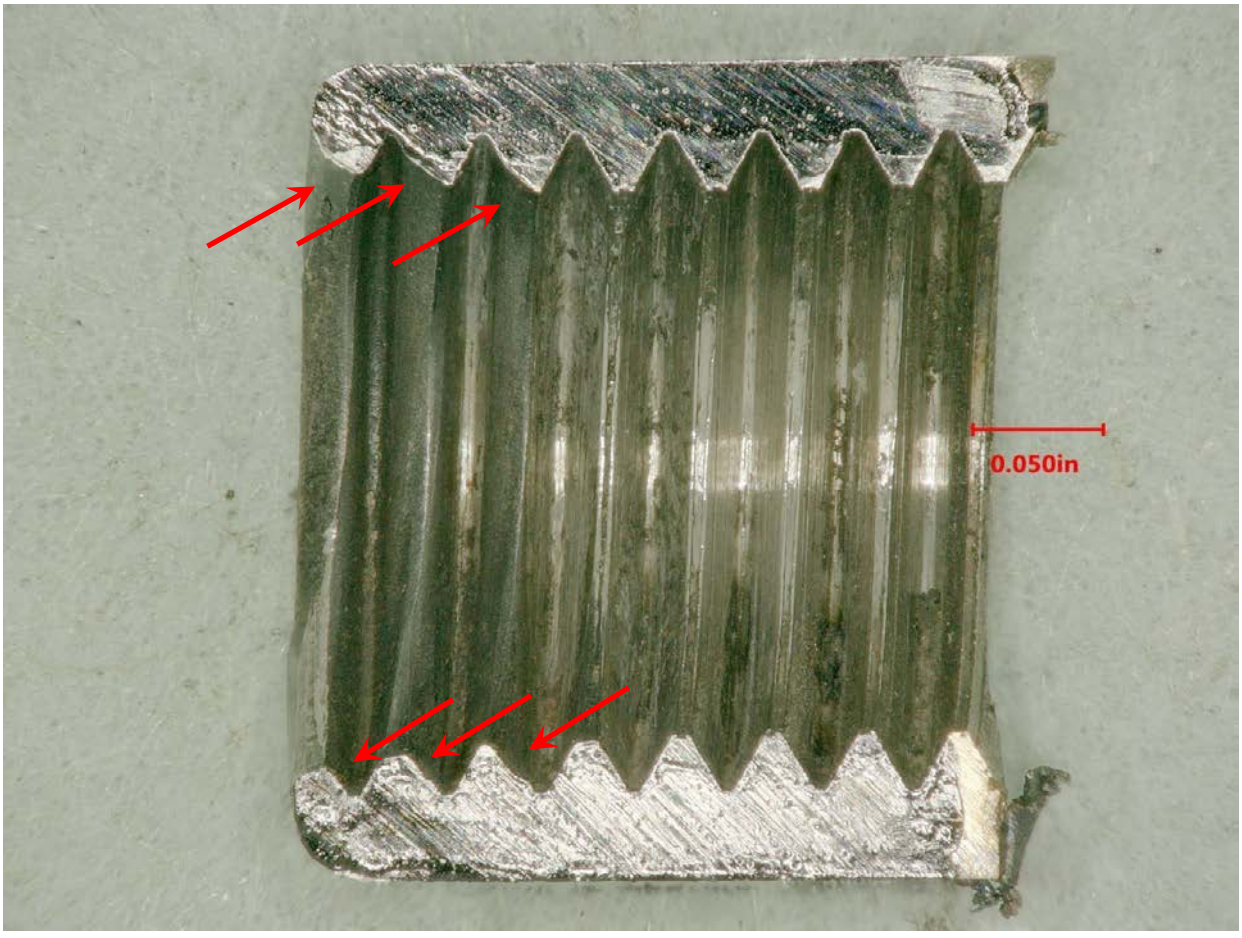


Figure 3. Upper view shows the three worn threads (red arrows) at the end of the rod. The pattern of wear (red arrows) is further evident on the vertical cross section through the threads below.



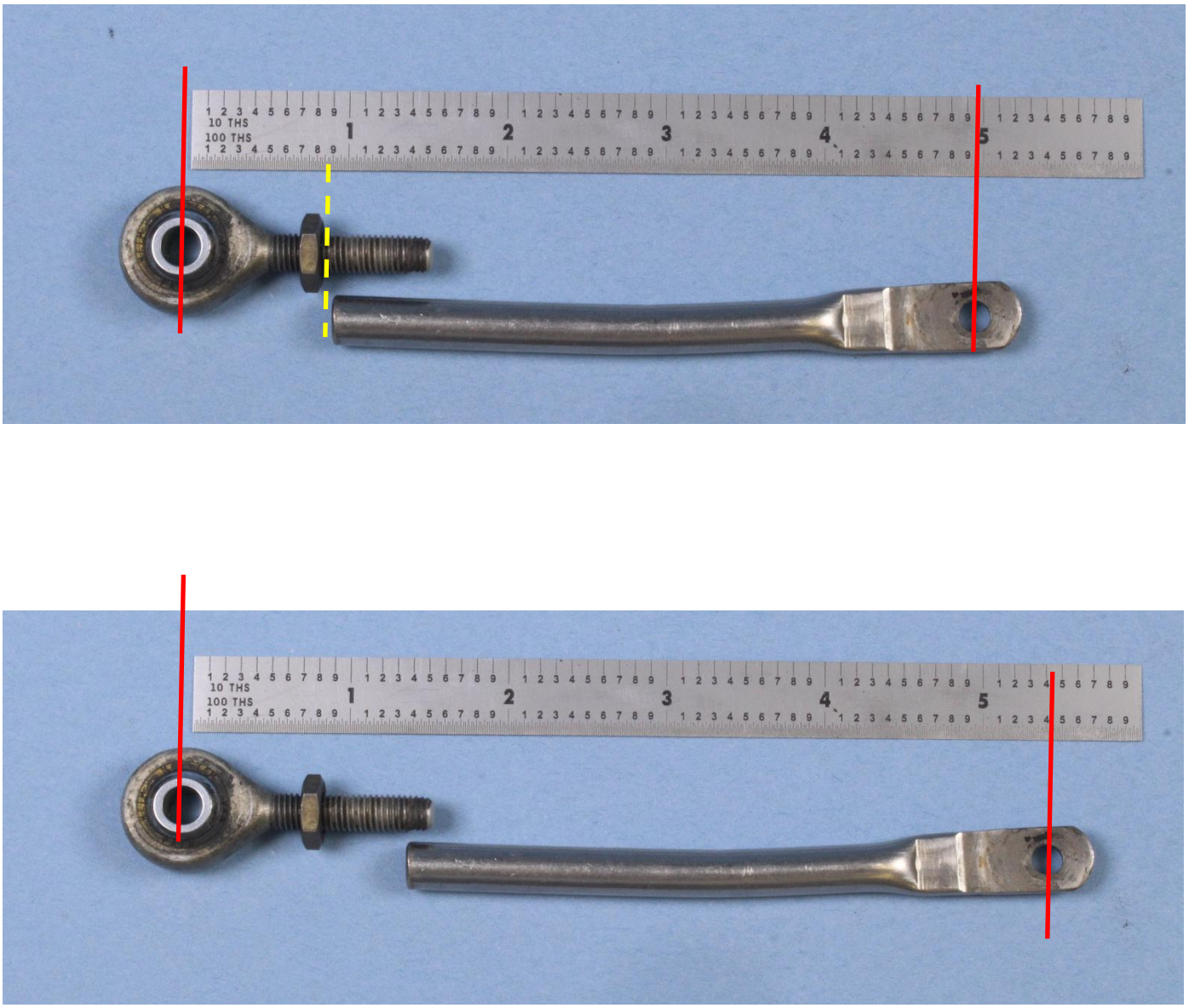


Figure 4. The upper view shows the relative thread engagement when the tie rod is adjusted to approximately the eye to eye length specified by the engineer drawing and maintenance documents, 4.97 =/- .020 inches. The lower view shows the overlap when only the three damaged threads are engaged. With an eye to eye distance of about 5.5 inches.

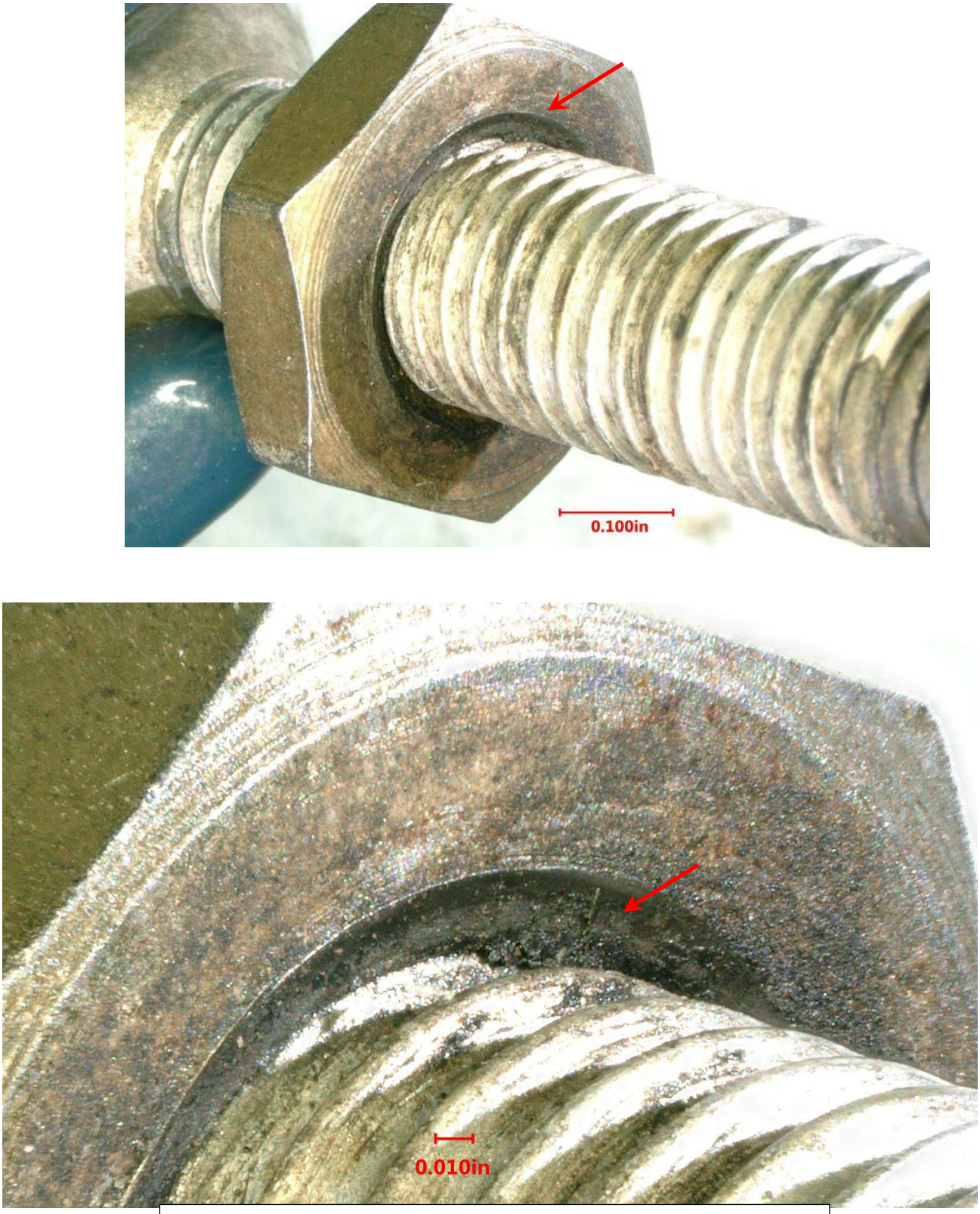


Figure 5. Two optical views showing the arc of wear, red arrow, on the rod side of the jam nut.

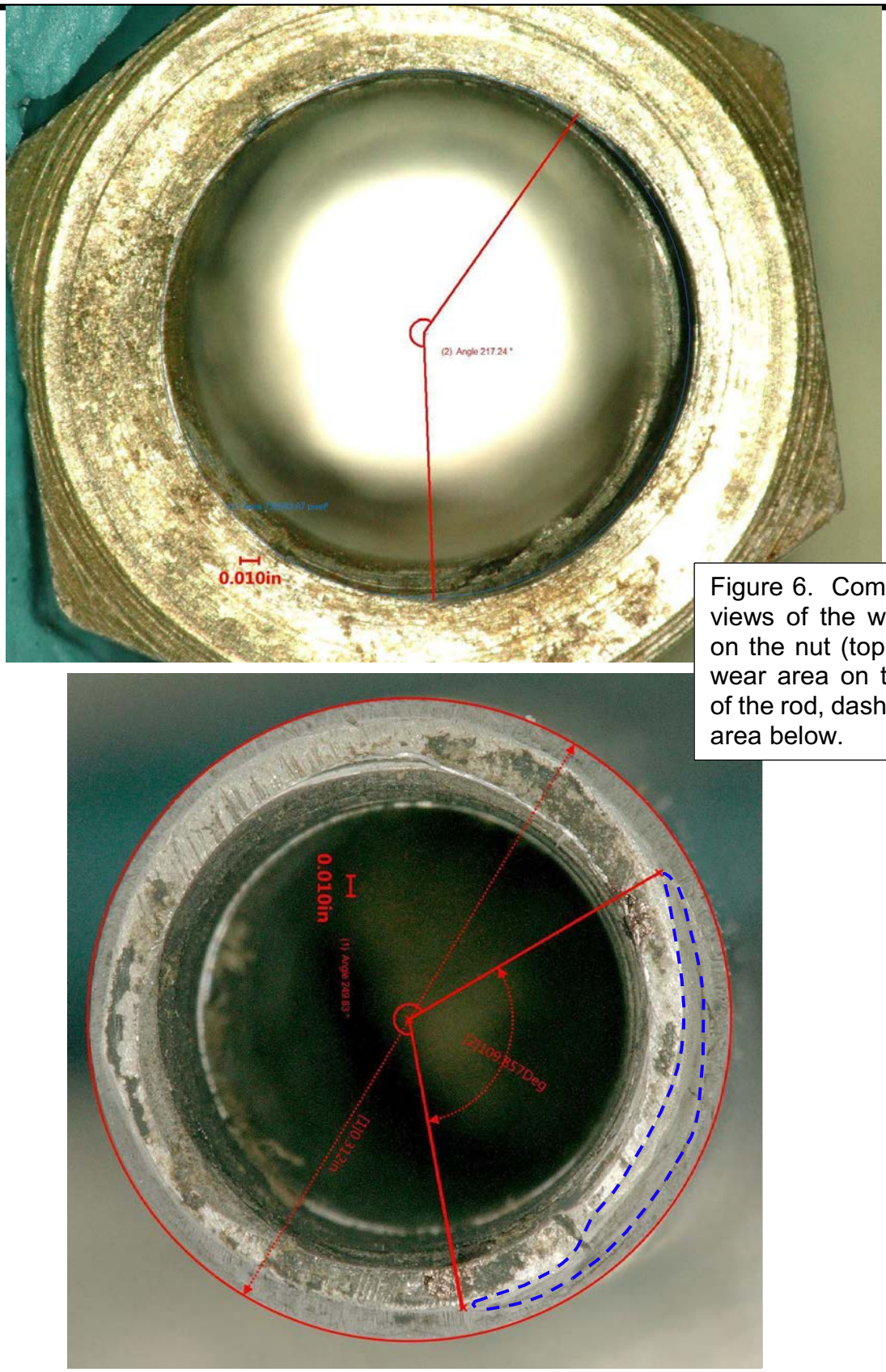


Figure 6. Comparison views of the wear arc on the nut (top) to the wear area on the end of the rod, dashed blue area below.

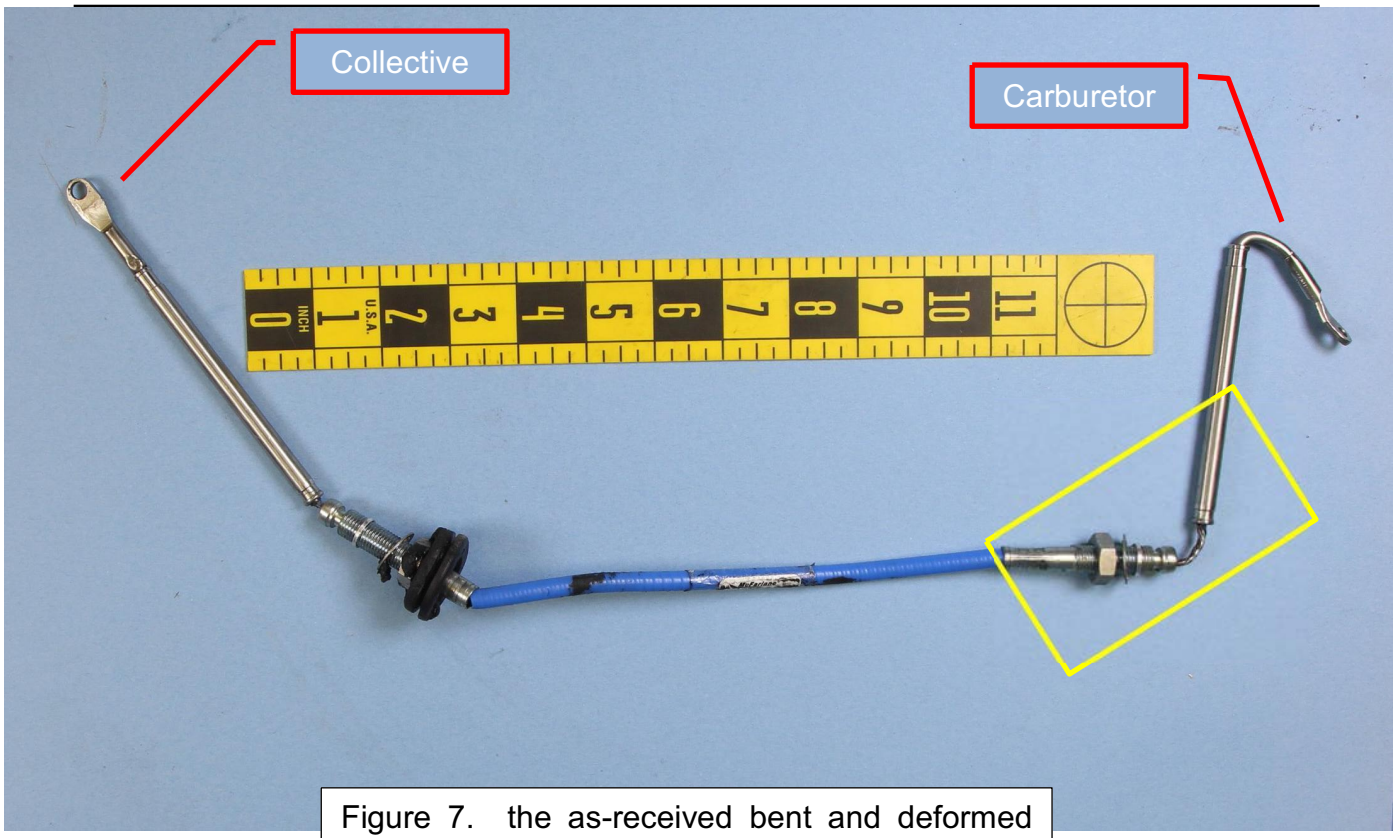
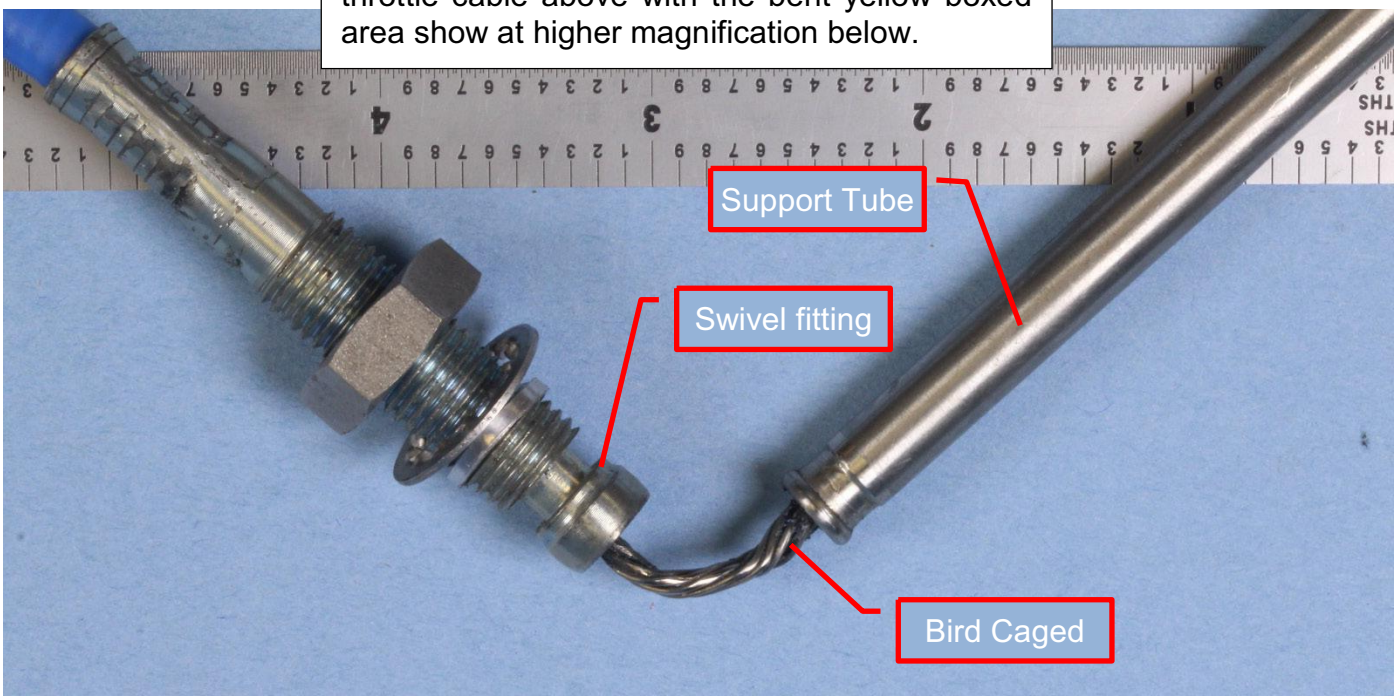


Figure 7. the as-received bent and deformed throttle cable above with the bent yellow boxed area show at higher magnification below.



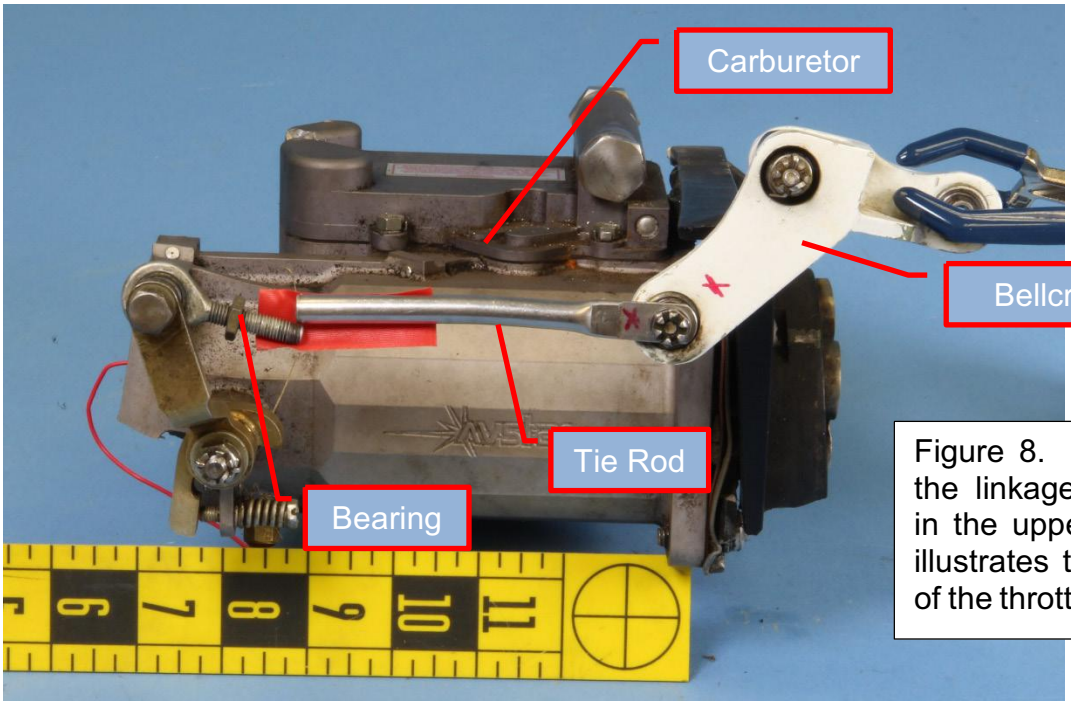


Figure 8. The carburetor with the linkage roughly positioned in the upper view. Lower view illustrates the 17 degree angle of the throttle arm at idle setting.