

NATIONAL TRANSPORTATION SAFETY BOARD

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



September 1, 2021

MATERIALS LABORATORY FACTUAL REPORT

Report No. 21-053

A. ACCIDENT INFORMATION

Place : Mineral Wells, Texas
Date : 5/02/2019
Vehicle : Cirrus SR 20 (SN 1381)
NTSB No. : CEN19LA133
Investigator : Andrew Todd Fox

B. COMPONENTS EXAMINED

1. Right aileron inboard hinge attachment bolt (NAS 6203-11H) with one large washer, two small washers, and a spacer.
2. Right aileron inboard hinge attachment bracket with riveted nut plate and actuation arm.
3. Portion of inboard 0.032-inch diameter safety wire with attachment tab for the right aileron inboard hinge attachment bolt.
4. Exemplar inboard attachment bracket with riveted nut plate, portion of inboard aileron hinge assembly, and aileron inboard hinge attachment bolt (NAS6203-10H).

C. DETAILS OF THE EXAMINATION

The purpose of this report is to determine the mode of separation of a 0.032-inch diameter safety wire associated with the inboard hinge bolt of the right aileron. In addition, this report will document the condition of the nut plate threads, the prevailing torque of the hinge attachment bolt in the nut plate on the right aileron inboard hinge attachment bracket. This report will also confirm that the hinge attachment bolt can be securely torqued to 25 lbf-in. For reference, the prevailing torque of a NAS6203-10H bolt will be measured when threaded into a riveted nut plate on an exemplar inboard attachment bracket.

The right aileron inboard hinge attachment bracket with riveted nut plate and actuation arm along with its 0.032-inch diameter safety wire and associated attachment tab from the incident airplane are shown in Figure 1. Closer views of the right inboard aileron hinge bolt and a portion of the hinge assembly are shown in Figures 2 and 3. The image in Figure 4 shows the illustrated parts catalog (IPC) figure for the full assembly, with the components of interest circled in red.

Views of the right aileron inboard hinge attachment bracket with riveted nut plate and actuation arm from the incident airplane are shown in Figure 5. The hinge attachment

bolt (NAS6203-11H) with 1 large washer (specified as MS63040-3), 2 small washers (specified as NAS1149F0332P), and a spacer is shown in Figure 6. This bolt threads into the nut plate that is riveted to the inboard hinge attachment bracket. Using a dial caliper, the dimensions of the large washer conformed to MS63040-3 and the dimensions of the small washers conformed to NAS1149F0332P.

The safety wire attachment tab for the inboard hinge attachment bolt is shown in Figure 7, with the remnant of double-twist safety wire attached. The diameter of the safety wire was approximately 0.0335 inch as measured with a dial caliper. The safety wire was fractured where it would have been threaded through a drilled hole in the bolt head, as identified in the figure (see also Figure 16 for reference). Adjacent to the attachment tab (see Figure 15), the safety wire was twisted approximately 22 twists per inch¹. The Cirrus SR20 maintenance manual recommends 6 to 12 twists per inch.

An exemplar aileron inboard attachment bracket with riveted nut plate, a portion of inboard aileron hinge assembly, and an aileron inboard hinge bolt (NAS6203-10H) were also submitted as presented in Figure 8. The purpose of these components was to measure the prevailing torque of the hinge attachment bolt in the nut plate and to confirm that the nut plate can withstand a final tightening torque of 25 lbf-in.

Close views of the right aileron inboard hinge attachment bolt from the incident airplane are shown in Figure 9. The grip area exhibits circumferential wear scars and marks. The threads are intact, fully formed, and in good condition; the thread roots are partially filled with black grease. Material loss due to wear is evident around the periphery of the drilled holes. A top view of the hexagonal head is marked with NAS6203-11 (it would be 11H with the drilled head). The IPC indicates that the hinge bolt shall be NAS6203-9H or NAS6203-10H. For reference, Table 1 lists grip length and overall length for select NAS6203 bolts.

Table 1—NAS6203 Bolt Grip and Length Dimensions

Dash	Grip length (inch)	Overall length (inch)
NAS6203-9H	0.562	0.885
NAS6203-10H	0.625	0.948
NAS6203-11H	0.688	1.011

Views of the internal threads of the nut plate on the aileron hinge attachment bracket from the incident airplane are shown in Figures 10-12. The threads are intact, fully formed, and in good condition; the roots are partially filled with black grease. The periphery of the threaded portion of the nut plate is relatively round. Typically, the

¹As determined in accordance with Federal Aviation Administration AC 43.13-1B - Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair, Chapter 7, Section 7, Figure 7-3a.

periphery of the threaded portion of the nut plate is intentionally deformed to an oblong or oval shape to provide mechanical resistance (or thread-locking) to the mating bolt threads. For comparison, the internal threads of the nut plate on the exemplar aileron hinge attachment bracket are shown in Figures 13 and 14. The threads are intact, fully formed, and in good condition. The periphery of the threaded portion of the nut plate was oval or oblong as viewed in Figure 14a. Table 2 reveals the prevailing torque of the incident and exemplar hinge bolt and attachment bracket pairs; measured using an analog torque wrench.

Table 2—Prevailing torque measurements for the hinge attachment bolt into the nut plate on the inboard attachment bracket

Approximate rotation position	Prevailing torque measurement* (lbf-in)	
	Exemplar bolt/exemplar attach bracket	Incident bolt/incident attach bracket [#]
180°	1.5	<1*
360°	3.5	<1*
540°	5.0	<1*
720°	7.0	3
Final seated	25	25

*Could be rotated by hand.

[#]The incident bolt and nut plate we used in the as—received condition with grease present in the threads—which could lower the prevailing torque.

*In accordance with AC 43.13-1B - Acceptable Methods, Techniques, and Practices – Aircraft Inspection and Repair, a self-locking nut with a 7/16-20 thread should have a minimum prevailing torque of 8 lbf-in.

A closer view of the hinge attachment bolt safety wire from the incident airplane is shown in Figures 15-23. In Figure 16, inset images conceptually show how the fractured ends of the safety wire had previously fit within a drilled hole in the hinge bolt hexagonal head. For orientation purposes, Figure 17 shows the location of higher magnification images of the safety wire fractures as well as the terminal cut on the pigtail. Figures 18-22 show images of the safety wire fractures and pigtail cut at progressively higher magnifications. Top-down scanning electron microscope images of the safety wire fractures are shown in Figure 23. Fractographic analysis indicates that the safety wire fractured due to torsional overstress.

Michael Budinski
Chief, Materials Laboratory Division

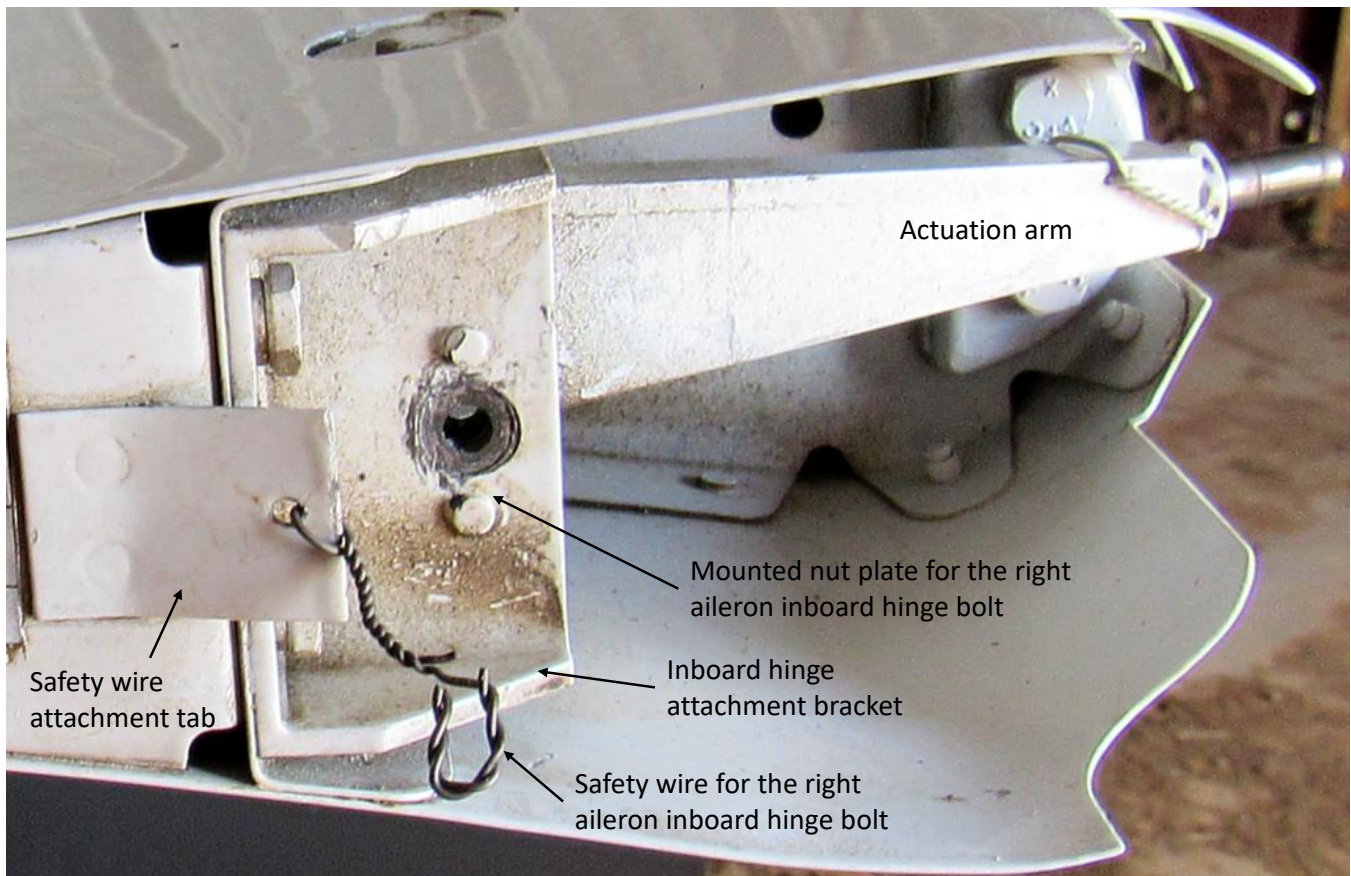


Figure 1 Overview of the as-installed right aileron inboard hinge attachment bracket with riveted nut plate, actuation arm, and safety wire for the inboard hinge attachment bolt with the attachment tab. The safety wire orientation is consistent with that specified in the Cirrus SR20 maintenance manual for right-handed threads.

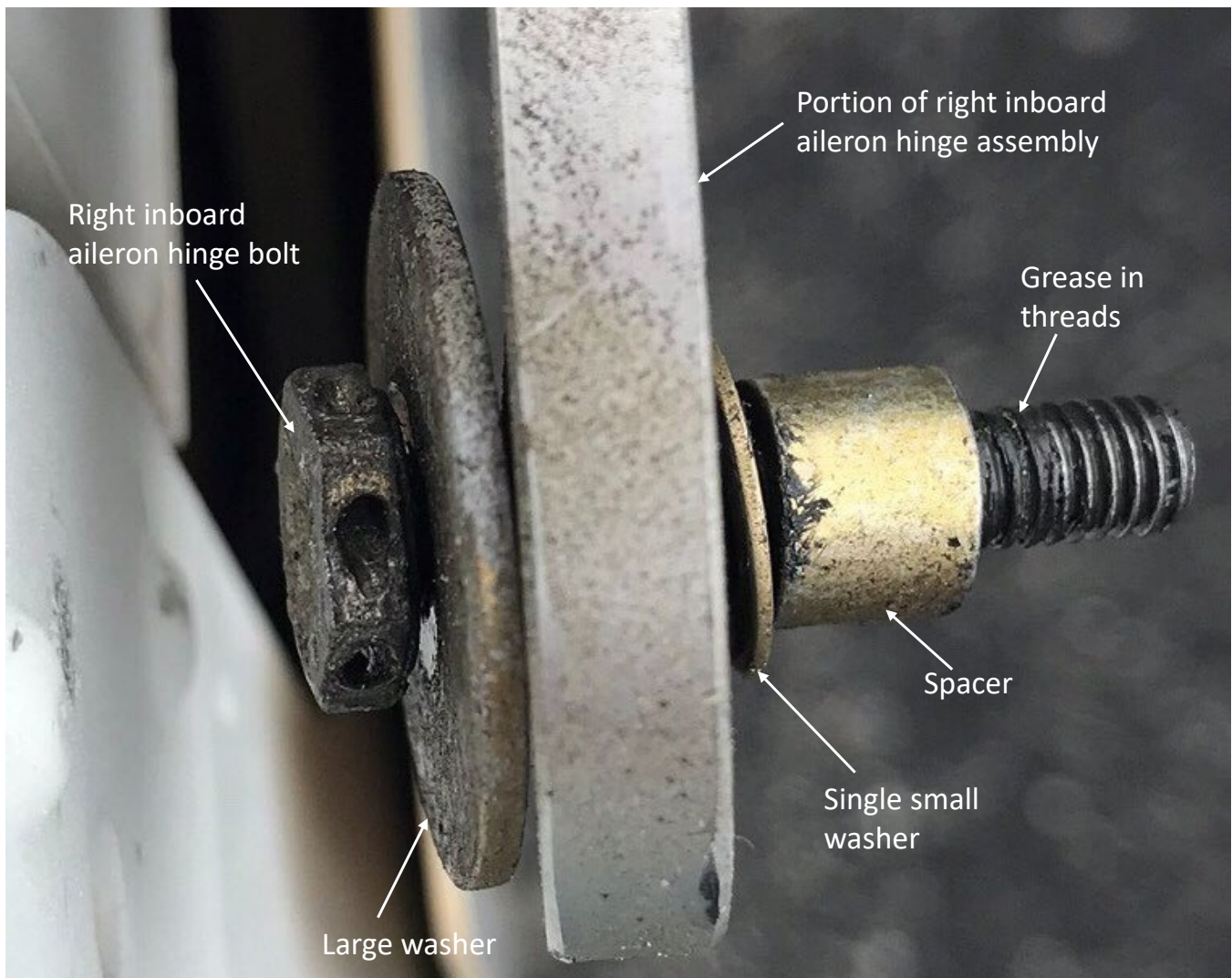


Figure 2 Close view of the right inboard aileron hinge bolt, a portion of the inboard aileron hinge assembly, and associated washers and spacers.

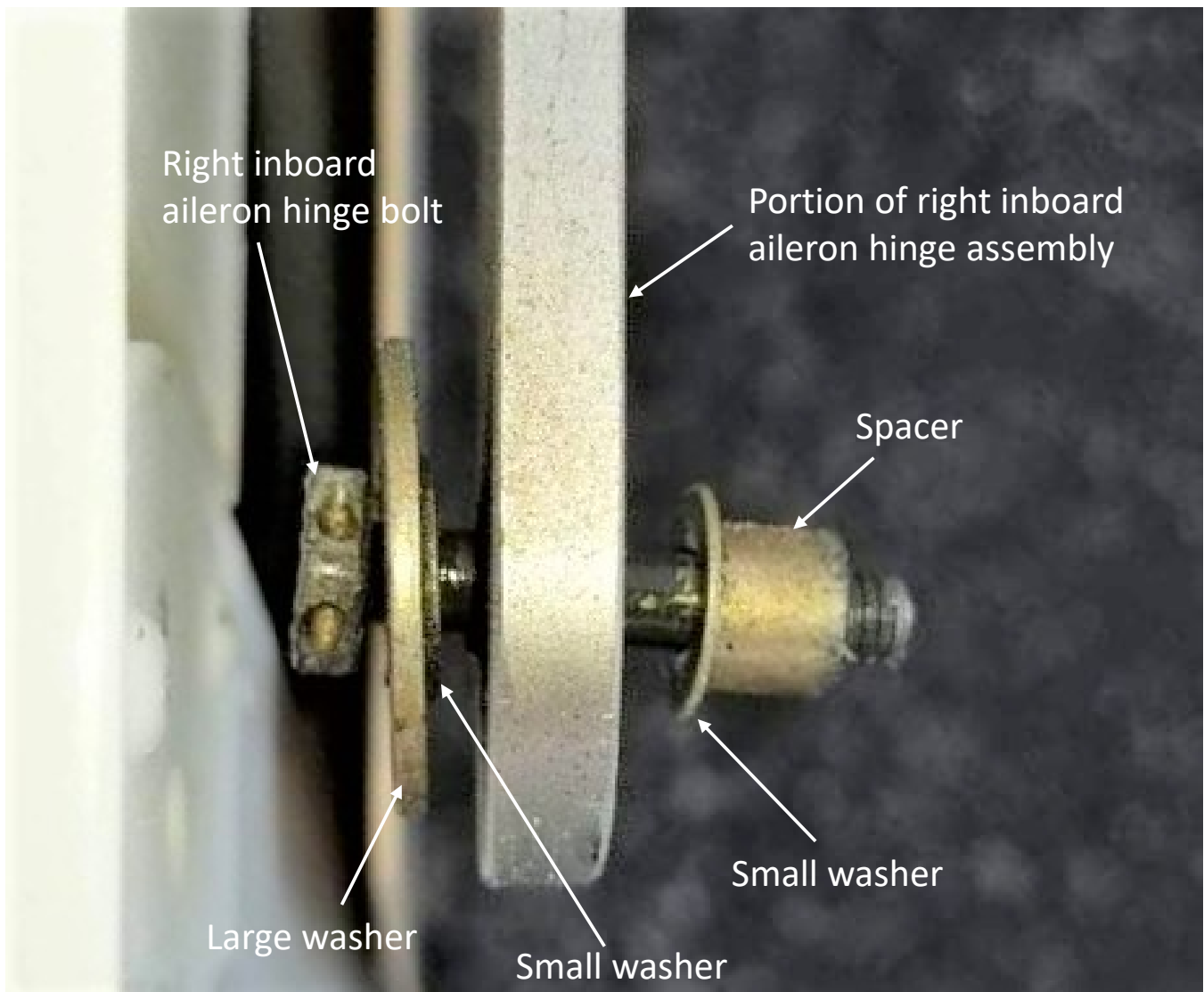


Figure 3 Close view of the right inboard aileron hinge bolt, a portion of the inboard aileron hinge assembly, and associated washers and spacers.



Figure 4 Image from the illustrated parts catalog detailing the aileron hinge assembly. The bolted assembly of interest is circled in red.

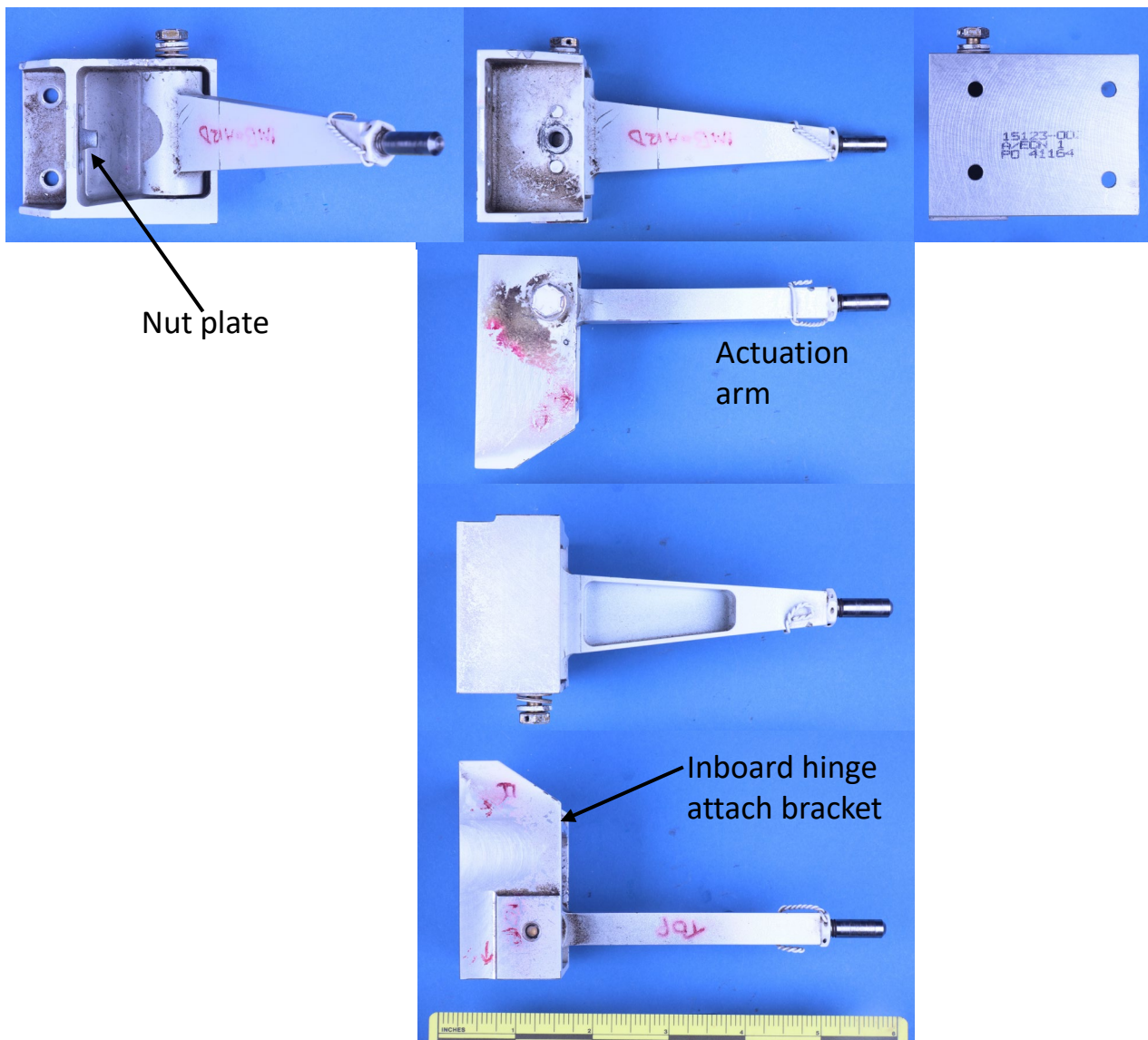


Figure 5 Images of the as-received right aileron inboard hinge attachment bracket and actuation arm.

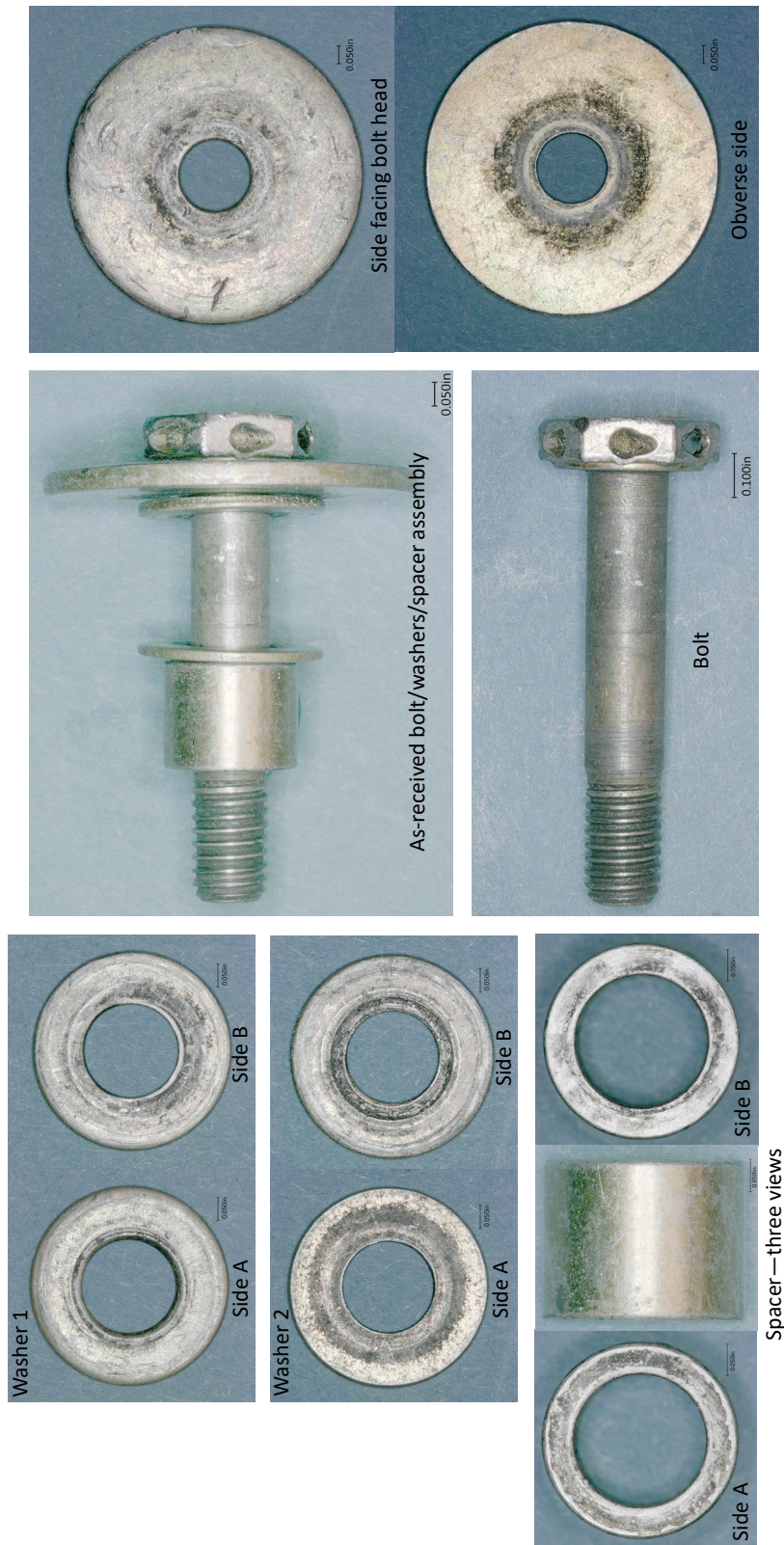


Figure 6 Images documenting the right inboard aileron hinge attachment bolt and associated washers and spacer (see also Figures 2 and 3).

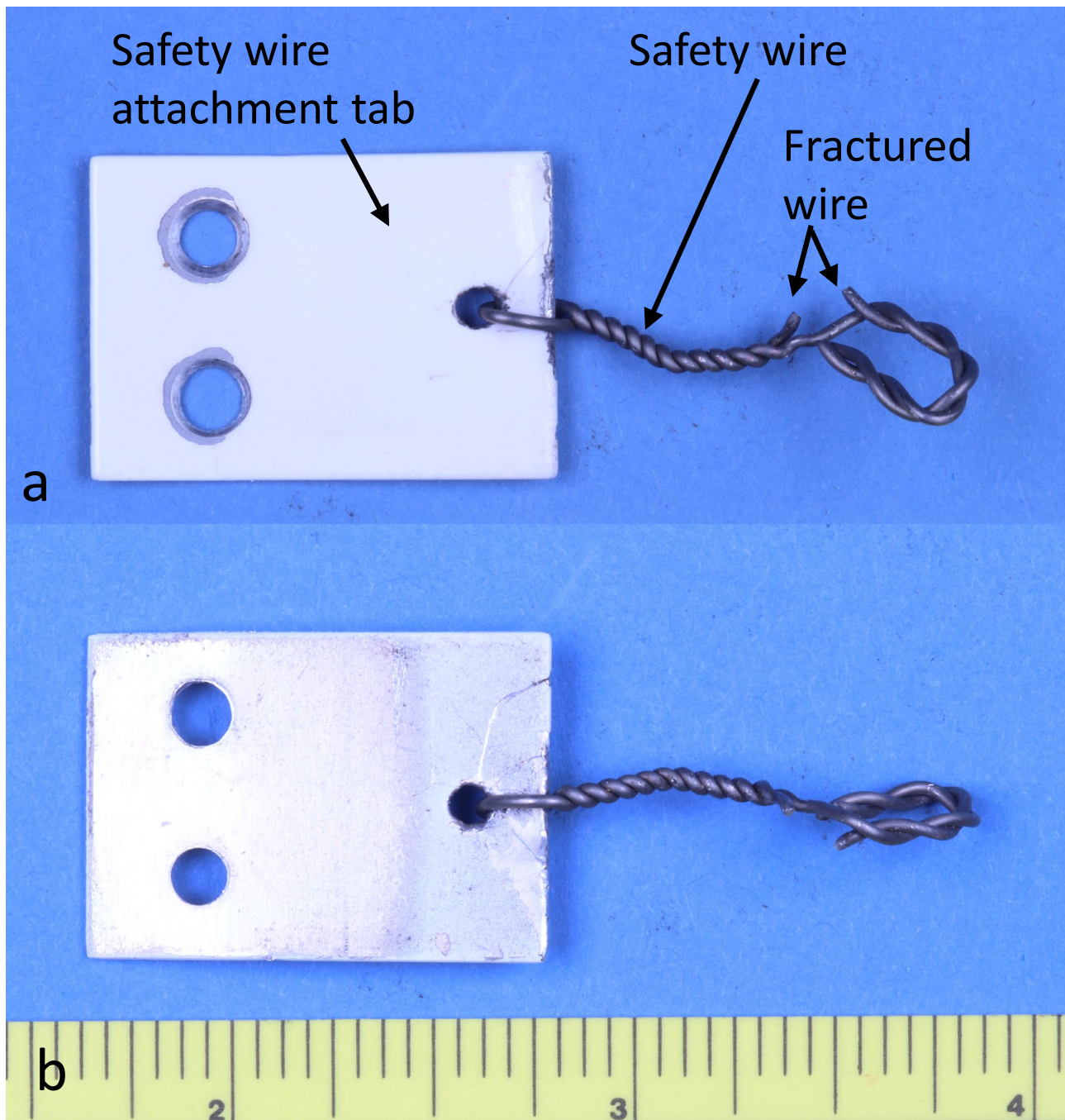


Figure 7 Front and back views of the safety wire for the right inboard aileron hinge attachment bolt and its associated attachment tab (removed from the airplane by drilling the rivets).

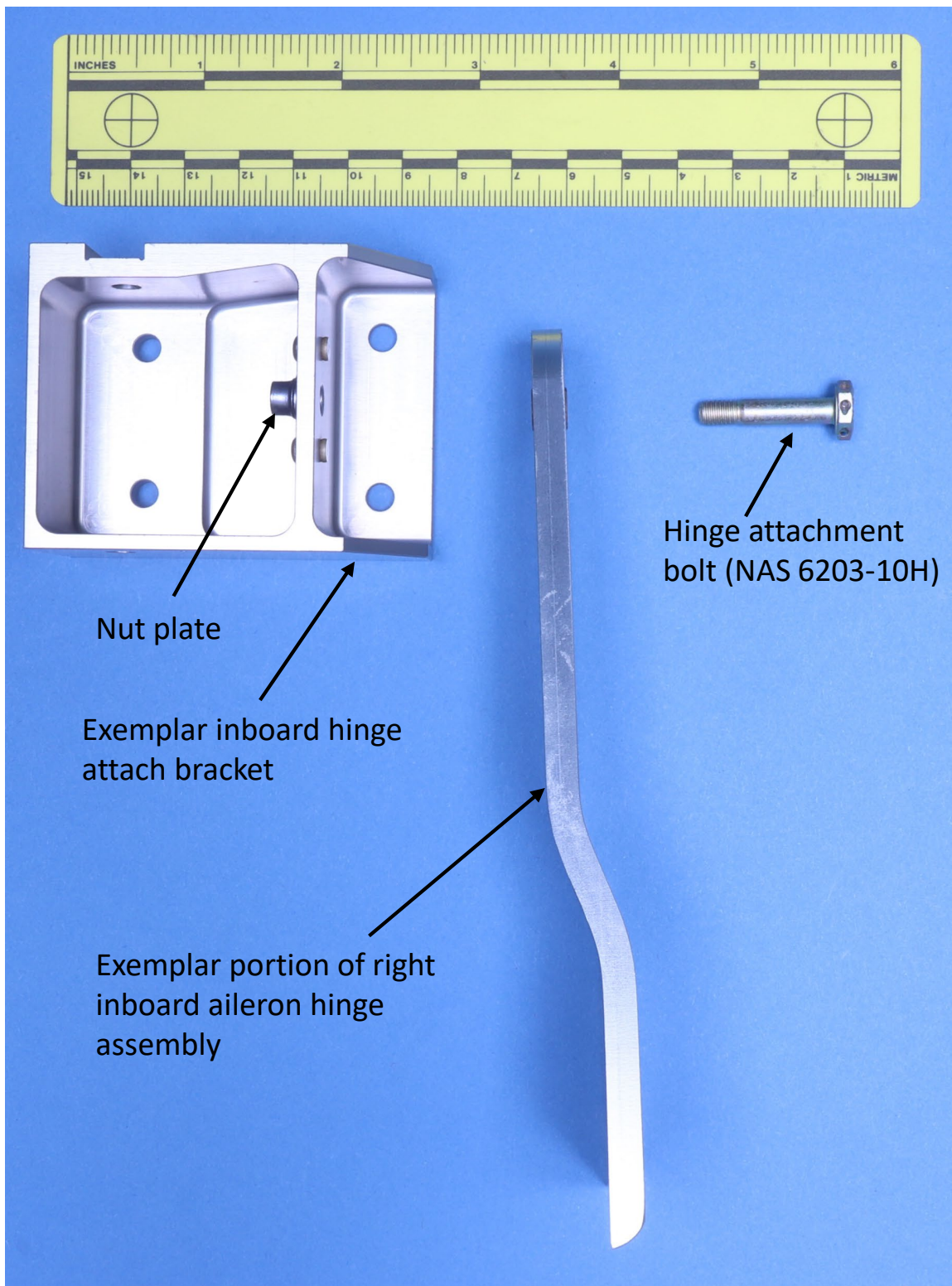


Figure 8 Image of an exemplar inboard hinge bracket, hinge attachment bolt, and a portion of the aileron hinge assembly.



Figure 9 Close views of the threads and head markings on the right aileron hinge attachment bolt.

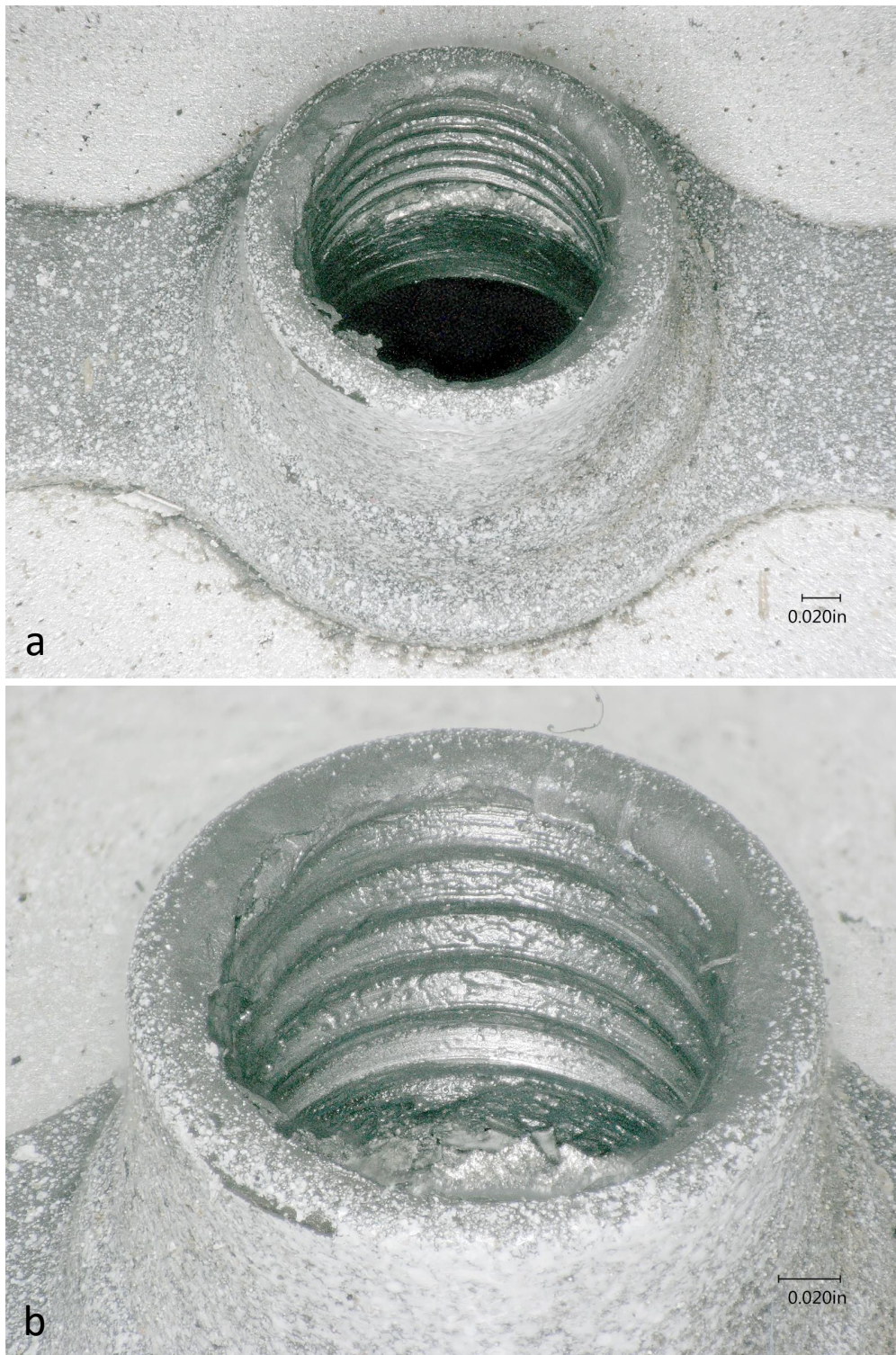


Figure 10 Close views of the exterior surfaces of the nut plate on the incident airplane right aileron inboard hinge attachment bracket.

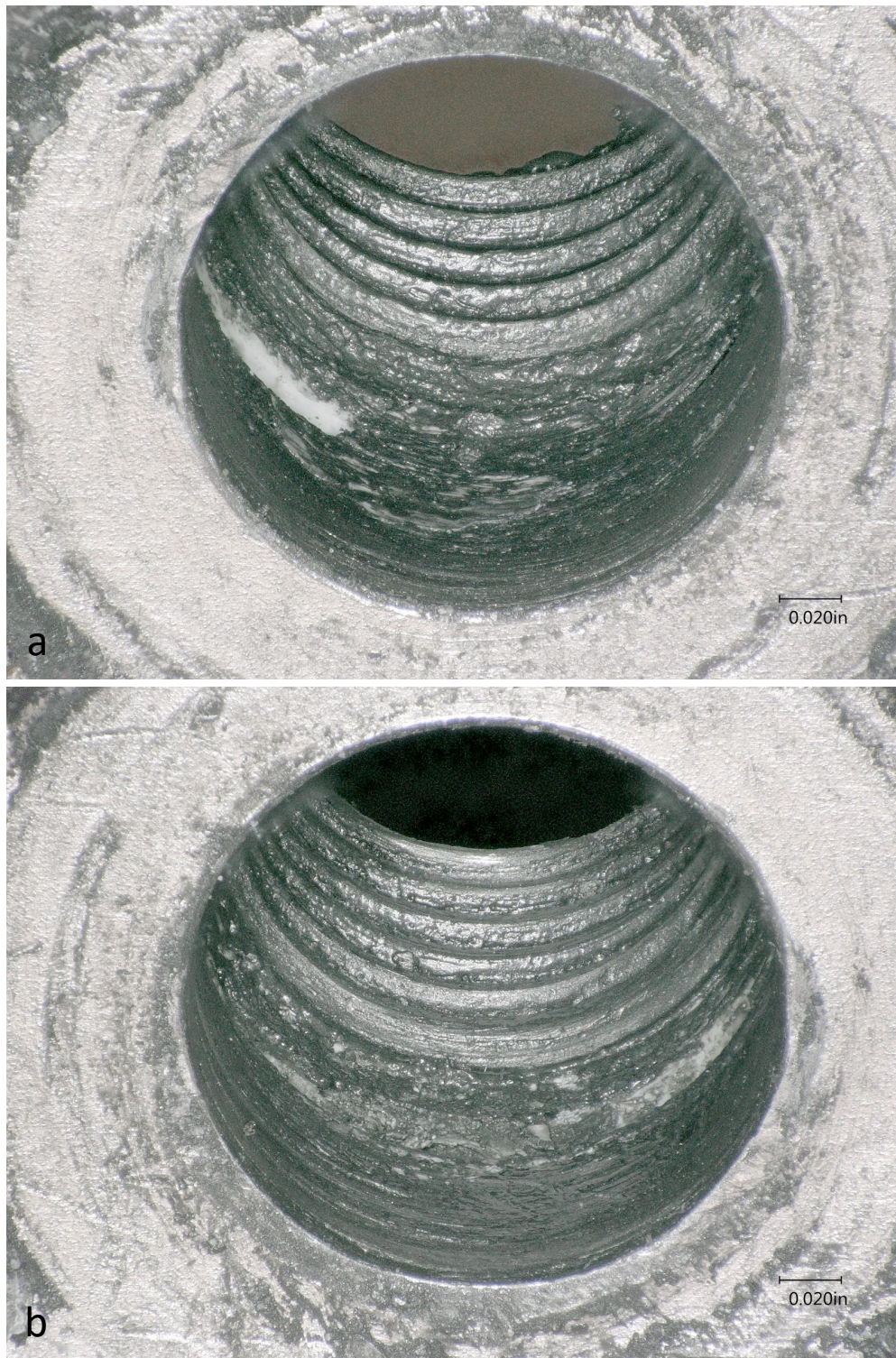


Figure 11 Close views of the threads in the nut plate on the incident airplane right aileron inboard hinge attachment bracket. Views a and b are 180° apart.

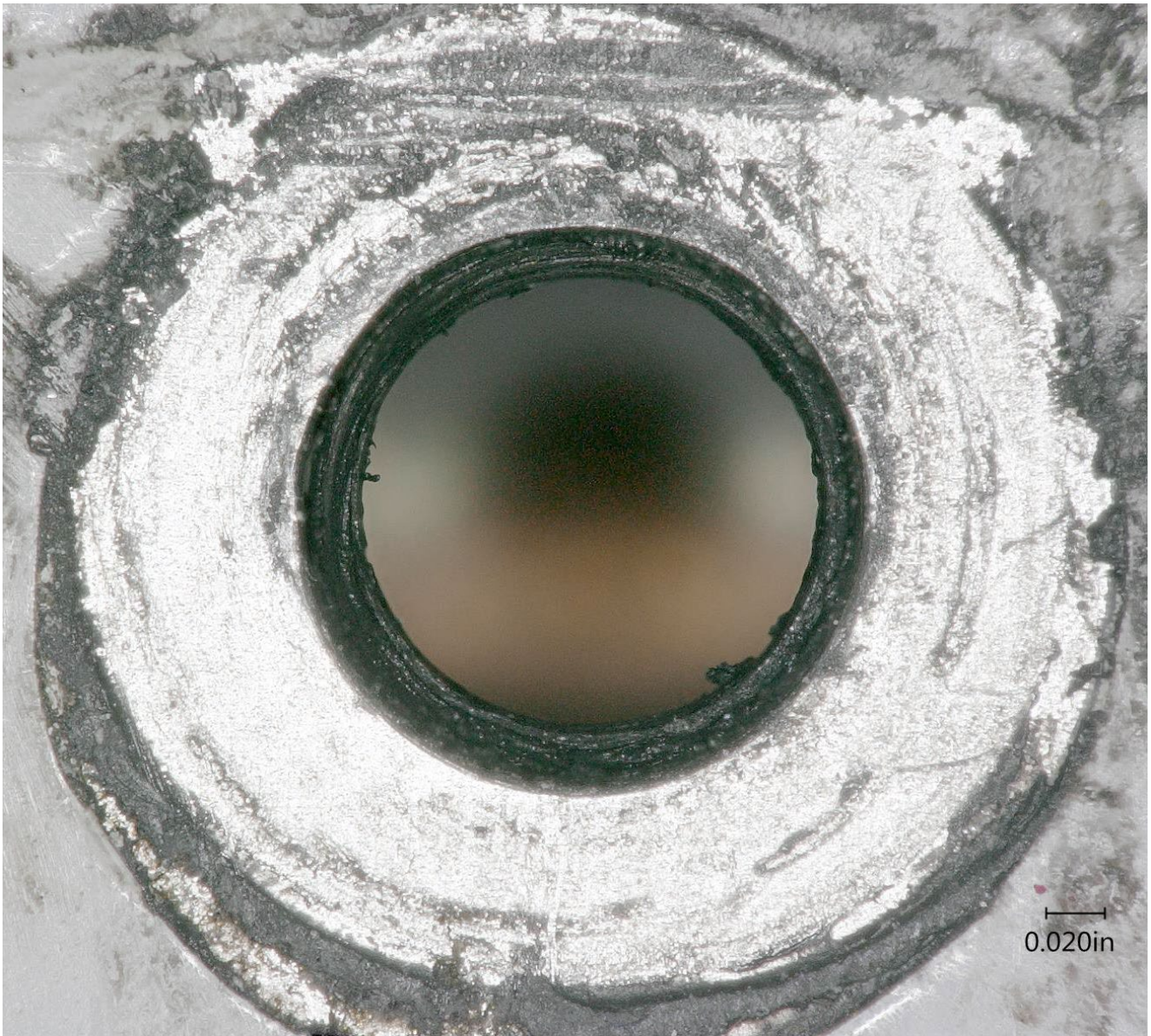


Figure 12 Top down view of the threads in the nut plate on the incident airplane right aileron inboard hinge attachment bracket.

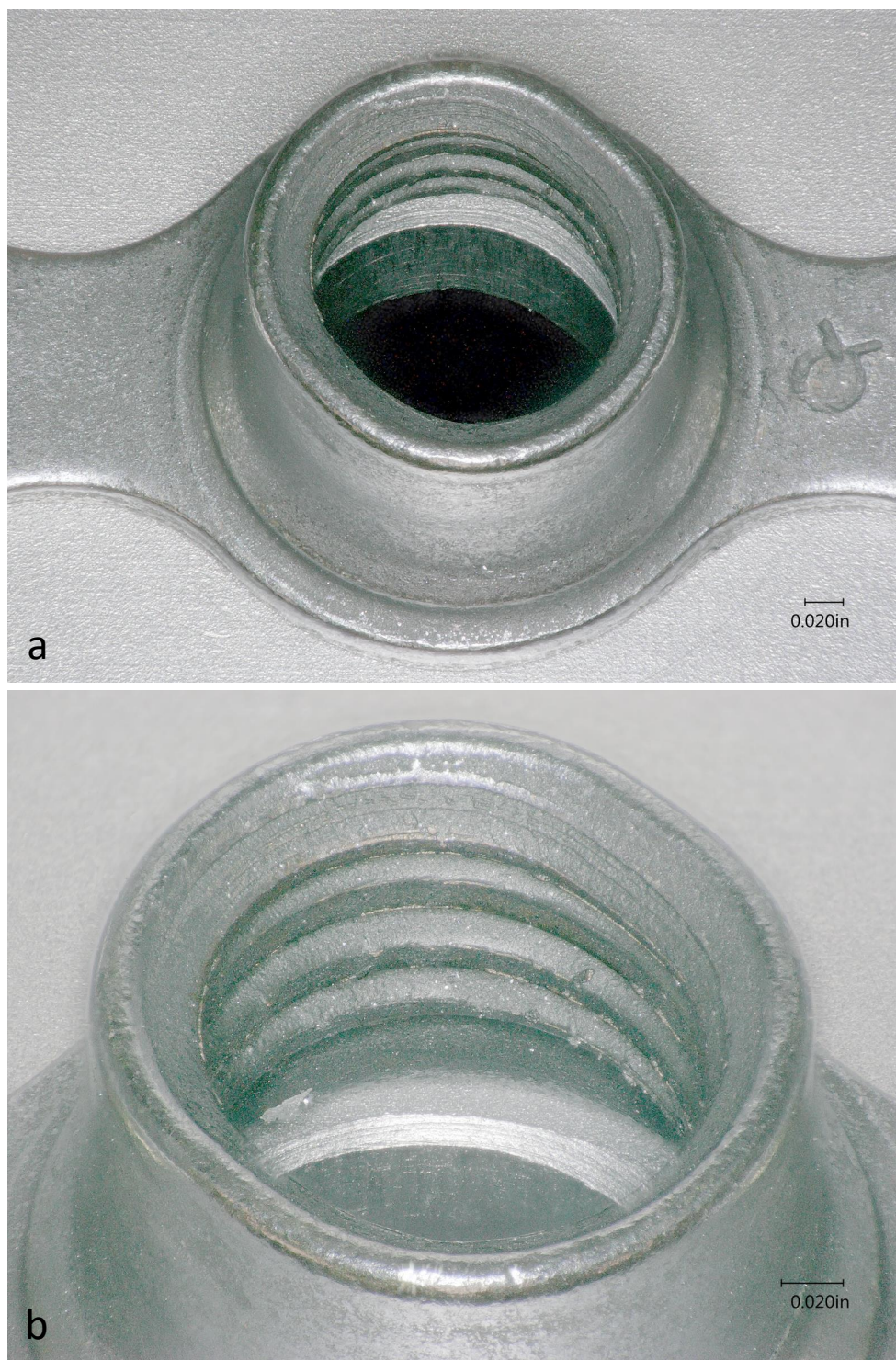


Figure 13 Close views of the exterior surfaces of the nut plate on the exemplar aileron inboard hinge attachment bracket.

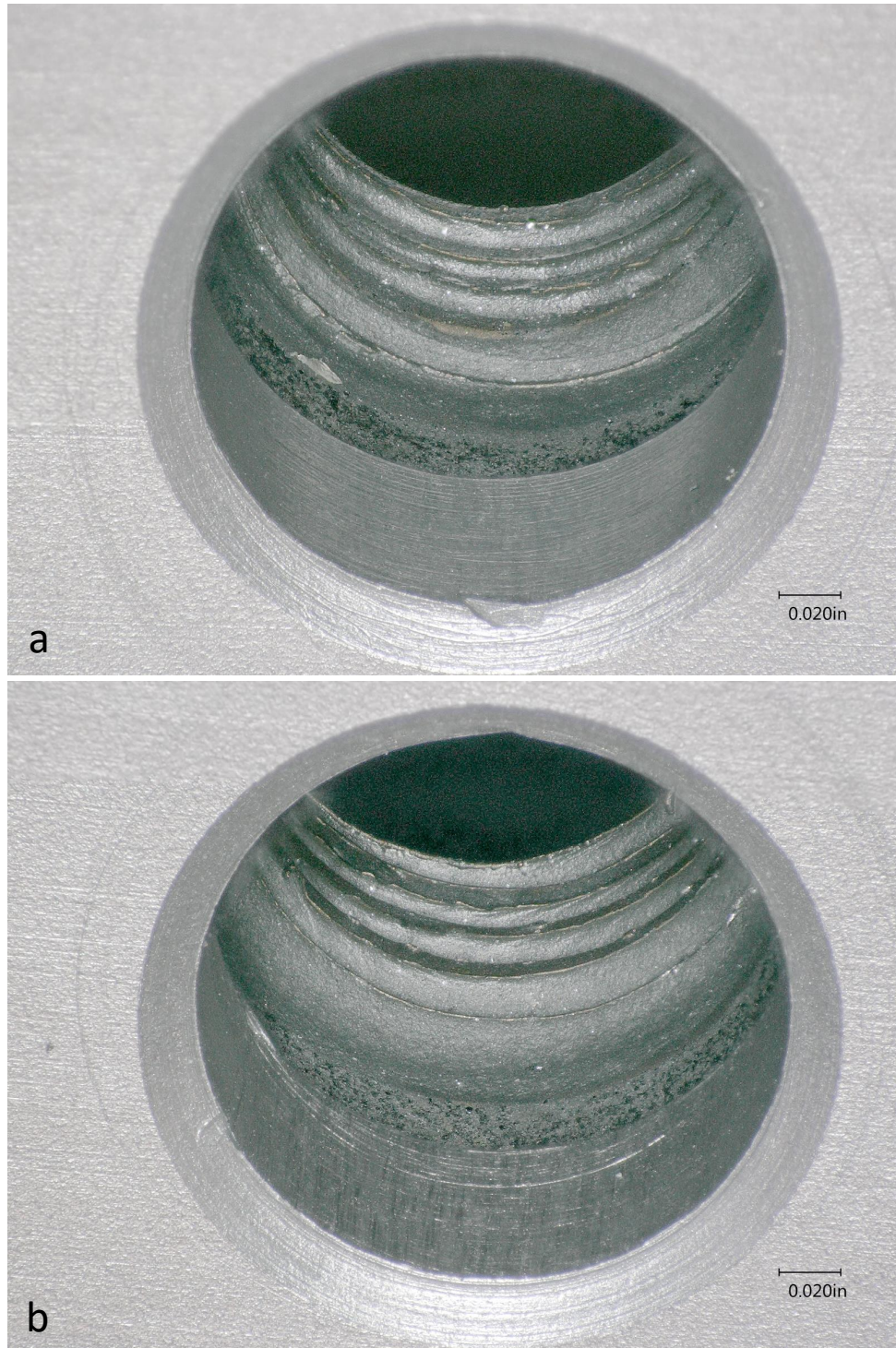


Figure 14 Close views of the threads in the nut plate on an exemplar aileron inboard hinge attachment bracket. Views a and b are 180° apart.

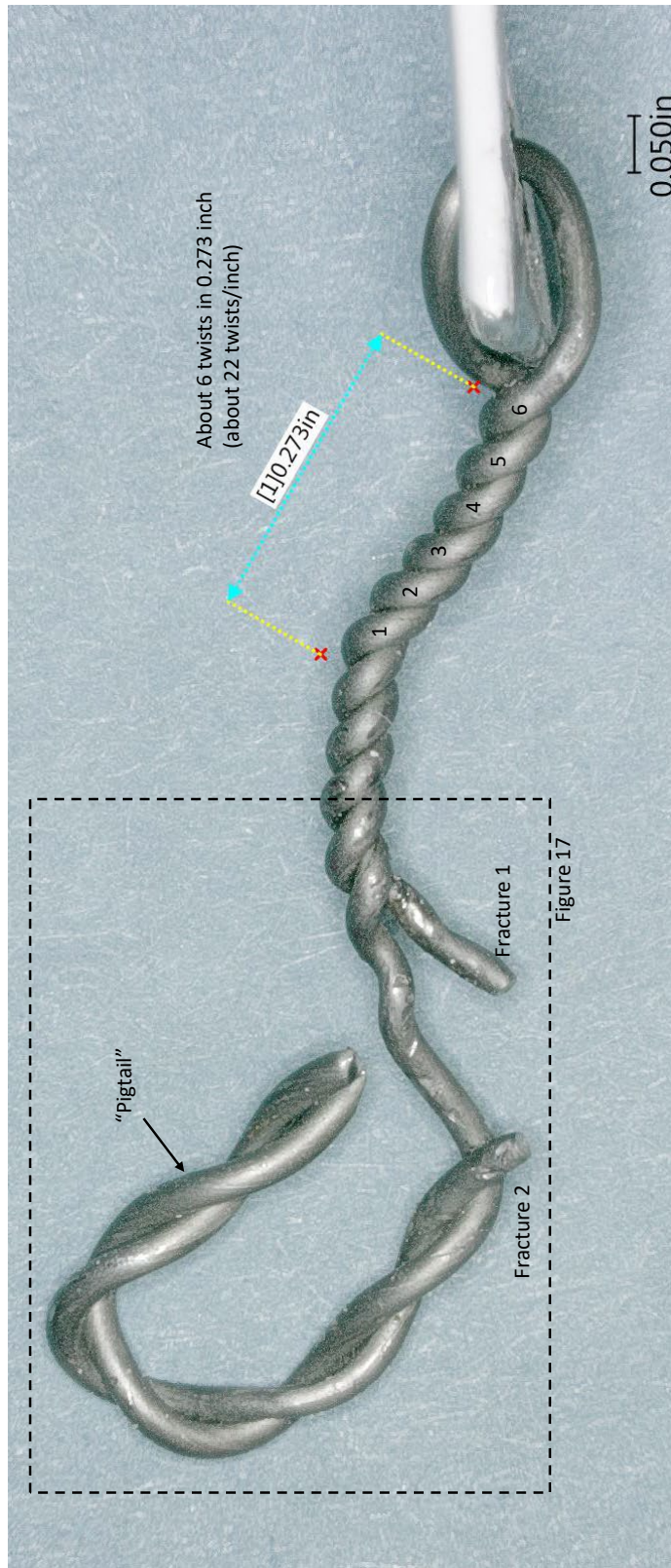


Figure 15 Close view of the right aileron inboard hinge attachment bolt safety wire. The location of a fracture in the wire is identified. The twists per inch was also measured as indicated in the figure.

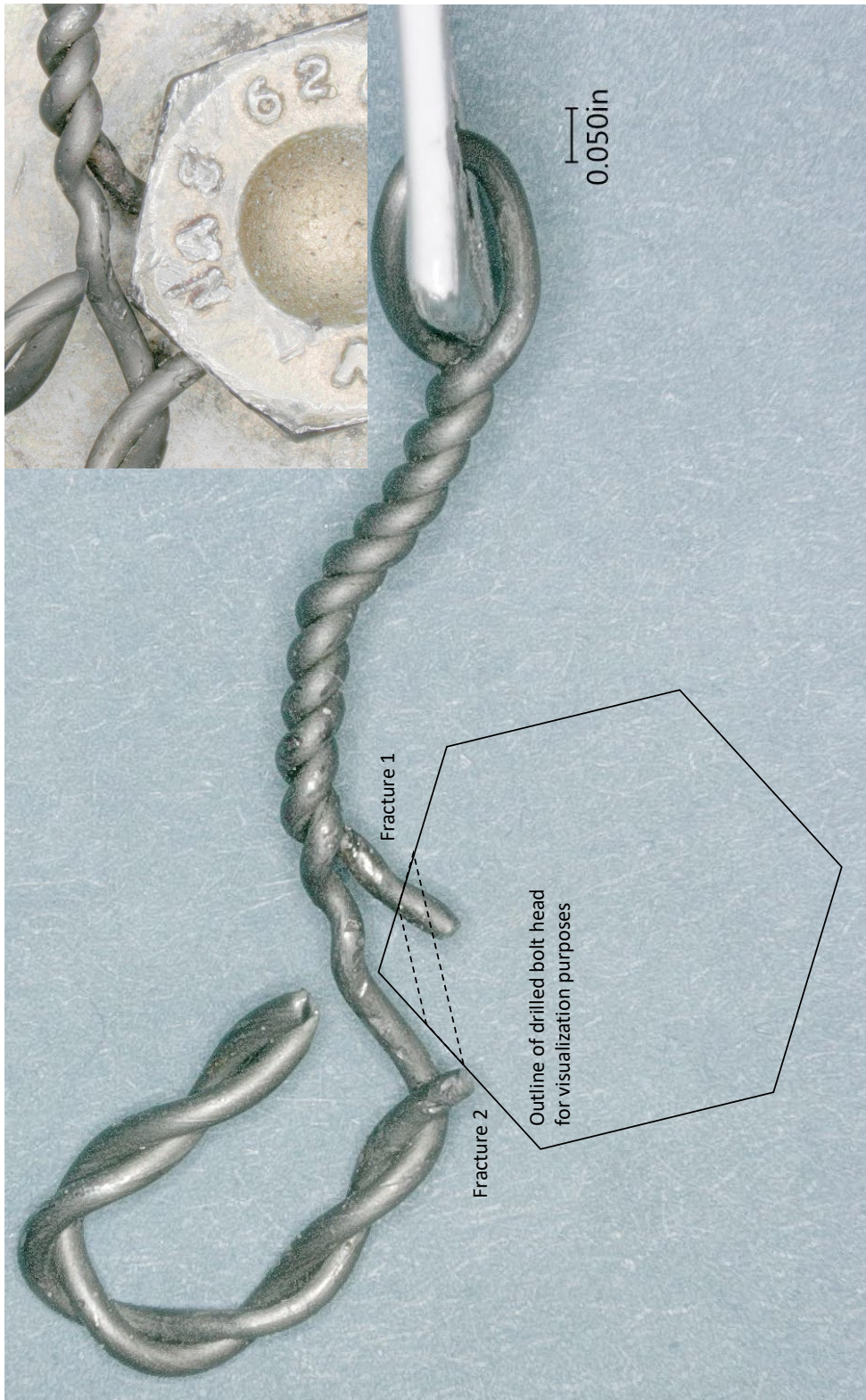


Figure 16 Close view of the right aileron inboard hinge attachment bolt safety wire. The location of a fracture in the wire is identified. The outline of a drilled bolt head is placed close to the fractured wire ends for visualization purposes. The inset image shows the approximate mechanical arrangement of the drilled bolt head in close proximity to the fractured safety wire ends.

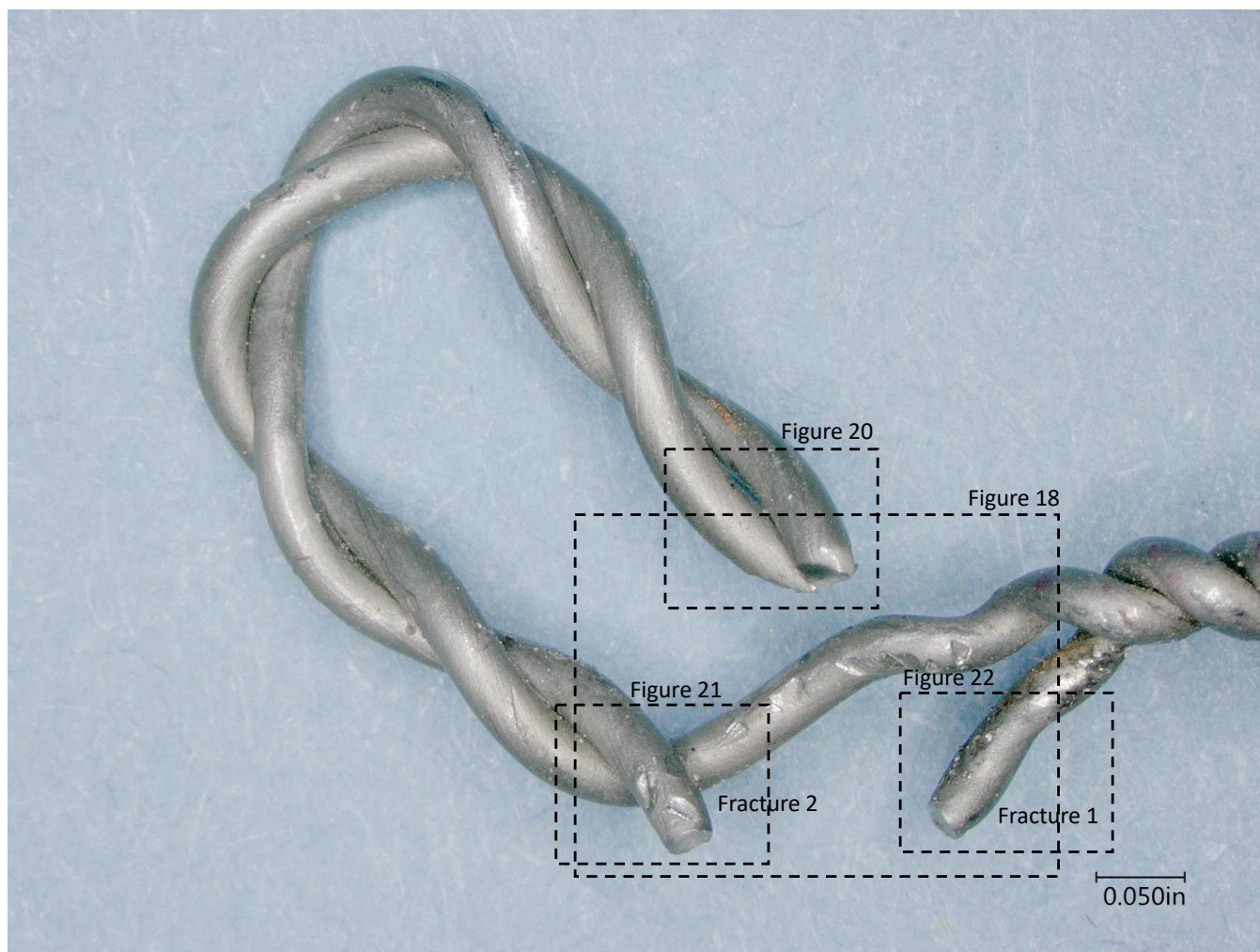


Figure 17 Close image of the fractured safety wire ends as well as the pigtail end.

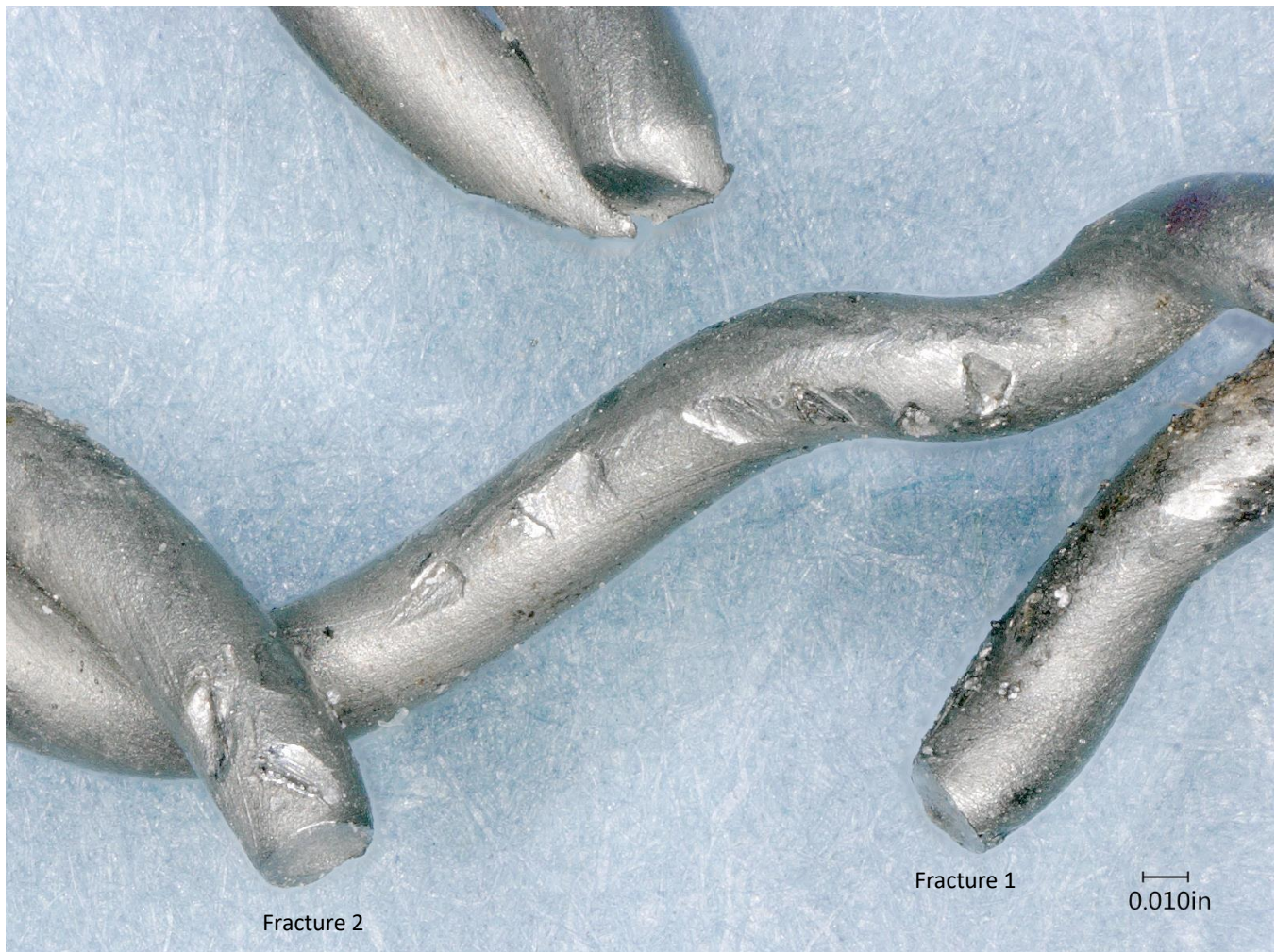


Figure 18 A closer view of the image in Figure 17. Note the mechanical damage to the surface of the intact wire.



Figure 19 Oblique view of the safety wire to reveal the fracture surfaces and the terminal cuts on the pigtail.



Figure 20 Higher magnification image of the plier-cut terminal-end of the safety wire pigtail.

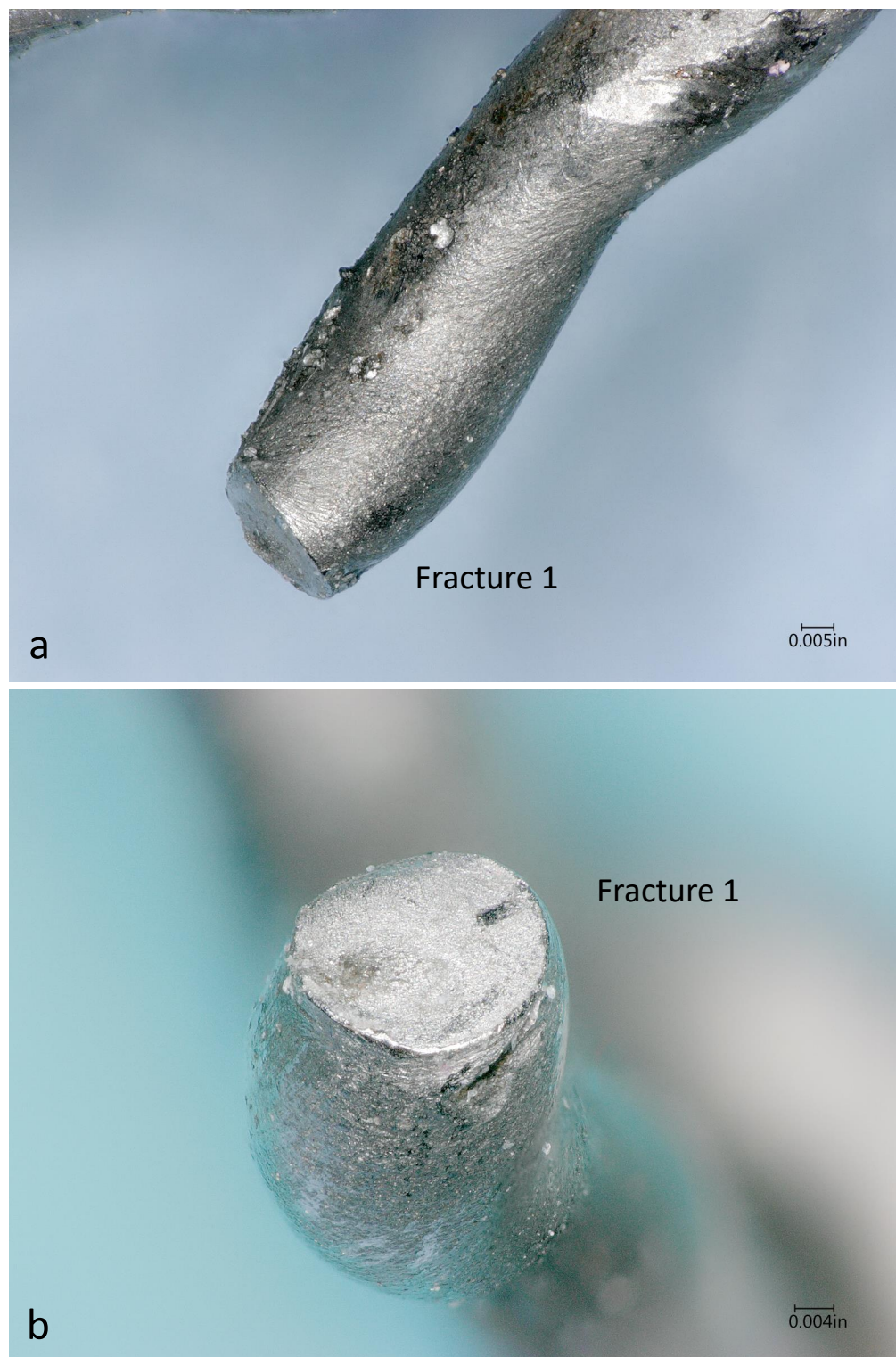


Figure 21 Side and top-down views of Fracture 1 (see Figure 17) safety wire fracture surface.

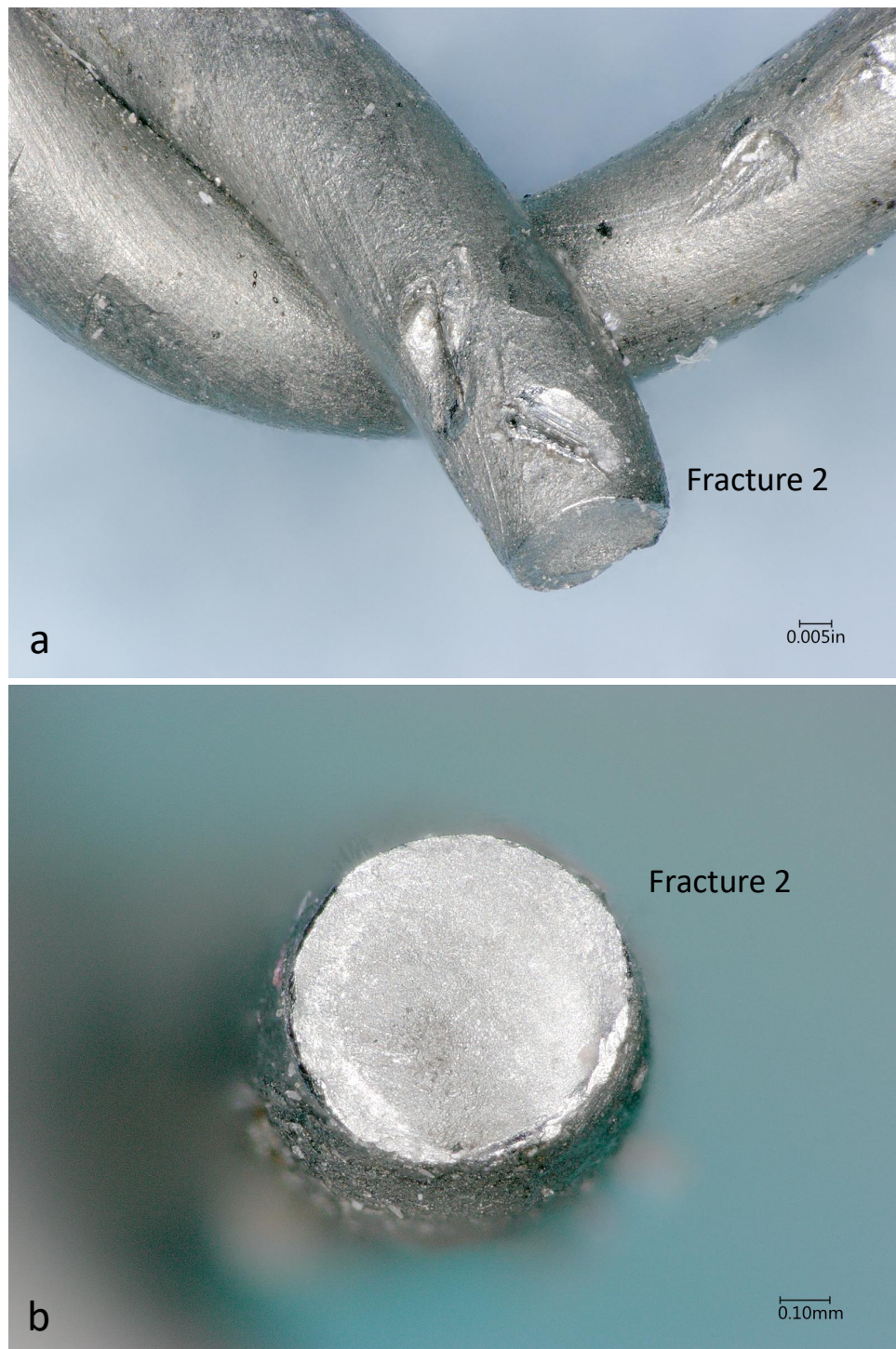


Figure 22 Side and top-down views of Fracture 2 (see Figure 17) safety wire fracture surface.

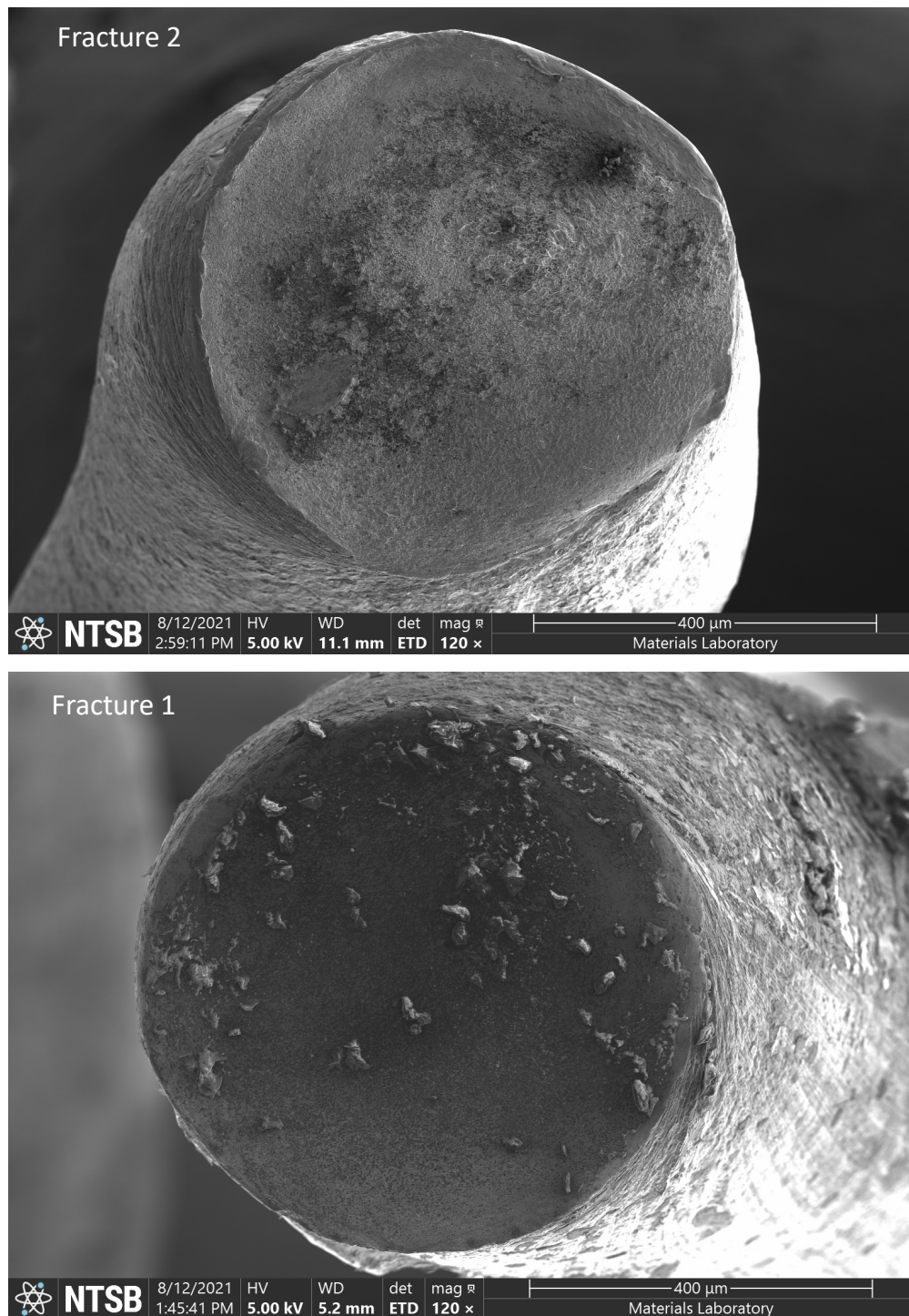


Figure 23 Scanning electron microscope images of the fractured safety wire ends identified in Figures 15-22.