

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



CEN22LA256

MATERIALS LABORATORY

Factual Report 22-095

December 20, 2022

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A. ACCIDENT INFORMATION

Location: Madison, Mississippi
Date: June 16, 2022
Vehicle: Bellanca 17-30A, N39880
Investigator: Michael Folkerts, ASI-CEN

B. COMPONENTS EXAMINED

Muffler assembly, right side, with separated outlet ball tube.
Tailpipe assembly, right side.

C. EXAMINATION PARTICIPANTS

Specialist Donald Kramer, Ph.D.
NTSB
Washington, DC

D. DETAILS OF THE EXAMINATION

The right-side muffler and tailpipe assemblies from a Bellanca 17-30A were submitted to the NTSB Materials Laboratory for examination as shown in figure 1. The muffler assembly consisted of a cylindrical shell with flanges welded to the forward and aft ends, and mid and aft risers welded to the shell along the top. The cylindrical shell was covered by a shroud that was part of a heat exchanger system. The forward and aft flanges each had an opening in the center, as seen for the aft flange in figures 2 and 3. The opening was formed in such a way as to construct a sleeve (figure 3) into which the forward tube or aft ball tube, respectively, was inserted. The flange sleeve and tube ends were aligned and then fusion welded to form an edge joint. The aft ball tube was connected to the tailpipe by a spherical joint backed by a compression ring and secured with a V-band clamp, as seen in figure 2a.

The bolt that secured the band clamp could be turned by hand and the nut had impinged upon the thread runout section of the bolt. The bolt and clamp were removed in the lab, separating the ball tube from the tailpipe. The compression ring was then removed leaving just the ball tube, which is shown in figures 4 and 5. The outside of the tube exhibited a rubbed and burnished appearance in the regions where it lapped the aft flange and at the connection to the tailpipe, as seen in figure 4.¹ The perimeter of the tube was assigned clock positions as if viewed from upstream looking downstream with 12 o'clock at top dead center. Between the 6 o'clock and 9 o'clock positions, the forward end of the tube had been cut back, as

¹ Bright spots in the burnished regions are due to the reflection of external lights.

seen in figure 5a. By contrast, near the 12 o'clock position, there was a region of raised up material at the forward end of the tube.

The cut back region of the ball tube is shown in greater detail in figures 6 and 7. As indicated in figures 6a and 6b, the end face and outer diameter of the tube exhibited multiple locations where the surface exhibited a rubbed and gold-tinted appearance. Rubbing/burnishing along the outer diameter, as previously described, is also indicated in figure 6b. The inner diameter surface along the cut back edge is shown in figure 7a - c. After removal of a layer of lead deposits, much of the surface had an intermingled and rough red and gray appearance, consistent with oxide scale. However, there were also regions along the edge that exhibited a silver mottled appearance that was consistent with material that had either been at the incipient point of melting or had partially melted before resolidifying, several regions of which are indicated in figure 7b. Near the ends of the cut back region (near 6 o'clock and 9 o'clock) there were pieces of metal that appeared to be fused to the adjoining metal, as indicated in figures 7a and 7c. Finally, near the 9 o'clock position, a piece of metal that was unfused or partially fused to the adjoining metal was observed and is indicated in figure 7c. The sleeve on the aft flange, shown in figure 8, was examined in this area for indications of fused material. No fused material was observed, however lead deposits on the face of the sleeve were.

The raised-up region on the tube around the 12 o'clock position and associated aft flange sleeve are shown in greater detail in figures 9a and 9b, respectively. The raised-up material appeared to be fused to the end of the tube. On the outer diameter surface, the material exhibited a rubbed/burnished appearance between the 12 o'clock and 1 o'clock positions (left side of figure 9a) and a smeared/scratched appearance toward the 11 o'clock position (right side of figure 9a). At the end of the smeared/scratched region, there was a crack/separation between the raised-up material and adjoining tube material, as indicated in the figure. The sleeve on the aft flange, shown in figure 9b, exhibited a rubbed/burnished appearance in the same region.

A crack was observed on the outward face of the aft flange between 3 o'clock and 6 o'clock as indicated in figure 2 and shown in figures 10a and b. The crack ran along the toe of a weld that joined the aft flange to the cylindrical body of the muffler. Examination of the crack with the aid of a binocular microscope indicated that the crack surfaces appeared oxidized and in at least one region, deposits were present on the fracture, as indicated in figure 10b.

E. ATTACHMENTS

Attachment 1 - Alexandria Aircraft Service Letter B-110, Bellanca - Exhaust System Inspection and Rerouting Magneto "P" Leads, May 8, 2007.

Attachment 2 - FAA Airworthiness Directive 2008-05-11, Alexandria Aircraft, March 4, 2008.

Submitted by:

Donald Kramer, Ph.D.
Senior Materials Engineer

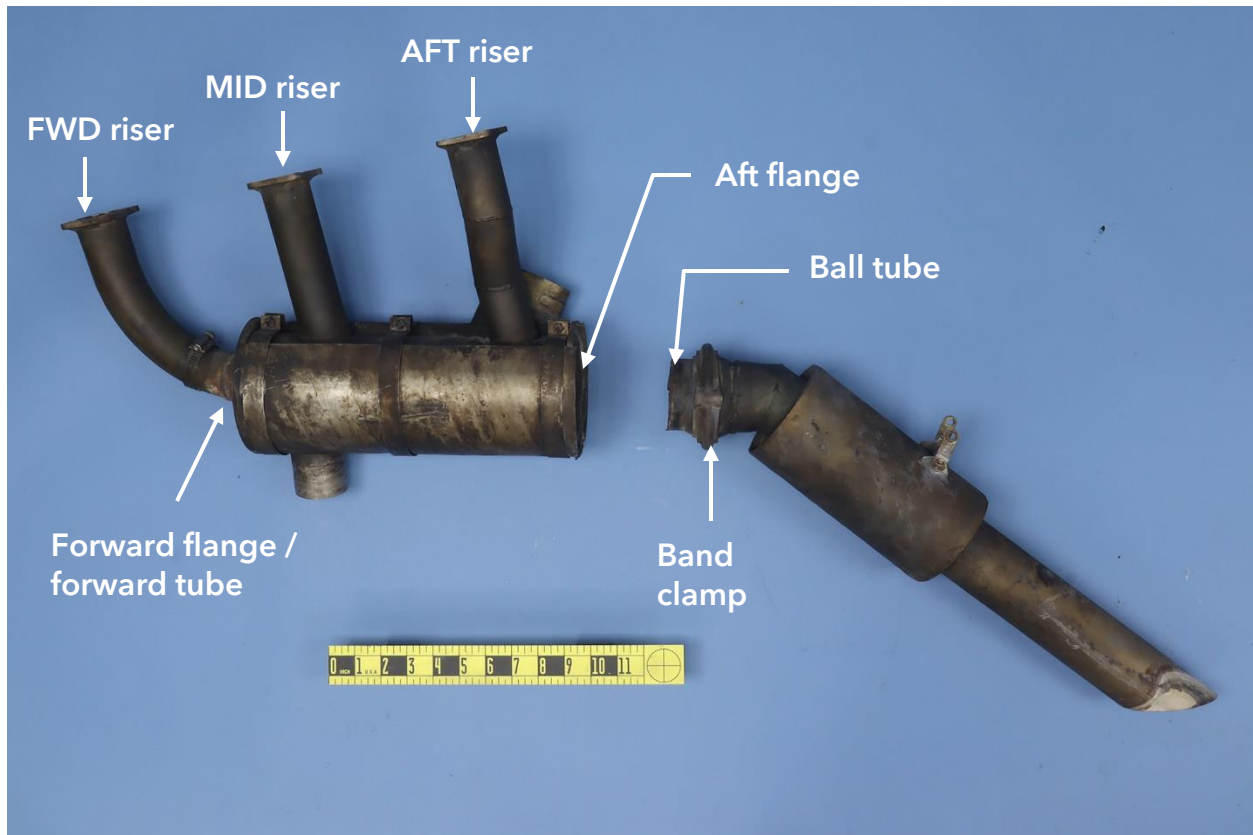


Figure 1. Image of the as received muffler and tailpipe assemblies. The ball tube at the outlet of the muffler had separated from the aft flange and was attached to the tailpipe by a band clamp.

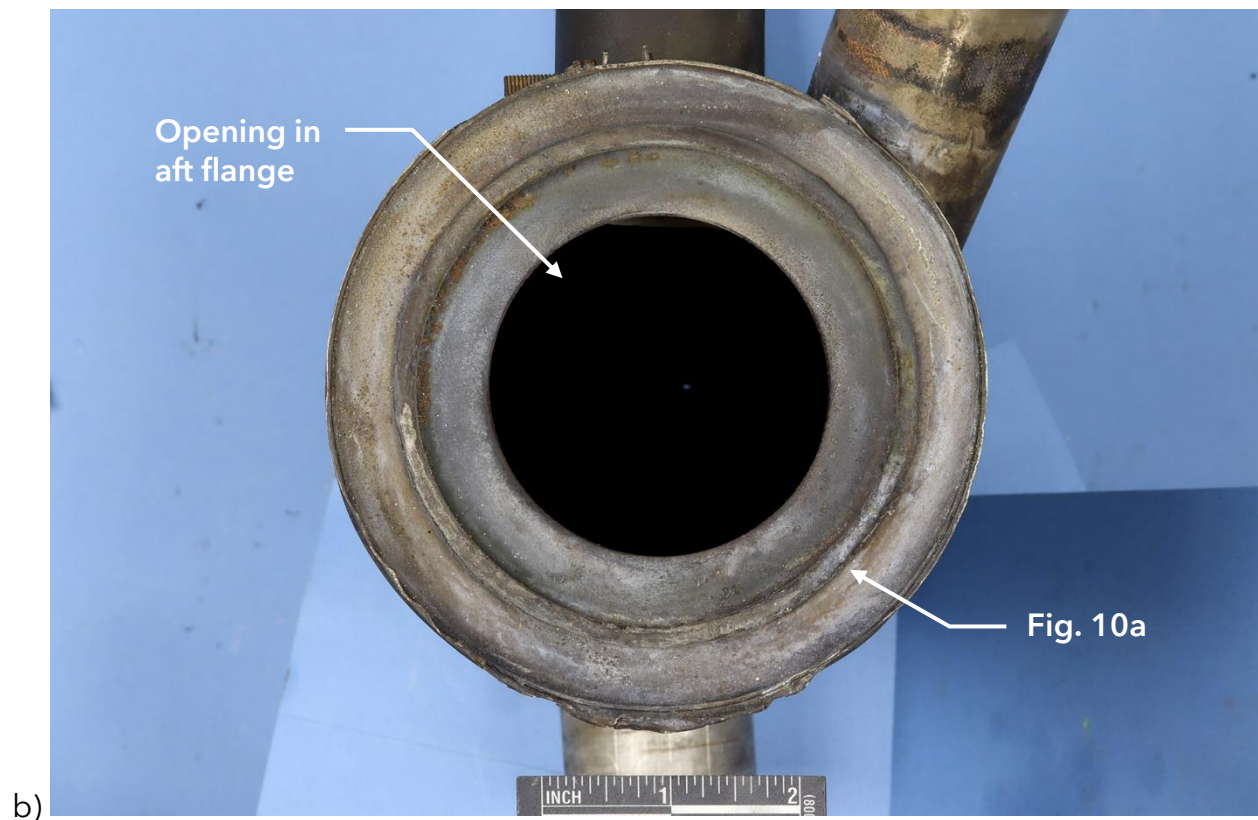
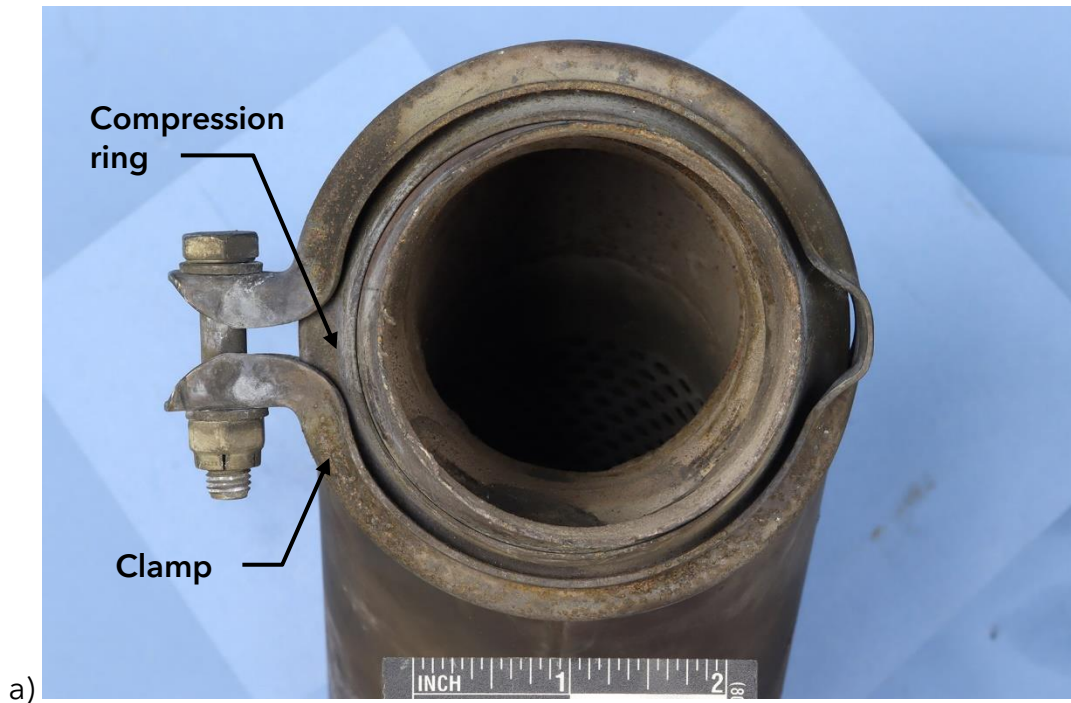


Figure 2. a) Image showing the insertion end of the ball tube and the band clamp and b) image of the aft muffler flange showing the opening into which the ball tube is inserted.

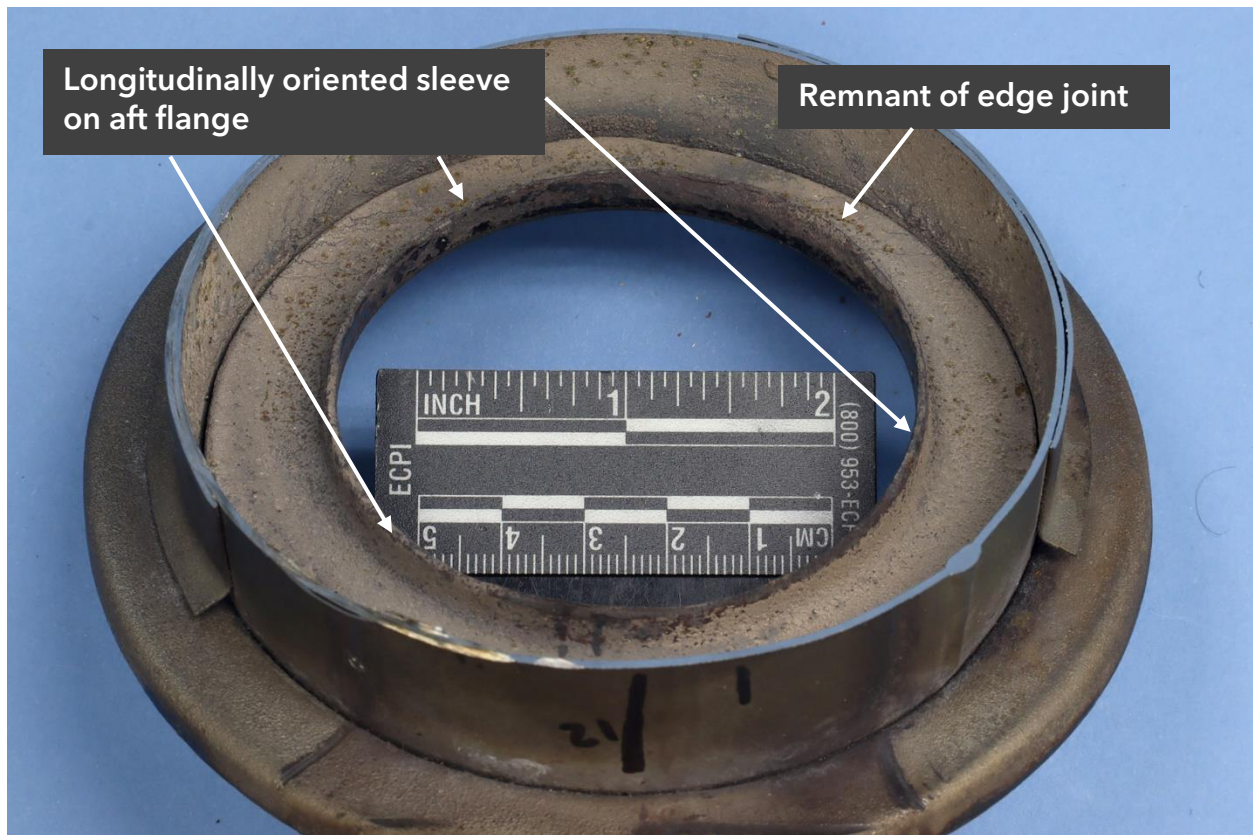


Figure 3. Image of the muffler aft flange inner surface after cutting the flange from the muffler body. The flange contained a longitudinally oriented sleeve that surrounded the opening and to which the tube was edge welded.

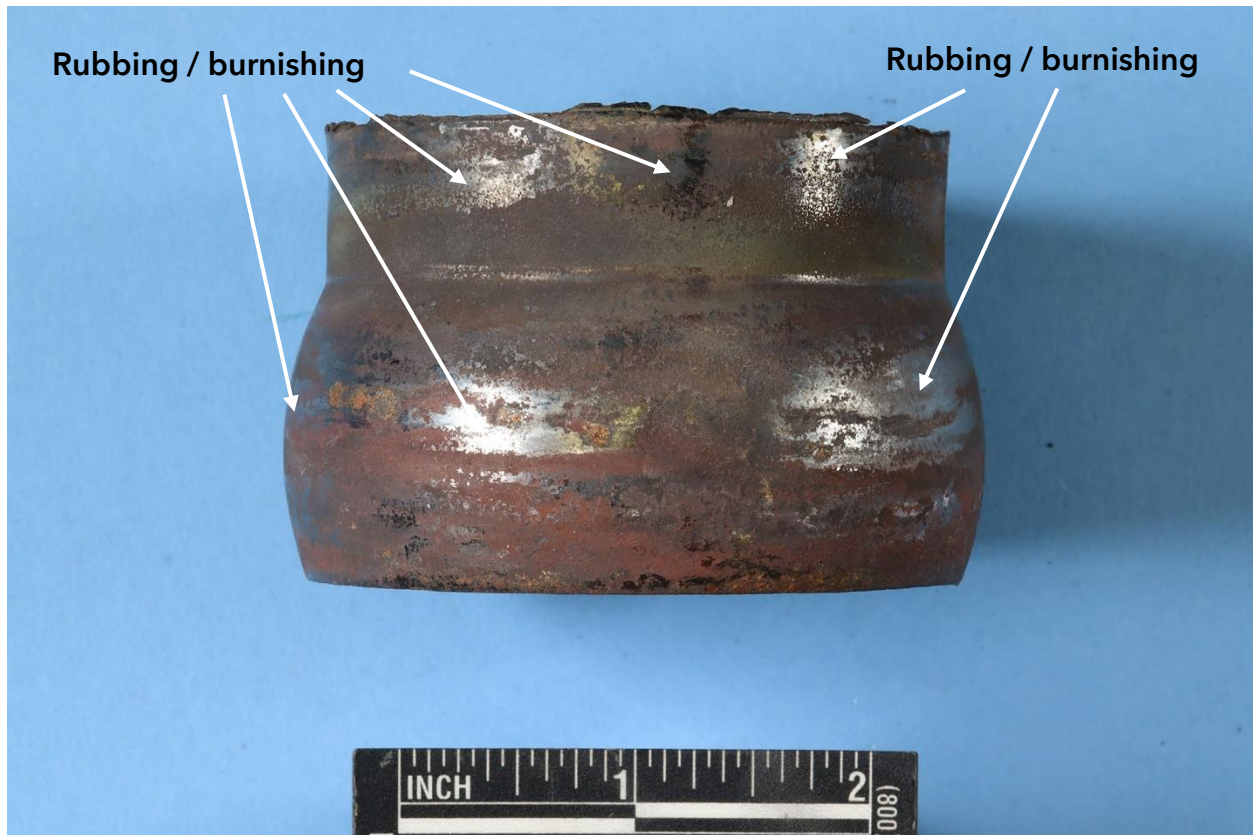


Figure 4. Image of ball tube showing rubbing / burnishing marks near the muffler aft flange sleeve and near the connection to the tailpipe. The marks were present around the entire perimeter of the tube.

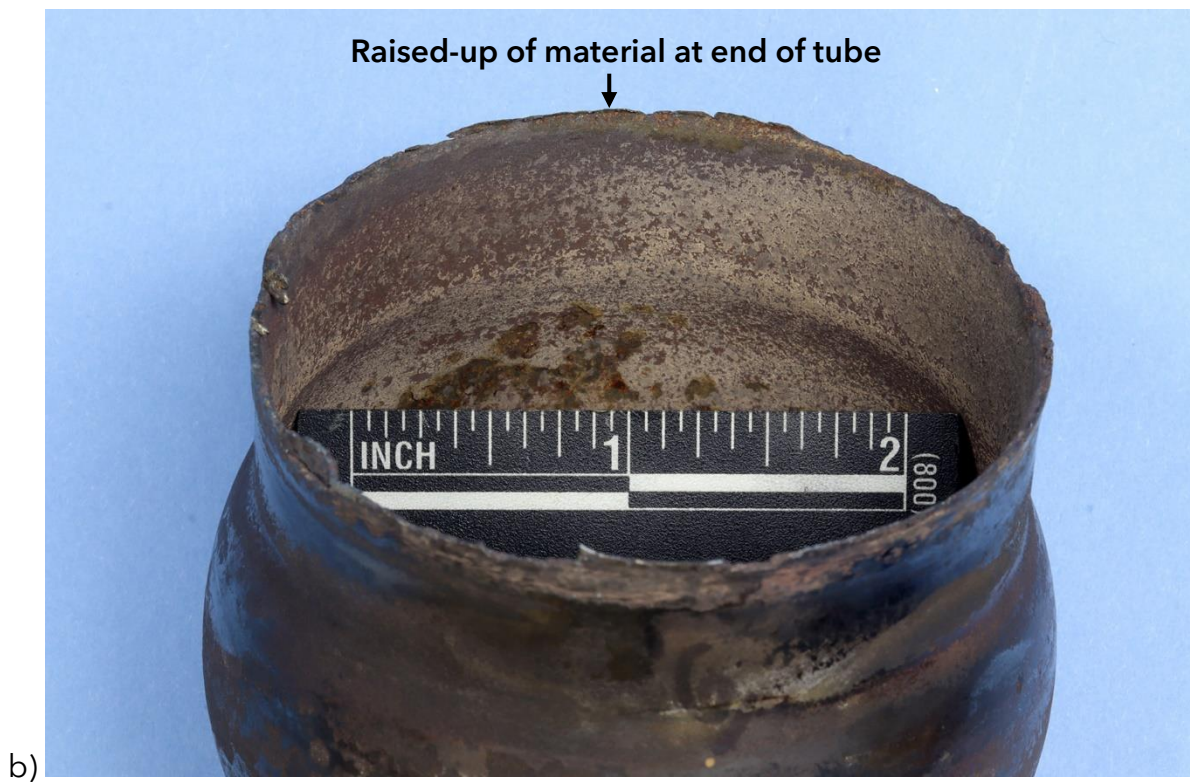
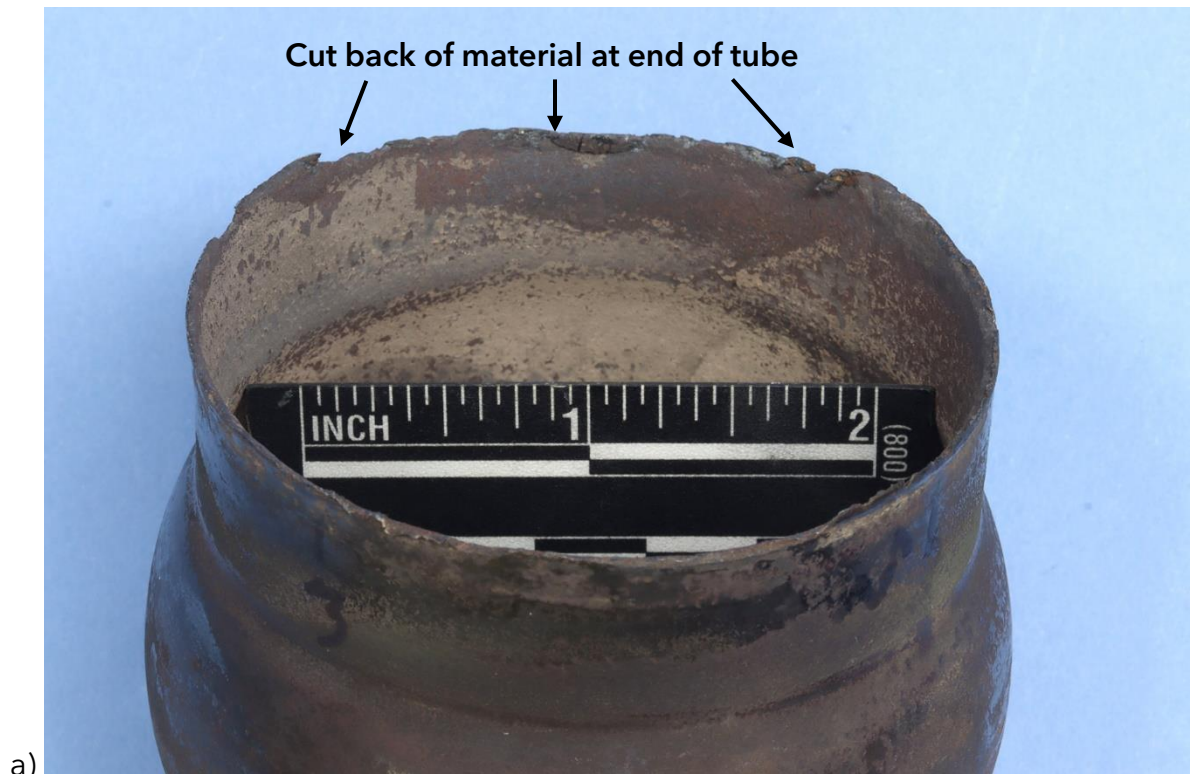


Figure 5. Images of the forward end of the ball tube, which is inserted into and welded to the muffler aft flange; a) region where material had been cut back from the end of the tube and b) region where material had been raised up at the end of the tube.

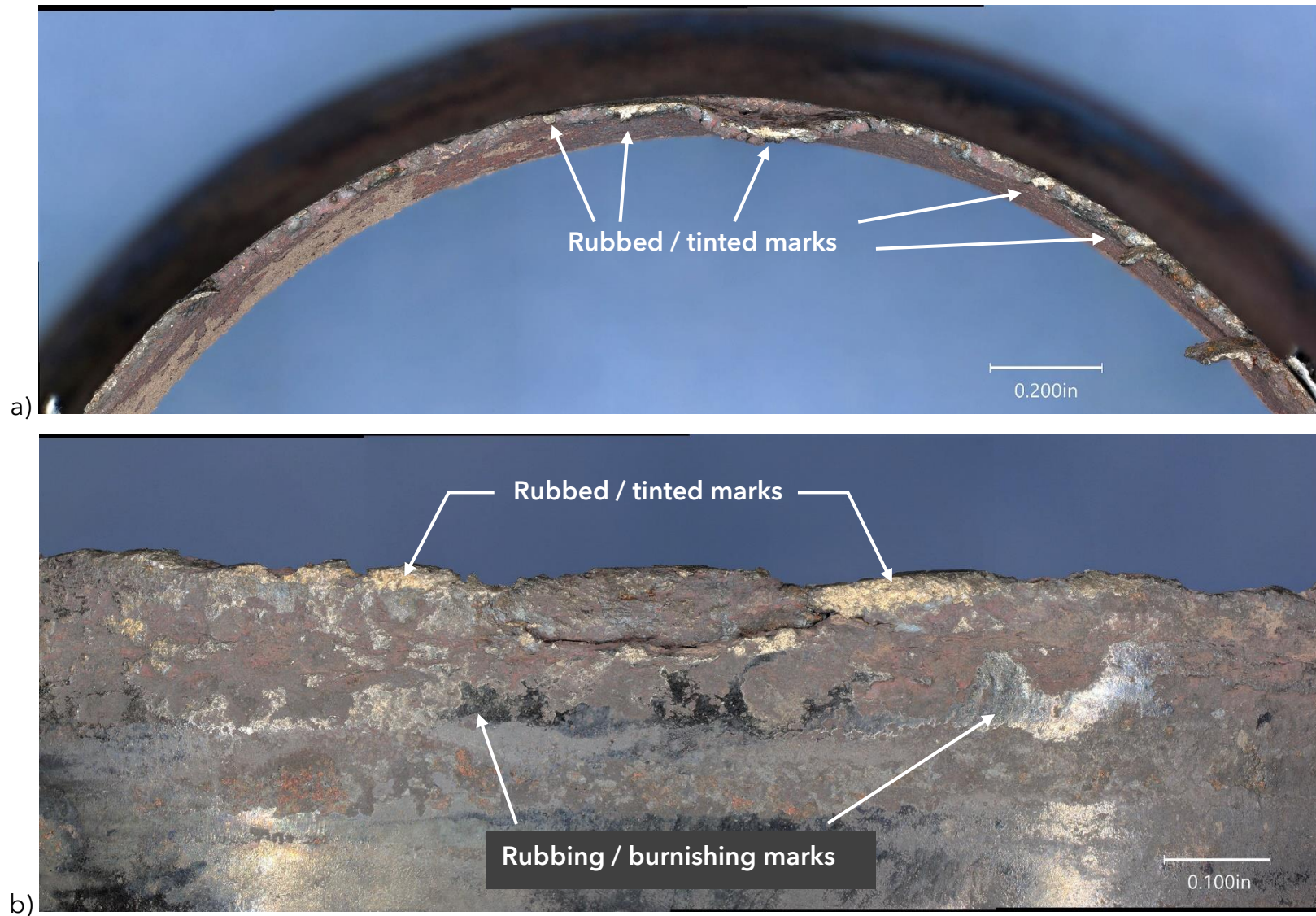


Figure 6. Images of the tube end where the material had been cut back; a) end view indicated rubbing and tinting on the end face and b) image of the outer diameter surface indicating rubbing, burnishing, and tinting.

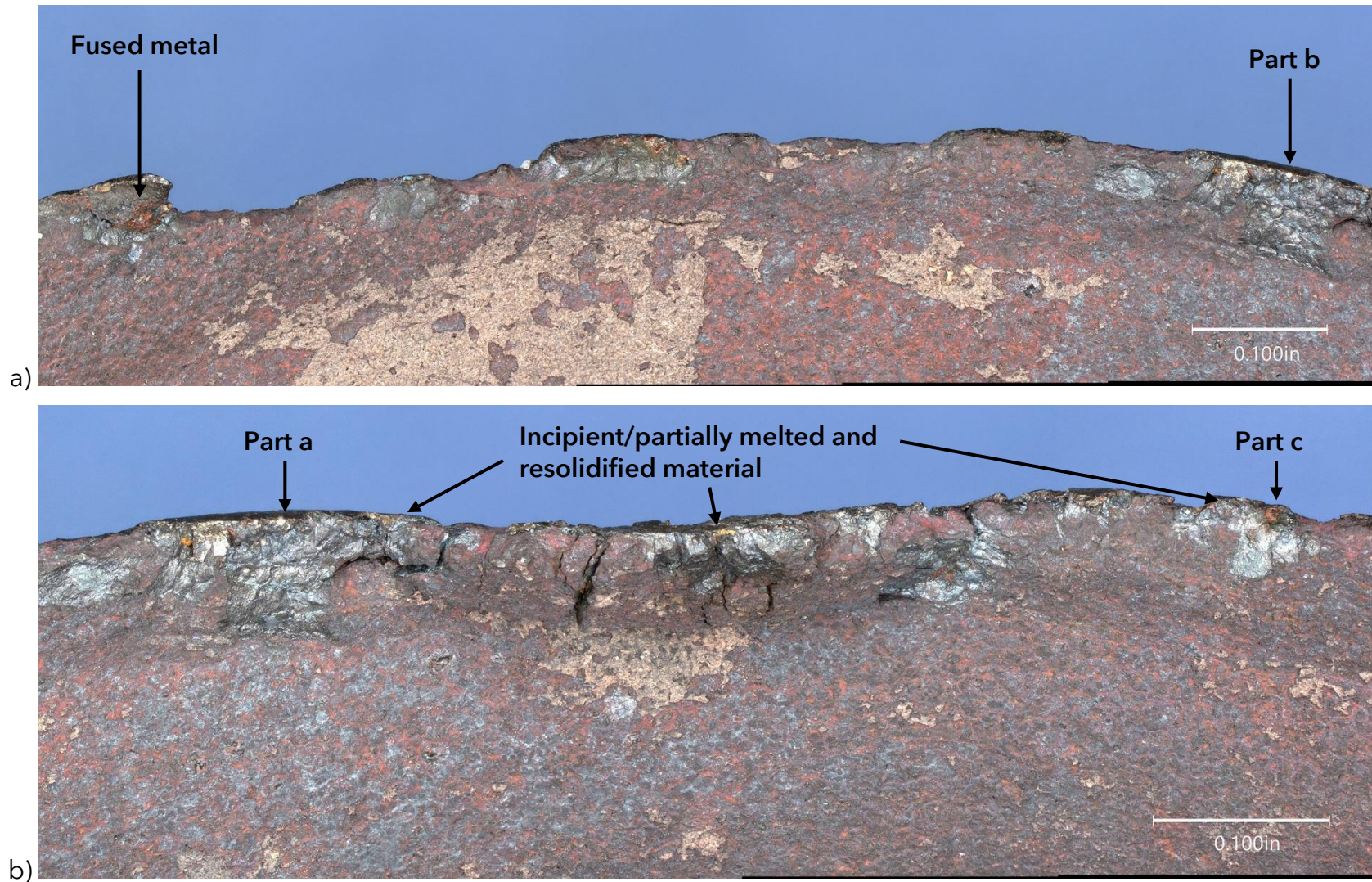


Figure 7. a) - c) Images of the inner diameter surface along the cut back edge. Regions of fused metal, molten and resolidified metal, and unfused metal were observed.

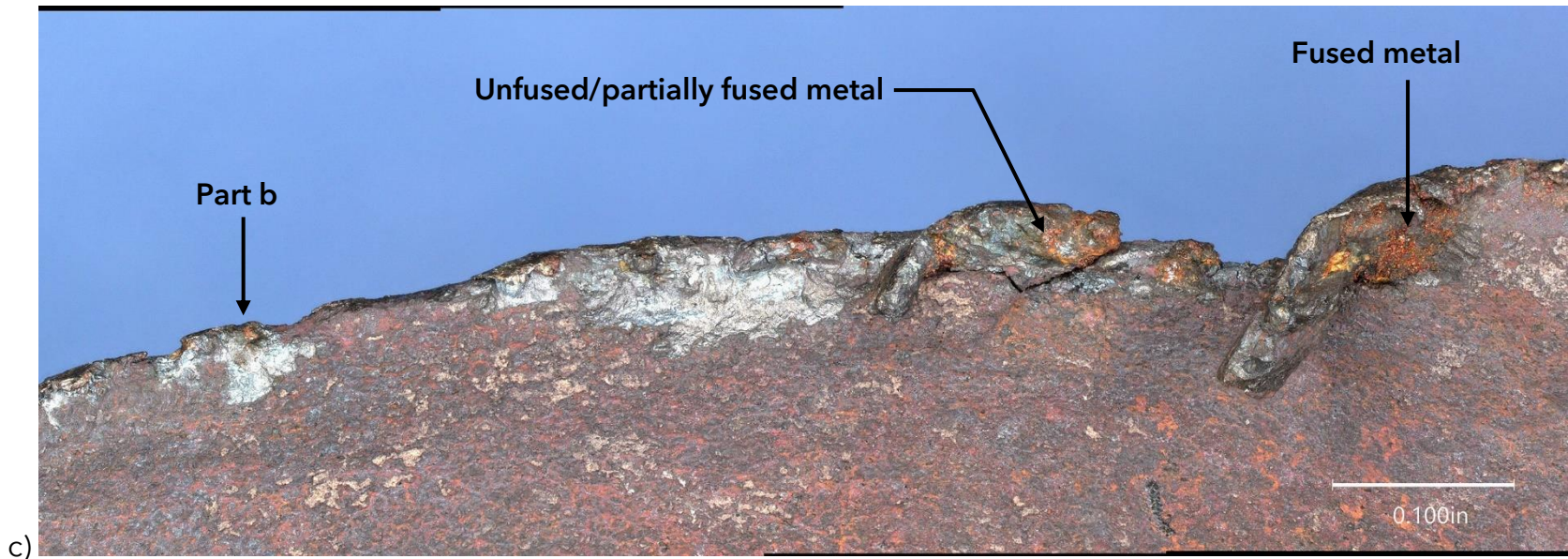


Figure 7 (cont.). a) - c) Images of the inner diameter surface along the cut back edge. Regions of fused metal, molten and resolidified metal, and unfused metal were observed.

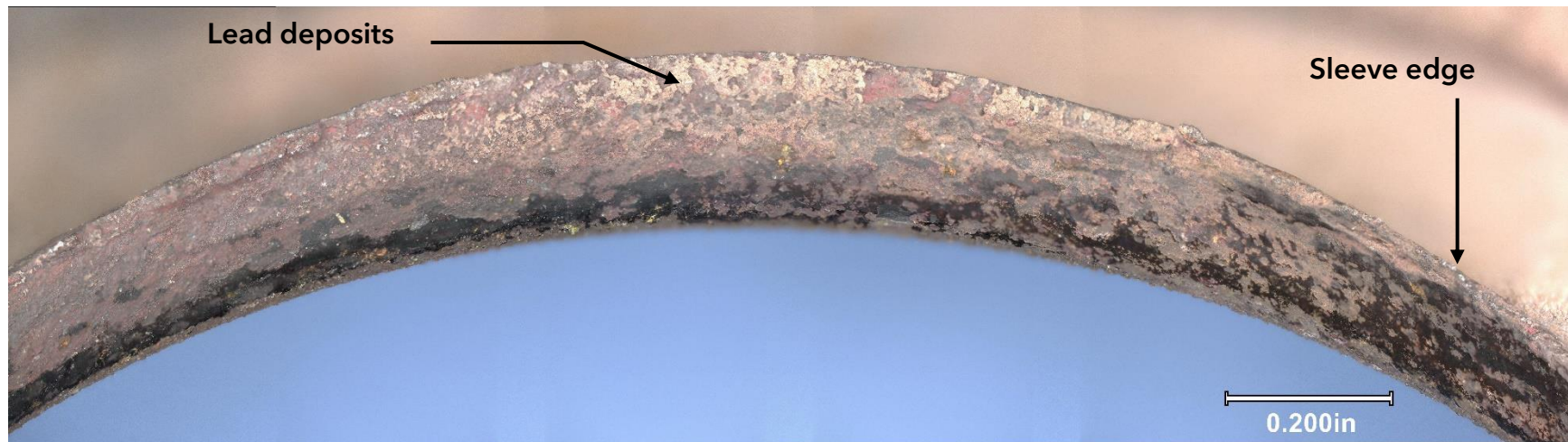


Figure 8. Image of the aft flange sleeve between the 6 o'clock and 9 o'clock positions.

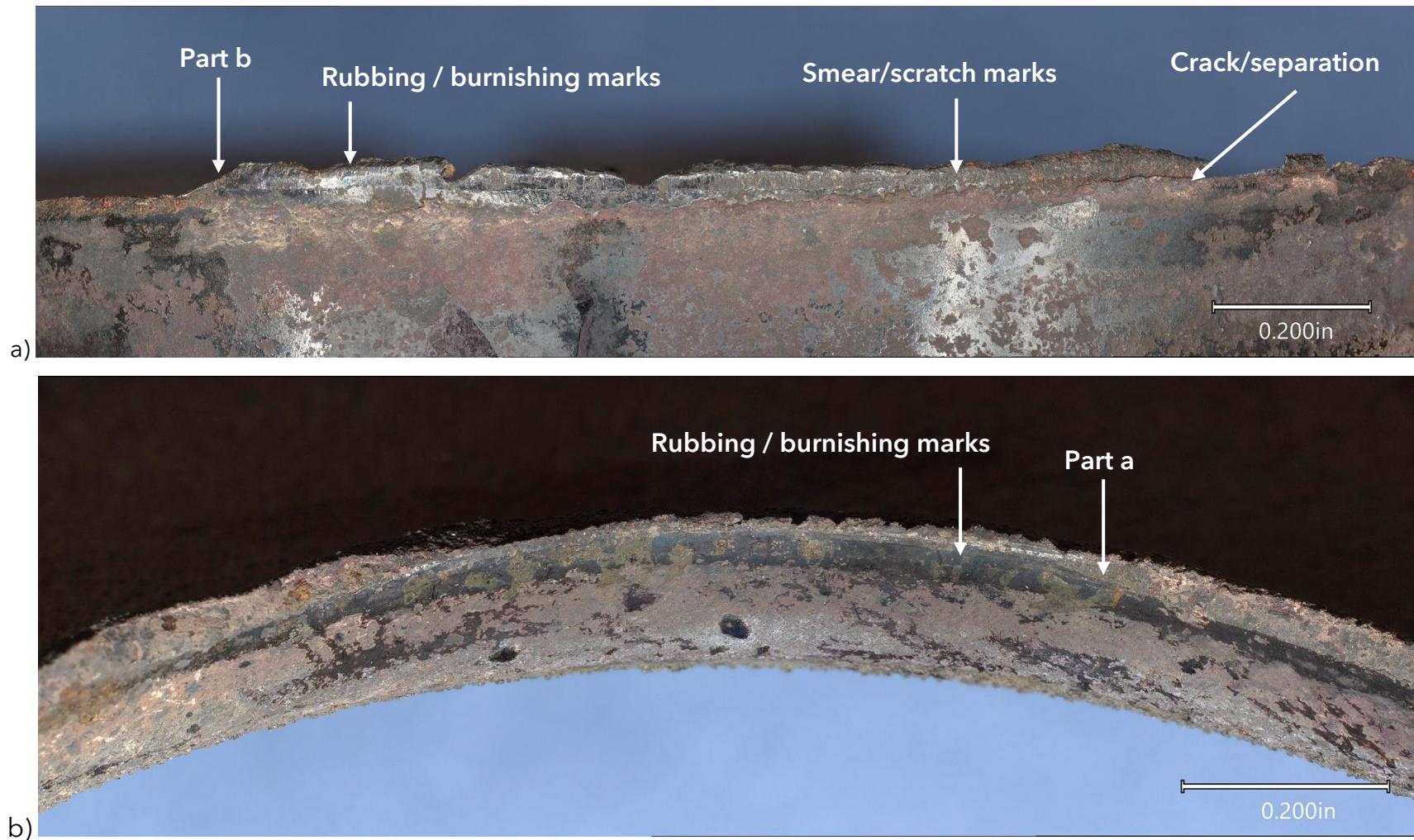


Figure 9. a) Image of the tube outer diameter surface at the location with raised up material with rubbing and burnishing marks indicated and b) image of the aft flange sleeve's inner diameter surface with burnishing mark indicated.

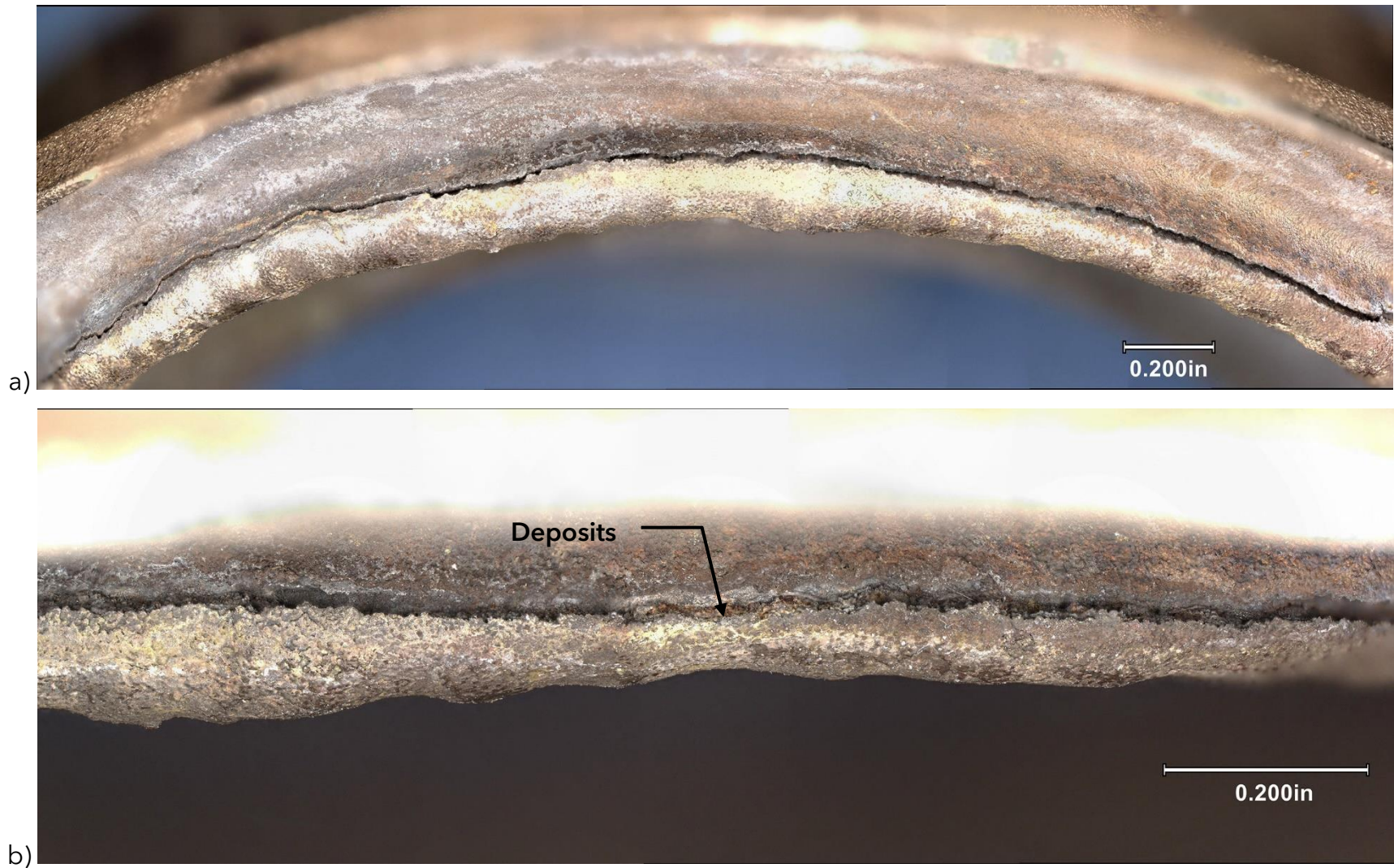


Figure 10. a) Image of a crack observed on the outer face of the muffler aft flange between the 3 o'clock and 6 o'clock positions and b) higher magnification image showing deposits in the crack.