

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



ERA25MA106 (KEYS# 199630)

COMPUTED TOMOGRAPHY

Specialist's Factual Report

June 9, 2026

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A ACCIDENT INFORMATION

Location: Philadelphia, Pennsylvania
Date: January 31, 2025
Time: 1807 eastern standard time (EST)
Airplane: XA-UCI; Learjet 55

B COMPUTED TOMOGRAPHY SPECIALIST

Specialist Caleb Wagner
National Transportation Safety Board (NTSB)
Washington, DC

C ACCIDENT SUMMARY

On January 31, 2025, at 1807 eastern standard time, a Learjet 55, XA-UCI, was destroyed when it was involved in an accident near Philadelphia, Pennsylvania. The two pilots, two medical crew members, and two passengers were fatally injured. One person on the ground was fatally injured, 4 people were seriously injured, and 20 people incurred minor injuries. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 129 air ambulance flight.

D DETAILS OF THE EXAMINATION

1.0 Methods

The flap actuators and trim motor from the accident aircraft were scanned using computed tomography (CT) to document the position and condition of the internal components. Additionally, x-ray radiographs and CT scans were performed on the oxygen valve and life raft inflation valve to document the status of the valves (open or closed) and the status of their pressure relief mechanisms¹. The scanning was conducted in Chicago, Illinois by Varex Imaging, Inc under the direction of the NTSB.

For the CT scans, the components were loaded into the imaging unit and placed on a turntable. The component was then rotated in front of the x-ray source, and the x-rays were captured by a detector after they went through the part. The x-ray source produced a cone shaped beam of x-rays, and the portion of the part imaged was adjusted slightly after each scan was completed until the entire assembly (or region of interest of the part) was scanned. The x-ray energy levels measured by the detector

¹ Initially, only two-dimensional radiographs of the valves were captured; however, it was not possible to make a determination based on the radiographs alone. CT scanning was subsequently performed.

were recorded at several thousand different points during each rotation, and this information was converted into slice images using reconstruction algorithms.

The scan protocols are shown in Table 1. The digital two-dimensional radiographs and CT axial slice images were provided by Varex Imaging to the NTSB where they were examined, processed, and analyzed to evaluate the component.

Table 1. Scan protocols.

Component	Combined Scan of LH & RH Actuators Retracted	RH Actuator Extended	Motor	Combined Scan of Valves
<i>CT System</i>	6 MeV scanning in bay 2 with 4343 HE detector	6 MeV scanning in bay 2 with 4343 HE detector	6 MeV scanning in bay 2 with 4343 HE detector	Bay 1 450 kV HPE tube with 4343N detector
<i>Component/Area</i>	Entire part	Entire part	Entire part	Entire part
<i>Number of Slices</i>	2650	1792	1325	2000
<i>Voxel² Size - X Direction (mm)</i>	0.2	0.2	0.2	0.1
<i>Voxel Size - Y Direction (mm)</i>	0.2	0.2	0.2	0.1
<i>Voxel Size - Z Direction (mm)</i>	0.2	0.2	0.2	0.1
<i>Image Projections per Revolution</i>	3960	3960	3600	2880
<i>Exposure Time (frames per second)</i>	1	1	1	1
<i>Frames to Avg (frames per projection)</i>	1	1	1	1
<i>X-ray Source Pulse Rate (hertz)</i>	400	400	400	450
<i>Source Filter Thickness (mm)</i>	8	8	8	9.4
<i>Source Filter Material</i>	copper	copper	copper	copper
<i>CT Matrix Size (voxels x, y, z)</i>	2250x2250x2650	451x426x1792	2250x2250x1325	2000x2000x2000
<i>Recon Software</i>	CST 2.4.1.6	CST 2.4.1.6	CST 2.4.1.6	CST 2.4.1.6

The data sets of slice images were examined, processed, and analyzed by the NTSB using the VGStudioMax software to convert the axial slice data into orthogonal

² A voxel is a three-dimensional picture element (pixel).

slice images and a three-dimensional reconstructed image of the component. As part of the evaluation, some sections of the components were digitally removed or rendered transparent to allow closer observation of interior parts. Generally, the higher density areas are shown as brighter shades of gray and lower density areas are shown as darker shades of gray. Each two-dimensional quadrant within the images shows a scale at the bottom of that quadrant - note that the scales in each quadrant may be different. The pointers shown in some of the images denote specific areas of interest within that image. The numbers associated with the pointer are the gray value at the pointer location and the three positional coordinates of the pointer.

2.0 Results

2.1 LH Flap Actuator

Both the lefthand (LH) and righthand (RH) flap actuators have the part number (PN) 660086-5; the LH flap actuator's serial number (SN) is unknown since the data plate is missing (Figure 1). The flap actuators are approximately 3 inches wide by 20 inches long when extended. The cylinder body is Al 7075 with nominal thickness of 0.27 to 0.82 inch based on exterior dimensions and specified bore diameter. The piston rod is 0.62 inches in diameter and chrome-plated steel.

According to the Airworthiness Group Chairman, the LH flap actuator was measured to be about 13-¼ inches long, which corresponds to about 2° of flap (retracted). The piston appeared to be jammed and could not be moved by hand.

The field investigator requested the actuators be inspected for potential internal issues and signs of internal damage that could provide insight into the flap position at the time of the crash. Another objective was to determine the location and condition of internal components, verify if all components are present, determine what is causing seizure of LH actuator, and evaluate if there is any evidence of damage to the cylinder body's inner walls.



Figure 1. LH flap actuator as received at the NTSB Materials Laboratory.

The CT results are shown in Figure 2 through Figure 6. The following observations were made.

All components were present and in their correct locations besides the extension and retraction elbow fittings, which were broken off and partially missing, and the rod end, which was broken off.

Debris was identified throughout the LH flap actuator. During the scan, the debris was found on both sides of the LH piston (Figure 3 and Figure 4). The voxel values of the debris ranged from about 5,500 to about 7,500.

Debris was also found near or within both the extension and retraction fittings (Figure 5) with voxel values ranging from about 6,500 to about 9,000. All of the debris was less dense than the cylinder body or piston rod indicating that it is unlikely to be aluminum or steel. For reference the cylinder body had a voxel value of about 9,700 to about 10,300 (Figure 6).

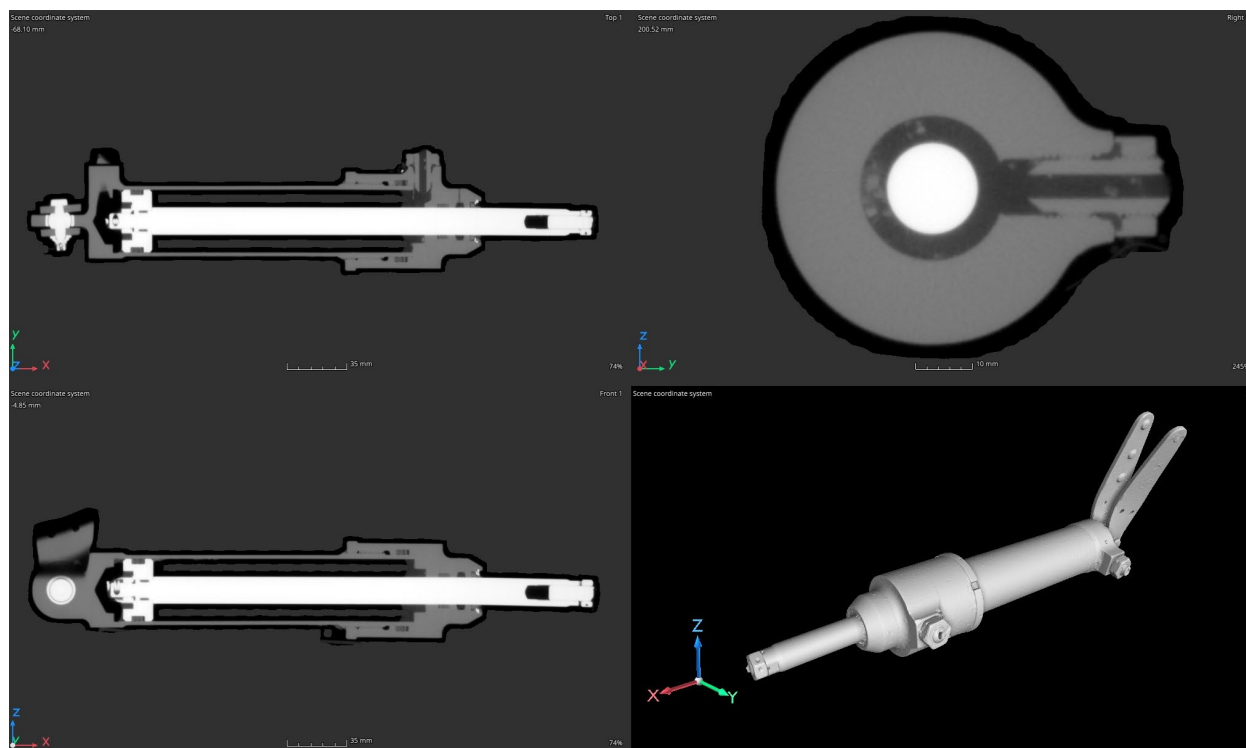


Figure 2. Views of the whole LH flap actuator.

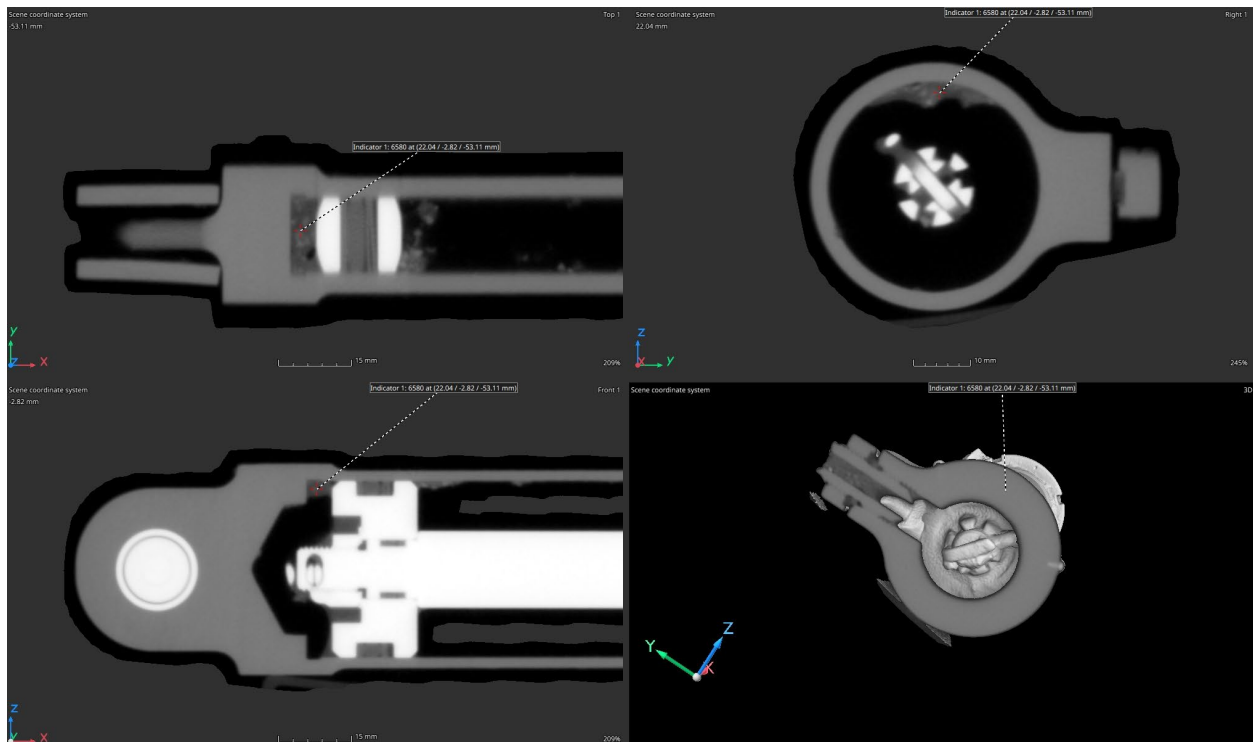


Figure 3. Debris on the inner walls of the cylinder body and the extension side of the piston head. The voxel value at the indicator is 6,580.

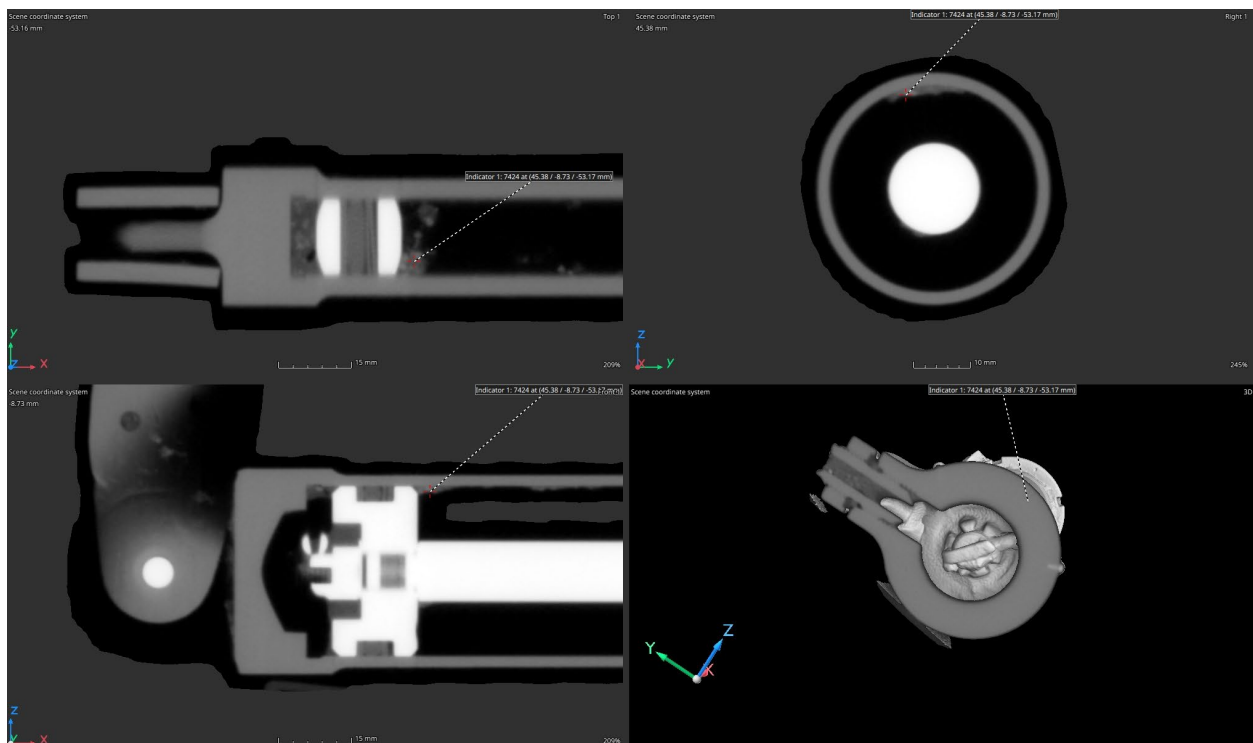


Figure 4. Debris on the inner walls of the cylinder body near the retraction side of the piston head. The voxel value at the indicator is 7,424.

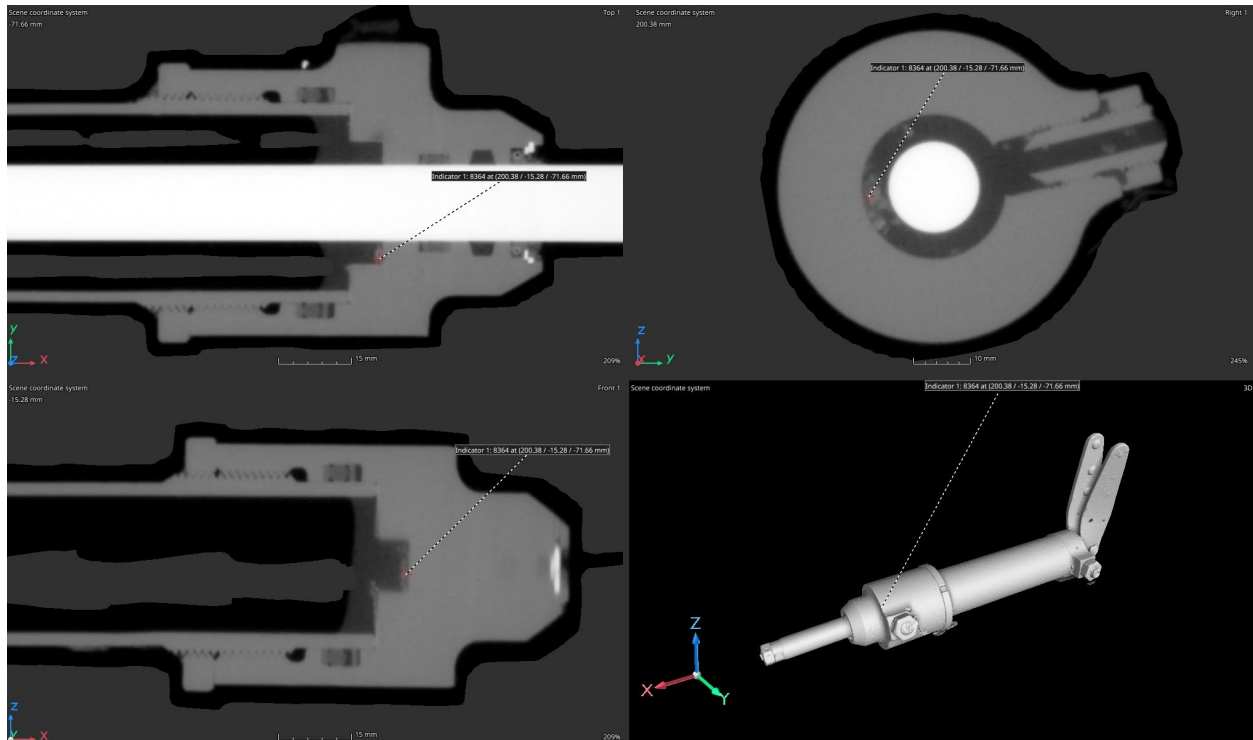


Figure 5. Debris between the inner walls of the cylinder body and the piston rod on the extension end of the actuator. The voxel value at the indicator is 8,364.

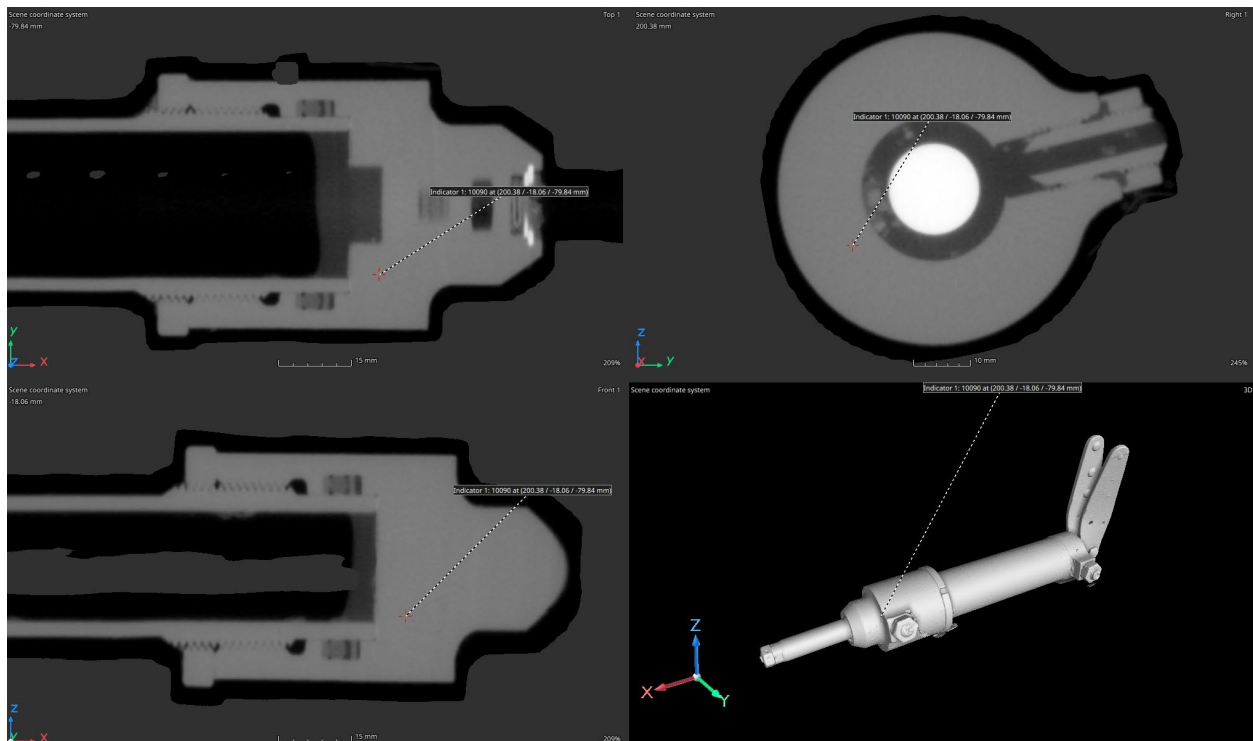


Figure 6. The density of cylinder body was taken for reference. The voxel value at the indicator is 10,090.

2.2 RH Flap Actuator

The righthand (RH) flap actuator has SN 0915 (Figure 7). According to the Airworthiness Group Chairman, it was removed from the wing, but during the removal the actuator piston was pulled and extended about 1 to 1-½ inches. The RH flap actuator measurement afterward this movement was 19 inches equating to full extension. Prior to the movement, it would have been about 17-½ to 18 inches. 17-½ inches corresponds to 30° of flap, which is not a standard position; however, when hydraulic pressure is not maintained, the piston rod is free to move.



Figure 7. RH flap actuator as received at the NTSB Materials Laboratory.

CT scans of the RH flap actuator were captured with the piston rod at minimum and maximum extension. The CT results are shown in Figure 8 through Figure 10. The following observations were made.

All components were present and in their correct locations. No debris was identified within the actuator. The internal components appear to move as expected. No anomalies were identified.

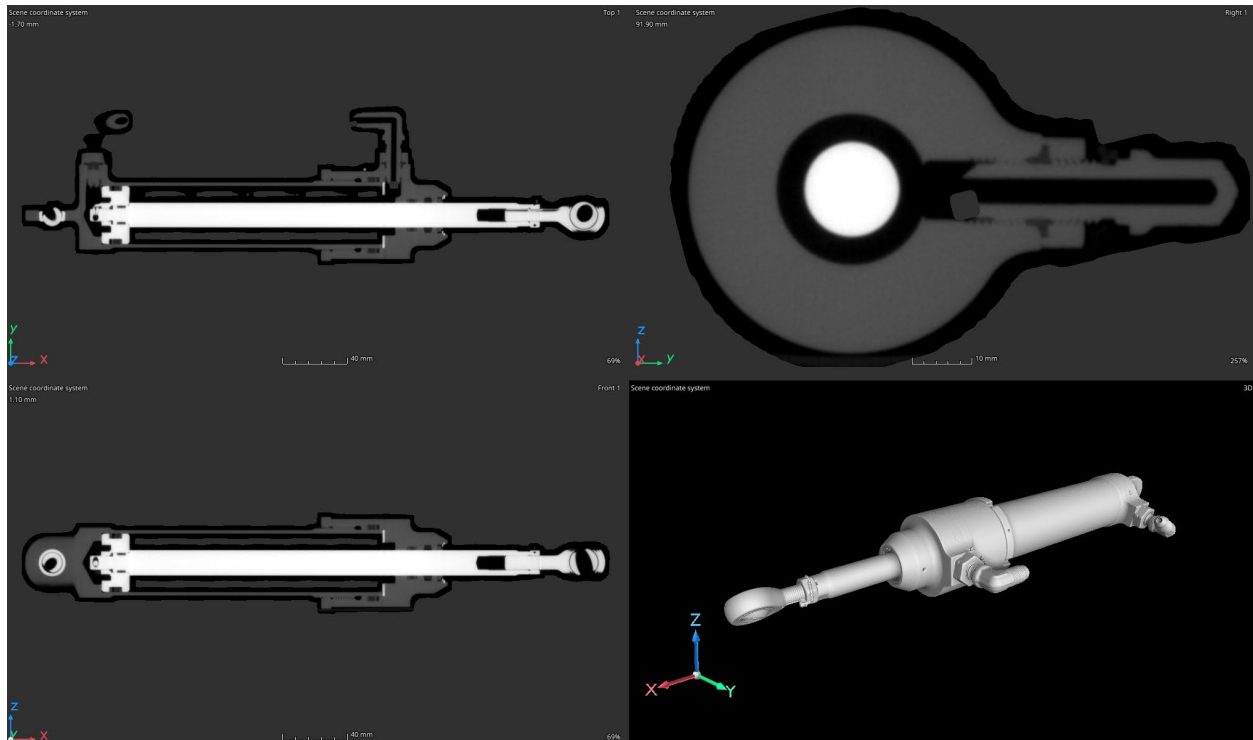


Figure 8. RH flap actuator in the retracted position.

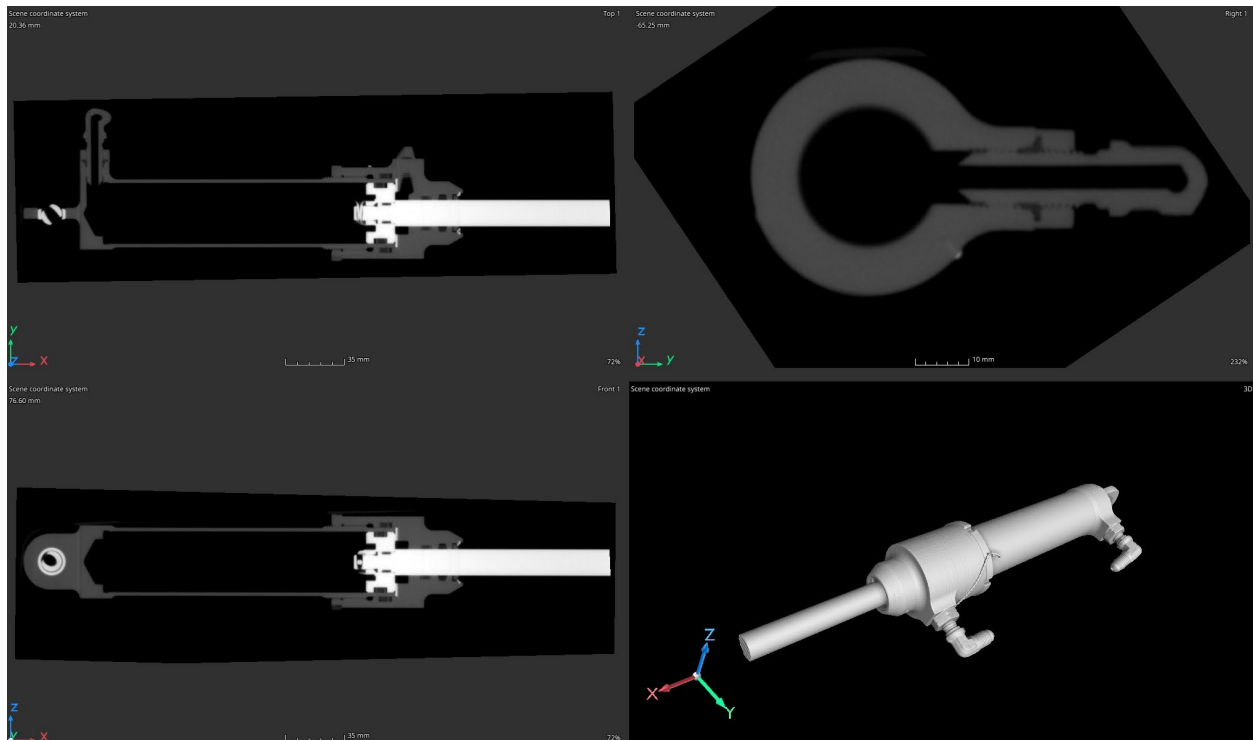


Figure 9. RH flap actuator in the extended position.

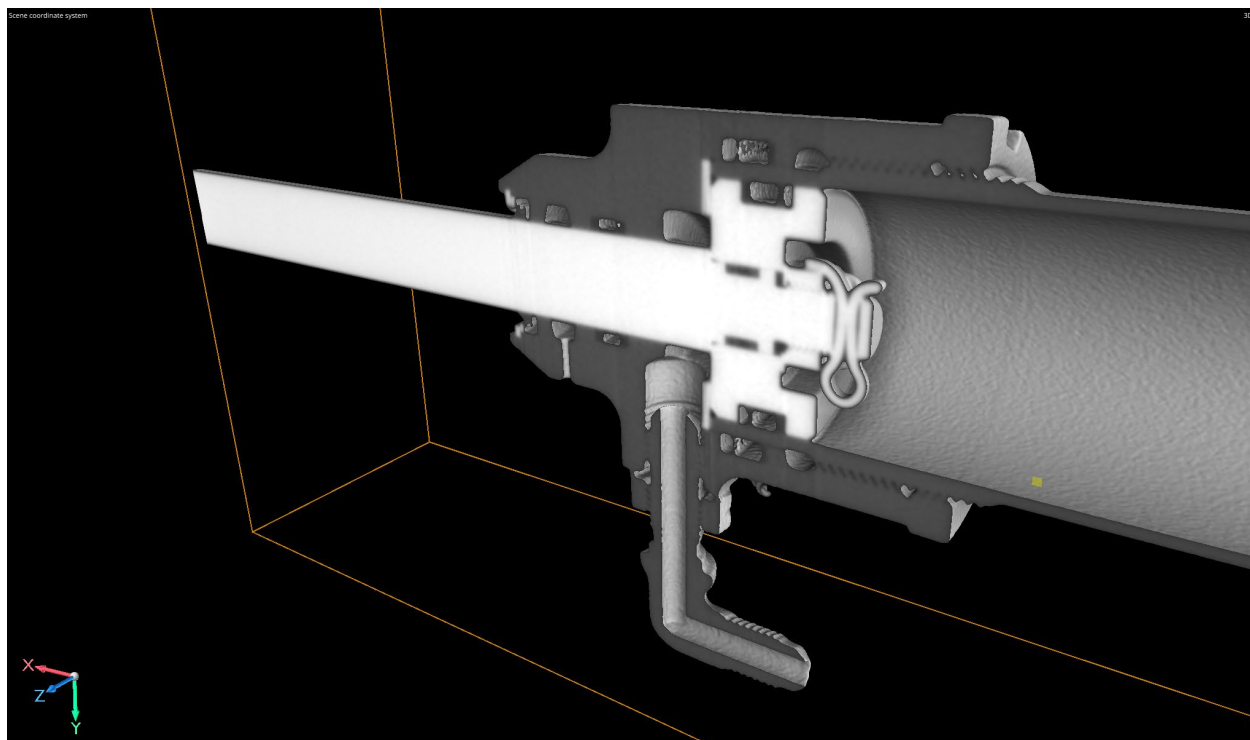


Figure 10. Sectioned and shaded isosurface view of the RH flap actuator in the extended position near the piston and retraction port.

2.3 Trim Motor

It was requested that the specialist evaluate a pitch trim motor for evidence of preimpact abnormalities (Figure 11).



Figure 11. Pitch trim motor as received at the NTSB Materials Laboratory.

The CT results are shown in Figure 12 through Figure 13. The following observations were made.

The drive shaft was permanently deformed. The end cap was dislodged and rotated. The outer bearing race remained with the end cap, but the ball bearings and inner race remained on the drive shaft. The housing beyond the commutator and rotor bearings was deformed radially inwards. The commutator and brushes appeared in good condition. No other anomalies were identified.

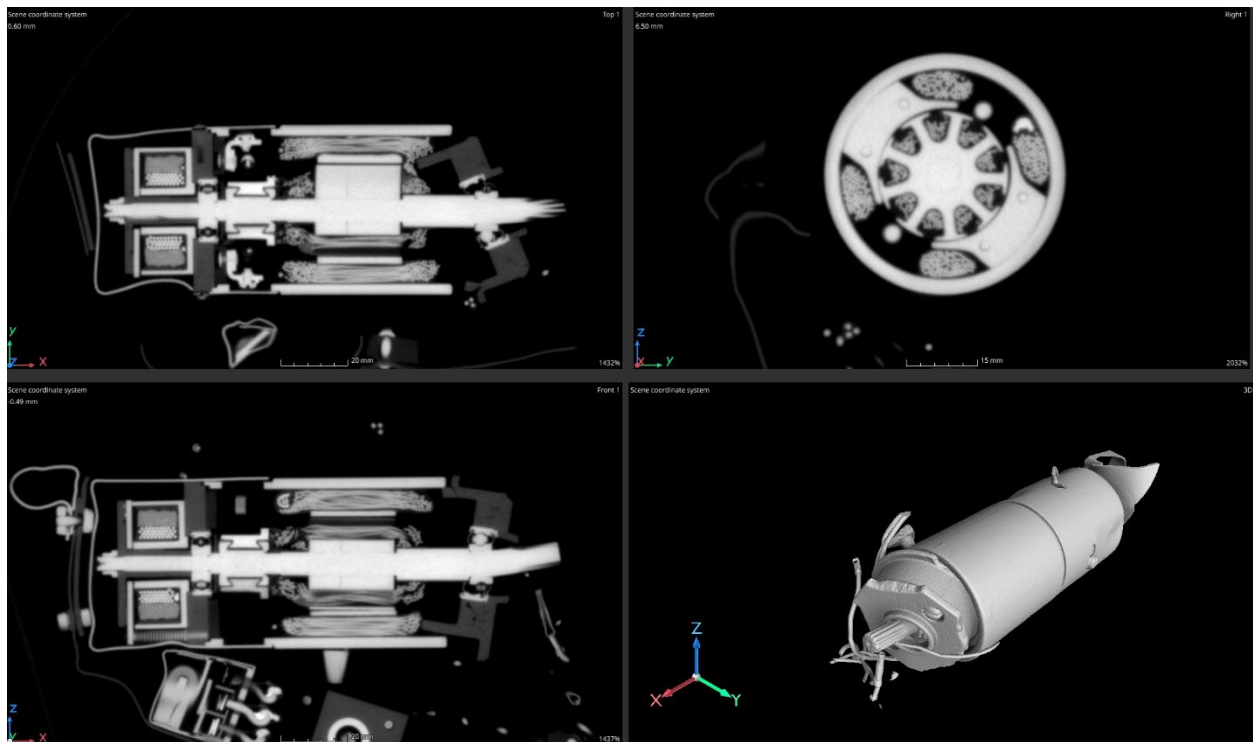


Figure 12. Views showing rotor and stator windings.

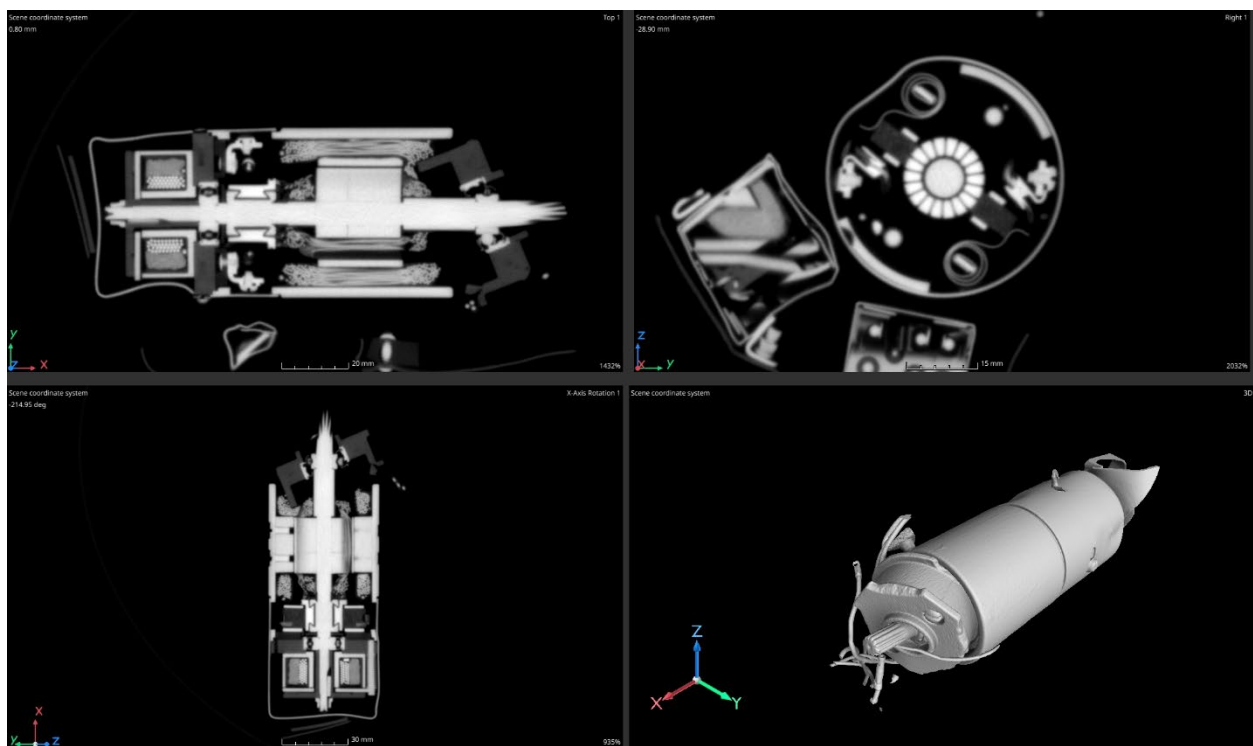


Figure 13. Views showing the commutator and brushes.

2.4 Medical Oxygen Pin Index Valve

One valve was submitted from an oxygen cylinder (Figure 14). The field investigator requested an assessment of whether the valve was opened and if the rupture disk pressure relief mechanism activated.



Figure 14. Oxygen medical pin index valve as received at the NTSB Materials Laboratory.

Medical oxygen pin index valves are specialized high-pressure valves designed for medical gas cylinders. The valve utilizes a Compressed Gas Association (CGA) 870 yoke-style connection following the pin index safety system (PISS) for safe, error-proof attachment to regulators.

The stamping on housing exterior says, "HARRISON 2104015 21/04 V9 ISO V U12" and "OXYGEN CGA870". According to the manufacturer, this indicates the following:

- DoM - April 2021
- Manufacturer identification or serial number - 2104015
- U12 inlet tank connection - O₂ cylinder threads onto bottom ¾-inch connection
- Complies with CGA V9 and ISO V standards
- Outlet connection CGA 870

The main components of the valve are labeled in Figure 15. The inlet connects to an oxygen cylinder. On the side of the valve is an outlet with two indexing holes for the PISS nearby. To open the valve manually, the stem rotates but does not move up or down. The bottom of the stem is a square-shaped key that engages with the plug. As the plug is rotated, it follows the threads in the housing to move up or down to control the flow of oxygen from the cylinder.

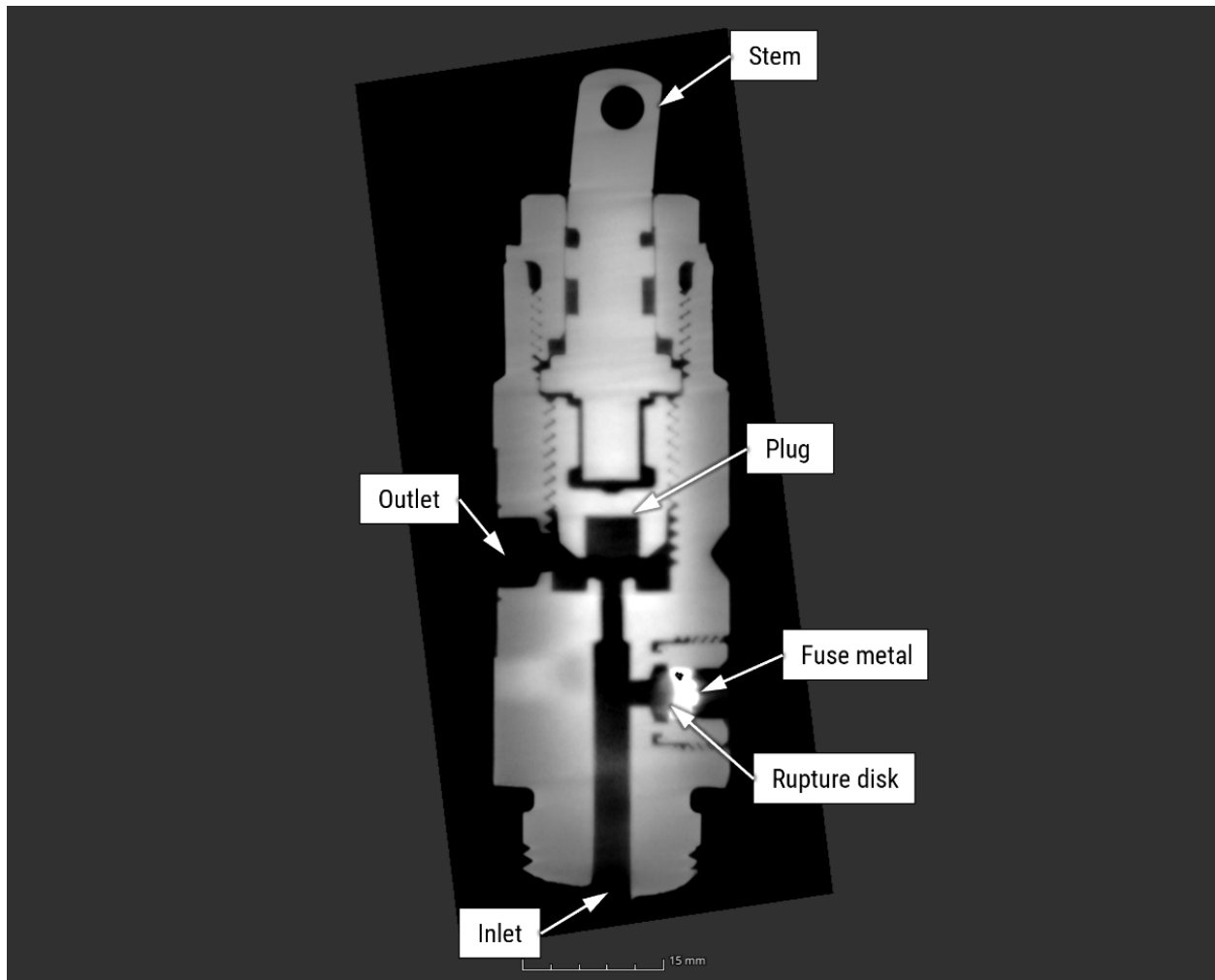


Figure 15. Oxygen valve parts labeled in CT slice.

The inlet threads were broken. The stem exhibited permanent deformation.

The position of the internal components show the plug is up; therefore, the valve is in an opened position with a clear gas path from inlet to outlet (Figure 16).

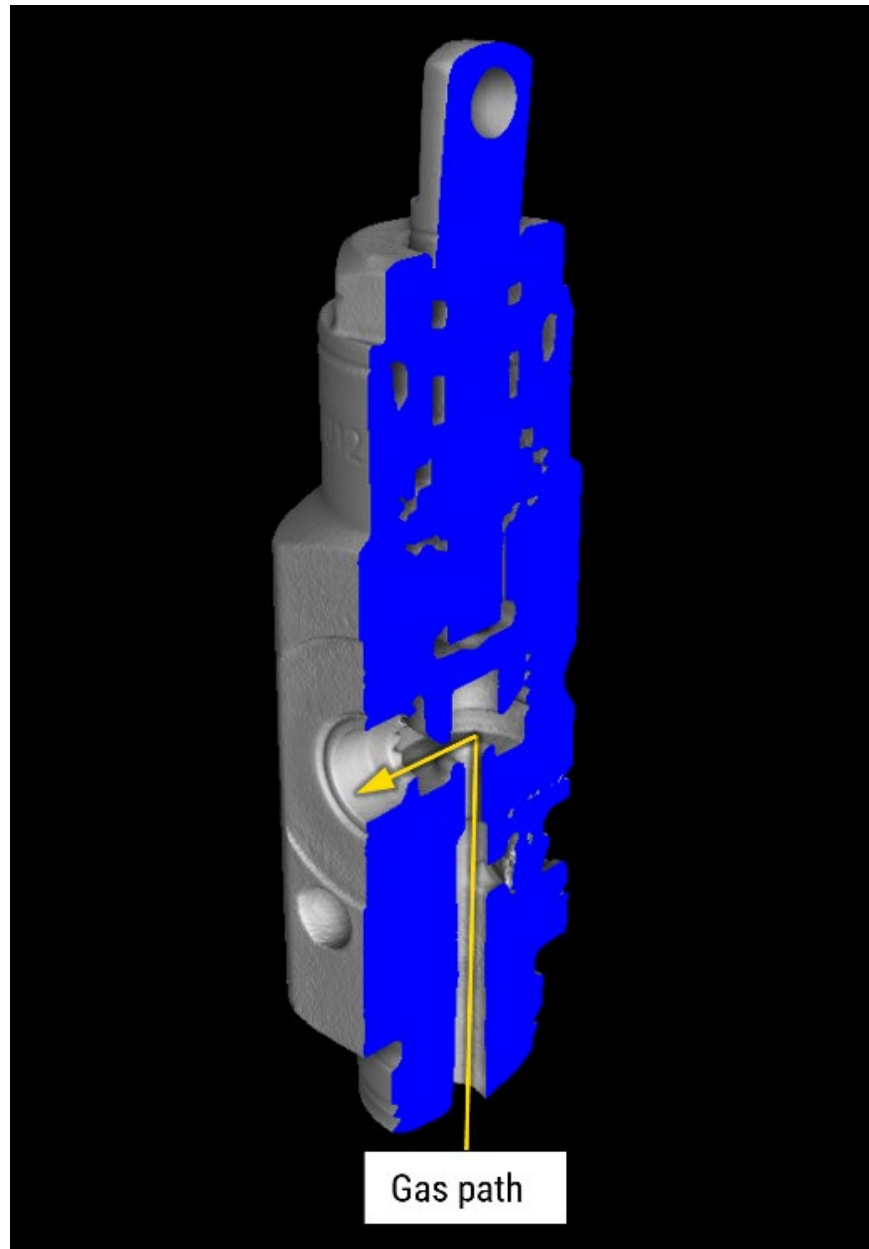


Figure 16. Gas path (yellow arrow) shown from cross-section of isosurface.

The unit also includes a CG-4 safety device (as defined by CGA S1.1) which automatically vents the cylinder when it is exposed to a fire. This prevents rupture of the cylinder. For pressure relief to occur, both an over temperature (165°F) and an over pressure (3,360 psi, nominal) condition must exist. The over pressurization function is achieved via a rupture disk on the opposite side of the valve from the outlet, whereas the over temperature function is achieved by a fusible alloy backing. When the valve is exposed to heat, the fusible alloy melts to allow a gas path to the ambient environment. Then, the internal pressure bursts the rupture disk and discharges the fusible alloy out the vent hole to release pressure from the cylinder.

The fusible alloy was not symmetrical and showed a bulge on the exterior with a small crater extending inwards. There was also void within the solder, but this did not appear to create a path from the interior to the exterior. Nevertheless, it does not appear that the conditions existed to activate the safety device, since the fusible alloy was still in place. See Figure 17.

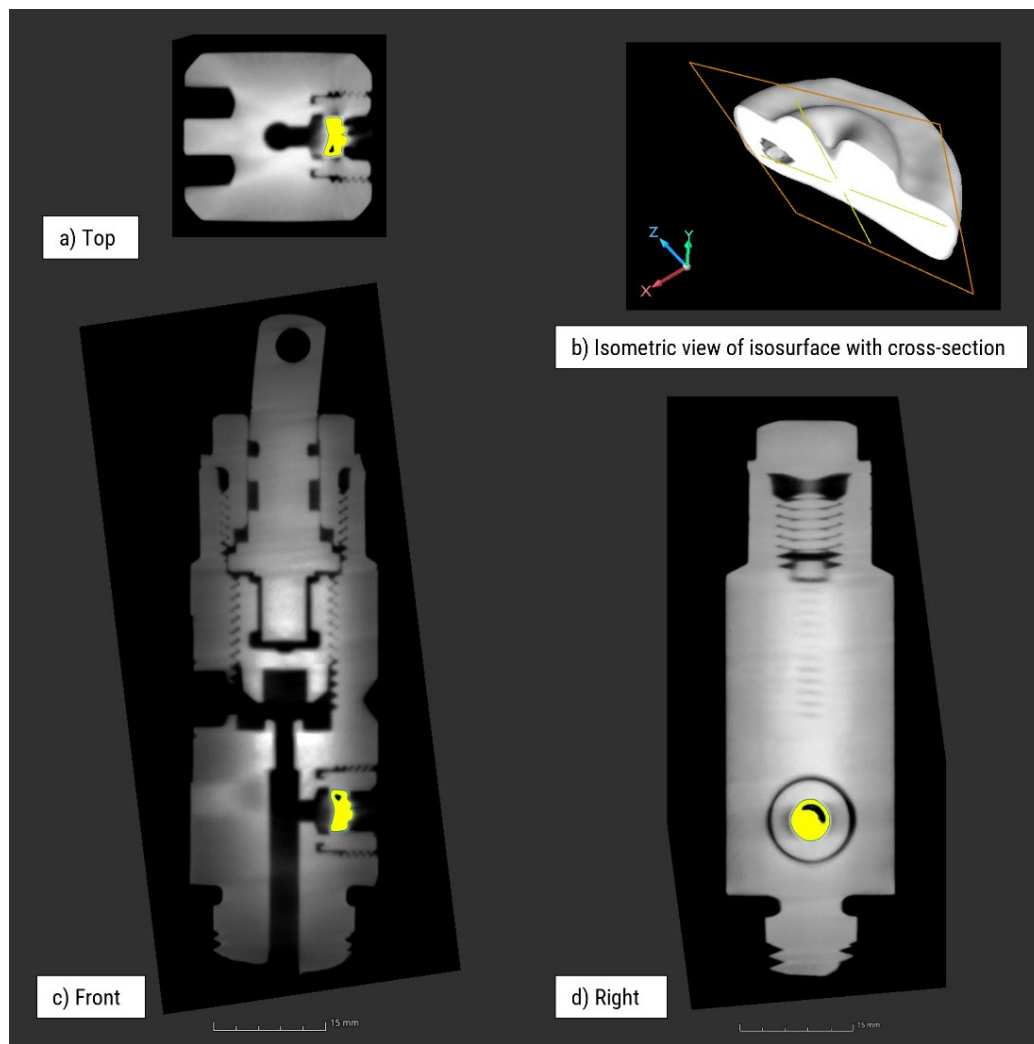


Figure 17. Three-view slices of the oxygen valve with the fusible alloy highlighted in yellow. An isometric view of the isolated fusible alloy is also shown in subfigure b).

2.5 Life Raft Inflation Valve

An inflation valve for an emergency raft was also submitted to the CT specialist (Figure 18). The field investigator wanted to determine the status of the pressure relief mechanism to determine if the valve or mechanism activated.



Figure 18. Emergency life raft inflation valve as received at the NTSB Materials Laboratory.

The TSO-C70a Type 1, 10-person life raft (PN RAF1210-101) is made by AVI Survival Products. The life raft is equipped with a manually activated, lanyard triggered, self-inflating system. The inflation system is composed of an aluminum gas cylinder charged with carbon dioxide. An inflation valve (PN VAL0107-101), which controls the actuation of the raft inflation through two flexible hoses, connected to two molded inlet check valves.

The components of the inflation cylinder and valve assembly are shown in Figure 19. The components of the inflation valve are shown in Figure 20. To inflate the raft, a hard pull must be applied to an inflation/retaining line. This extracts the pull cable grommet (Figure 20, items 40 and 100) which breaks the breakaway pin (item 180) and allows the trigger piston (item 270) and the trigger ball (item 250) to move outwards. This allows the bayonet spring (item 230) to extend and drive the puncture disk bayonet (item 20) into a metal seal on the end of the siphon tube (Figure 19, item 20). Then the compressed carbon dioxide can flow from the cylinder to the outlet

fittings (Figure 20, item 90), through the flexible hoses and inlet check valves, and into the life raft's buoyancy tubes.

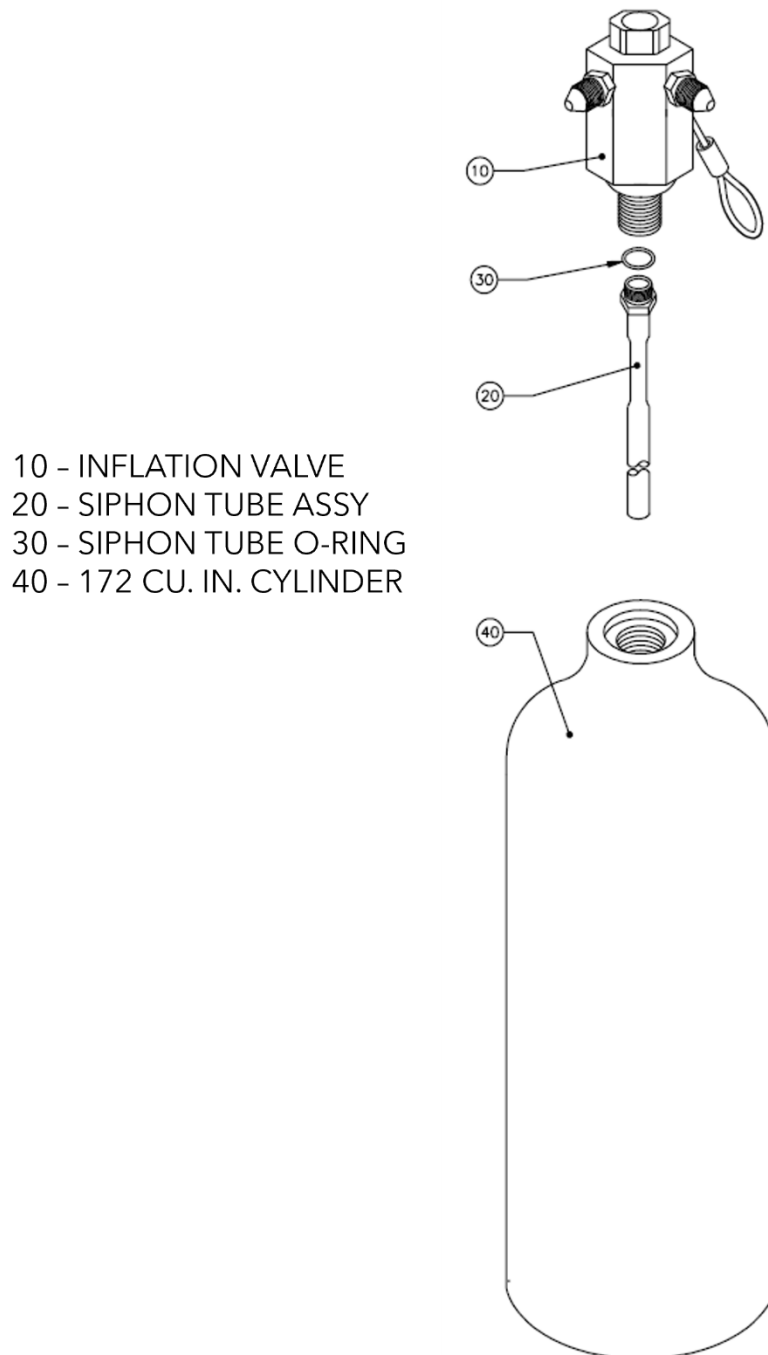


Figure 19. Inflation cylinder and valve assembly illustrated parts breakdown with critical components labeled (Source: AVI Survival Products, modified for clarity).

-
- RAYONET
- CARTRIDGE
- SK
- MMET
- ON
- AINER
- G
- 10, 20, 30, 40, 50, 60, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270
- DETAIL A
- SEE DETAIL A

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Figure 21 shows a CT slice through the trigger mechanism of the inflation valve from the accident. The pull cable was missing. The breakaway pin (item 180) was not visible in the CT scan. Also, the trigger piston and ball have been shuttled outwards.

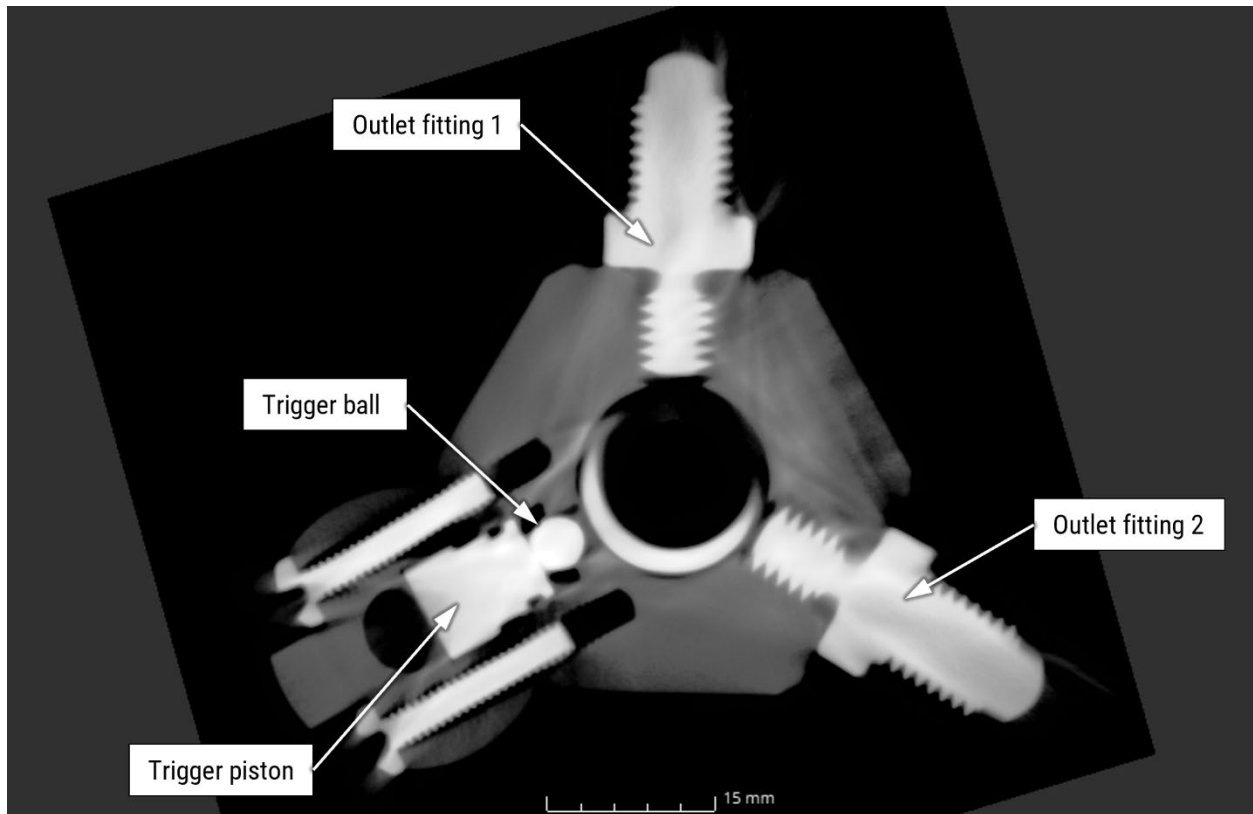


Figure 21. Components of the inflation valve assembly; top view.

Figure 22 shows a CT slice of the inflation valve from the accident. Given that the bayonet spring (Figure 20, item 230) is in its most uncompressed state without disassembling and that the puncture disk bayonet (item 20) has stroked towards the inflation port, the inflation valve appears to have been activated. Furthermore, a metal seal appears to be broken and curled underneath the puncture disk bayonet.

The following additional observations were made. The inlet area appears to have sustained damage including a broken siphon tube (Figure 19, item 20) and broken threads where the valve body (Figure 20, item 10) mates with the carbon dioxide cylinder. The green safety disk (item 80) appears to be intact (see Figure 23). No other anomalies were identified.

It could not be determined whether the inflation valve activated before or after the airplane impacted the ground.

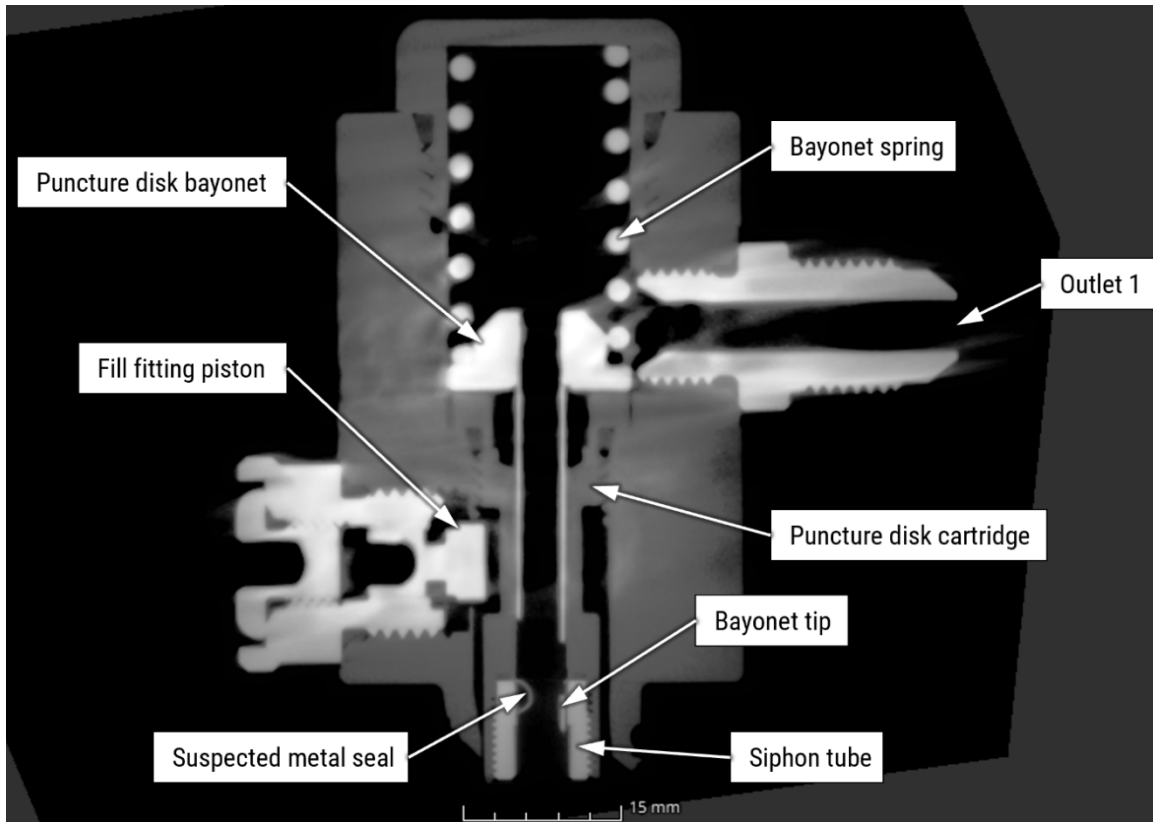


Figure 22. Components of the inflation valve assembly; front view.

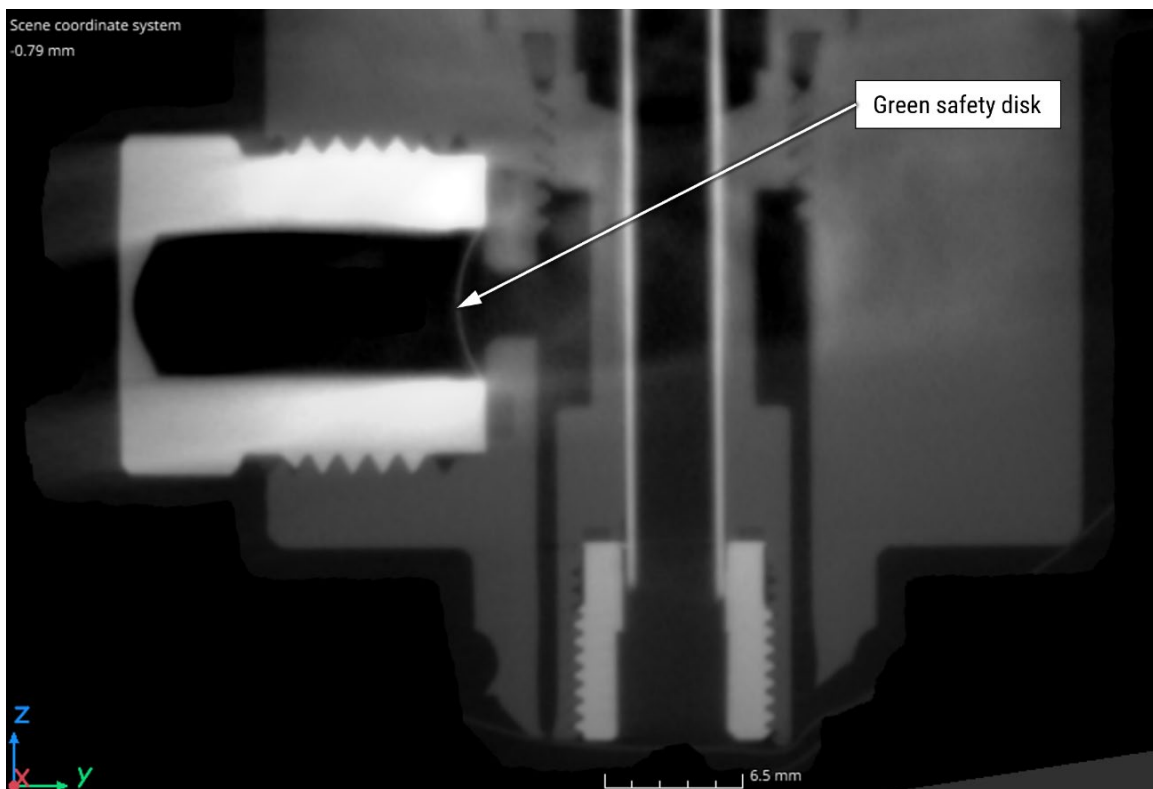


Figure 23. Green safety disk as seen in CT slice.

Submitted by:

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CT Specialist