

Joshua Young  
Air Safety Investigator  
AS-ERA

**Date:** 6/5/2025

**Subject:** ERA25LA375, Woodward Bellows Report

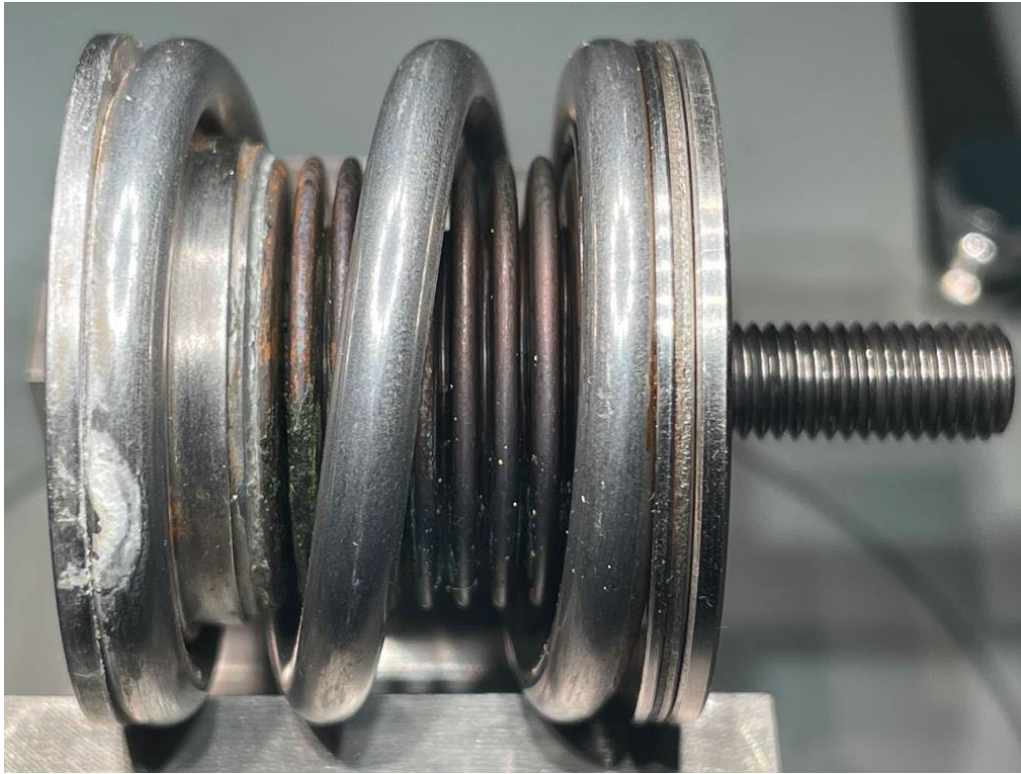
**Contact:** Matthew Zolnierczyk, Product Engineer, Woodward

The Woodward fuel control installed on engine at the time of the incident was P/N 8061-328, S/N 2136223. The unit originally shipped from Woodward on May 11, 1988. Most recent shipment from Woodward was April 27, 1993 with no returns recorded since then.

The initial investigation of the fuel control unit was performed at Pratt and Whitney Canada in Montreal, with Woodward in attendance. PWC engineering reviewed the engine data of the reported 24 second drop in fuel flow from 82 to 11 gph. These fuel flows equate to approximately 525 pph and 75 pph for 80° F JetA aviation fuel. 75 pph is the minimum flow condition for the FCU.

A visual inspection of the FCU was performed. A VSE sticker was present on the cover, indicating the unit had been serviced since last shipment from Woodward. The condition lever and max forward stop screw were bent, but did not prevent testing of the FCU.

An as-received test was then performed. Following the as-received testing the FCU was disassembled to perform a visual inspection on the internal components. There was no evidence of contamination in the tach valve or fuel valve system. The bellows exhibited evidence of corrosion, with orange and green colors present on the exterior. A white foreign material was observed on the coil spring of the bellows. See figures below. No other anomalies were observed during disassembly of the FCU.



*Figure 1: View of the bellows assembly. (Courtesy of Woodward)*



*Figure 2: View of corrosion on the bellows assembly. (Courtesy of Woodward)*



*Figure 3: View of corrosion on the bellows assembly. (Courtesy of Woodward)*

The bellows was returned to Woodward for further investigation. A 24 hour leakage check was performed on the bellows. The bellows length was measured, the bellows was then placed in an ambient pressurized chamber for 24 hours, and length was immediately measured afterwards. An increase in length indicates a potential leak. This test was re-run for 72 hours. Results are shown below:

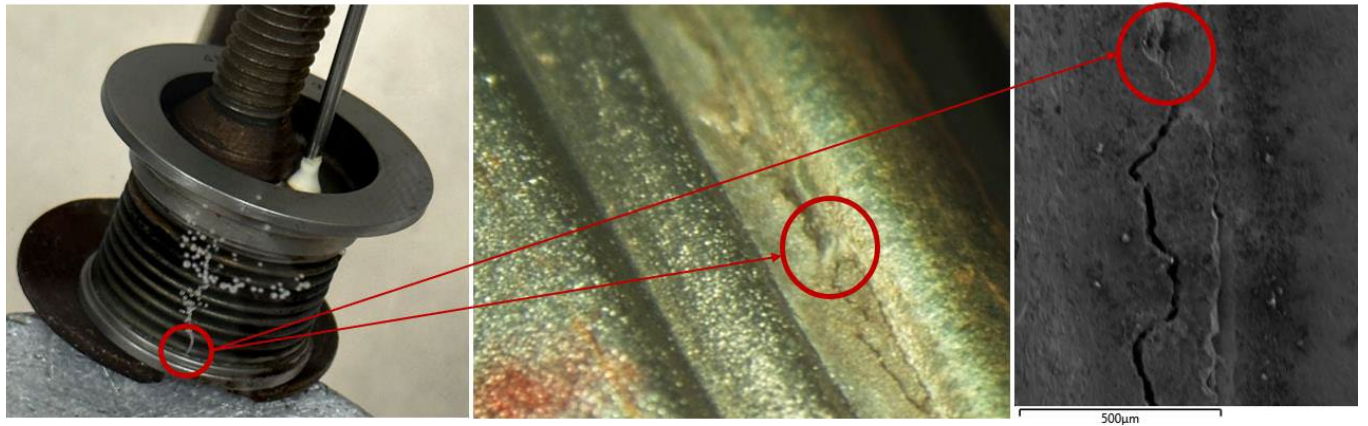
| Test          | Pre-Test Length (in.) | Post-Test Length (in.) |
|---------------|-----------------------|------------------------|
| 24 hour check | 1.01136               | 1.01352                |
| 72 hour check | 1.01300               | 1.01640                |

Another 24 hour leak check was performed again after pressure washing the bellows to remove any corrosion precipitate that may have sealed any small voids in the bellows. The length increased from 1.01284 to 1.01346 inches for this test.



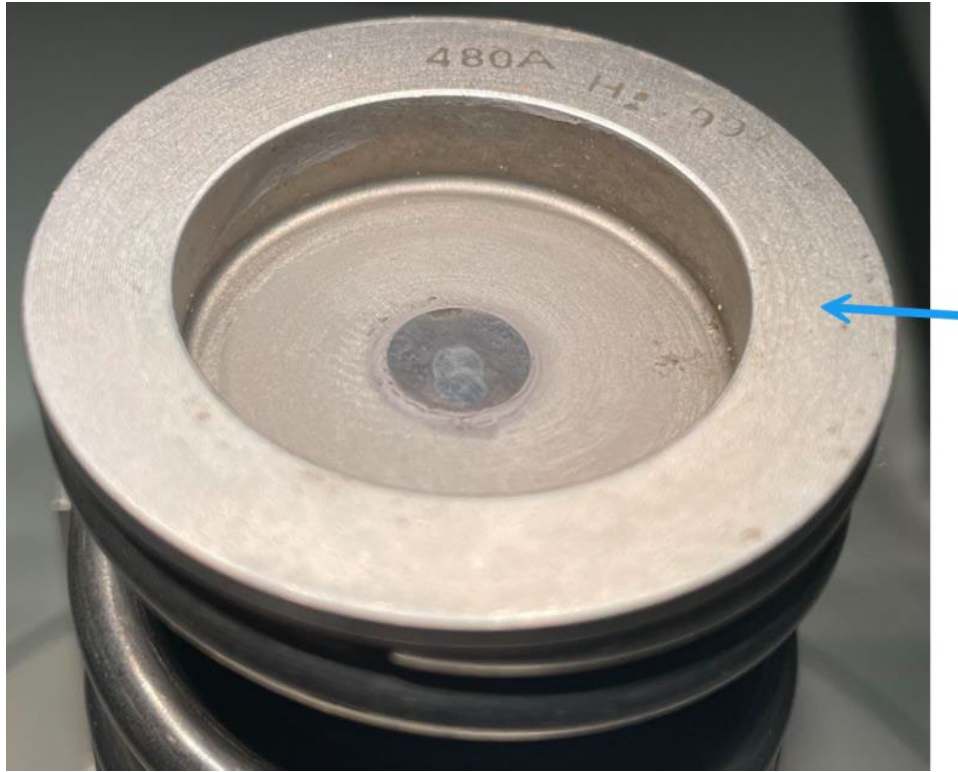
*Figure 4: View of the cleaned bellows. (Courtesy of Woodward)*

The bellows was then evaluated by the Woodward materials lab to determine location of the leakage. The bellows was internally pressurized and submerged in fluid. Leakage was observed at the solder joint between the bellows and end cap. Three images from this analysis are shown below. The left image shows the bellows leaking during the pressure test. The middle image is a magnified image to pinpoint the location, a bubble can be seen escaping the bellows. The right most image is a SEM inspection of the defect. The materials analysis concluded a silver deficiency at interface of the solder joint, which is consistent with oxidation due to corrosion of the bellows.



*Figure 5: Images of the bellows and crack found. (Courtesy of Woodward)*

Woodward service bulletin 83212-73-023 was issued October 13, 2014 which includes instructions to measure the bellows length ("L" dimension marked on the part) for various models. For this bellows part number 5215-084 the SB states that bellows manufactured prior to January 1993 are not marked with an "L" and should therefore be replaced. It also states this should be accomplished any time the unit is returned for service. This particular bellows is not marked with an "L" and therefore should have been replaced at last repair/overhaul. The image below shows the bellows surface where the "L" would be marked if manufactured after January 1993.



*Figure 6: View of the bellows end without a "L" marking. (Courtesy of Woodward)*