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

November 16, 2016

MATERIALS LABORATORY FACTUAL REPORT Report No. 16-088

A. ACCIDENT INFORMATION

Place	:	Texarkana, Arkansas
Date	:	May 23, 2016
Vehicle	:	Cessna 501, N804ST
NTSB No.	:	CEN16LA197
Investigator	:	Mitchell Gallo, AS-CEN

B. COMPONENTS EXAMINED

1. Pieces of pressurization check valve p/n 9912078-8
2. Worm- gear style hose clamp

C. DETAILS OF THE EXAMINATION

Figure 1 shows the as-received pieces of a pressurization check valve and a hose clamp. As indicated in Figure 1, the check valve has two flappers, arbitrarily numbered 1 and 2 for the purposes of identification in this report. Flapper 1 was fractured into numerous pieces and not all pieces were recovered or submitted.

The submitted pieces from flapper 1 are shown in Figure 2, with the pieces arranged in their approximate position on the part. Based on Fourier-transform infrared spectroscopy and fractographic analysis, the flappers are fabricated from glass-filled polybutylene terephthalate (PBT). Based on the presence of an injection gate and ejection pin marks, the flappers are fabricated by injection molding (See Figure 2). Flapper 1 had the following number molded onto the downstream side surface: DSP 904-0012-3 and did not exhibit any other identifying marks such as a date code or mold cavity number.

For identification purposes, individual cracks within flapper 1 were arbitrarily identified by letters A through H. Flapper 1 exhibited radially-oriented cracks originating within the identified region in Figure 3 (Cracks A, B, C, D, G, H). Two of the primary cracks (Cracks A and B) were nearly bilaterally symmetric in shape consistent with possible flow patterns and knitting in the part from the mold filling process. In all instances, the cracks initiated on the downstream side and propagated through the thickness towards the upstream side—driven primarily by bending stresses on the flapper. As indicated in Figure 3, some portions of the flapper were not recovered after the accident.

As identified in Figure 2, one fragment from flapper 1 was selected for deeper examination as shown in Figures 4 and 5. Figure 5 shows close views of the downstream surface and the presence of networks of fine cracks (also known as surface checks, surface crazing, or craze cracks). In Figure 5c a fine network of cracks are present adjacent to the main fracture surface. Figure 6 shows an oblique top-down view of the fracture surface of Crack A (see Figures 3, 4, and 5). The fracture surface of the polymeric resin phase was smooth and glassy with hackle marks indicative of though-thickness crack propagation from the downstream side to the upstream side. The fracture surface exhibited yellow discoloration in areas along its length indicating that portions of Crack A were pre-existing. Scanning electron microscope examination of Crack A as shown in Figure 7 revealed a fine network of secondary cracks along the main fracture. Similar observations were made for Crack B.

The hinge fragments for flapper 1 exhibited cracks that progressed radially outward from the inside surface to the outside surface. The fracture surfaces on two of the hinge cracks exhibited yellow discoloring, consistent with progressive crack development with time (slow crack growth).

Views of the check valve housing and flapper 2 are shown in Figure 8. Manufacturer markings are clearly indicated on the upstream side of the housing. Flapper 2 had the following number molded onto the downstream side surface: DSP 904-0012-3 and did not exhibit any other identifying marks such as a date code or mold cavity number. Flapper 2 exhibited a primary crack on the downstream side as indicated in Figure 9. A portion of one hinge was also missing as indicated in the figure. Closer views of the hinge with missing material are shown in Figure 10. Stereo-zoom microscopic evaluation indicated that a portion of one of the hinges fractured due to the development of a crack that initiated at the inner surface and propagated to the external surface. One of the fractures exhibited yellow discoloring, consistent with progressive crack development with time (slow crack growth).

Based on unique artifacts molded into the surfaces of the flappers, flapper 1 and 2 were molded from the same mold cavity.

Figures 11 and 12 show the submitted hose clamp with the manufacturer-associated markings indicated.

Marking stamped on the band:
BREEZE
UNION, N.J.
M48

Marking stamped on the worm gear housing:
Q.S. 200
ALL STAINLESS
Aero-Seal

The inside surface length of the hose clamp is about 11.1 inch and corresponds to an approximately 3.5 inch diameter. The hose clamp design is consistent with a worm gear style with a safety collared screw and perforated band manufactured by C. McGunnigle Co. Inc. Kenilworth, NJ, under the Breeze Aero Seal ® trademark. The clamp is consistent with an SAE J1508 Type F size 48 (2 9/16 to 3 1/2 diameter size range).

Michael Budinski
Chief, Materials Laboratory Division

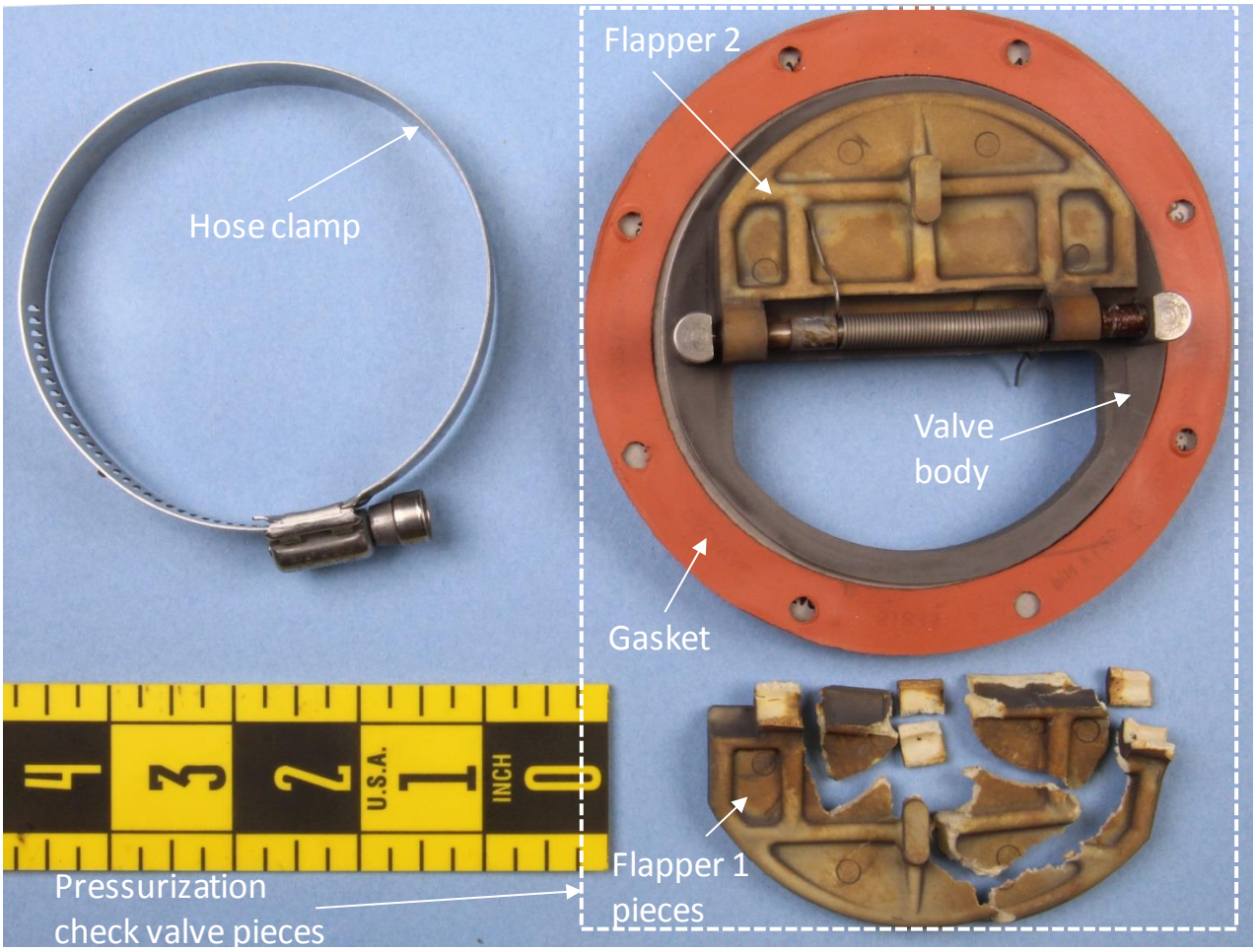


Figure 1 As-received pieces of the pressurization check valve and an hose clamp. The flappers are consistent with being molded from natural-colored polymeric resin, however, the surfaces are discolored and appear dark grey-brown.

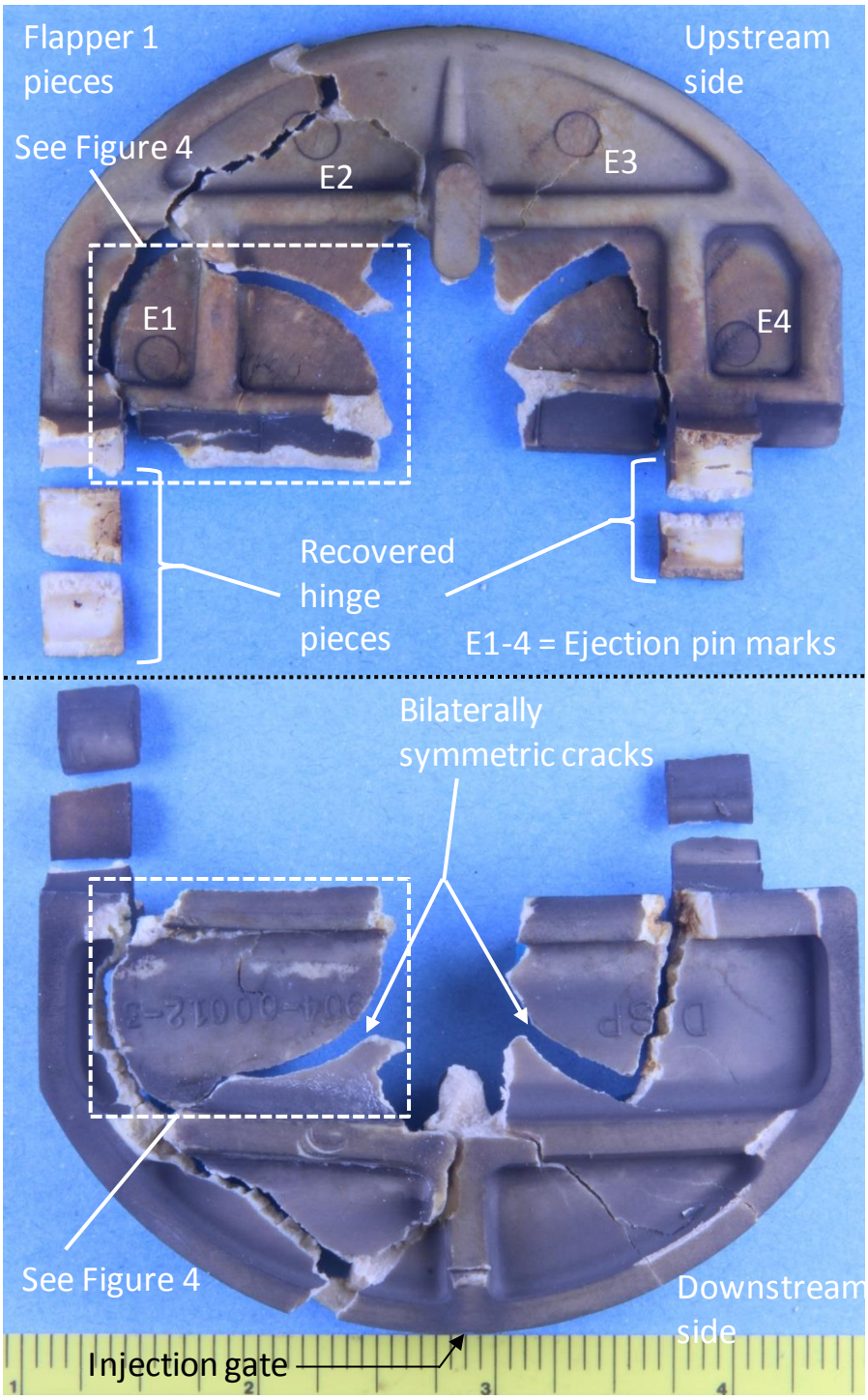


Figure 2 Pieces from flapper 1, arranged to reconstruct the original flapper shape. Some portions of the flapper were not recovered after the accident.

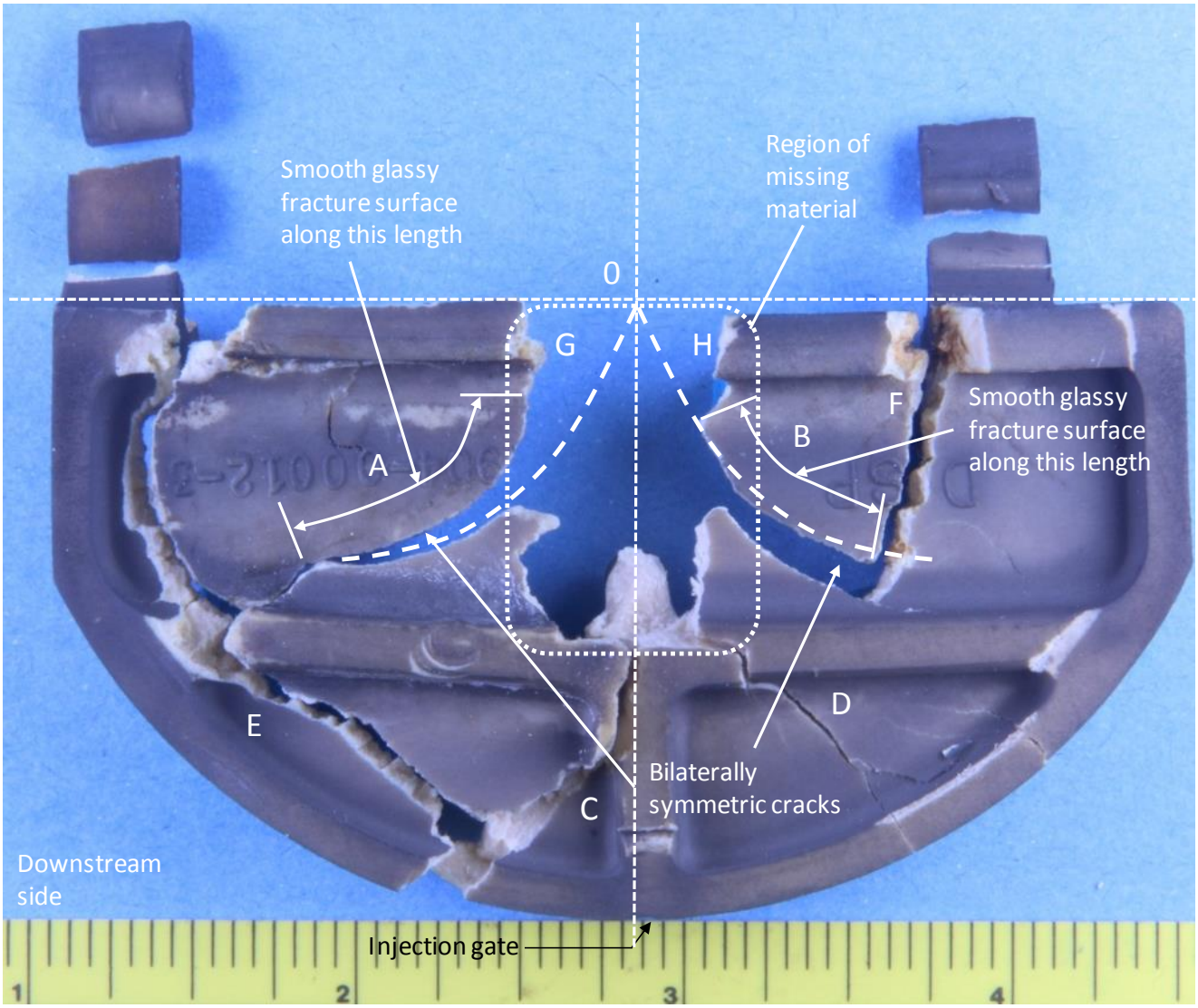


Figure 3 View of the downstream side of flapper 1 with annotations to identify the individual cracks and well as the areas of missing material.

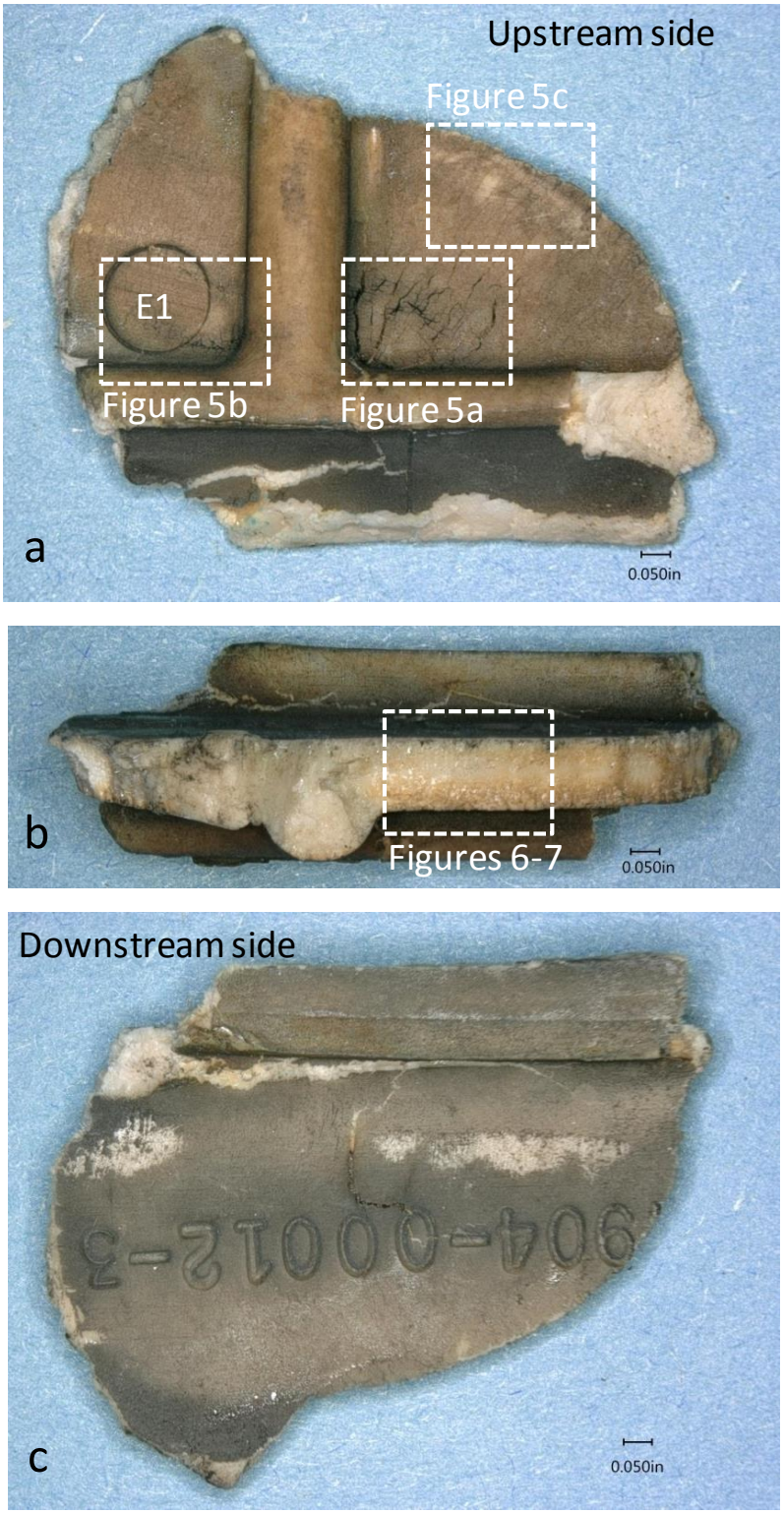


Figure 4 Closer views of an individual piece of flapper 1. See Figure 2 for the location of this piece.

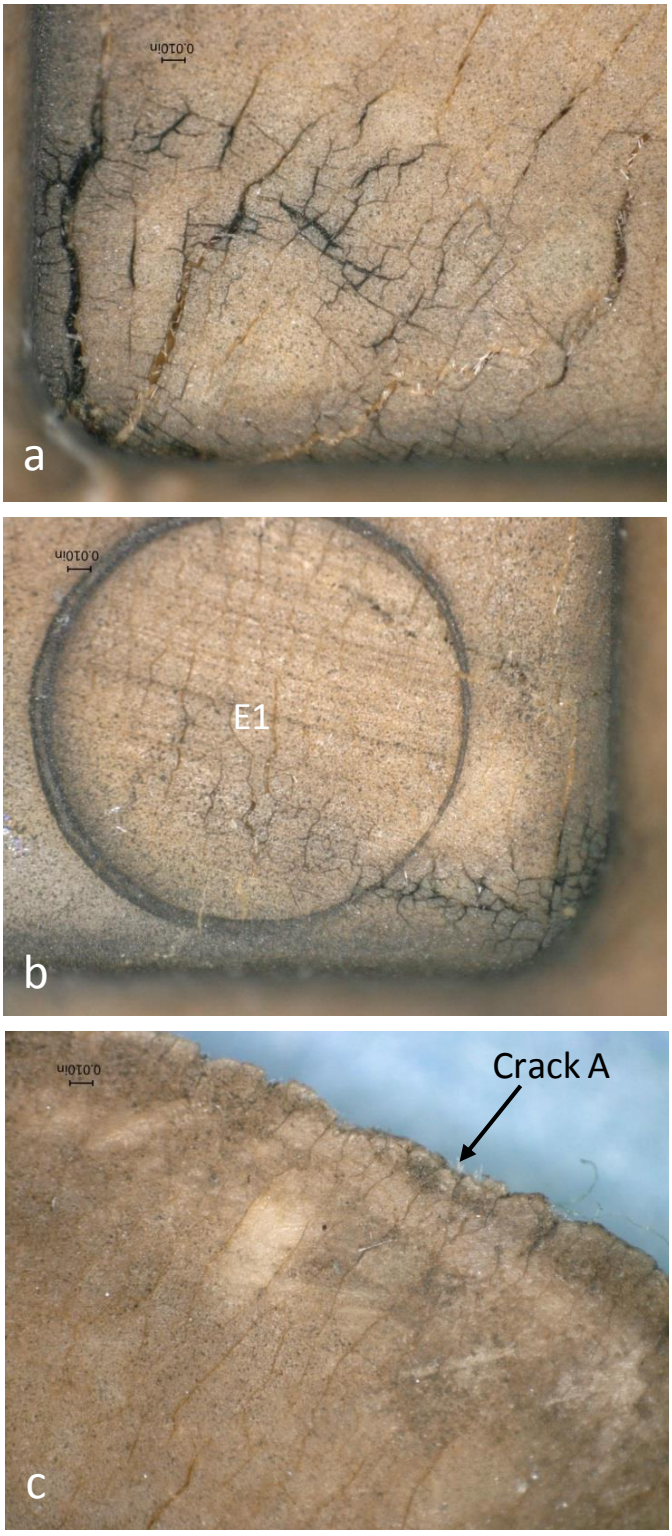


Figure 5 Digital microscope images of the downstream side surface of the piece shown in Figure 4. In all images, fine network cracks are observed.

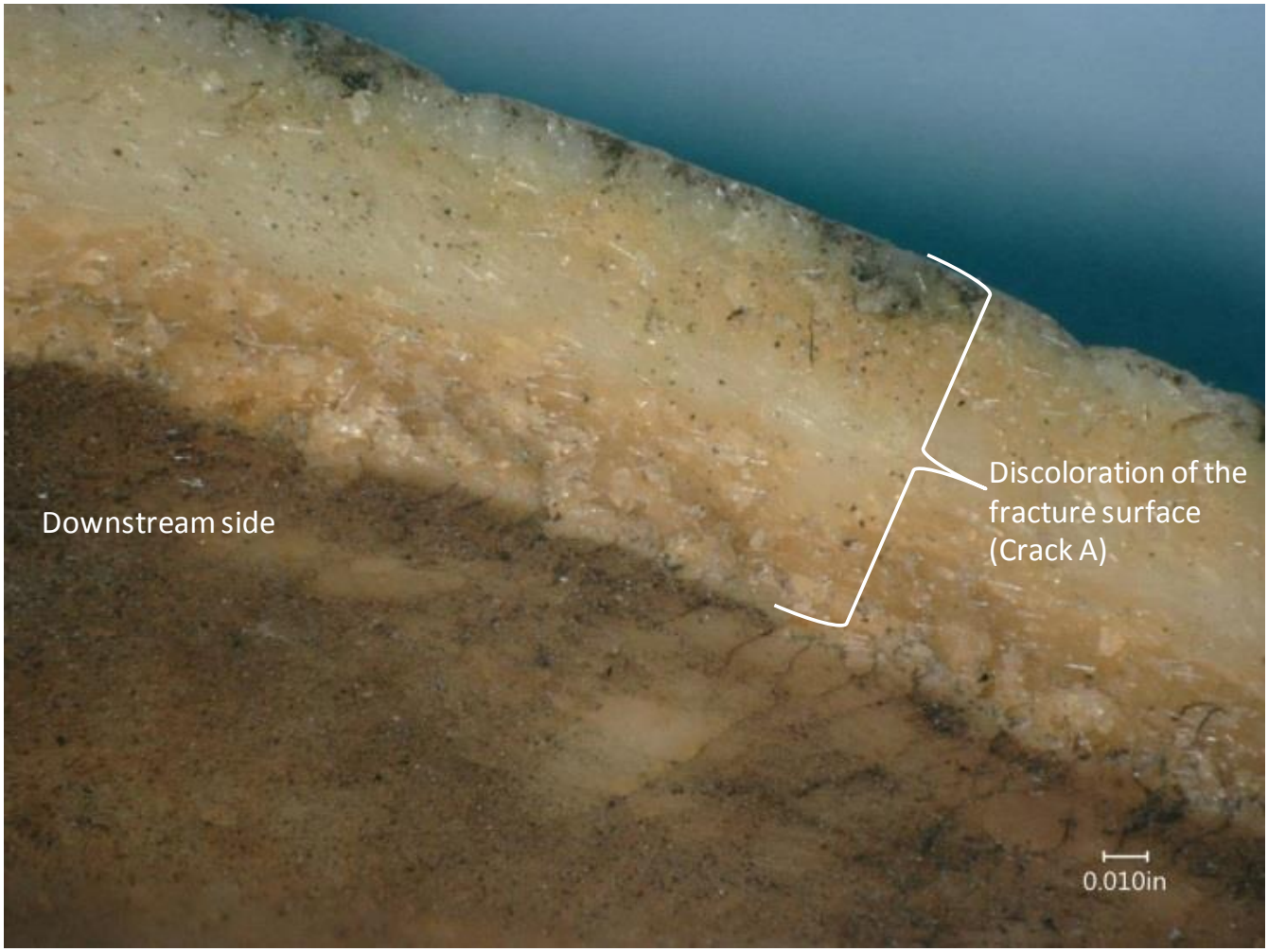
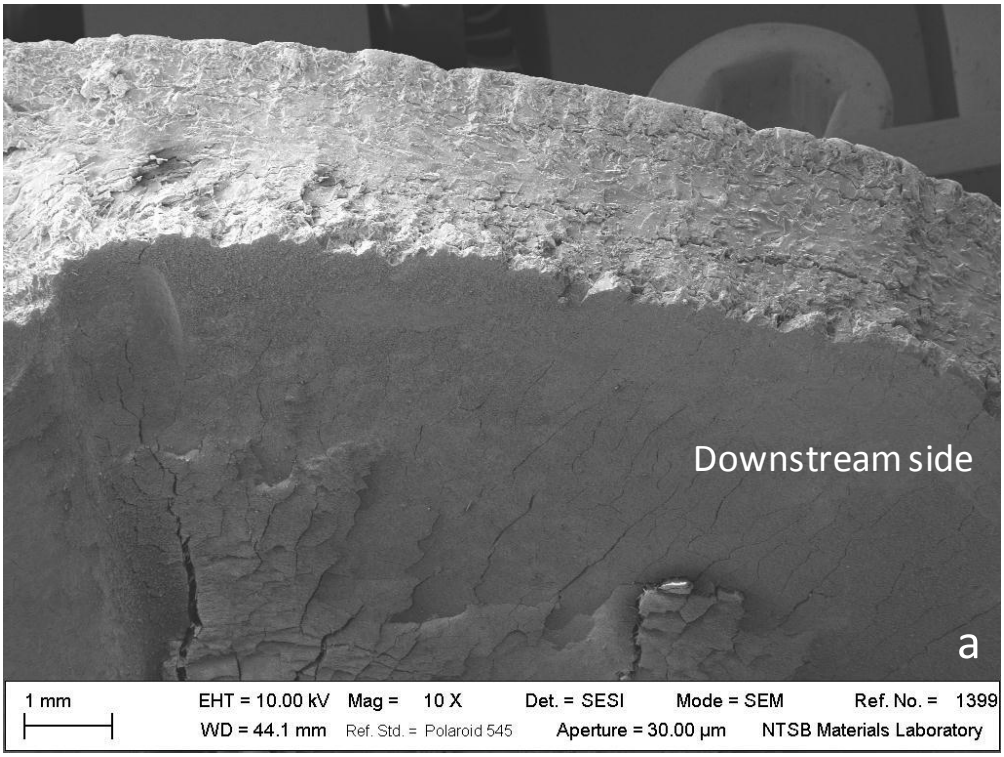


Figure 6 Digital microscope image of the fracture surface identified as Crack A in Figure 3. Fine network cracks are noted adjacent to the main crack on the downs stream side. Also yellow discoloration on the fracture surface is indicative of a preexisting crack.



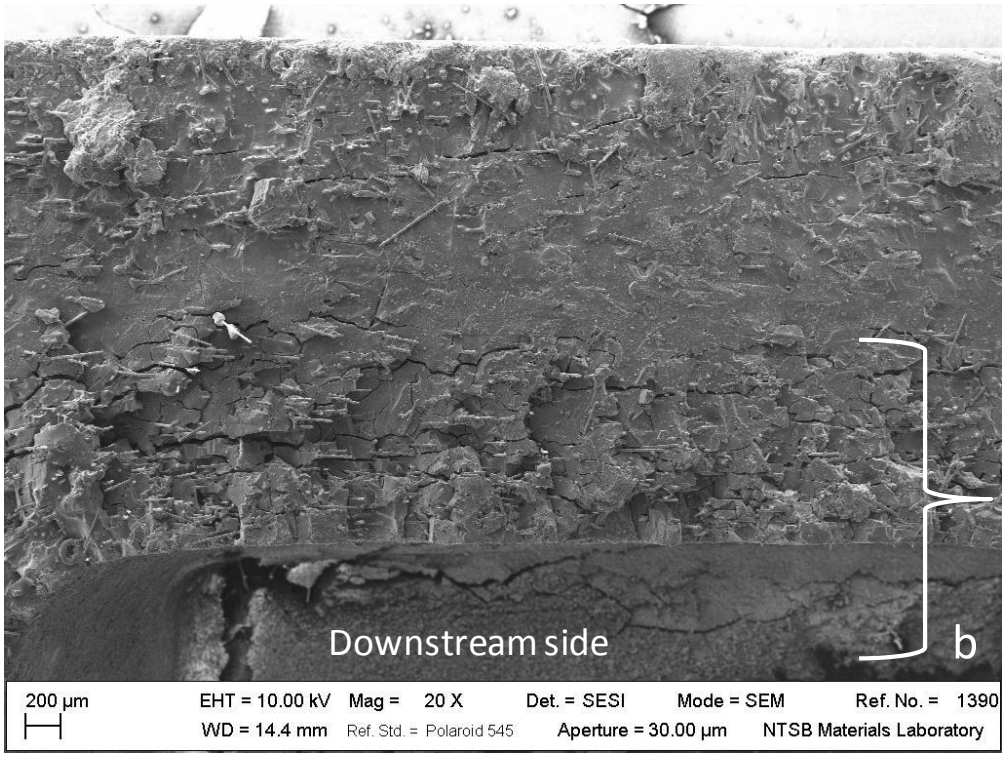


Figure 7 Scanning electron micrographs of the fracture surface identified as Crack A in Figure 3. Fine network cracks are identified in view b.

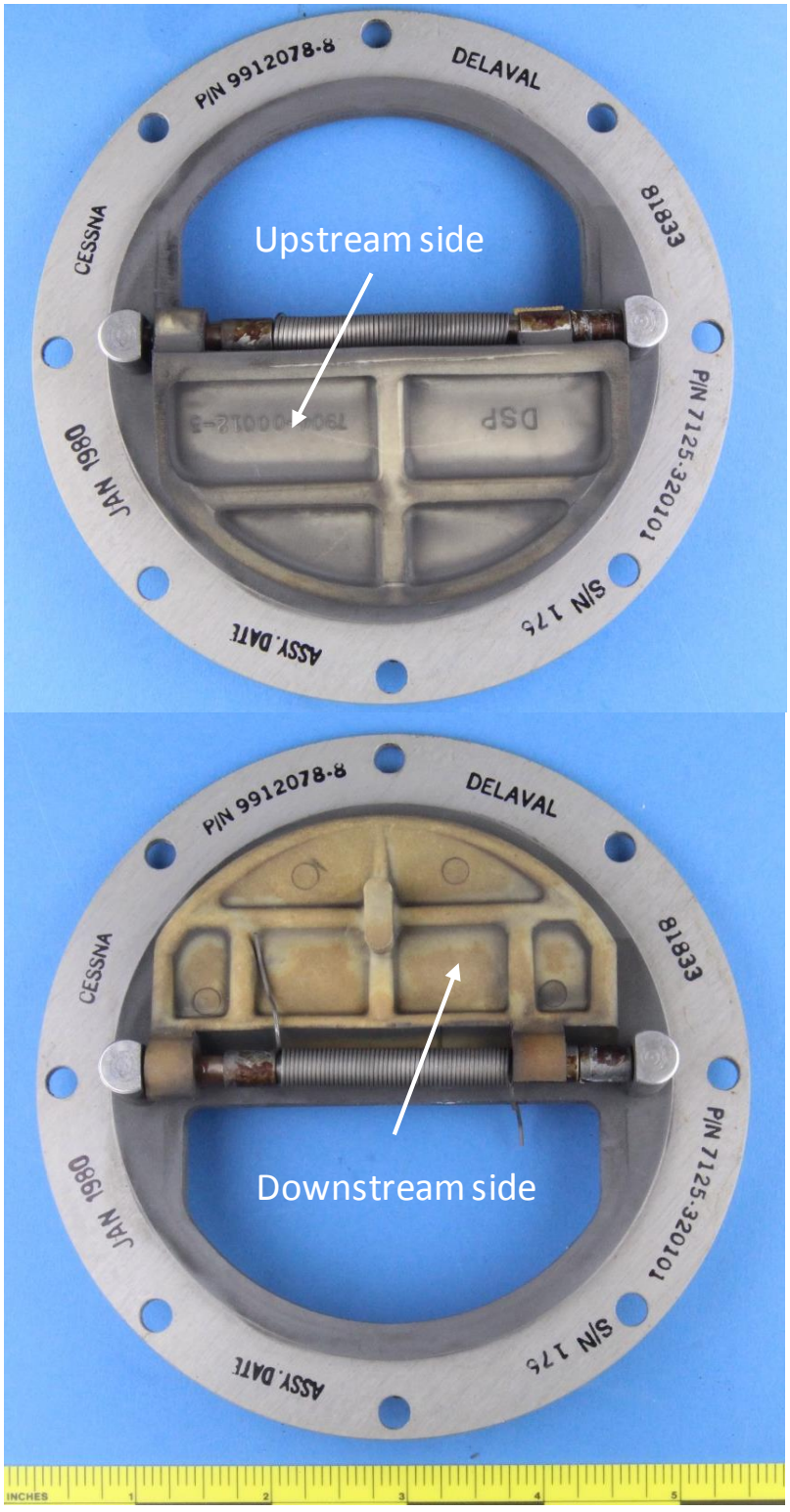


Figure 8 Images of the pressurization check valve body and flapper 2.

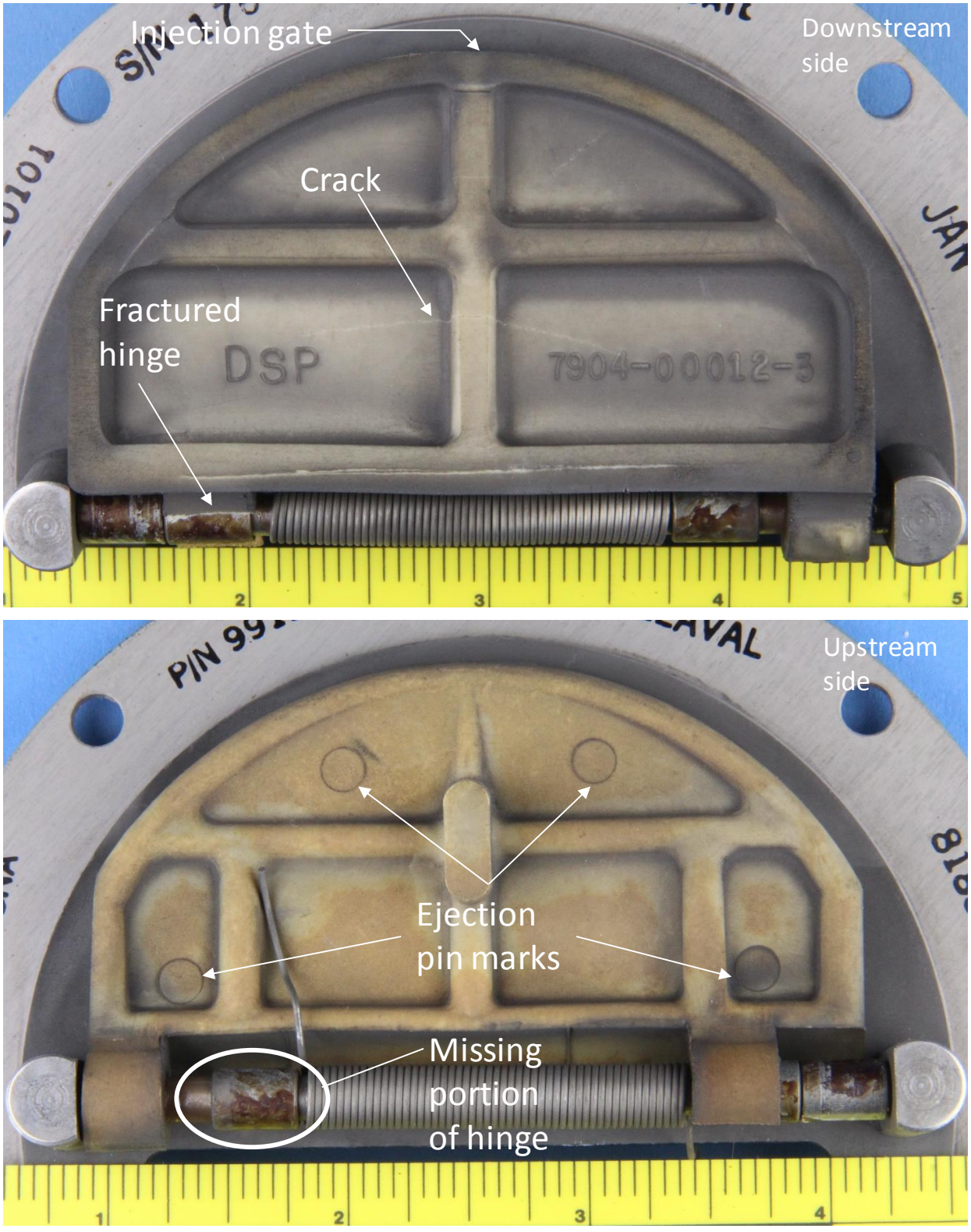


Figure 9 Views of the upstream and downstream faces of flapper 2.

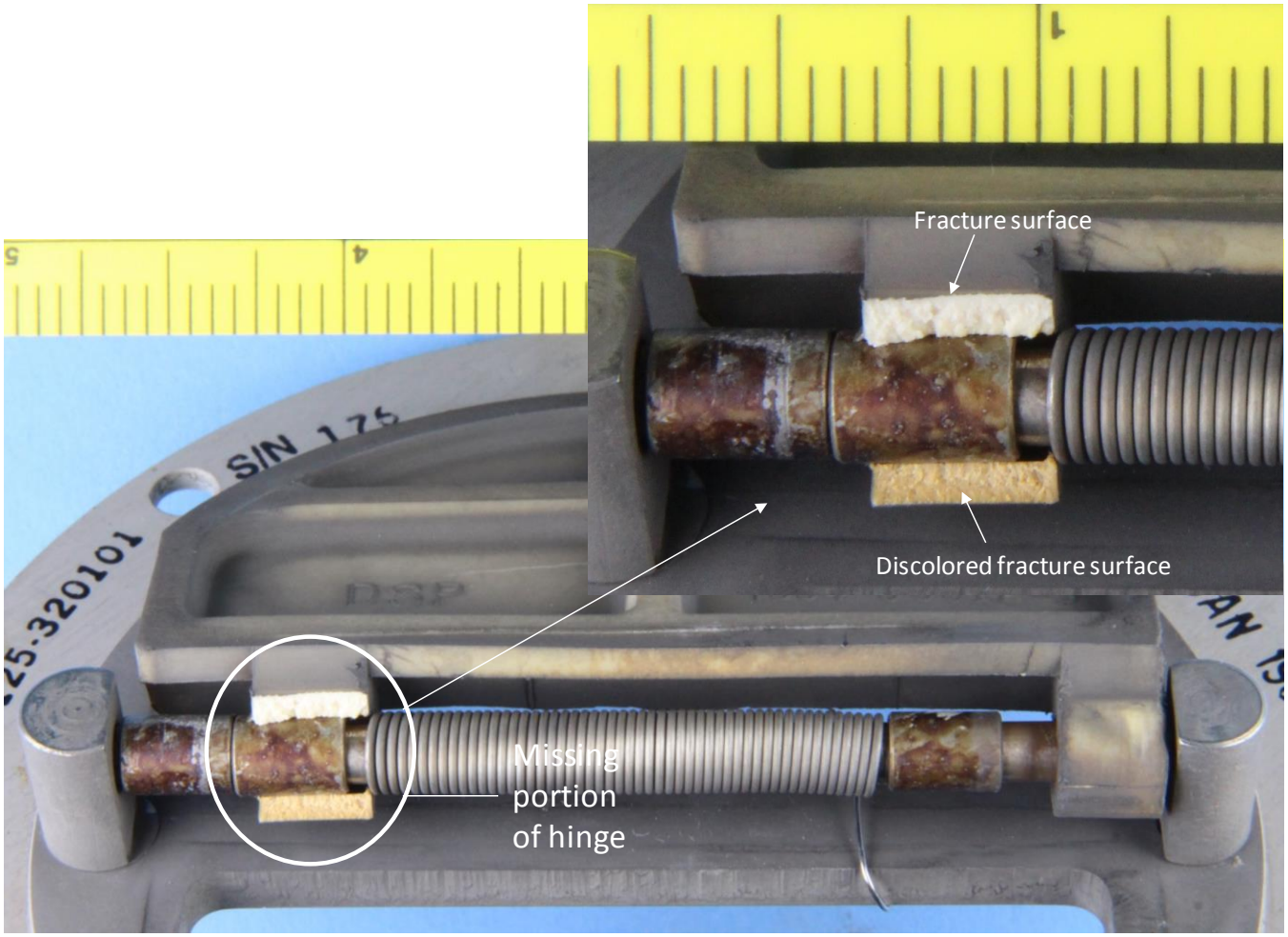


Figure 10 Closer views of the fractured hinge on flapper 2.

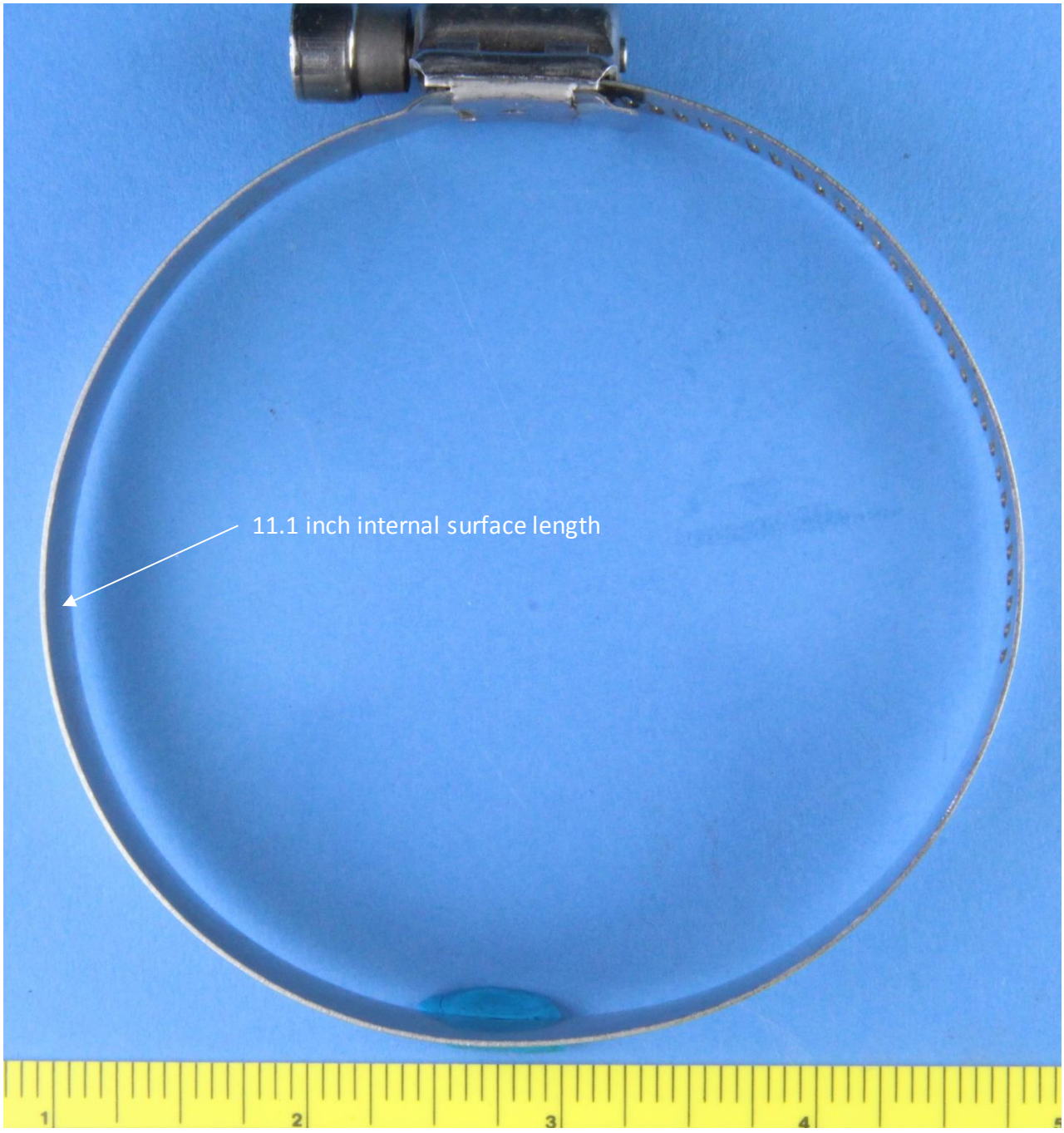


Figure 11 Overall view of the submitted hose clamp.

Figure 12 Views of the manufacturer's marks on the hose clamp.