

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



CEN23LA399

MATERIALS LABORATORY

Factual Report 24-053

August 14, 2024

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A. ACCIDENT INFORMATION

Location: Ava, Missouri
Date: September 1, 2023
Vehicle: Beechcraft 35-B33, N9522Y
Investigator: Michael Hodges, ASI-CEN

B. COMPONENTS EXAMINED

Eaton Aeroquip E-Z Drain Sump Valve (AE99950G)

C. EXAMINATION PARTICIPANTS

Specialist Brian Fuchs, Ph.D.
National Transportation Safety Board
Washington D.C.

D. DETAILS OF THE EXAMINATION

The sump valve was received by the Materials Lab in the fully 'closed' position, as shown in **Figure 1**. Per instructions available from Eaton, the valve can be opened by turning the union nut (copper in color) counterclockwise, pushing the nut up along the body of the valve, and then turning it clockwise. This action pushes up an internal stem, moving a metal plate and O-ring out of the sealed position and allowing oil to flow through the stem. A ball embedded into the union nut follows a 'C'-shaped guide channel machined into the surface of the valve, and the valve is held open when the ball rests at the upper end of the C. When closed, the union nut is held in place by an internal spring that inhibits its rotational and axial motion.

Closer examination of the guide channel on the accident valve showed damage to the surfaces around the channel. As machined, the guide channel is expected to have straight edges along the inside walls of the C. This can be seen in the image of a similar valve taken from Eaton marketing materials (**Figure 2**). However, the walls at the top and bottom of the C showed damage consistent with impingement by the ball in the union nut. These damages are highlighted in **Figure 3**.

A secondary groove - hereafter referred to as a 'false channel' - was imprinted into the surface next to the guide channel, extending between the two impingement areas. The channel was approximately 0.02 inch deep and 0.06 inch wide at the center. Towards the lower end of the channel, just above the edge of the union nut, the channel widened to 0.08 inch. At this widening point, a tertiary groove (perpendicular to the guide channel and false channel) appeared to connect the two channels. This groove was approximately 0.06 inch wide. These damages are highlighted in **Figure 4**. These damages are consistent with the union nut being

forced across the body of the valve, causing the ball to impinge on the surface and creating the groove. When the union nut was pushed up such that the ball engaged with the impingement at the lower end of the C, the inner stem would move up by approximately 0.09 inch (**Figure 5**). In this configuration, the O-ring was visible but still inside the body of the valve. When released from this position, the valve would return to its 'closed' configuration.

Mechanical damage was also visible on other surfaces. **Figure 6** shows tool marks on opposite sides of the knurled portion of the union nut, consistent with pliers, channel locks, or similar equipment. Finally, damage was noted on the safety wire guides at the top end of the valve (**Figure 7**), consistent with a small-gauge wire impinging on the outside edge of the guides.

The valve still appeared to operate as normal. The union nut could be turned and pushed up along the guide channel. X-ray imaging with computed tomography (X-ray CT) (**Figure 8**) revealed that the spring and other internal structures were intact.

The valve was submitted to Eaton Aerospace in Jackson, MI, for leak tests on their specialized testing equipment. Eaton verified the calibration of the equipment prior to testing and further verified that liquid could flow through the valve when it was open. The leak tests were conducted according to standard Eaton procedures, first at 5-10 psi for minimum 30 s and then 300 psi -0 psi/+30 psi for minimum 30 s. The valve was initially tested with the copper crush washer that was submitted along with the valve. In this configuration, a leak was observed at the threaded joint at both low and high pressures (**Figure 9**). In a second round of testing, Eaton replaced the crush washer with a rubber O-ring, as this is the standard configuration in which the valves are sold. No leaks were observed when the valve was tested in this configuration.

Submitted by:

Brian Fuchs, Ph.D.
Materials Engineer

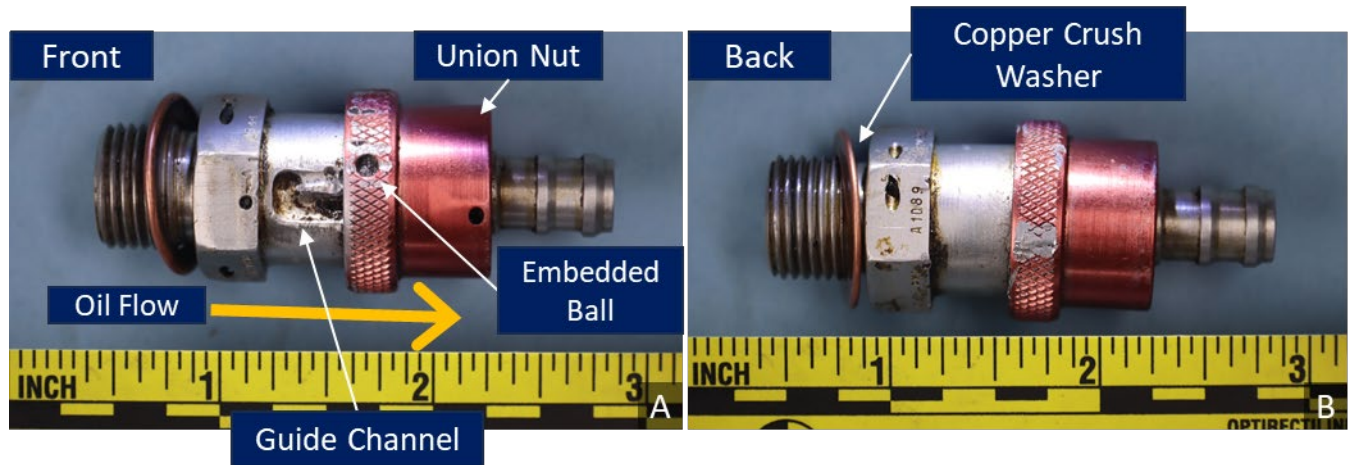


Figure 1. A) Front and B) back of the valve as received.



Figure 2. Image of a new Aeroquip E-Z Drain Sump Valve, adapted from Eaton marketing materials.

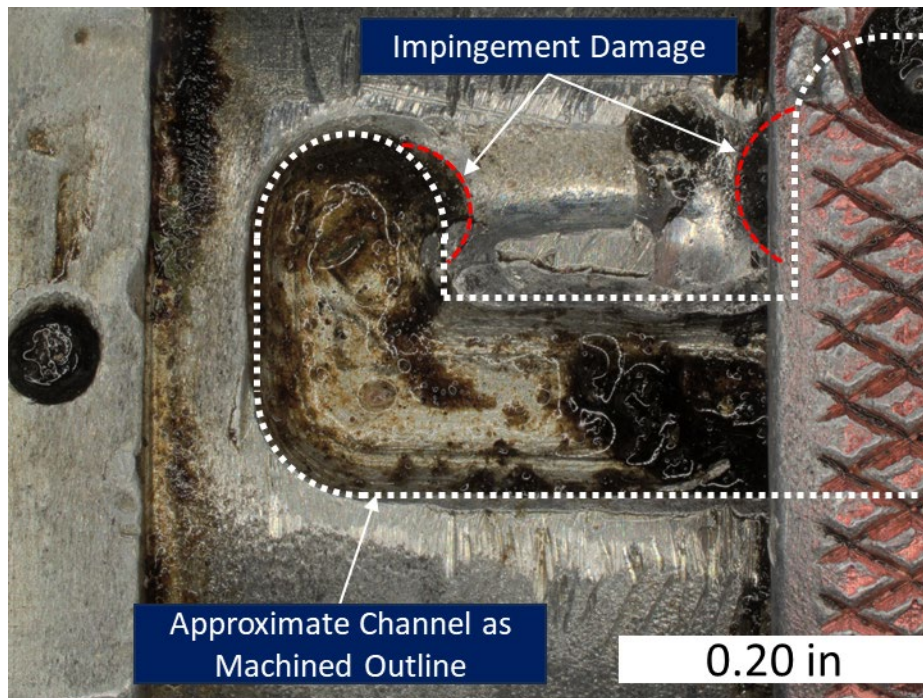


Figure 3. Guide channel with impingement damage illustrated. The white line shows the approximate edges of the guide channel as it would have been machined. The red lines show the distortion of that channel due to impingement.

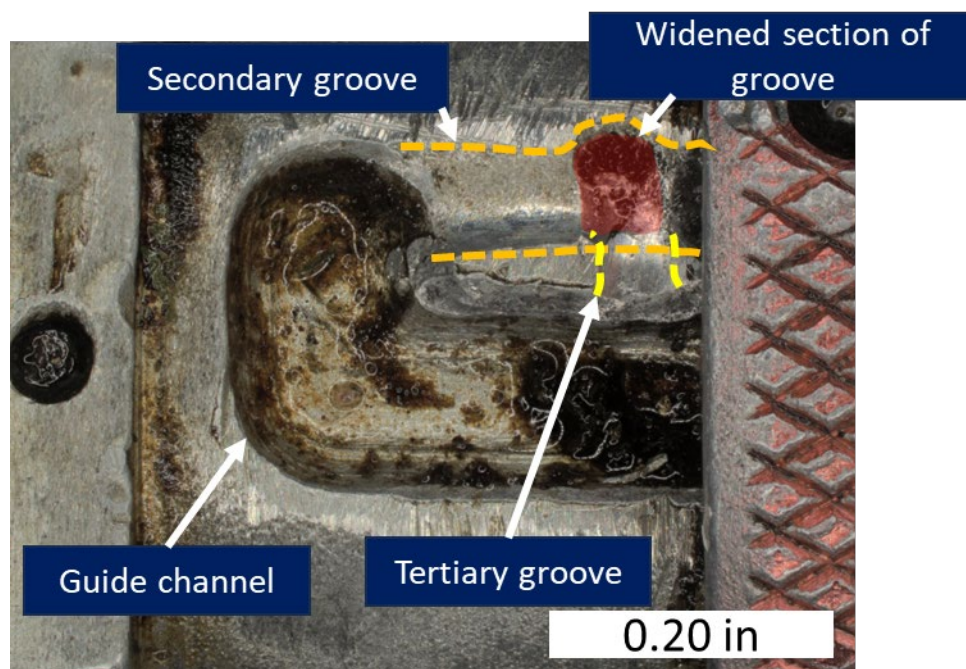


Figure 4. Secondary (orange) and tertiary (yellow) grooves outlined.

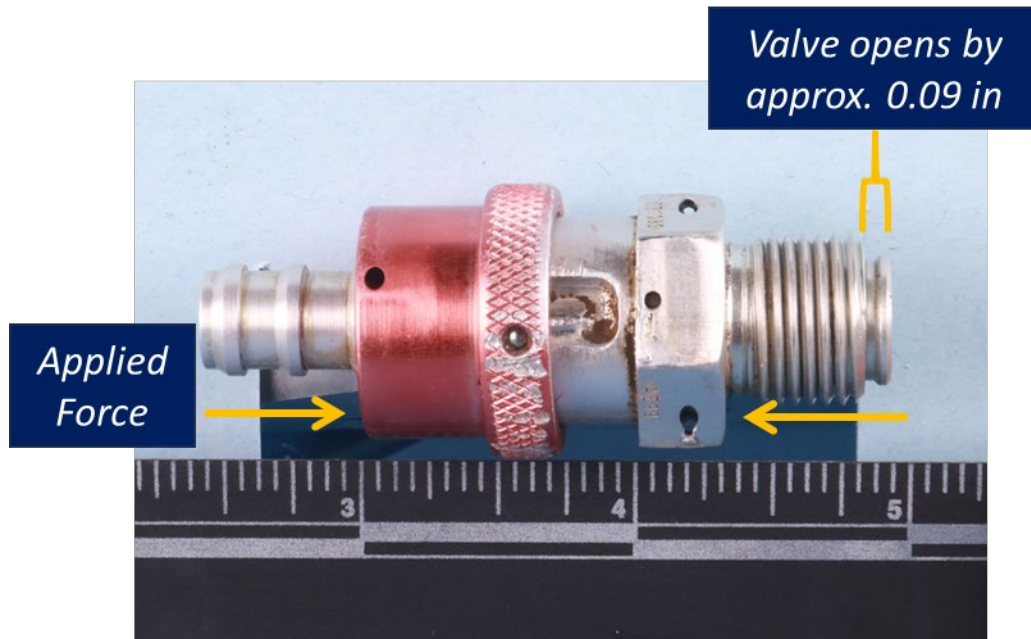


Figure 5. Partial opening of valve when an axial force is applied to the union nut. Valve held open by clamp. When the clamp was removed, the valve returned to the fully-closed position.

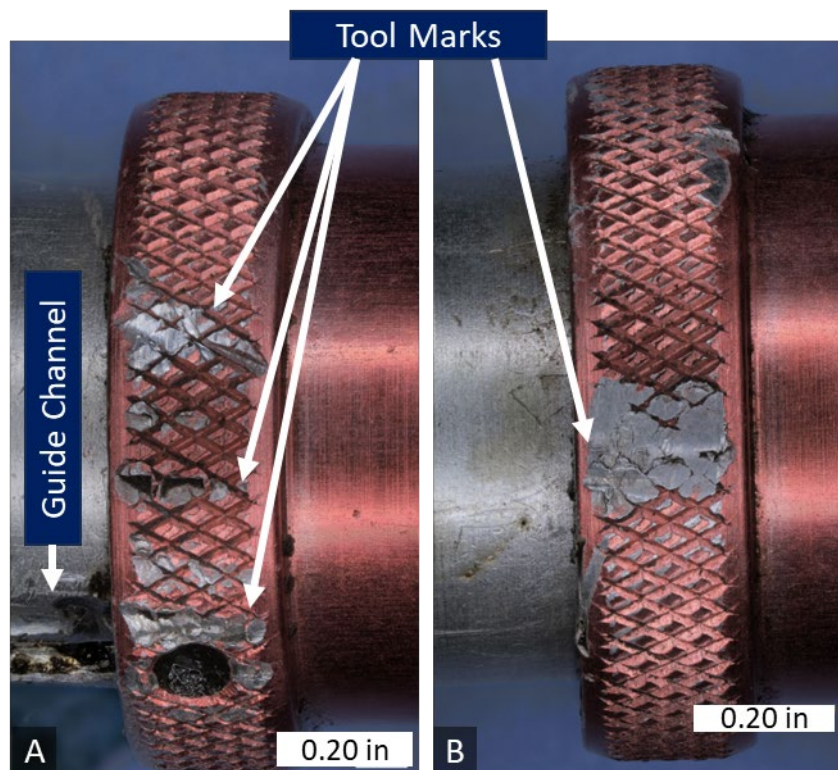


Figure 6. Tool marks on the knurled ring of the union nut A) near the guide channel and B) approximately opposite from the first set of marks.



Figure 7. Damage on one of the safety wire holes.

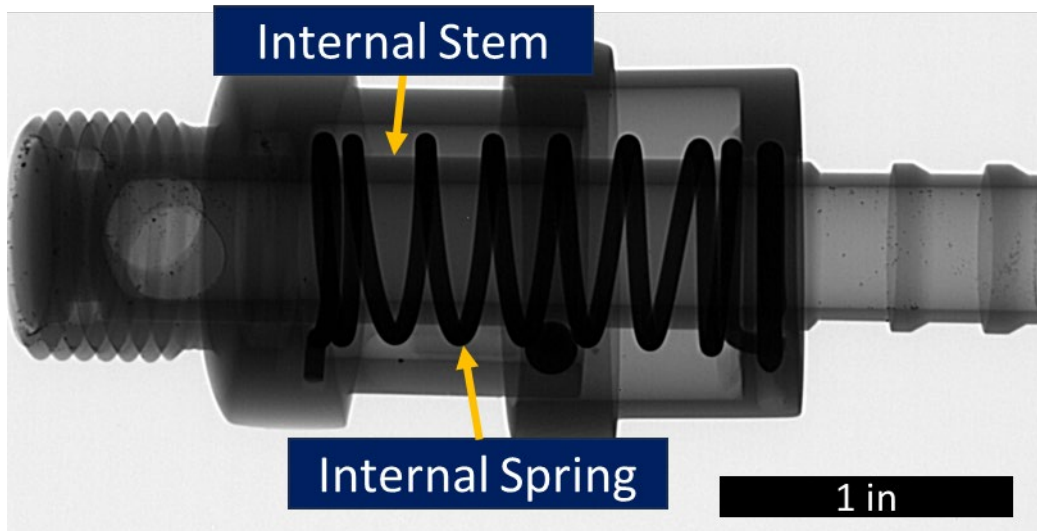


Figure 8. X-ray CT of the valve showed no damage to internal structures.

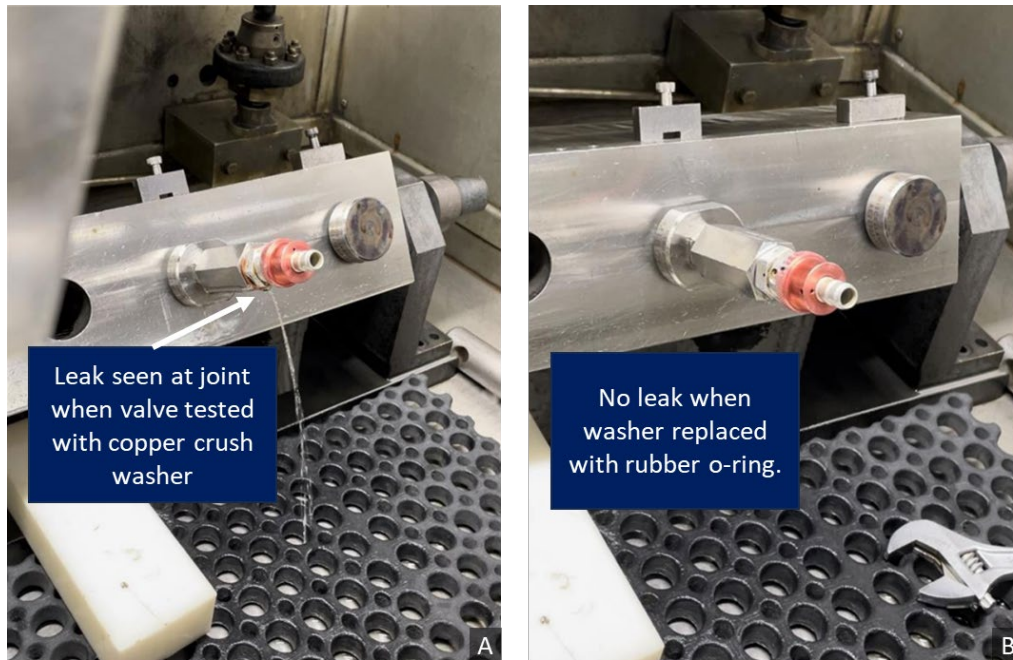


Figure 9. Leak tests on the accident valve conducted at Eaton A) with the copper crush washer and B) after replacing the washer with an O-ring.