



**A Red Valve Company
And Tideflex Technologies White Paper**



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**ALL ELASTOMERIC INLINE DUCKBILL CHECK VALVES FOR
PREVENTION OF SEWAGE BACKFLOW IN LIFT STATIONS AND
WASTEWATER TREATMENT PLANTS**

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Abstract

Although it is an everyday occurrence, it can be costly for municipalities when lift station check valves fail and leak sewage back into the wet well from force mains.

Pump wear, as well as the operational expense of inspecting, cleaning, repairing and maintaining check valves, is well documented. Also understood is the expense of force main sewage backflow into the wet well having to be pumped multiple times.

This paper is a brief discussion of the techniques and use of Inline Duck Bill All Elastomeric Check Valves to prevent force main sewage backflow.

Keywords

Force main, wet well, pump wear, SCADA (Supervisory Control and Data Acquisition), pump downs, outfall all elastomeric duck bill check valves, inline all elastomeric duckbill check valves, force main sewage backflow, pump down cycle, check valve inspections.

Introduction

It is 2:45 am and very little water is being used in homes, businesses and institutions. Because it is not raining, there is currently no I&I. At the local duplex pump lift station, the all off float has reached its set point level and the lead pump, pump 1, went off 28 minutes ago. The level in the wet well has just risen to the set point of the lead pump float and pump 2 turns on and begins the cycle of pumping down the wet well and discharging the sewage into the force main (and eventually the WWTP) until the all off float is again satisfied.

Although the timing of this cycle is equivalent to the designed time cycle of moderate to heavy flow, **it happens to be between 2:00 and 3:00 a.m. and there is little to no inflow.**

Failing lift station check valves cause extra wear of pumps, increased power usage and often cause damage to pumps (both by rotating backwards and starting up when rotating backwards).

Maintenance personnel performing regular inspections alert the lift station manager if check valve failure is occurring. SCADA can tell approximately when and for how long the check valve has been leaking force main sewage back into the wet well. Neither will prevent or permanently solve the problem.

Cleaning and repairing the check valve does temporarily stop check valve failure and backflow. But, it is impossible to be proactive in preventing ragging, mechanical failure or sewage debris (rags solids, etc.) from blocking the flapper or ball from sealing properly to the seat.

The Costs of Failed Check Valves in Lift Stations

Multiple wet well pump shut downs cause higher electrical bills and excessive pump wear. The increased potential of pump damage and increased inspections, as well

as constant cleaning and repair of failed mechanical checks, also add to the planned and unplanned operational costs.

Why Mechanical Checks Used in Lift Stations Fail and Require Constant Maintenance

Commonly used lift station checks are assisted checks. They are tilted (gravity assisted), tilted weight and lever, tilted spring and lever, or a combination of the above.

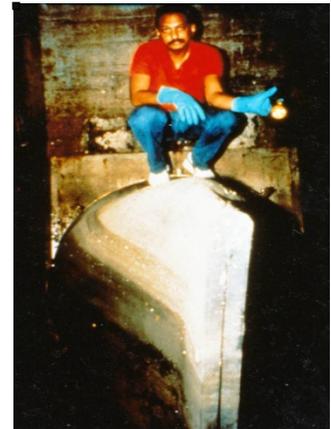
The problem is not with the mechanical check valves themselves, but with the sewage debris that is trapped in them. Mechanical checks cannot seal off against rags, rope, grease and all of the solids and debris that end up in wet wells.

Even with resilient seating, the force applied by all of the above mentioned assisted mechanical checks often cannot break up or crush what is between the seat and the gate, preventing them from making a good seal and stopping any backflow from the force main.

When there is little or no debris between the seat and gate to cushion the force, slamming occurs. Vacuum from pump drainage is another cause. Force main backpressure and accelerated backflow and its associated vacuum also can cause slamming.

History of All Elastomeric Check Valves

In 1981,¹ to combat backflow, high maintenance and other problems relating to backflow in combined sewers, storm sewers and sanitary sewers; the EPA Research Division² commissioned Red Valve Company to create and test an "All Elastomeric Duck Bill Check Valve."³ In fact, the first All Elastomeric Duck Bill Tideflex[®] Check Valve (54") that Red Valve manufactured and installed in New York City, in 1984, is still in service today.



*Wards Island Outfall
New York City, NY
Installed in 1984*

On an EPA grant, the Elastomeric Duckbill Tideflex[®] Check Valve was observed and evaluated for three years and was found to eliminate the operational and maintenance problems associated with flap gates. "In particular, the elastomeric gates are designed to close tightly around objects that might otherwise prevent a flap gate from closing."³

Currently, over 600,000 large and millions of smaller Tideflex[®] Check Valves are in service solving backflow problem in both gravity and pumped inline applications. No matter what the debris, head pressure and back pressure conditions are, Tideflex[®] All Elastomeric Check Valves are proven to perform reliably without the need for costly maintenance.

Series 39 Inline Duckbill Tideflex® Check Valve for Pumping and High Pressure Applications

At the heart of the Series 39 is a fabric-reinforced elastomer check sleeve that provides through-flow at minimum pressure drop across the valve at all times. The Series 39 Inline Check Valve is provided with a cleanout port and two flush ports. It is also available with an optional site glass indicator. The Series 39 comes standard with a cast iron body, which is available with special coatings. The valve has face-to-face dimensions that meet ANSI B16.10 specs of other commonly used lift station checks.

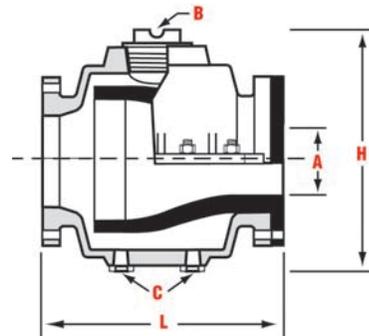
The Series 39 is especially useful for the conditions and severe service of lift stations. The recessed saddle allows for an unobstructed flow of sewage debris, while preventing any check sleeve problems from unanticipated increases in force main backpressure or vacuum. Options of coating of the SST and/or the inner check valve body to insure long lasting service in high H₂S conditions are also available. Saddle support technology is standard for all pumped applications. The option of a site glass indicator is also available.

Why All Elastomeric Inline Duckbill Check Valves Work in Lift Stations

There are physical characteristics that are required to achieve the low headloss, high back pressure and the “close tightly around objects”³ abilities of the elastomeric Tideflex® Check Valves. The main characteristic is that the duckbill opening dimension is 1.57 X the I.D. of the pipe.⁵ This enables the Tideflex® Check Valve to open to the full ID of the pipeline. This allows the bill to close and seal around debris as well as pass whatever debris in the pipelines.



*Series 39 Inline
Check Valve*

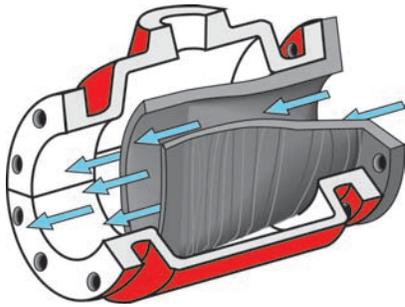


*B - 4" Cleanout or Combine Cleanout
With 3" Site Glass Position Indicator*

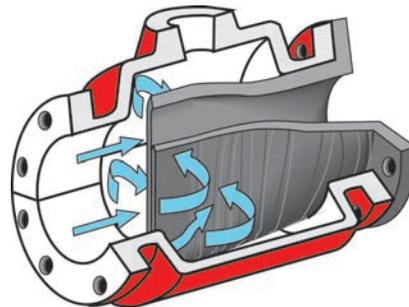
C - Flush Ports

The Series 39 Slurry Duckbill Check Valve is designed to handle abrasive slurries, sewage, sludge and other difficult services. Forward pressure opens the valve

automatically and reverse pressure seals the valve. The check sleeve can even seal around entrapped solids.



*Tideflex® Check Valve Opens
With Positive Pressure*



*Reverse Pressure Seals the Bill of the Tideflex®
Check Valve to Prevent Backflow*

This inner rubber duckbill check valve minimizes wear and deterioration caused by continuous operation of abrasive slurries. There are no mechanical parts such as hinges, discs or metal seats that can freeze, corrode or bind valve operation. The Series 39 Inline Duckbill Check Valve, provided with a clean-out port and two flush ports, also has the option of a site glass position indicator. It has a cast iron body, which is available epoxy-coated or rubber-lined. The valve has through-drilled flange holes. Face-to-face dimensions meet ANSI B16.10 specifications. When ordering, line pressure and backpressure must be provided, as each valve is custom-built to match the flow requirements of the installation. For higher backpressure ratings or to lower headloss while maintaining backpressure ratings, the Saddle Support Technology (SST) can be used in conjunction with the Series 39 and is standard on all pumped applications.

Dimensions Series 39 4"-24"

| Valve Size A | Length L | Height H | Clean-Out Plug Diameter B | Flush Connection(s) C | Max. Backpressure (psi) | |
|-----------------|-------------|-------------|---------------------------------|-----------------------------|-------------------------|------------------------|
| | | | | | Standard Tideflex® | With Saddle Support |
| 4 | 11 1/2 | 10 3/4 | 2 | 1 - 1 | 75 | 150 |
| 6 | 14 | 14 | 4 | 1 - 1 | 75 | 150 |
| 8 | 19 1/2 | 17 1/4 | 4 | 2 - 1 | 60 | 125 |
| 10 | 24 1/2 | 22 3/4 | 4 | 2 - 1 | 45 | 75 |
| 12 | 27 1/2 | 24 3/4 | 4 | 2 - 1 | 35 | 75 |
| 14 | 31 | 27 3/4 | 4 | 2 - 1 | 25 | 70 |
| 16 | 34 | 31 1/4 | 4 | 2 - 1 | 20 | 60 |
| 18 | 38 1/2 | 35 | 6" Flanged | 2 - 1 | 15 | 45 |
| 20 | 40 | 42 3/4 | 6" Flanged | 2 - 1 | 10 | 40 |
| 24 | 51 | 45 1/2 | 6" Flanged | 2 - 1 | 10 | 40 |

Numbers indicate maximum dimensions in inches.

Saddle Support Technology (SST)

For higher backpressure applications, the Saddle Support Technology (SST) is used to increase the backpressure rating of Tideflex® Check Valves. The SST, constructed of steel or stainless steel, is designed to nest inside of the Tideflex® Check Valve. It is engineered to support the saddle area of the valve where backpressure acts to close the valve. Overall stiffness of the Tideflex® can be reduced, providing a lower headloss flow characteristic. The engineered SST is designed to meet your pressure and headloss requirements.

Common increase in backpressure rating is approximately 3:1, depending on the size and construction of the valve.

The Saddle Support has a streamlined design, does not hinder valve operation and has no areas for solids to collect or hang up. Also, the headloss of a Tideflex® Check Valve with SST is less than a standard Tideflex® Check Valve because the stiffness of the valve can be reduced because it is supported by the SST. Saddle Support is standard in all pumped applications.

Finite Element Analysis (FEA) and Independent Hydraulic Testing

From the outside, Tideflex® Check Valves appear to be a simple rubber valve configured in a duckbill shape. However, for each Tideflex® Check Valve there can be hundreds of layers of various natural and synthetic elastomers and fabric-reinforced plies. This allows Tideflex® Technologies to design for drastically different characteristics such as resilience, durometer, compression set resistance, tensile strength and elongation. Each Tideflex® Check Valve is customized to your specific hydraulic needs.

Tideflex® Technologies has conducted extensive Finite Element Analysis (FEA) testing to analyze the stress, strain, force and deflection characteristics under many load conditions. Modeling was run for discharging and backpressure conditions. These results were used in developing detailed flow curves so that Tideflex® Check Valves can be built to withstand long-term variable load conditions, while producing optimum desired hydraulic flow characteristics.

Hydraulic Variations

With the extensive data collected, Tideflex® Technologies developed modeling programs which allow you to select the optimal check valve for your unique application needs. Tideflex® Check Valves are not one size fits all. There are more than 50 different variations of check valves within each nominal size. Each variation has its own hydraulic characteristics for headloss, jet velocity, effective diameter and backpressure rating. This is achieved by changing the geometry and relative stiffness of the valve and adding or subtracting SSTs.

Tideflex® Check Valves are constructed similar to a truck tire with many types of elastomers and fabric-reinforced plies. Each material has a different mechanical property, which when fabricated into a unibody construction these materials produce specific hydraulic characteristics. ***Only Tideflex® Technologies has performed extensive hydraulic testing and backpressure testing to correlate the specific***

construction details with the hydraulic performance and back pressure rating of each valve.

Features of Inline Tideflex® Check Valves

- All-elastomer, maintenance-free design.
- No hinges to seal or bind.
- Resists abrasion.
- Provides backflow prevention in adverse conditions.
- Can be mounted in any orientation.
- Closes on entrapped solids.
- Allows flow at very low pressure (1" – 2").
- SST for high backpressure.

Materials of Construction:

- Cast iron ASTM A126 body.
- Check sleeves available in pure gum rubber, neoprene, Hypalon®, Buna-N, Viton® and EPDM.
- ANSI Class 125/150, DIN PN6, PN10, PN16.
- Special coatings available.

References

- ¹ Abbreviated Tideflex® Development Chronology, http://www.tideflex.com/beta/documents/documents2/check_valves/Tideflex_timeline.pdf.
- ² EPA Risk Reduction Engineering Laboratory, Cincinnati, Ohio.
- ³ EPA 600S289020 EPA Development Evaluation a Rubber Duck Bill Tide Gates, February, 1990.
- ⁴ Tideflex® Inline Check Valves Catalog. Carnegie, PA: Red Valve Company, 2006.
- ⁵ Specification TT-TF-1 1.02:E, Bill slit conforms to 1.57 times the pipe diameter.