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

February 11, 2022

MATERIALS LABORATORY FACTUAL REPORT Report No. 21-093

A. ACCIDENT INFORMATION

Place	:	Farmersville, Texas
Date	:	June 28, 2021
Vehicle	:	Pipeline pig launcher
NTSB No.	:	PLD21FR002
Investigator	:	Sara Lyons (RPH)

B. COMPONENTS EXAMINED

Four-inch kicker valve for an in-line inspection tool (pig) launcher for a natural gas transmission pipeline.

C. DETAILS OF THE EXAMINATION

Figures 1 and 2 show photographs of the 4-inch diameter kicker valve.

Valve Information

The nameplate indicated that the valve was serial number 61-433709; manufactured by Flowserve Nordstrom Valves, Sulfur Springs, Texas, in May 2008; and operated at a maximum allowable operating pressure (MAOP) of 1,500 pounds per square inch gauge (psig) at minus 20 °F, MAOP of 1,477 at 250 °F, and MAOP of 1,370 psig at 450 °F. The same nameplate was marked “Dynamic Balance Valve”; “Size “4R” indicating it was a 4-inch diameter valve and “R” indicating the valve was configured with a reduced port valve; “FIG K 2245” with “2245” portion indicating the drawing configuration and “K” portion indicating the revision; “Body WCC” indicating the body was made from Cast Carbon Steel per ASTM A216 Grade WCC; “Plug IRON” indicating the plug was made from ASTM A-48 grey cast iron; “Stem T416” indicating the stem was made from type 416 series stainless steel per ASTM A 582; and the bill of material (B/M) was 1637687. The markings on the nameplate indicated the valve complied with specifications “API-6D”, ASME “B16.34” and “API 6FA”.[1] The Flowserve product brochure for this valve indicated the “plug” valve was wrench-operated; conformed to

[1] API Standard 6D is titled “API Specification for Steel Gate, Plug, Ball, and Check Valves for Pipeline Service”; ASME B16.34 is titled “Valves – Flanged, Threaded, and Welding End”; and API Standard 6FA is titled “Standard for Fire Test and Valves”.

ASME Class 600 (PN 100)[2]; was a “Regular Pattern” type; and weighed approximately 175 pounds.[3]

Basic Operation

Plug valves are rotary motion valves that require a quarter turn (90-degree rotation) to open or close the valve. Collar stops on the top of the valve engage with the stem collar restricting the valve stem rotation to 90 degrees. The valve contains a dial indicator at the top end that indicates the position of the valve. The two extreme positions for the dial indicator are the “open” and “closed” positions.

The valve features a conical-tapered plug and a rectangle through-bore at the center**.** When the length of the rectangle bore is parallel (in-line) with the length of the valve body, the valve is fully open, and gas flows from one end of the valve to the other end. The needle indicator at the top of the valve will point to the “open” position. When the length of the rectangle-bore is oriented perpendicular to the length of the valve body, the valve is in the closed position, and the wall portion of the plug blocks gas from flowing from one end of the valve to the other. The needle indicator at the top of the valve will point to the “closed” position.

Post-Accident Testing

On October 15, 2021, the plug valve in the post-accident condition was examined and pressure tested at the manufacturer facility (Flowserve Corporation, Sulphur Springs, Texas). The following representatives witnessed the testing.

Frank Zakar	Group Chair	NTSB
Chuck Askins	Member	Flowserve
Chris Moser	Member	Flowserve
Randy Wood	Member	Flowserve
Michael Mangum	Member	ATMOS

Visual Examination

Visual examination of the valve revealed it was wrench-operated and was flanged at both ends. The top side of the body contained a needle indicator that points to the condition of the valve. The needle indicator was pointing to the “closed” position. The body of the valve was painted white and the outer diameter of the flanges were painted blue. The painted surfaces were intact and showed no evidence of heat damage (showed no indication of peeling, tinting, or deterioration), and no evidence of corrosion or mechanical damage.

[2] PN stands for nominal pressure. PN is followed by a designation number, which indicates the approximate pressure rating in bars.
[3] Brochure titled “Flowserve Nordstrom Valves Steel Lubricated Plug Valves”, number FCD NVENBR1004-02.

Each end of the valve (launcher and pipe end) was examined to document the condition of the plug, internal wall, and for evidence of lubricant at the interface between plug and wall. Figure 3 show photographs of the plug from both ends of the valve. The rectangle-bore portion of the plug at each end of the valve was not visible consistent with a valve that was is the closed position, see figure 3. The plug portion at each end of the valve showed no evidence of corrosion and was covered with a film of lubricant.

When looking into the port at the pipe end, evidence of lubricant squeeze-out was observed all around the interface between the plug and the wall with the exception of a small region on the right side. When looking into the port of the launcher end, the interface between the plug and the wall on the right side showed evidence of lubricant squeeze-out. The remaining interface between the plug and wall showed no evidence of lubricant squeeze-out.

Nitrogen High Pressure Leak Testing

The valve was pressure tested with nitrogen to determine whether a leak existed at the interface between the plug and the wall on the launcher end. This was performed using a visual gas bubble test. The tests were performed with the plug valve in the closed position (post-accident condition) and at four different pressure levels (80 psig, 628 psig, 731 psig, and 800 psig). Table 1 shows the rationale for selecting the four test pressure levels. Pressure was held at each interval for five minutes to check for a leak.

In preparation for the test, a blind flange with at threaded tap at the center portion of the blind flange was installed at both ends of the valve. The blind flange at the pipe end was fitted with a flexible tube that led to a nitrogen tank. The blind flange at the launcher end was fitted with a flexible tube that led into a vial of water. If the launcher end of the valve leaks gas, gas will have passed through the tube and would have escaped into the vial of water, causing gas bubbles in the water. The valve at the pipe end was pressurized at the four pressure intervals and no evidence of a gas bubble was detected in the vial of water.[4]

New Plug Valves

All new plug valves have been hydrostatic pressure tested at the factory to determine whether they are leaking. All valves have been subjected to a hydrostatic body (shell) test and a hydrostatic seal test. No leaks are permitted for this type of valve. Any indication of a leak, such a water bubble, at the interface between the plug and internal wall would have been cause for a valve to be rejected.

According to the Flowserve Steel Plug Valve brochure referenced earlier in this report, the cold working pressure for this type valve is specified as 1,480 psig.[5] The

[4] If gas bubbles were detected, the vial of water would have been replaced with a bank of flow meters (in range between 1 standard cubic foot t per hour [SCFH] and 200 SCFH) to measure the volumetric gas leak rate.
[5] ASME 16.34 dictates the required pressure tests. The cold working pressure is based on material of the body and pressure class (this valve is an ASME Class 600).

hydrostatic shell test is performed with the valve in the open position. The entire body of the valve is subjected to the test pressure of 1.5 times the cold working pressure which calculates to 2,225 psig. This test is performed to determine whether the exterior surface of the valve shows evidence of a leak. The hydrostatic seat test is performed with the plug in the closed position. The valve is tested at 1.1 times the cold working pressure which calculates to 1,650 psig. Since the valve is bidirectional[6], this hydrostatic test is performed for the seat at each end of the valve. One end is pressure tested while the other end is monitored for a leak. Afterwards, the ends of the valve are rotated and the pressure test is repeated for the opposite seat.

Prepared by:

Frank Zakar
Senior Metallurgist

[6] In a unidirectional valve, the medium can flow only in one direction. However, in a bidirectional valve, any side can be used as upstream and downstream.

Table 1. Rationale for Testing at Specific Pressure Intervals[7]	
Pressure Interval (psig)	Rationale
80	Optional low pressure gas test specified in several valve testing specifications
628	Operating pressure of pipe at time of accident
731	Maximum operating pressure of pipe in the last 5 years
800	MAOP of pipeline

[7] NTSB Operations Group Chair Factual Report

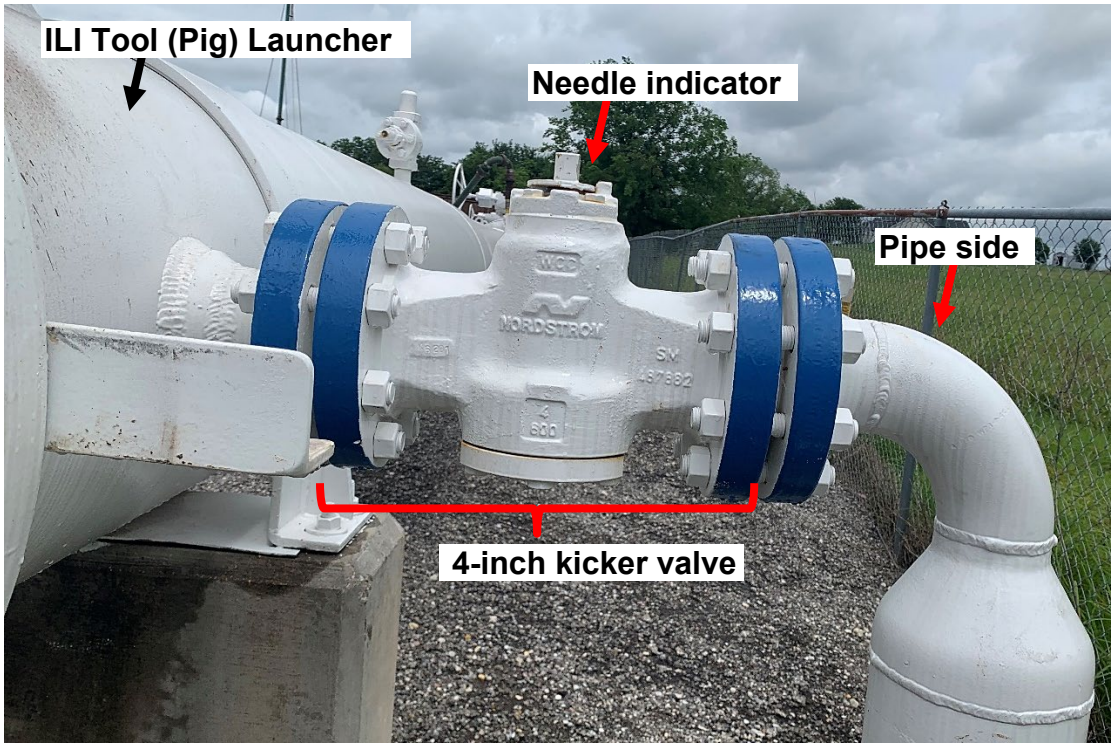

Figure 1. Partial view of the pig launcher and the 4-inch kicker valve. Source NTSB.

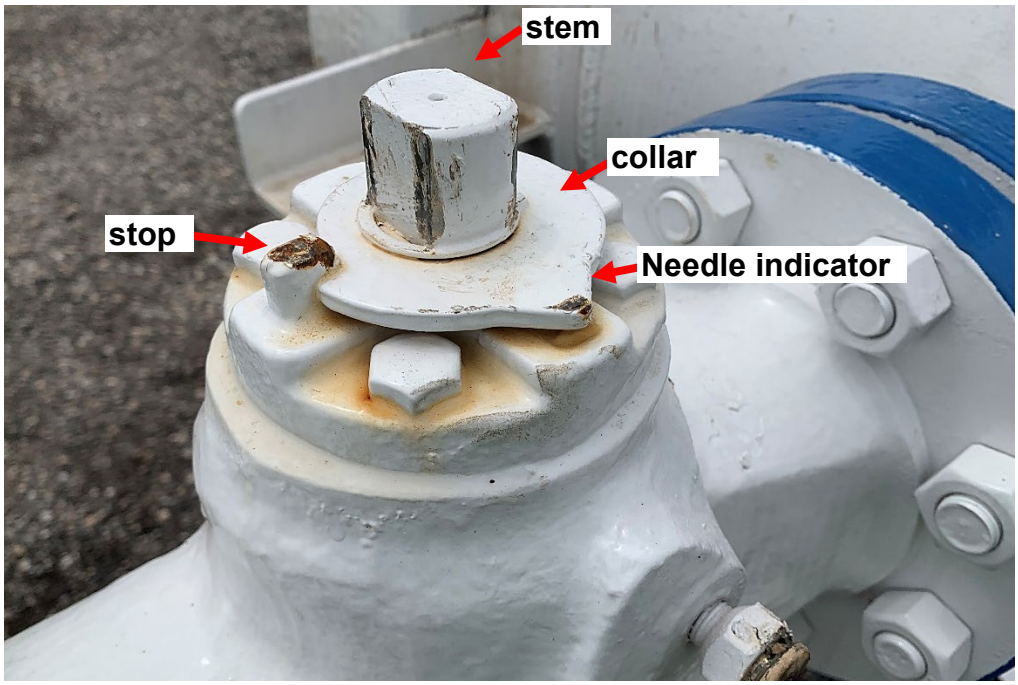

Figure 2. Oblique view of the 4-inch kicker valve, stem, stem collar, and stop for the stem. The needle indicator was oriented perpendicular to the length of the pipe, which is the "closed" position. Source NTSB.

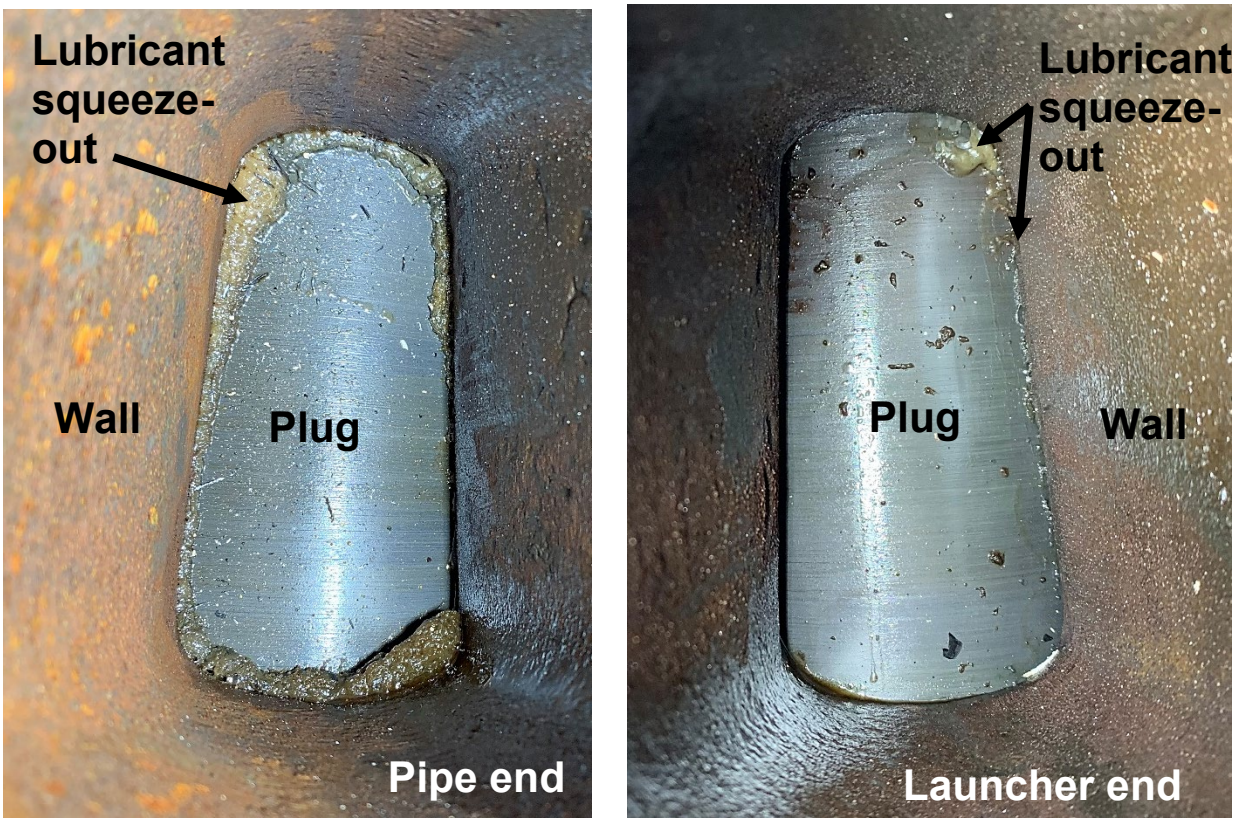

Figure 3. View looking into the ports of the 4-inch kicker valve showing the plug at the pipe end (left) and the plug at the launcher end (right).