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

September 28, 2022

MATERIALS LABORATORY FACTUAL REPORT Report No. 22-028

A. ACCIDENT INFORMATION

Place	:	Brookshire, Texas
Date	:	October 19, 2021
Vehicle	:	McDonnell Douglas DC-9-87
NTSB No.	:	DCA22MA009
Investigator	:	Tom Jacky, AS-40

B. COMPONENTS EXAMINED

Left and right elevator geared tab links with attached fixed bearing fittings and attachment hardware, actuating cranks, and pushrods.

C. DETAILS OF THE EXAMINATION

An overall view of the submitted left and right geared tab links with attached fixed bearing fittings and attachment hardware are shown in figure 1, and an overall view of the corresponding actuating cranks and pushrods are shown in figure 2. As installed on the airplane, the lower ends of a pair of geared tab links are attached to a fixed bearing fitting that is bolted to the horizontal stabilizer aft spar, and the upper ends are attached to the forward end of the actuating crank. The aft end of the actuating cranks is attached to a pushrod that extends aft to the elevator tab. The geared tab links were received attached to the fixed bearing fittings with lock pins in place, and the actuating cranks were received attached to the pushrods. The links had been disassembled from the actuating crank, and the associated hardware was included as shown in figure 1.

Each of the submitted geared tab links were bent laterally outboard. The pair of links for the right geared tab assembly were also twisted counterclockwise as viewed from above. Peeling white paint was observed, and the underlying surfaces were covered with dark reddish-orange oxides. The paint had peeled from most of the deformed area in the middle of the links and was also peeling from areas of the tabs that showed little or no deformation. The actuating cranks were also bent outboard in the beam portion of the crank near the clevis at the aft end as shown in figure 3.

The fixed bearing for each assembly moved smoothly and freely by hand. To facilitate further examination and testing of the links, the links were disassembled from the fixed bearings and labeled by relative position on the airframe (right and left) and relative to the fixed bearing (inboard and outboard). Loosely adhering paint and oxides were removed from areas of the upper tabs on each link using an abrasive pad, and the

thicknesses were measured using a micrometer. The width across the link in the bent web portion of the links was also measured using a caliper. Results of these measurements are shown in table 1. According to the engineering drawing, the links are made from 0.090-inch thick sheet of cadmium-plated alloy 4130 steel, and the width across the web should be 0.75 inch. The accuracy of the width measurements was likely affected by deformation to the links, particularly on the right side where forward and aft faces were no longer parallel due to twisting deformation.

Table 1. Dimension and Hardness Measurements

Link	Thickness (inch)	Width (inch)	Hardness (HRC)
Left outboard	0.0885	0.764	32.8
Left inboard	0.0886	0.764	32.0
Right inboard	0.0901	0.765	31.3
Right outboard	0.0883	0.765	33.1

Next, the tab area at the upper end of each link was sectioned to prepare areas for hardness testing and composition analysis. The sectioned pieces were ground to produce parallel flat surfaces, and one face was further ground to a 600-grit finish. The prepared pieces were then tested using a Rockwell indenter. Results of the hardness tests are listed in table 1. All hardness results were within the specified range for the link material specified in the engineering drawing.

The composition of the link material area was tested in the ground using an Olympus Vanta x-ray fluorescence (XRF) alloy analyzer. The analyzer reported the material for each link was Alloy 4130 steel, consistent with the material specified in the engineering drawing.

The actuating cranks were sectioned in the beam portion near the forward end of the crank to facilitate hardness, conductivity, and composition analysis. A transverse cut in the beam portion of the crank was ground to a 600-grit finish and then was tested using a Rockwell indenter. The average hardness measured 82.5 HRBW for both the left and right actuating cranks. Conductivity measured 36.9% IACS and 37.8% IACS for the left and right actuating cranks, respectively. Hardness was within the expected range of 74.5 to 83.5 HRB, and conductivity was within the expected range of 36 to 42% IACS as reported previously.[1] The Olympus Vanta alloy analyzer reported the material to be aluminum alloy 2014 or 2017. The specified alloy was not noted in the report referenced in the footnote below.

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[1] M. Bauer, Accident Docket DCA17FA076, *Systems Group Chairman's Factual Report*, National Transportation Safety Board (2018).

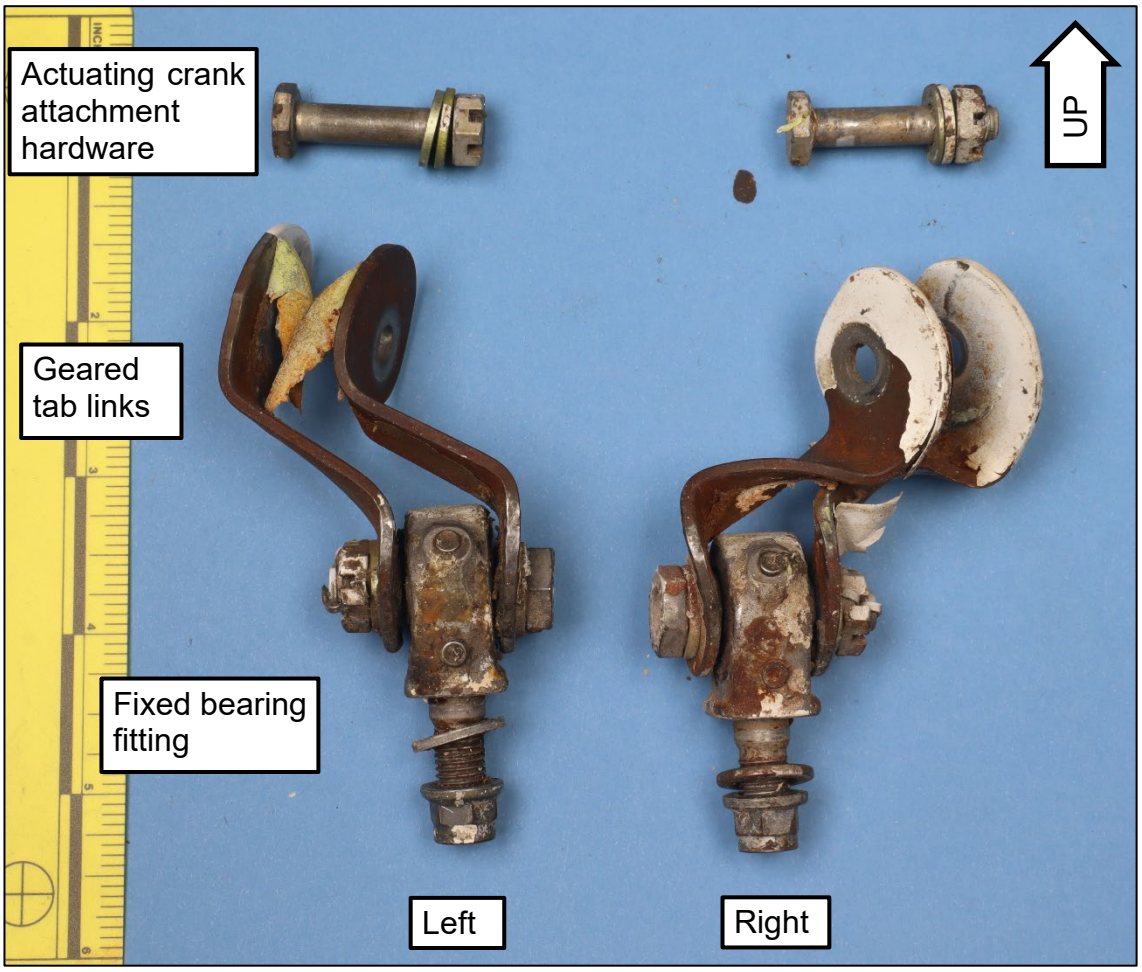

Figure 1. Overall view of the aft side of the submitted links, fixed bearing fittings, and associated hardware.

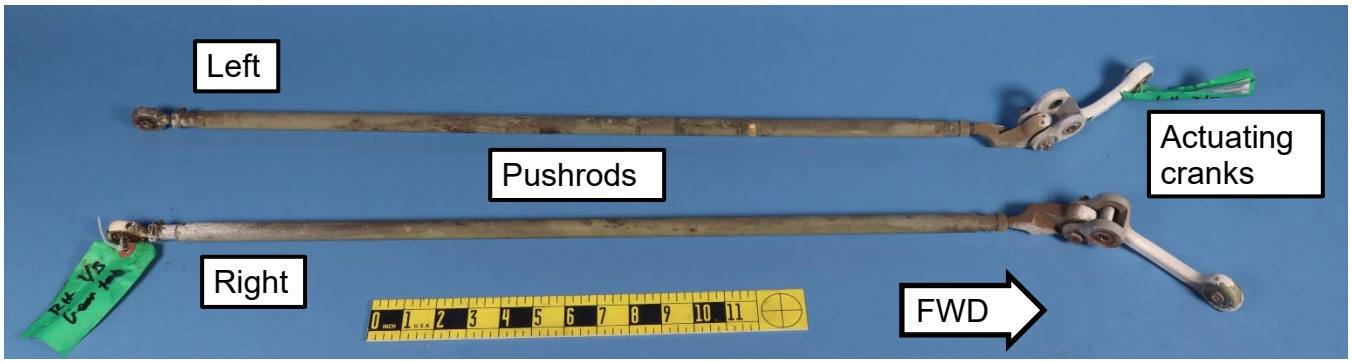

Figure 2. Overall view of the upper side of the submitted actuating cranks and attached pushrods.

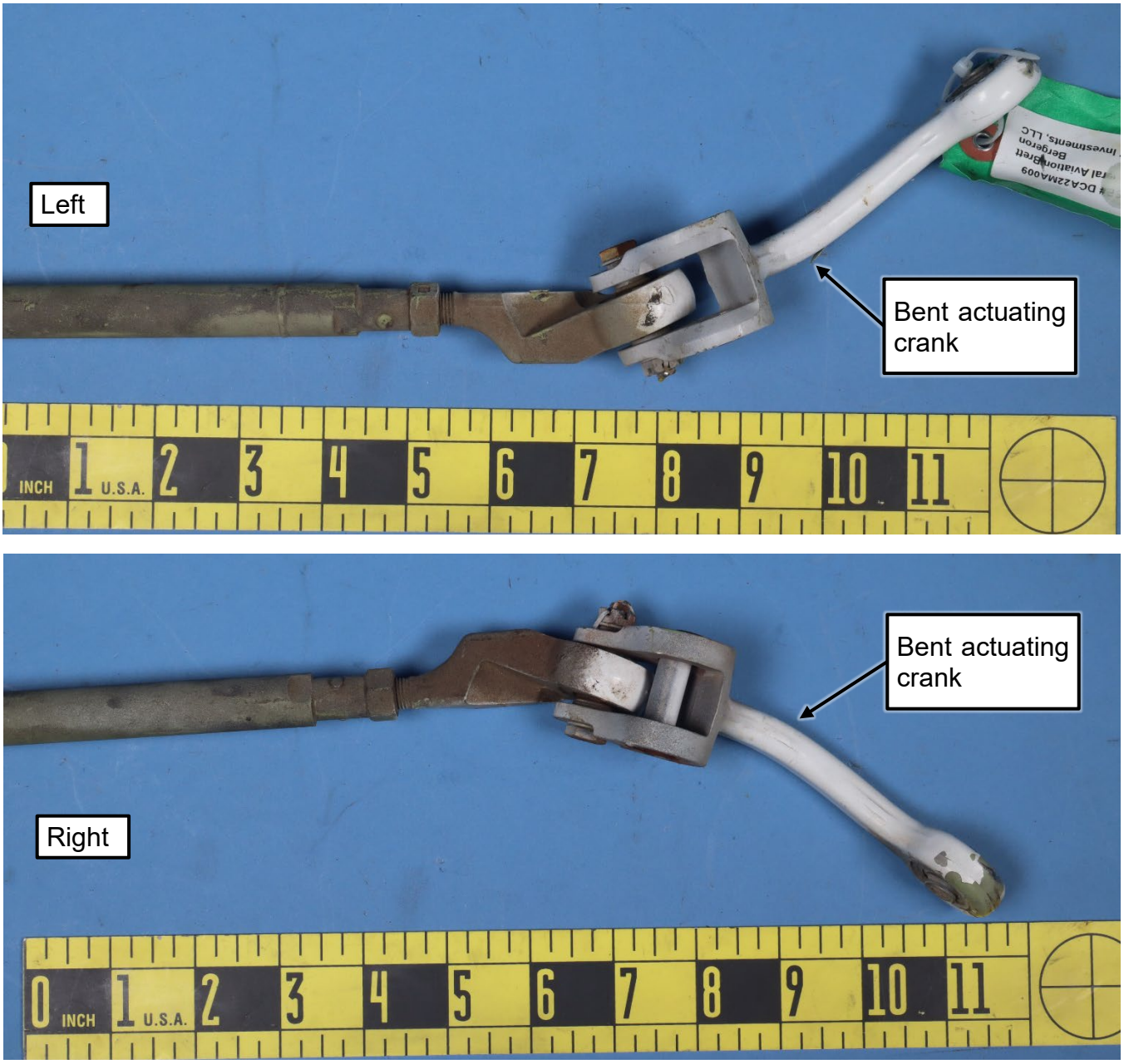

Figure 3. Forward ends of the left and right pushrods showing closer views of the bent actuating cranks.