

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



ERA25MA106

MATERIALS LABORATORY

Factual Report 25-067

June 25, 2026

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A. ACCIDENT INFORMATION

Location: Philadelphia, Pennsylvania
Date: January 31, 2025
Vehicle: Learjet 55, XA-UCI
Investigator: Robert Gretz, AS-ERA (IIC)

B. COMPONENTS EXAMINED

1. ERA25MA106-HAZ-02: Fractured valve inlet stem removed from Oxygen Cylinder #2
2. ERA25MA106-HAZ-03: Compressed oxygen cylinder with fractured valve inlet stem (Cylinder #3)
3. ERA25MA106-HAZ-04: Fractured valve inlet stem removed from Cylinder #4
4. ERA25MA106-HAZ-05: Fractured valve inlet stem removed from Cylinder #5
5. ERA25MA106-HAZ-06: Fractured valve inlet stem removed from Cylinder #6
6. ERA25MA106-HAZ-07: Fractured valve inlet stem and siphon tube removed from Cylinder #7
7. ERA25MA106-HAZ-08: Compressed oxygen cylinder with through wall fracture and fractured valve inlet stem (Cylinder #8)
8. ERA25MA106-HAZ-09: Fractured valve body type CGA870
9. ERA25MA106-HAZ-10: Life raft inflation valve assembly with fractured inlet stem

C. EXAMINATION PARTICIPANTS

Specialist Michael Meadows
National Transportation Safety Board
Washington, District of Columbia

D. DETAILS OF THE EXAMINATION

The NTSB Materials Laboratory received the components identified above for closer examination, refer to the Hazardous Materials Cargo/Gas Cylinders Specialist's Factual Report for additional details on each component.

Fractured pieces of compressed gas valve inlet stems which had been removed from their respective compressed gas cylinders were submitted. HAZ-02 was reportedly from a CGA540-type valve. HAZ-04, HAZ-05, and HAZ-06 were reportedly from CGA870-type valves. Images of the fractured valve inlet stems and example images of the respective valve types are shown in figures 1 - 4. The distance from the base of the inlet stem to the fracture surface was measured to be 0.65 - 0.80 inch (HAZ-02), 0.55 - 0.65 inch (HAZ-04), 0.50 - 0.55 inch (HAZ-05), and 0.85 - 0.95 inch (HAZ-06). HAZ-06 was fractured above the threaded inlet stem through a

reduced diameter section of the valve body which measured approximately 0.63 inch. The fractured piece exhibited bending deformation as shown from side profile views against a straight edge in figure 5. HAZ-09 was a CGA870 type valve which was fractured through the threaded inlet stem as shown in figure 6. It was determined from visual examination that HAZ-09 and HAZ-05 were mating fracture surfaces.

The fracture surfaces were cleaned using a soft bristled brush and a diluted soapy water solution followed by a water rinse and air dry to facilitate closer examination using a 4X – 80X zoom stereomicroscope. All fracture surfaces exhibited a matte gold appearance, consistent with a brass material composition. The fracture surfaces were generally oriented perpendicular to the axis of the valve inlet stem and exhibited a rough, matte, and fibrous texture. Radial fracture ridges emanated from broad origin areas at thread roots on the outer diameter (outer surface for HAZ-06) and extended through the wall thickness before intersecting at regions of final separation or forming shear lips along the inner diameter and outer diameter surfaces. The fractures were consistent with rapid overstress separation from combined bending and torsional impact forces.

The major diameter (inches) and thread pitch (threads per inch) measured for HAZ-02 was consistent with a 1.125-12 threaded inlet connection. Similar measurements for HAZ-04, -05, -06, and -09 were consistent with a 0.75-16 threaded inlet connection.

One DOT-3AL-2015 medical oxygen cylinder (HAZ-03) was submitted for examination (figure 7). The cylinder was dented at the crown and near the base and exhibited diametrically opposite regions of angled and transverse scratches and material transfer on the surface. On one side, the color of the material transfer ranged from blue to dark gray, and white on the opposite side. A portion of the fractured valve stem was retained in the cylinder boss. The fracture surface was similar in appearance to that of HAZ-04, -05, -06, and -09 and was also consistent with rapid overstress separation from combined bending and torsional impact forces.

One DOT-3AA-1800 compressed gas cylinder (HAZ-08) was submitted for examination (figures 8-10). Numerous dents were observed on the outer surface of the cylinder. One side of the cylinder was plastically deformed to a flattened profile and exhibited angled gouges and scratches. The base metal was exposed in this region where the exterior green coating had separated. A partially fractured through-wall crack was observed at the apex of a bulge formed between two adjacent dents near the cylinder crown (figure 9). A gouged region was observed in one of the dents which intersected the fractured area of the crack, bound by a yellow dashed line in the figure. The crack was S-shaped and extended over a length of approximately 0.75 inch. The fracture surfaces were oriented along a slanted plane through the wall thickness and exhibited a rough matte texture. The fracture was consistent with ductile overstress separation.

A portion of the fractured shutoff valve/pressure regulator assembly was retained in the cylinder boss (figure 10). The mating portion, shown boxed in yellow in the schematic, was not recovered. A reddish clay-like material was impacted over the fractured valve inlet surface. The fracture surface was cleaned using a soft bristled brush and water followed by an ethanol rinse and air dry. The fracture surface was matte gray in appearance and exhibited a rough fibrous texture interspersed with areas of smeared and displaced metal consistent with post fracture mechanical contact. Radial fracture ridges extended from broad origin areas at thread roots on the outer diameter surface and extended through the wall thickness. Shear lips were observed around the inner diameter surface. Portions of the shutoff valve/pressure regulator assembly threads above the fracture surface had sheared off and were retained in the corresponding thread roots of the cylinder boss. The pressure regulator assembly fracture was consistent with rapid overstress separation from combined bending and torsional impact forces followed by shear overstress fracture of the threads as the mating side was pulled away from the cylinder. The material of the fractured pressure regulator assembly was predominantly aluminum as identified with x-ray fluorescence spectroscopy.

The inflation valve for the onboard life raft was submitted for examination (figure 11). The lanyard used to activate raft inflation was reportedly recovered separated from the valve. The valve was attached to a portion of the life raft via two flexible hoses connected to check valves affixed to the raft surface. The valve inlet stem was fractured, and the mating piece was submitted after it had been extracted from the separated carbon-dioxide cylinder used to inflate the raft once the lanyard is pulled from the valve (under normal operation). The fractured valve stem was attached to a siphon tube which extends to the bottom of the carbon-dioxide cylinder. The valve stem exhibited slanted and fibrous textured fracture surfaces that extended through two thread courses and were consistent with shear lips. The fracture mode was consistent with rapid overstress separation from tensile or bending impact loads.

The flexible hoses (rubber coated braided steel wires) were crushed in between the connection fittings at the inflation and check valves (figure 12). One of the hoses was bent and partially fractured through the braided steel wires at the base of the fitting connected to the inflation valve, indicated within the boxed region. The fractured wire ends were deformed and exhibited reduced diameters (necking) at the point of separation, consistent with ductile overstress separation. Imprints resembling wire tracks were observed at the base of the fitting nipple, which were consistent with plastic deformation from impinging wires during an excessive bending or compression event.

The fractured CGA870 type valve body (HAZ-09) and the life raft inflation valve (HAZ-10) were submitted for radiographic/computed tomography examination to

examine the internal components. Refer to ERA25MA106 Computed Tomography Specialist's Factual Report for additional details.

Submitted by:

Michael Meadows
Materials Engineer



Figure 1. Perspective view (left) and birds-eye view of the fracture surface (right) of the fractured valve inlet stem (HAZ-02) from a CGA540 type valve. An example of the valve (gascylindersource.com) is shown in the upper left with the approximate fracture plane indicated.



Figure 2. Perspective view (left) and birds-eye view of the fracture surface (right) of the fractured valve inlet stem (HAZ-04) from a CGA870 type valve. An example of the valve (gascylindersource.com) is shown in the upper left with the approximate fracture plane indicated.



Figure 3. Perspective view (left) and birds-eye view of the fracture surface (right) of the fractured valve inlet stem (HAZ-05) from a CGA870 type valve. An example of the valve (gascylindersource.com) is shown in the upper left with the approximate fracture plane indicated.



Figure 4. Perspective view (left) and birds-eye view of the fracture surface (right) of the fractured valve inlet stem (HAZ-06) from a CGA870 type valve. An example of the valve (gascylindersource.com) is shown in the upper left with the approximate fracture plane indicated.

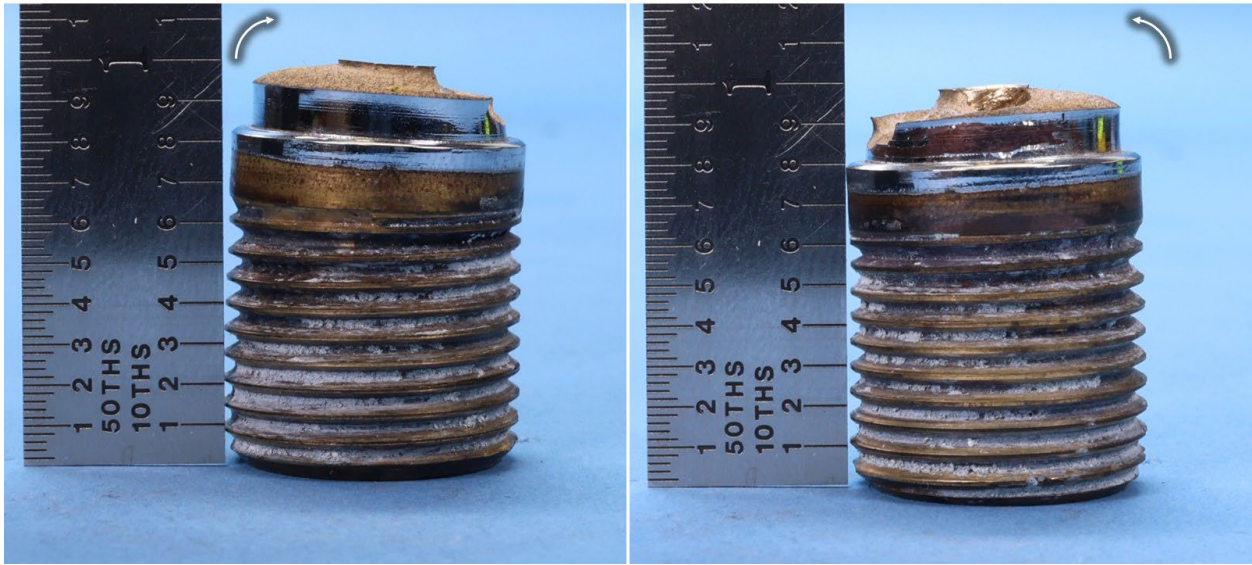


Figure 5. Diametrically opposite side profile views of HAZ-06 relative to a straight edge showing bending deformation in the direction indicated by arrows.



Figure 6. Photographs of the fractured CGA870 type valve (HAZ-09). The bottom right image shows the mating fracture surfaces (HAZ-09 and HAZ-05). An example of the valve (gascylindersource.com) is shown in the upper right with the approximate fracture plane indicated.

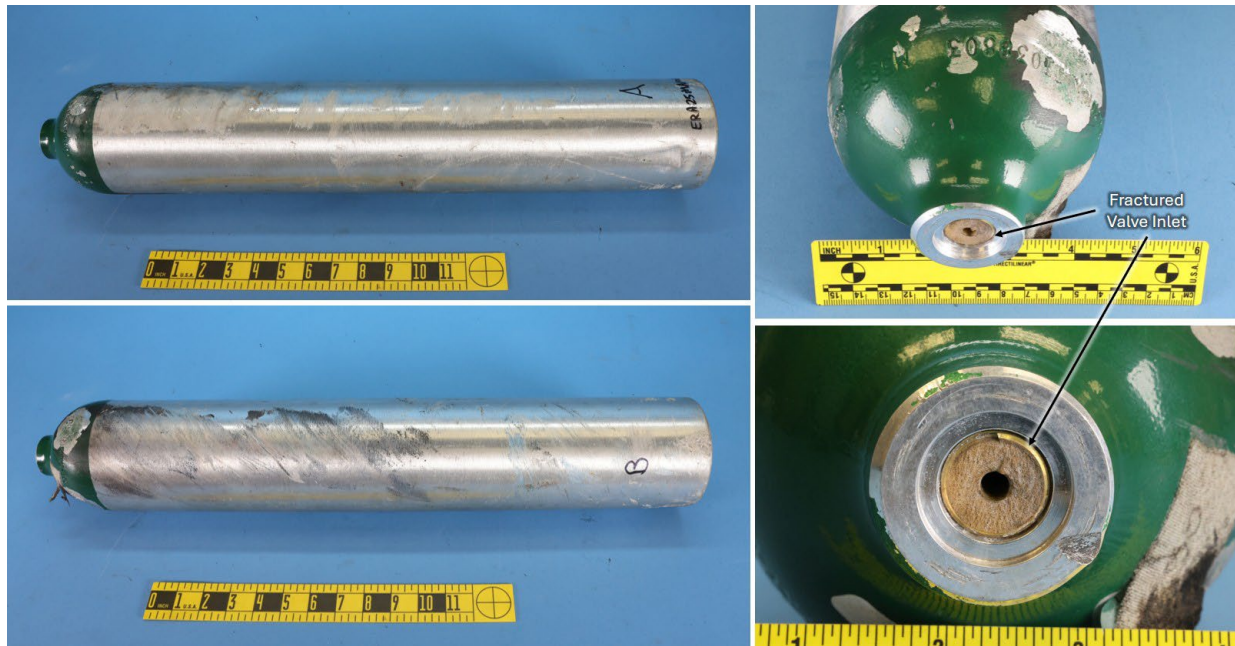


Figure 7. Photographs of the compressed oxygen cylinder with a portion of a fractured valve inlet retained in the cylinder boss (HAZ-03).



Figure 8. Photographs showing multiple sides of the dented and deformed compressed oxygen cylinder (HAZ-08).

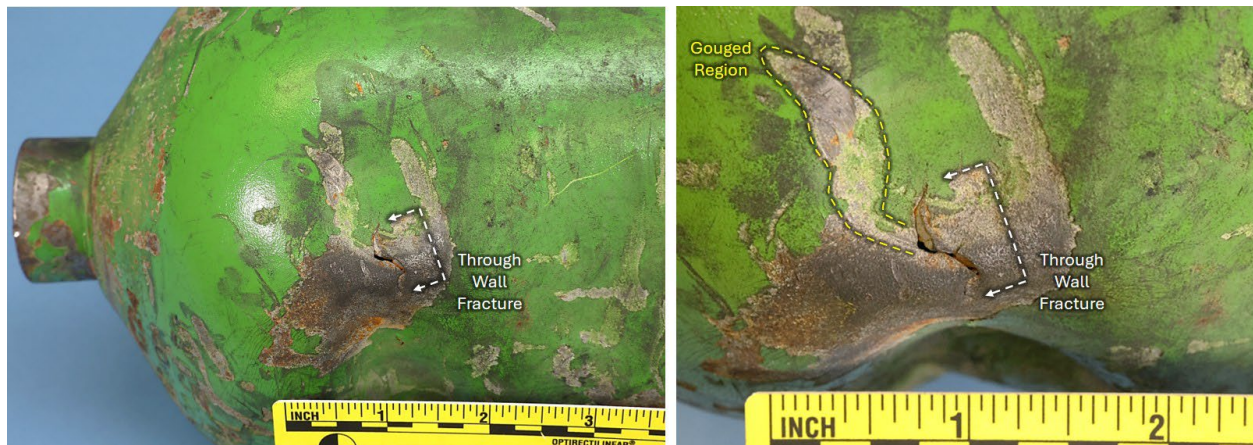


Figure 9. Closer photographs of the through wall fracture observed along a bulge between dented regions (HAZ-08). A gouged region, bound by a yellow dashed line intersected the through wall fracture.

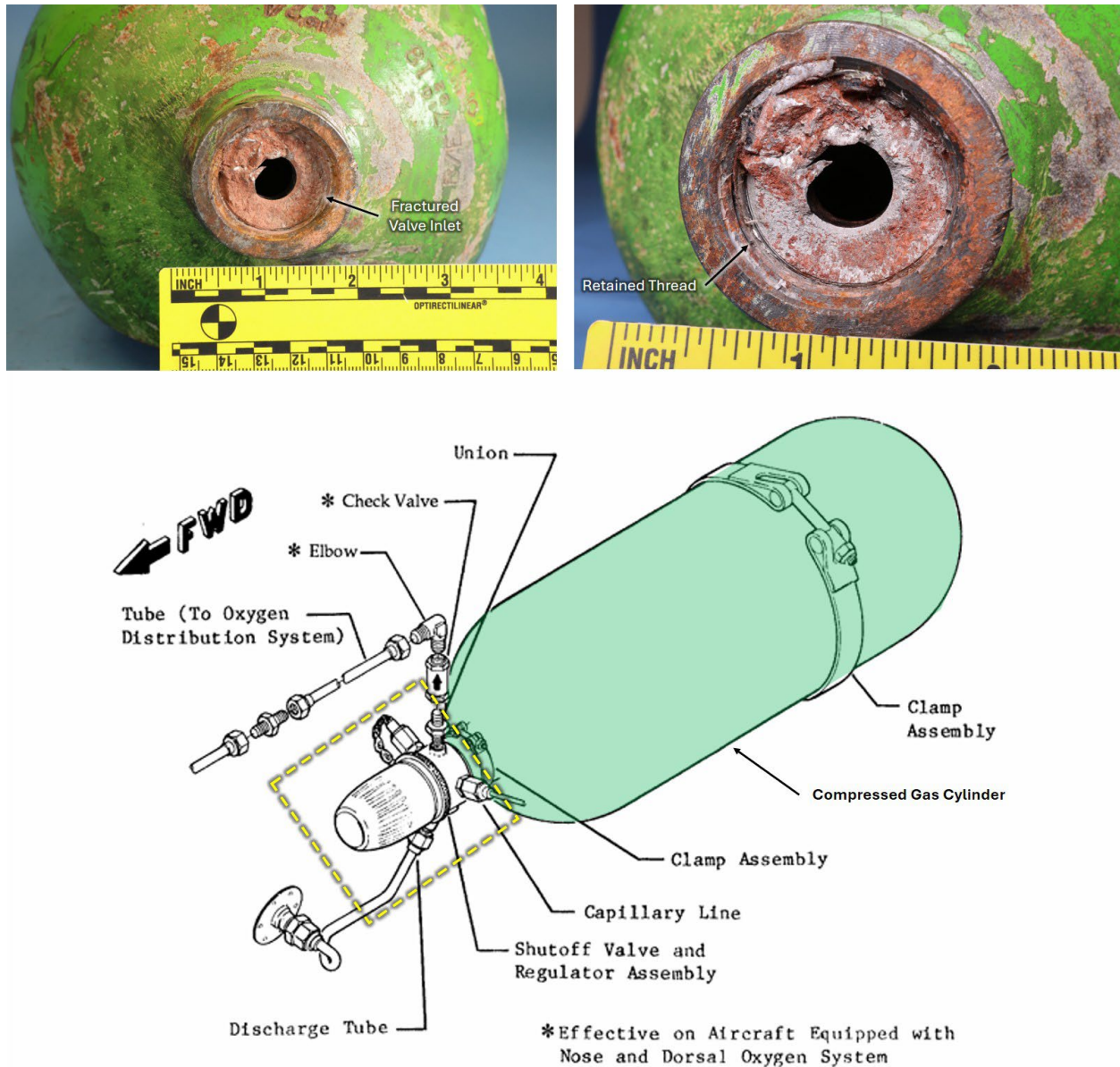


Figure 10. Photographs of the fractured shutoff valve/regulator assembly inlet (HAZ-08) retained in the cylinder boss before cleaning (left) and after cleaning (right). A schematic of the oxygen cylinder (highlighted green) and the shutoff valve/regulator assembly is shown below for reference. The boxed area indicates the portion of the valve that fractured and was not recovered. Schematic Source: Learjet 35/35A/36/36A Maintenance Manual Chapter 35-20-01 Figure 203 dated January 12, 2001 modified by NTSB.

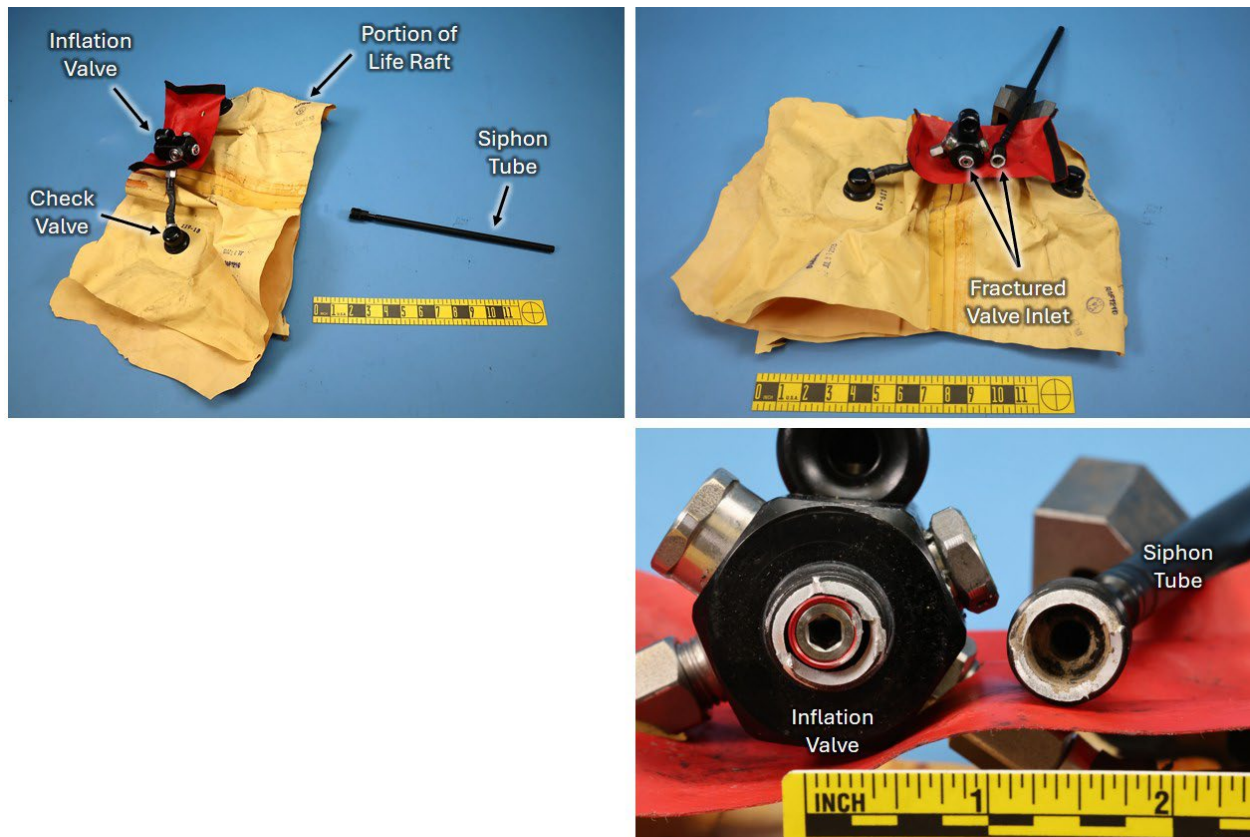


Figure 11. Photographs of the portion of the life raft with the fractured inflation valve inlet placed in close proximity to the mating fracture and siphon tube (HAZ-10).



Figure 12. Photographs of the crushed flexible inflation hoses with the life raft inflation valve removed (HAZ-10). A closer view of the bent and fractured end of one of the inflation hoses (boxed area) is shown in the right image.