NATIONAL TRANSPORTATION SAFETY BOARD

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

December 8, 2010.

MATERIALS LABORATORY FACTUAL REPORT Report No. 10-095

A. ACCIDENT

Place	:	Aleknagik, Alaska.
Date	:	August 9, 2010.
Vehicle	:	DHC-3 Otter, N455A.
NTSB No.	:	ANC10MA068.
Investigator	:	Robert Swaim, AS-40.

B. COMPONENTS EXAMINED

Altimeter.

C. DOCUMENTS REVIEWED

United Instruments illustrated parts list, TM-5934.

D. DETAILS OF THE EXAMINATION

The altimeter to be submitted for examination is illustrated in Figure 1 as found at the accident scene. The 100ft needle which indicates 100 foot increments of altitude, the 1,000ft needle which indicates 1,000 foot increments of altitude, and the 10,000ft flag which indicates 10,000 foot increments of altitude are identified. The increments are numbered 0 – 9 on the dial and sub-divided into five (5) smaller divisions. The 10,000ft flag is indicating zero, the 1,000ft needle is indicating one small division past zero which corresponds to an altitude of 200 feet, and the 100ft needle is indicating the numerical 2, which corresponds to 200 feet. Figure 1 shows the altimeter indicating an altitude of 200 feet. The crosshatch flag is also identified and is a part of the 10,000ft flag. The crosshatch is increasingly obscured as the altitude increases and would be completely obscured at 20,000 feet, the altimeter's calibrated altitude. The Kollsman[1] window indicates the barometric pressure, in inches of mercury, the altimeter was set to. The barometric pressure indicated in the Kollsman window may be adjusted by turning the knob indicated by the yellow arrow. The Kollsman window was found set at a barometric pressure of 29.51 inches of mercury[2].

The condition of the altimeter as received at the NTSB Materials Laboratory is shown in Figure 2 and different values are displayed when compared to Figure 1. The 1,000ft needle is indicating between the #9 and the #0 numeral and the 100ft needle is indicating between the #2 numeral and the #3 numeral. The 10,000ft flag is located to the left of zero, indicating less than zero feet, and the crosshatch flag is fully visible. As received, the

[1] The Kollsman window is named after its inventor, Paul Kollsman.
[2] At standard atmospheric conditions the barometric pressure at sea level is 29.92 inches of mercury.

needles are indicating minus 760 feet. The Kollsman window was still set at a barometric pressure of 29.51 inches of mercury.

The rear of the altimeter displayed an identification plate identifying it as a United Instruments, Inc. altimeter with an operating range of -1,000ft to 20,000ft. The part number "5934P-3", the serial number "443237", the inspection date "2/05" and code A. "194" were stamped on the plate.

Prior to the start of the examination the altimeter reading was found to have changed again but was still displaying a negative altitude. The altimeter is illustrated in Figure 3 with the 100ft needle, the 1,000ft needle, the 10,000ft flag, the crosshatch flag and the Kollsman window identified. The 10,000ft flag is indicating less than zero feet and the crosshatch flag is fully visible. The 1,000ft needle, as indicated by the blue line, is pointing to the right of the 600ft graduation, counterclockwise from the "0" numeral. The 100ft needle, as indicated by the green line, is pointing to the right of the 600ft graduation, counterclockwise from the #5 numeral. As illustrated, the altimeter is indicating minus 560 feet. The Kollsman window was still set at a barometric pressure of 29.51 inches of mercury.

In order to see the altimeter dial more clearly the barometric pressure adjustment knob, indicated by the yellow arrow in Figure 1, was removed followed by removal of the front bezel, with the two glass covers (the outer cover was fractured and incomplete but the inner cover was intact). During removal of the bezel the quadrant of the case indicated by the green arrow in Figure 3 separated from the remainder of the case as illustrated in Figure 4. The exposed dial is illustrated in Figure 4 and the altimeter display had changed again but was still displaying a negative altitude. The 1,000ft needle, as indicated by the blue line, was pointing to the left of the 600ft graduation, counterclockwise from the "0" numeral. The 100ft needle was pointing to right of the 100ft graduation, counterclockwise from the "4" numeral. As illustrated, the altimeter is indicating minus 635 feet. The Kollsman window was still set at a barometric pressure of 29.51 inches of mercury.

Initial examination of the dial face revealed that the needles were not visibly in contact with any portion of it at the time of the examination. An examination under ultra-violet light revealed that no fluorescing paint[3] had been used on the dial or the needles and no fluorescing paint transfer from the underside of a needle was observed on the dial. Microscopic examination revealed what appeared to be white deposits located to the left of the 10,000ft flag. The area around the deposits is illustrated in the left image in Figure 5 with a portion of the 10,000ft flag and the tip of the 1,000ft needle identified. The deposits are indicated by the yellow arrow and illustrated in the right image in Figure 5 at a higher magnification. During manipulation of the altimeter under the microscope, the 1,000ft needle was found to move freely between the #1 numeral and the #4 numeral.

The dial and gear assembly and the mechanism assembly were extracted from the case. The dial assembly was gently separated from the mechanism assembly and during the handling the 100ft needle fell off the dial. Examination of the removed assemblies and

[3] In an impact event, a needle covered with a fluorescent paint will sometimes strike the dial and transfer paint to it, thereby indicating its actual position at the event.

comparison with the illustrated parts list in section C revealed that all parts were accounted for. Manipulation of the aneroid wafers in the mechanism assembly revealed that motion was continuous to the center pinion that normally engages with the gears in the dial assembly and to which the 100ft needle is normally attached. Manipulation of the gears within the dial assembly revealed that motion was continuous from the gears that normally engage with the center pinion to the 1,000ft needle and the 10,000ft flag.

Examination of the 100ft needle revealed a distinctly scratched area on the underside of the shorter black painted portion. The scratches were oriented perpendicular to the edge of the needle, initiated on the edge of the needle and tapered off as distance from the edge increased. The inverted needle was placed adjacent, and parallel, to the 10,000ft flag with the needle's center aligned with the center of the dial. The inverted 100ft needle is illustrated and identified in Figure 6 with the 10,000ft flag and the 1,000ft needle identified. The scratched area is indicated by the white arrow. A closer view of the scratched area is illustrated in the left image in Figure 7 with the scratched area similarly indicated by a white arrow. Lighter scratches were observed along the opposite edge and are located between the two red arrows. A view of the initiation edge, in the direction indicated by the blue arrow in the left image is illustrated in the right image with yellow arrows indicating three distinct grooves in the edge. The underside of the needle was generally unpainted but a thin band of paint along the edges matched the paint on the upper surface and the area between the bands displayed small droplets consistent with overspray.

With the dial removed from the case, a more detailed examination of the dial was performed. The examination revealed what appeared to be more white deposits to the left of the deposits illustrated in Figure 5. The deposits are illustrated in Figure 8 and indicated by the white arrows. With the needle positioned as illustrated in Figure 6 the blue dashed line indicates the location on the underside needle where any paint would have been transferred from. The location was also indicated by marking the underside with the tip of a black marker. A closer view in the vicinity of the marker is illustrated in the central image in Figure 8 with the blue dashed line repeated as in Figure 6. Examination of the underside of the needle in the vicinity of the marker revealed no disturbance on the surface of the paint band along the edge. The area within the red box in the central image in Figure 8 is illustrated in the left image with the blue arrow indicating the marker. The white arrow indicates the paint band and the yellow arrow indicates the overspray droplets. The area within the yellow box in the central image in Figure 8 is illustrated in the right image with the blue arrow indicating the marker. The white arrow indicates the paint band and the yellow arrow indicates the overspray droplets.

Derek Nash
Mechanical Engineer

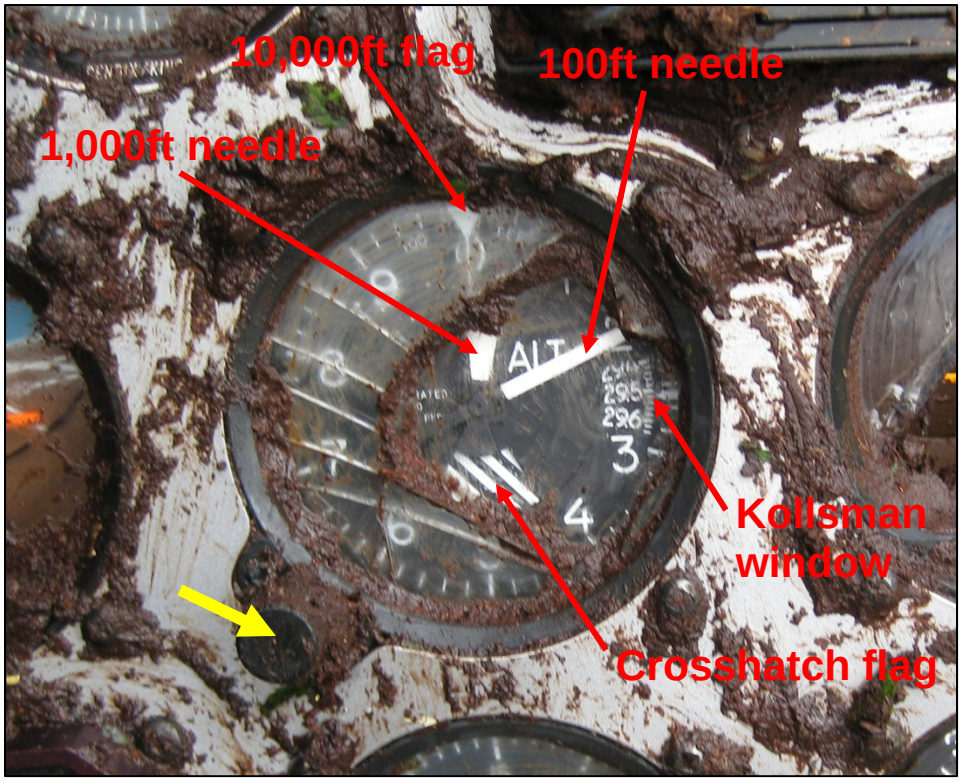

Figure 1. The altimeter as found at the accident scene.

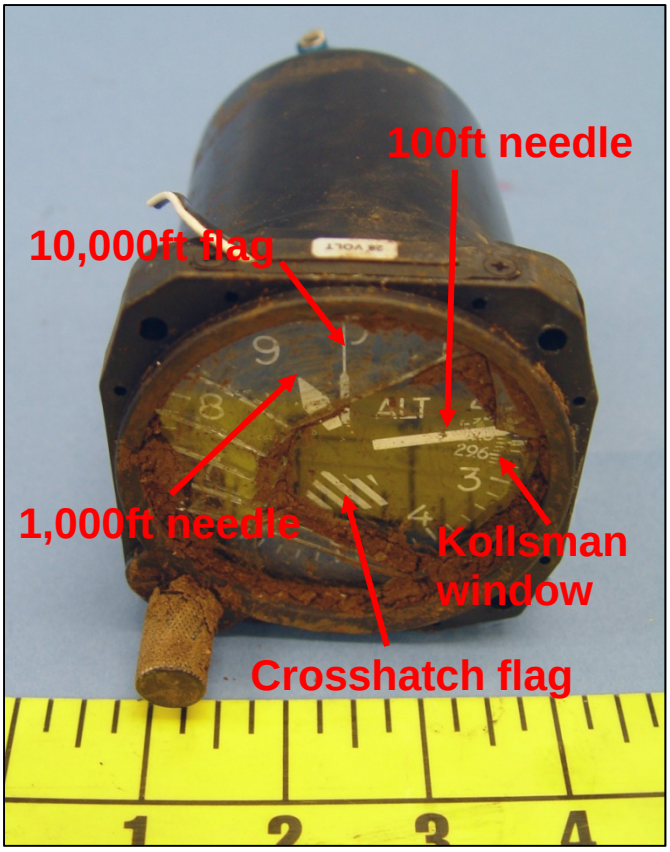

Figure 2. The altimeter as received for examination.

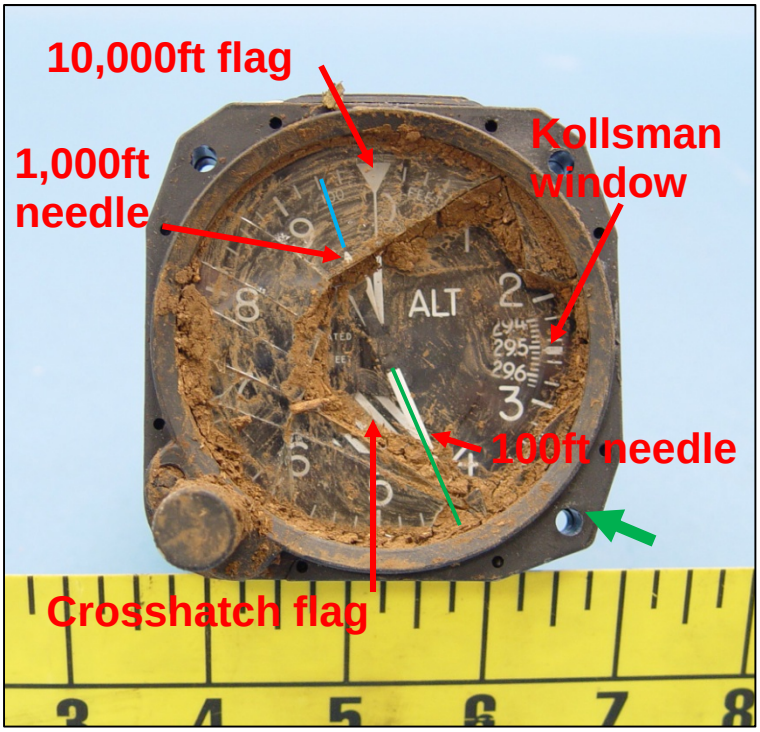

Figure 3. The altimeter immediately prior to the examination.

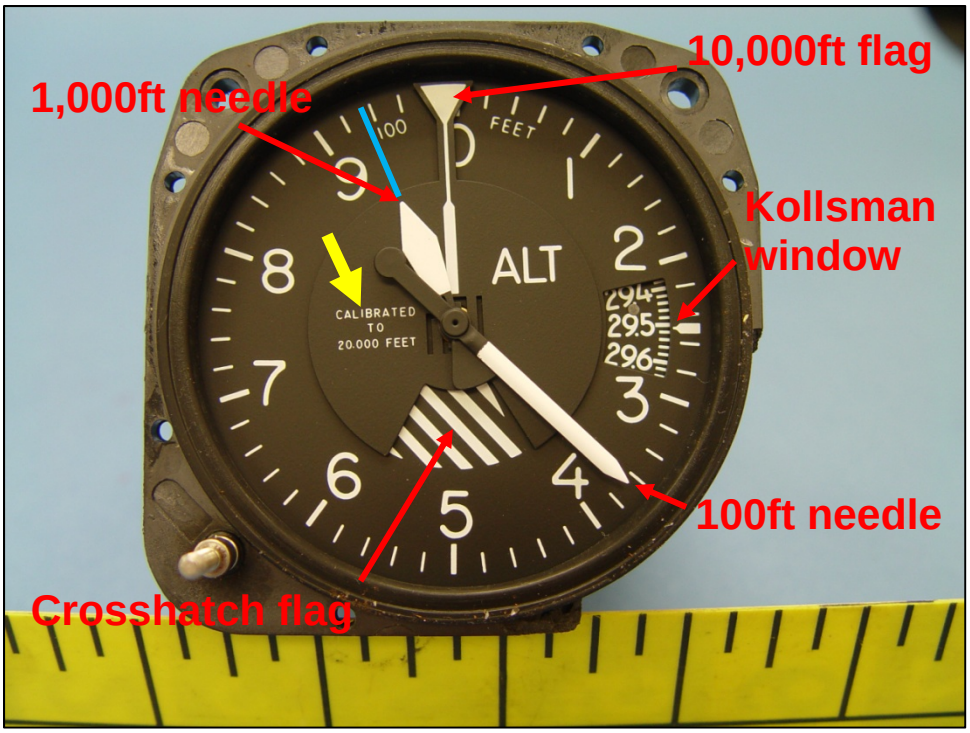

Figure 4. The altimeter dial after removal of the glass covers.

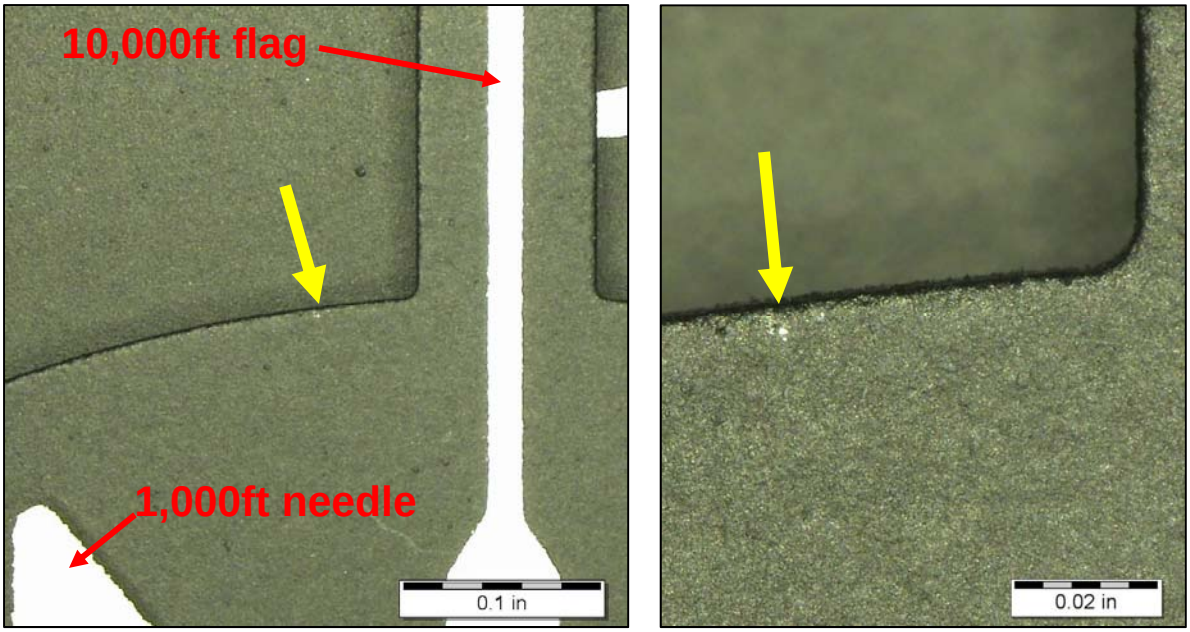

Figure 5. White marks observed to the left of the 10,000ft flag (left) and a closer view of the marks (right).

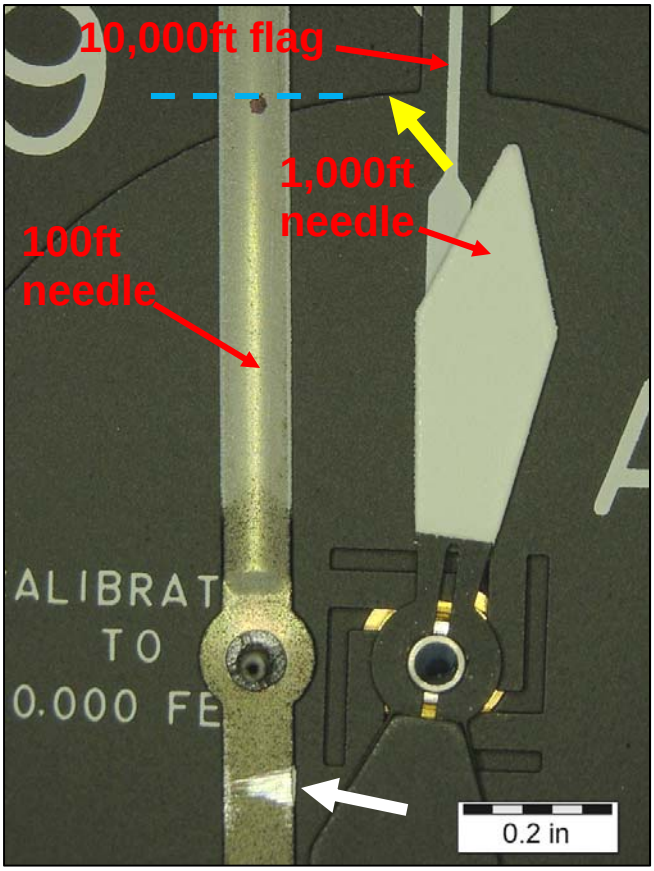

Figure 6. The inverted 100ft needle centered adjacent to the 10,000ft flag.

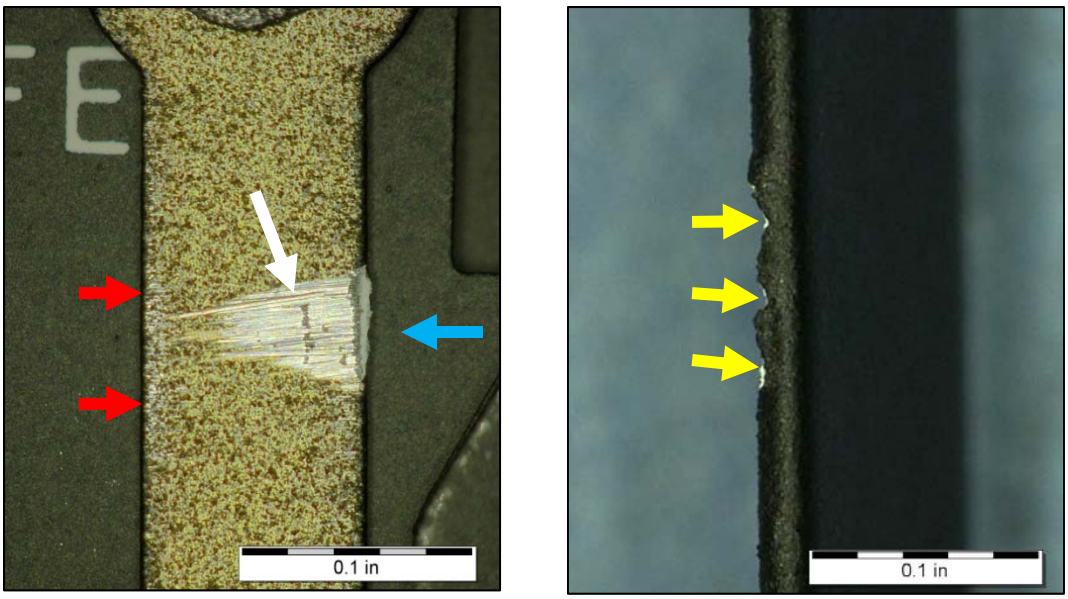

Figure 7. The scratches on the underside of the 100ft needle (left) and a closer view of the edge indicated by the blue arrow (right).

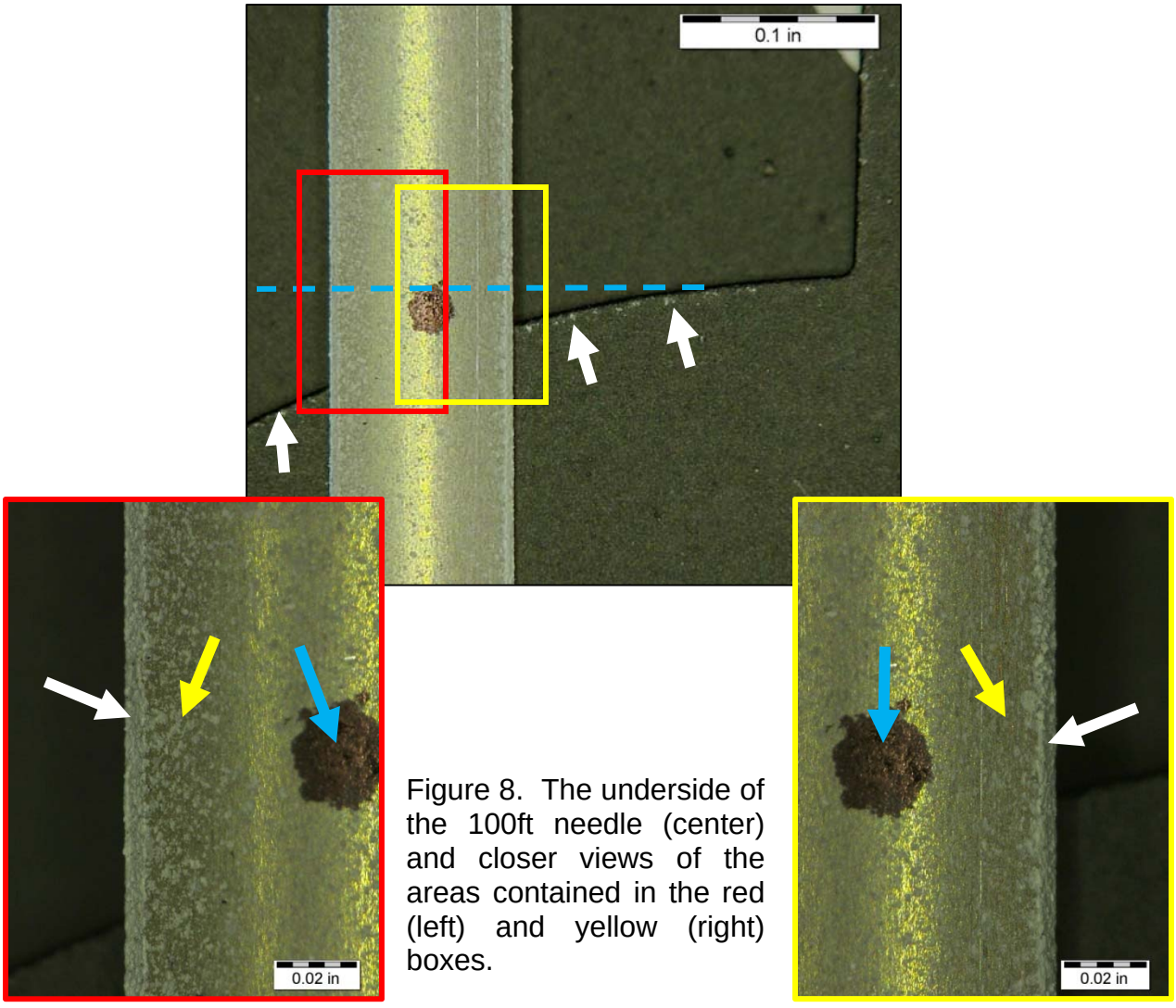

Figure 8. The underside of the 100ft needle (center) and closer views of the areas contained in the red (left) and yellow (right) boxes.