

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



ERA23FA138

MATERIALS LABORATORY

Factual Report 23-101

December 22, 2023

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A. ACCIDENT INFORMATION

Location: West Palm Beach, Florida
Date: March 5, 2023
Vehicle: Diamond Aircraft DA40, N804ER
Investigator: Timothy W. Monville, AS-ERA

B. COMPONENTS EXAMINED

Number 2 fuel injector nozzle assembly and fuel line.

C. EXAMINATION PARTICIPANTS

Specialist Matthew R. Fox, Ph.D.
NTSB
Washington, DC

D. DETAILS OF THE EXAMINATION

An overall view of the submitted number 2 fuel injector nozzle assembly and associated fuel line and closer view of the hardware at the nozzle are shown in figure 1. The nut and insert were received separated from the nozzle as shown in figure 1.

Two views of the fuel line attachment threads on the fuel injector nozzle are shown in figure 2. Around approximately $\frac{3}{4}$ of the circumference, thread peaks showed smearing deformation toward the fuel line end of the fitting as indicated with unlabeled arrows in figure 2. In one quadrant, the thread were mostly intact as shown in the lower image in figure 2. On either side of the quadrant with intact threads, threads were fractured with angled displacement toward the fuel line end with increasing distance from the intact threads in either direction as indicated with dashed lines in figure 2.

Views of the nut at the nozzle end of the fuel line are presented in figure 3, where threads on opposing sides of the nut are shown. On the quadrant shown at the left in figure 3, the threads were mostly intact with some thread damage mostly near the thread peak on the noncontact flank. On the opposing side of the nut, threads were fractured with sliding deformation consistent with the thread peaks displacing toward the nozzle relative to the rest of the nut. A small crack was observed at the end face near the middle of a wrenching flat on one side of the intact area, and the adjacent area with the intact threads was deformed radially outward.

Contact marks that deformed the edge of the nut were observed on the side of the nut opposite the intact threads as indicated with unlabeled arrows in figures 3 and 4. The marks were located on a flat adjacent to the nut end face that faced the nozzle, and the end face was deformed at the contact location. The contact marks

appeared as two smooth angled grooves, and arrows point parallel to the length of the groove. A groove at a similar angle and a similar location circumferentially was observed on the last thread of the nozzle as indicated in figure 4.

The conical sealing face for the insert from the fuel injection nozzle is shown in figure 5. One side of the sealing face was deformed radially outward with a smooth curving profile consistent with off-axis contact with the conical end profile of the mating nipple on the fuel line. Two distinct contact marks were observed at the edge of the insert on either side of the deformed area as indicated with unlabeled arrows in figure 5. The contact marks corresponded to mating marks on the inside diameter of the nipple end face as indicated in the right image in figure 3. Additional angled contact marks were observed on the sides of the nut corresponding to contact with the edges of the insert when the contact marks in the deformed area of the insert were positioned against the mating marks at the nipple opening. The contact marks corresponded to lateral and angular displacements of the fuel line nipple axis relative to the nozzle insert axis, and the orientation of the angular displacements were consistent with the orientation of the angular thread damage observed on the nozzle threads.

Submitted by:

Matthew R. Fox, Ph.D.
Chief Technical Advisor - Materials

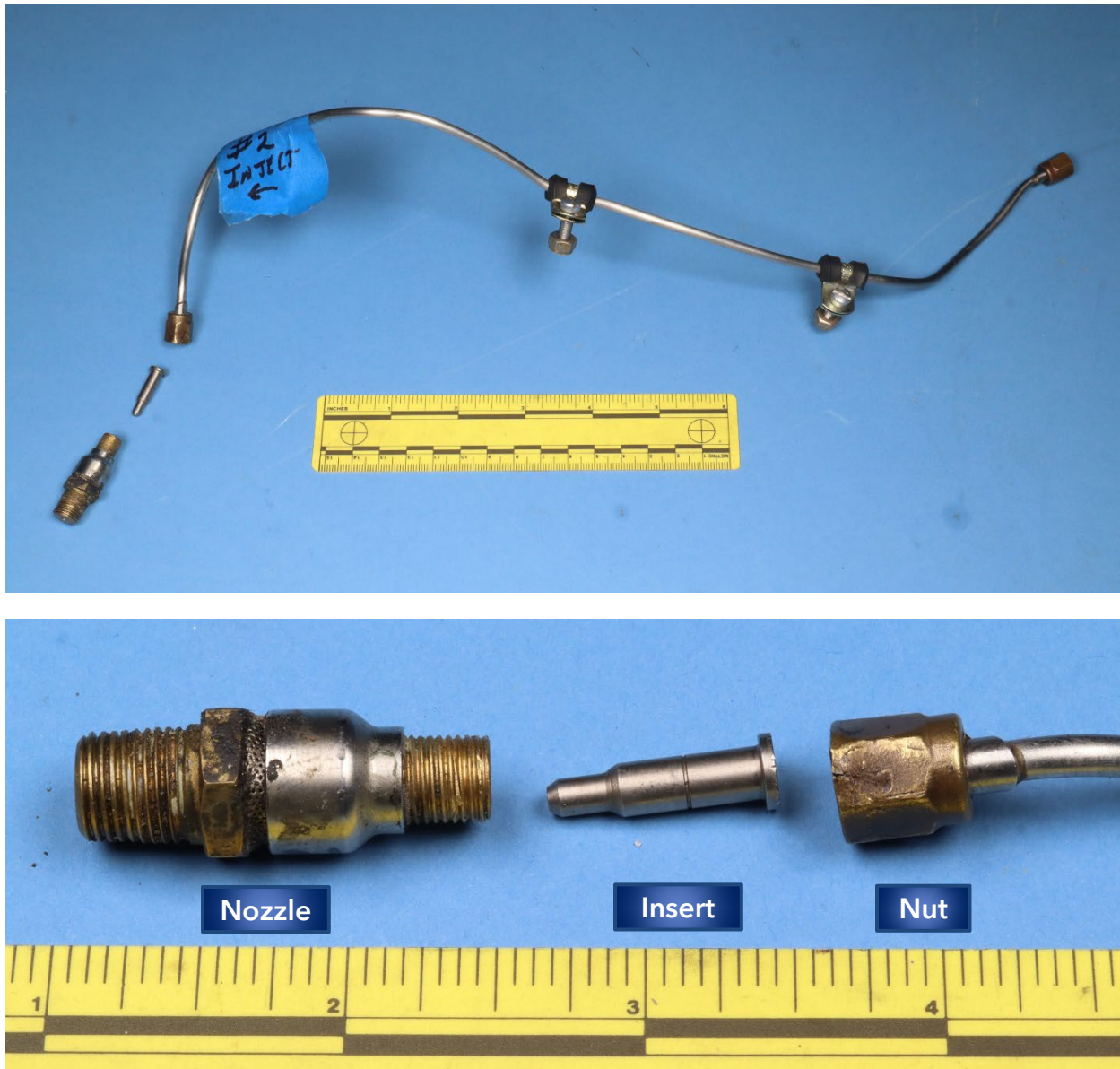


Figure 1. Overall view of the submitted number 2 fuel line and fuel injector nozzle assemblies (upper image) with a closer view of the fuel injector nozzle, nozzle insert, and nut at the nozzle end of the fuel line (lower image).

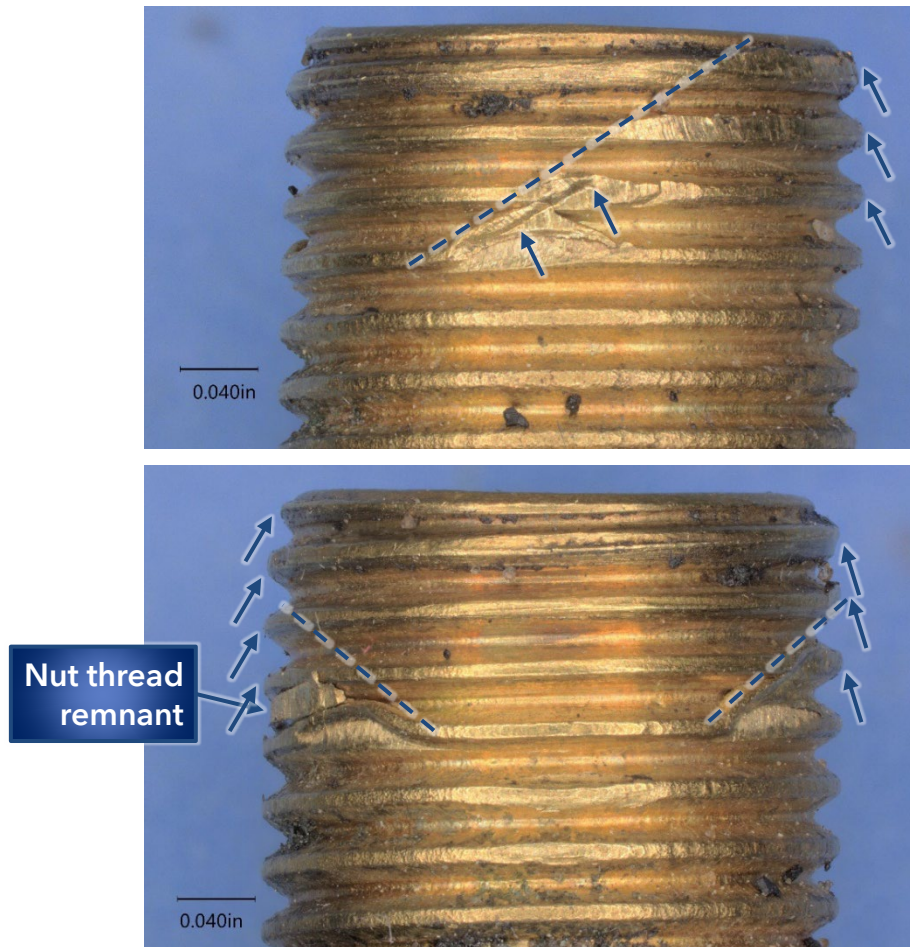


Figure 2. Fuel line attachment threads on the fuel injector nozzle showing two orthogonal views rotated about the fitting axis. Arrows point to the direction of thread peak smearing, and dashed lines indicate displaced thread angles.

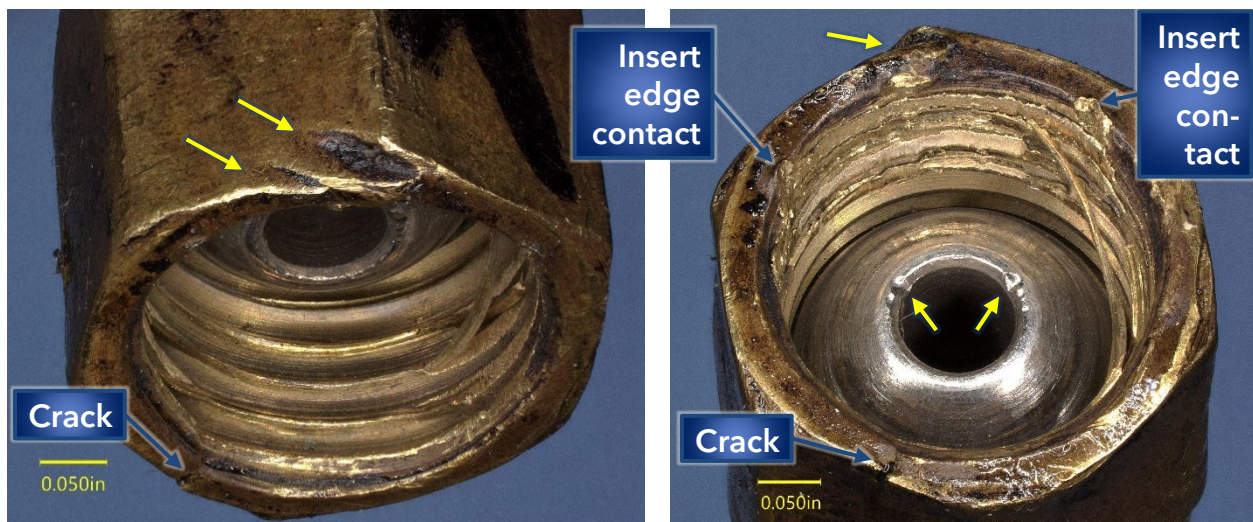


Figure 3. Views of thread damage on opposite sides of the nut for attaching the fuel line to the fuel injector nozzle. Unlabeled arrows point to contact damage on the inside diameter of the conical nipple and on the exterior of the nut.

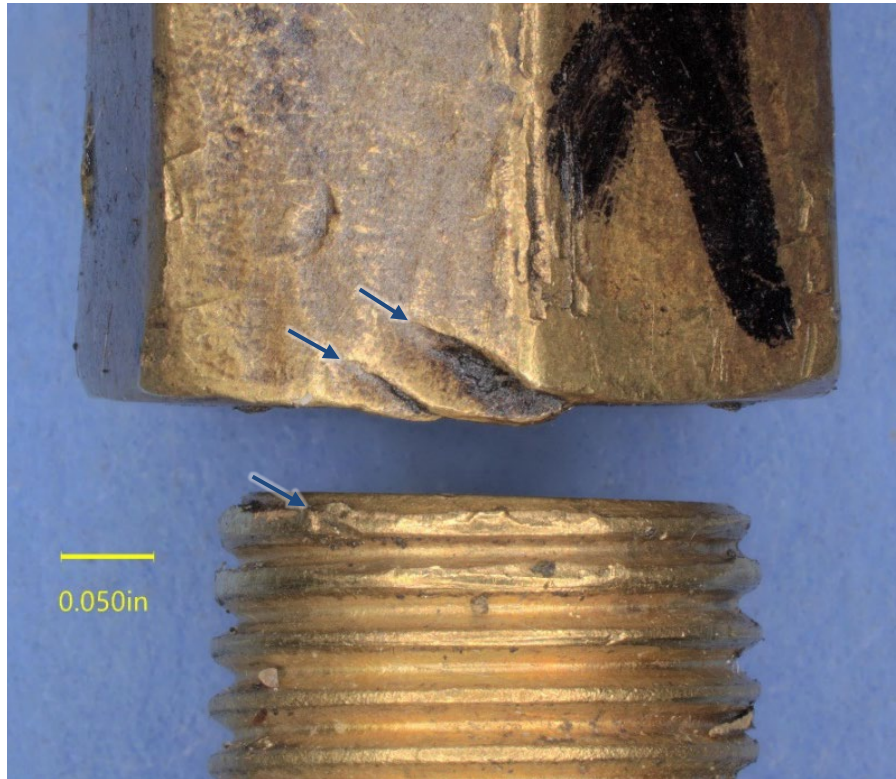


Figure 4. Contact damage on the side of the nut opposite the intact threads and corresponding thread damage on the fuel injector nozzle on the side opposite the intact threads shown in the lower image in figure 2. Unlabeled arrows point to similarly-angled contact grooves on the side of the nut and on the last nozzle thread.

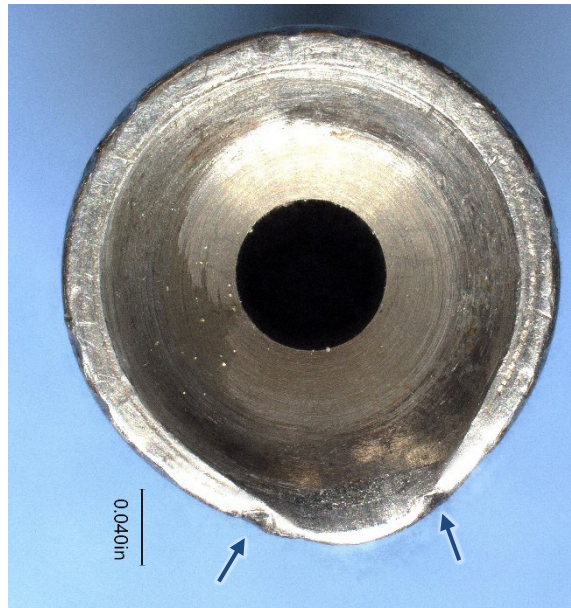


Figure 5. Seal face for the fuel nozzle insert showing a deformed edge on one side corresponding to angled contact with the mating seat on the fuel line. Unlabeled arrows point to contact damage that corresponded to marks at the inside diameter on the mating nipple as indicated in figure 3.