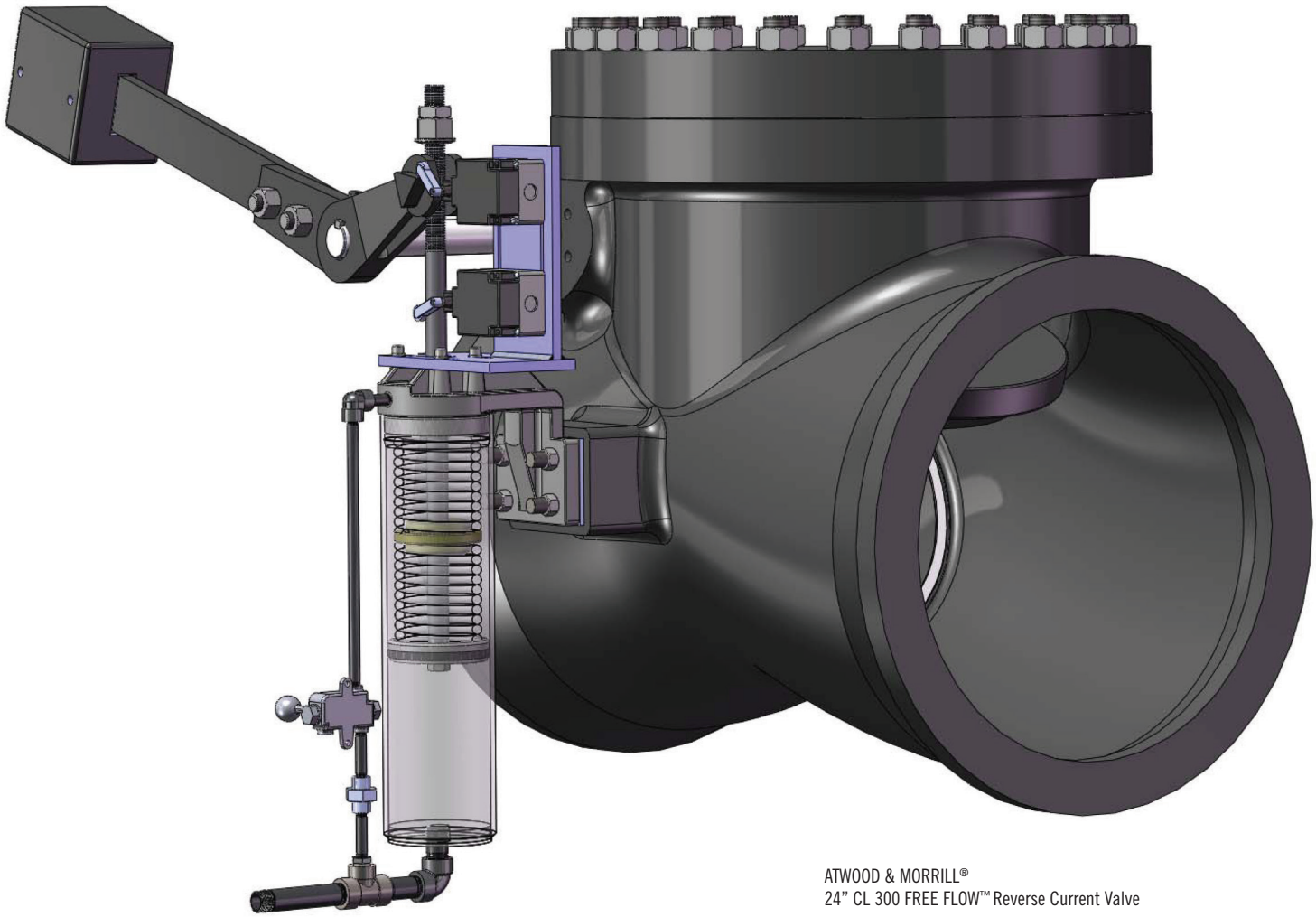
TRILLIUM FLOW TECHNOLOGIES™

Sales & Technical Bulletins

TRILLIUM Valves USA™ www.trilliumflow.com



ATWOOD & MORRILL®
24" CL 300 FREE FLOW™ Reverse Current Valve

Specialists in Valve and Flow Control Equipment for Over 100 Years

Trillium - Table of Contents

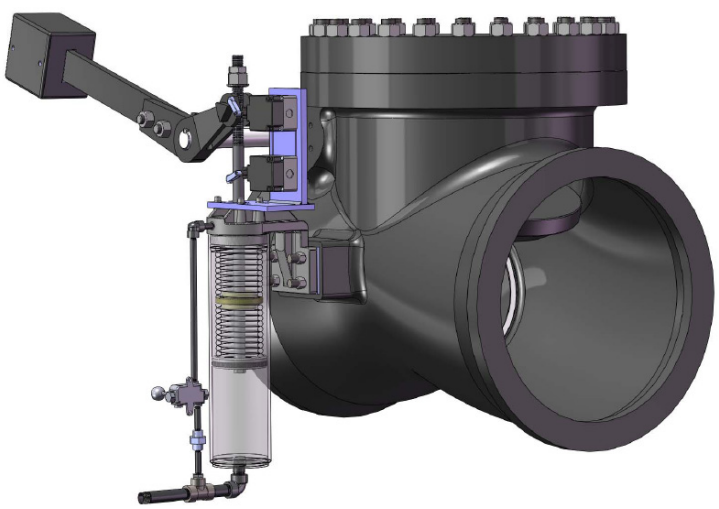
FREE FLOW™ Technical Support Program

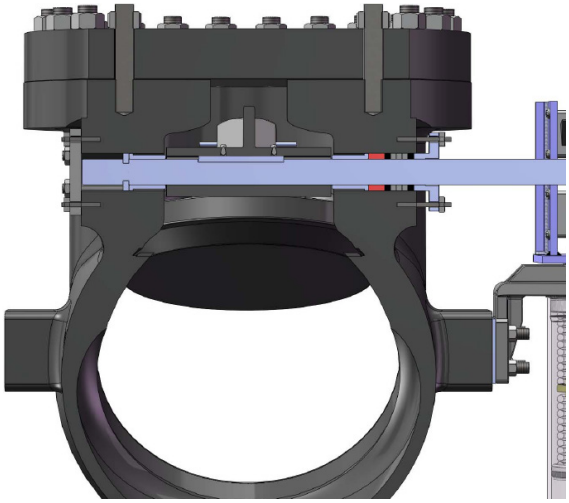
Since 1929, TRILLIUM Valves USA™ has been manufacturing Atwood & Morrill® FREE FLOW™ Reverse Current Valves. The A&M® FREE FLOW™ has become the industry standard for steam turbine protection in the global power generation market. Contact us for a worldwide installation list or customer references

Our offering of FREE FLOW™ Reverse Current Valves is as follows:

- Sizes: 3” to 48”
- Pressure Classes: 150-1500
- Materials: Carbon, Alloy or Stainless Steel

Expedited lead times and pricing for outage emergent work are available upon request.





The A&M® FREE FLOW™ is designed in accordance with ASME B16.34 and has been certified to meet SIL requirements (IEC 61508:2010, Parts 1-7). TRILLIUM Valves USA™ can support your plant with replacement valves, spare parts, technical and field service support.

24/7 Technical Support

1-978-744-5690
(8 am to 4:30 pm EST)

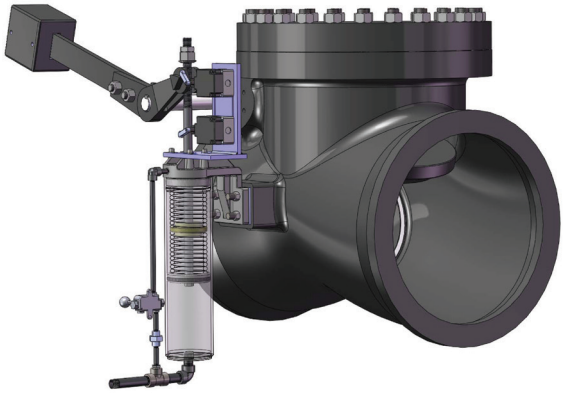
1-877-411-9347
(after hours & weekends)

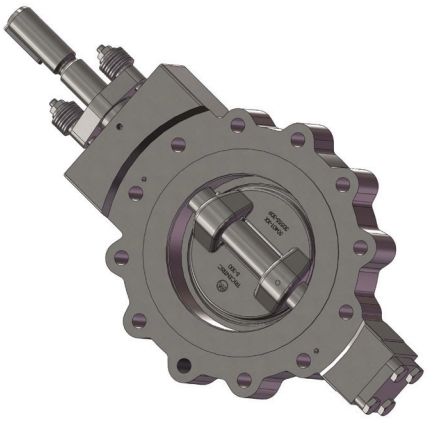
SB3 R2

Technical Support Program - Valves & Parts

TRILLIUM Valves USA™ supports our valve offering with original equipment replacement parts. We understand your needs in keeping critical plants operating and your concerns when a failure occurs or plant/system turnaround is scheduled. For this reason, we offer Atwood & Morrill® , Hopkinsons® and TRICENTRIC® spare parts

- Spare parts available for:
  - Compressor Discharge Check Valves
  - FREE FLOW™ Reverse Current Check Valves
  - Parallel Slide Gate Valves (PSGV)
  - Spring Relief Valves
  - Three Way Valves
  - TRICENTRIC® Triple Offset Butterfly Valves
  - Wye Globe Valves
- Genuine fully Warranted OEM parts.
- Dedicated customer focused aftermarket organization.
- No compromise on OEM quality.
- OEM Authorized service crews available for on-site installation help.





24/7 Technical Support

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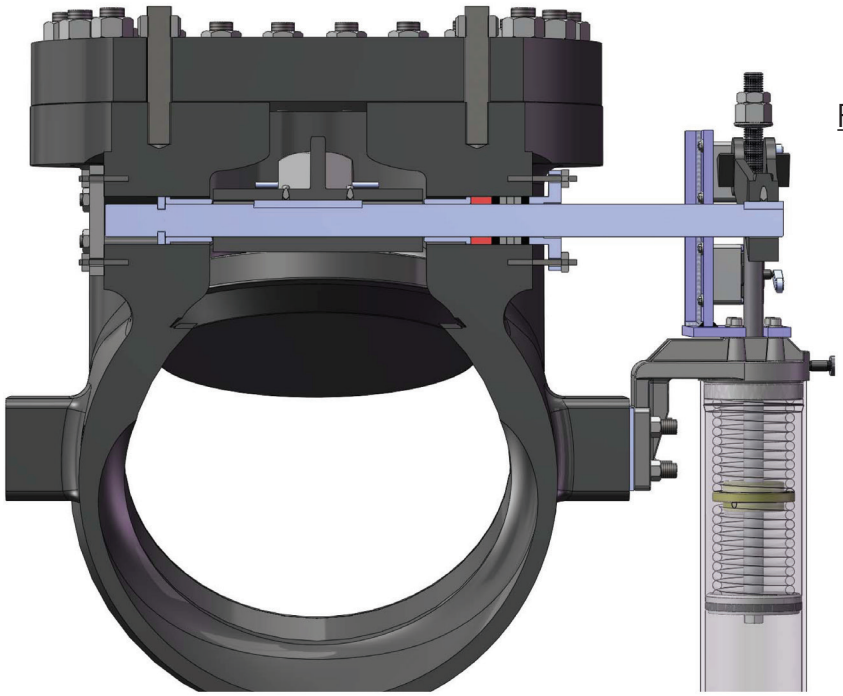
1-877-411-9347
(after hours & weekends)

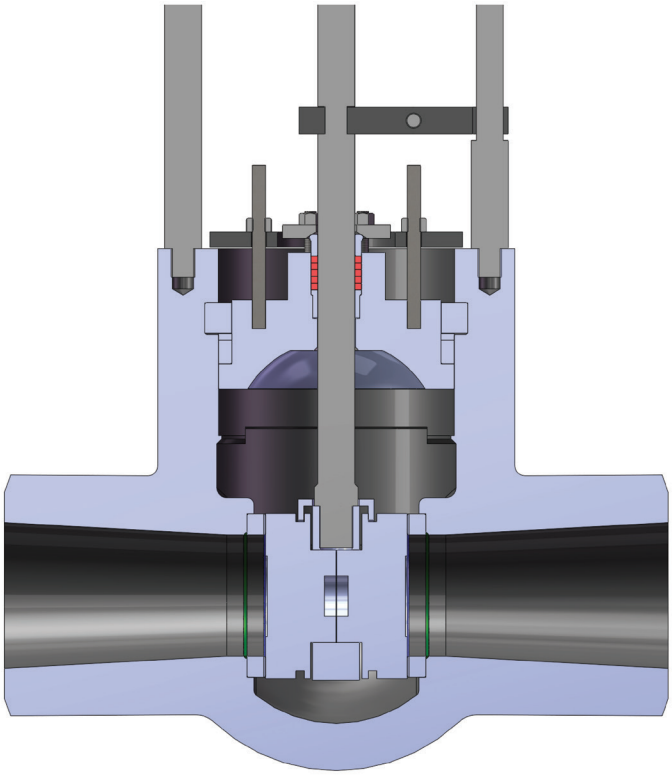
Our mission is to provide world-class quality valve products and services to the global power, nuclear, industrial, oil and gas industries by exceeding the expectations and requirements of our customers. We are committed to a continuous quality improvement philosophy in all facets of our business and we strive to achieve total customer satisfaction. Contact us at +1 978 744 5690 for spare parts and technical support.



Recommended Spares:

FREE FLOW™

- All Soft Goods
- Bushings
- Split Ring
- Shaft
- Keys
- Insulating Spacer
- Air Cylinder Can
- Air Cylinder Repair Kit
- Piston Rod
- Disc Nut Pin



Recommended Spares:

PSGV

- All Soft Goods
- Bushings
- Locking Tab
- Stem & Carrier Ring
- Spring
- Shoulder Screws

SB3 R2

ATWOOD & MORRILL® Parallel Slide Valve Case Study

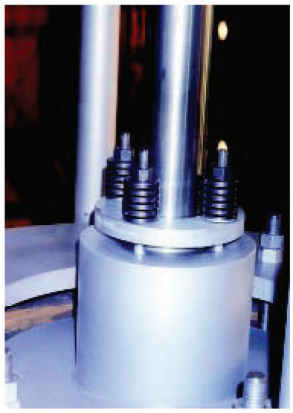
ATWOOD & MORRILL® Parallel Slide Valves are a proven solution for high temperature service. Trillium Engineers designed a 36" ASME Class SPL INT 705 valve relying on more than 30 years of experience with Parallel Slide Valves and modern techniques such as Finite Element Analysis. Special consideration was given to the high temperature and need for exceptional seat tightness. Production tests indicate that these valves have zero leakage. Four of these valves will be used to provide isolation for the Hot Reheat lines at Keyspan Energy's Ravenswood Power Plant on Long Island, New York. Design conditions are 725 psig at 1010ºF.

Parallel Slide Gate Valves are the best solution for high temperature service. They are position seated and allow the discs to contact the valve seat without any wedging forces. The discs can move freely to accommodate the expansion and contraction of the valve body caused by temperature changes and pressure forces. The best designs like the ATWOOD & MORRILL® design allow the cool stem to freely expand when inserted into a hot valve body.

The A&M® Parallel Slide Gate Valve is position seated (not torque seated) with independent discs, features that eliminate the possibility of thermal binding. Thermal binding is a condition commonly associated with Wedge Gate Valves and occurs when the valve is closed when hot and subsequently cools and contracts, trapping the Wedge between the seats. Frequently, it is not possible to open a wedge valve without heating it with torches or dismantling it. Parallel Slide Gate Valves open easily under all conditions.

Parallel Slide Gate Valves are the best solution for high temperature service.

36" Class 705 SPL INT Parallel Slide Gate Valve WT – 25,300 lbs. 15 ½ Ft. Tall



Live Loaded Packing Prevents packing load loss due to:
- Thermal Expansion
- Packing Consolidation
- Bolt Creep

SB3 R2

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 1 of 2

Subject: FREE FLOW™ Reverse Current Valves - Preventative Maintenance **Bulletin No. 1.2**

APPLICATION

Turbine Extraction Check Valves.

PURPOSE

The purpose of this bulletin is to alert Power Plants equipped with ATWOOD & MORRILL® FREE FLOW™ of a potential for turbine damage and to make specific recommendations to prevent this from occurring.

BACKGROUND

There have been two reported incidents of turbine damage due to reverse flow that could have been prevented by the installed A&M® FREE FLOW™ valves. Upon investigation by Trillium, it was discovered that in the first failure the installed valves had received no systematic inspection or maintenance in several years. During disassembly and inspection of the valves, it was discovered that severe corrosion had caused the valves to bind to a point where they could not close.

In the second failure, investigation revealed that important internal parts of the valve had been fabricated by someone other than Trillium. The parts were neither machined nor installed properly with the result that the valve could not close.

Since the entire reason for installing the ATWOOD & MORRILL® FREE FLOW™ is to protect your turbines, any compromise of these valves should be taken very seriously. In both of the reported failures, routine systematic inspection of the valves and the installation of the correct parts, when required, would have prevented serious turbine damage.

RECOMMENDED PREVENTATIVE MAINTENANCE

The frequency (or periodicity) suggested are minimums.

MONTHLY

Exercise the valves utilizing either the test feature on the air cylinder or manually move the lever arm. Exercising the valve demonstrates that it is operating freely.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 2 of 2

EVERY TWO YEARS:

1. Replace the air or oil cylinder seals unless a history of very high operating temperatures indicates more frequent replacement.
2. Remove the cover to visually inspect the internal condition of the valves. Perform a paper test between the seal and disc as outlined in the Instruction Manual.

EVERY FOUR YEARS:

Completely disassemble the valves and visually inspect the internal condition of the valves.
Carefully inspect the shaft and bushings for indications of wear, corrosion and damage:

- Check the disc arm for bending or wear in the post area
- Check disc post for straightness and excessive wear
- Replace the air cylinder can or cylinder liner if so equipped
- Replace the gasket and packing
- There are three areas within the valve to inspect for signs of wear: between the shaft and the two bushings and between the disc arm and the disc post.
- If signs of wear are visible, record the dimensions as a bench mark to assess the wear rate of internal valve components. This will help determine how often to replace components or disclose wear patterns which should be investigated further.

EVERY EIGHT YEARS:

Completely disassemble the valves as described above and replace shaft, bushings, split rings and shaft dog if so equipped.

SUPPORT SERVICES AVAILABLE:

TRILLIUM Valves USA™ can offer assistance to our customers in this important preventative maintenance effort:

1. Repair Kits
2. Recommended Spare Parts List
3. Duplicate Service Manuals
4. Field Service Engineers

CONCLUSIONS

ATWOOD & MORRILL® turbine protection check valves have been around for so long they are often forgotten and neglected. These valves play a vital role in protecting turbines against reverse steam flow on turbine trip and, in certain cases, water induction. Neglect, as well as improper parts and assembly, has resulted in turbine damage in two separate documented incidents. Following the recommendations contained in this bulletin will mitigate against future turbine damage of this nature.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 1 of 3

Subject: FREE FLOW™ Reverse Current Valves **Bulletin No. 2.2**

PRODUCT

FREE FLOW™ Reverse Current, Extraction Steam Check Valves with Internally Balanced Shaft (IBS). Most A&M® valves 12" and smaller have the IBS design. IBS design allows a free swinging disc without packing friction.

PURPOSE

Our field service reports have noted improperly adjusted A&M® IBS Check Valves. Visual inspection of the valve, while in service, can help maintenance personnel identify incorrect air cylinder piston rod adjustments. This bulletin provides instructions to identify and correct improper setups to avoid the possibility of valve failure and help prevent damage to steam turbines.
Quick, In-Line, Visual Inspection Can Identify Potential Problems.

BACKGROUND

The FREE FLOW™ Reverse Current Valve features a two step closing method. First, it acts as a swing check valve. Second, the side air cylinder provides a positive closure mechanism. The cylinder does not open the valve.

When the side air cylinder is energized (piston extended), the shaft and shaft dog are turned to allow the disc to act as a free swinging check. It will open under positive flow conditions. The disc will close under its own weight when the flow has stopped or a flow reversal occurs. Releasing the air from the cylinder allows the spring to give a closing force to the disc.

Check Valves must be setup correctly to operate and protect the turbine.

VISUAL INSPECTION

A valve which has been improperly setup can quickly be spotted by looking at the Inspection lever arm adjustment nuts. Wide Gaps between the flange nut faces and lever arm indicate that the valve may not function as designed. The valve needs to be reset as soon as possible.
Note: Adjustments for proper setup can only be done with the valve cover removed.
Quick visual inspection is not an assurance that the valve has been properly set, as the exact disc position is not known.

Incorrect Setup:
more than 1/8" between bottom Flange Nut Face and Lower Arm.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 2 of 3

External Visual Inspection is NOT a Substitute for Internal Inspection by a Trained Technician!

RECOMMENDED INSPECTION

Verify that the air cylinder is "open", i.e., the normal air supply pressure is being applied underneath the air cylinder piston and the lever arm should be set with the piston rod fully extended.

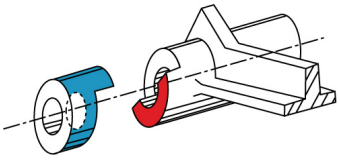
Inspect the clearance between the lever arm and the flange nuts on the air cylinder piston rod.

- **Tight Against the Bottom (Cylinder) Side Flanged Nut**
- **Within 1/8" (One Turn) Clearance from the Top Flanged Nut**

The valve will require adjustment during the next available shutdown if these conditions are not met. Do not make any adjustments at this time.

Correct Setup:
Flange Nut Face within 1/8" of Lever
Arm on IBS FREE FLOW™ Reverse Current Valve

ADJUSTMENT PROCEDURE FOR CYLINDER PISTON, NUTS AND LEVER ARM



- Remove the valve cover.
- Remove the top flanged and jam nuts.
- Apply 70-100 psi air below the piston of the operating cylinder. This will extend the piston rod.
- Lift the disc directly by pulling upwards on the disc arm. Do not raise the disc using the lever assembly.
- Fully open the disc assembly until the disc arm stop firmly contacts the body. Ensure that the disc itself is not contacting the valve body.
- With the disc in the fully open position, rotate the shaft counterclockwise (move the lever assembly in the closed direction), until the shaft dog barely contacts the disc arm cutout. This places the lever in the correct position.
- Thread both the upper and lower flanged nuts within one turn (1/8") of contact with the shaft lever assembly and lock in place using the jam nuts.
- Lower the disc to the body seat.
- Exhaust the air pressure from the cylinder. The upper flanged nut should now force the lever connection down which in turn engages the shaft dog to the disc arm and firmly holds the disc against the body seat.
- Verify that the shaft dog does not interfere with proper seat to disc contact.
- Verify that the lever arm strokes easily between the two flanged nuts. If the lever arm does not stroke easily, this indicates that the valve packing is too tight, or that there is some misalignment of the piston rod and lever arm.
- Reinstall the valve cover using a new gasket.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 3 of 3

REPLACEMENT PARTS

The following valve replacement parts should be available at the beginning of a scheduled repair:

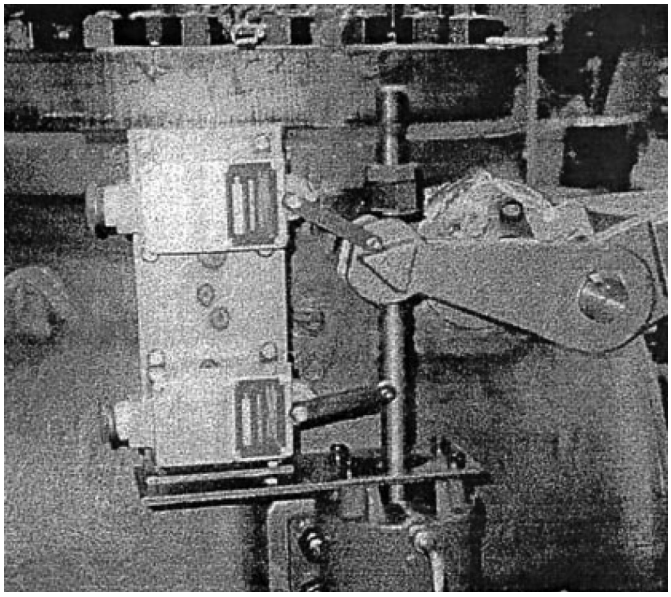
LARGER VALVES - NOT IBS

- Cover Gasket
- Shaft Dog Key
- Shaft Dog
- Lever Arm Key
- Packing

RECOMMENDED INSPECTION

A&M® FREE FLOW™ valves 14” and larger do not normally use the IBS design.
These valves have only one set of adjusting nuts on the top side of the lever arm.

If you encounter valves larger than 12” with an upper and lower adjusting nut, contact our office for resolution. This arrangement may be the result of incorrect maintenance or a special valve design.



RECOMMENDATIONS

Please contact TRILLIUM Valves USA™ at +1 978-744-5690 with any questions or to schedule a service appointment.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 1 of 2

Subject: Modification to New Style Air Cylinder **Bulletin No. 3.2**

PRODUCT

Air/spring closure assist cylinders on FREE FLOW™ Reverse Current Valves.

APPLICATION

Turbine Extraction Steam Check Valves. These valves prevent the introduction of steam, or water from a damaged heater, into the turbine.

PURPOSE

To advise power plants equipped with ATWOOD & MORRILL® turbine extraction check valves, which have cast iron air cylinders, of an upgrade modification which will save time and money and provide a more reliable system.

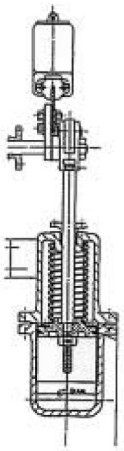
BACKGROUND

Over the years, ATWOOD & MORRILL® manufactured two different styles of air cylinders. Older valves have a cast iron air cylinder which can easily be identified by bolts which hold the upper and lower halves of its two piece air cylinder (Figure 1). Newer valves have a one-piece rolled steel air cylinder (Figure 2). The newer style has many advantages over the older one which are outlined on page 2 of this bulletin.

If you have not already converted to the new style cylinder, you should schedule to do so during your next outage. It is getting increasingly difficult for Trillium to support the older style and the economics of continuing to do so are not favorable.

The cost of a complete new air cylinder assembly, including the necessary adapters, is not much more expensive and can be less than a rehab or replacement of the old cylinder. Re-machining of the cylinder pad on the side of the body is not required to accommodate the new cylinder.

Figure 1



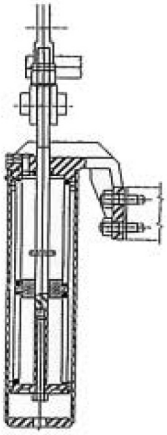


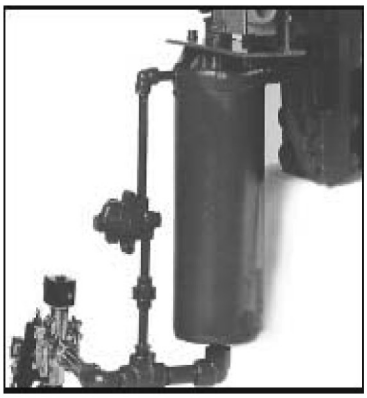
Figure 2

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 2 of 2

CONCLUSIONS

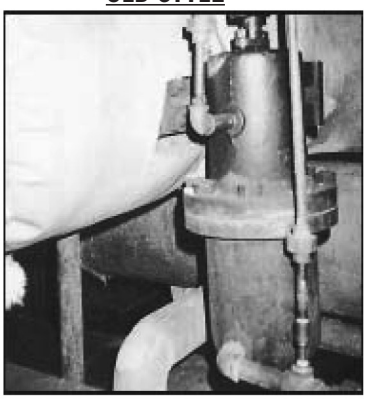
All FREE FLOW™ Reverse Current Check Valves equipped with the old style cylinder should upgrade to the new style during their next outage. It costs less than replacing the cast iron cylinder and has many advantages over the old style.

NEW STYLE



- **Time** One person can install, remove and transport the new style cylinder weighing about 70 lbs.; no chainfall is needed. This saves you valuable time and money during your critical outage season.
- **Availability** New cylinders are being manufactured every day for our new FREE FLOW™ Check Valves. New cylinders are available "off the shelf" with next day delivery for every part.
- **Better Design** Air enters the bottom of the cylinder preventing the least amount of condensation from building up. The new cylinders are specially treated with a coating to minimize wear and to prevent rusting.
- By removing just four nuts the entire actuator can be removed as a single unit, with no small parts to lose.
- **Cost Savings** Spare parts for the new cylinder assembly are much less than the old style. Repair time is much less and can be performed by one person.

OLD STYLE



- Three people are needed to remove or install the old cast steel actuator weighing 190-210 lbs. Chainfalls, slings and carts are needed to handle the old style cylinder.
- Spare parts of major components are no longer available off the shelf. Each replacement order requires long lead times.
- Air enters a side opening allowing rust and scale to build up in the bottom of the lower cylinder.
- A solid linkage system directly connecting the actuator to the shaft requires precisely locating the actuator on the valve body. The result is more time and skill expended.
- Pins with snap rings are used to connect linkage arms together. The snap rings are small, hard to handle and easily lost, delaying reassembly by hours.
- Spare parts for the older style air cylinders are expensive and require much longer lead times.

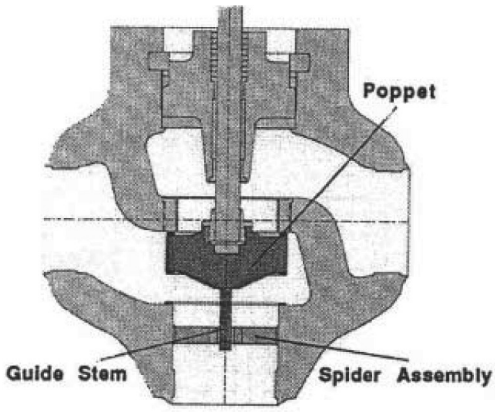
Reference: ATWOOD & MORRILL® 3-Way Valves	Pages: 1 of 3

Subject: 3-Way Valve Modification Kits to a Cage Guided Poppet **Bulletin No. 4.2**

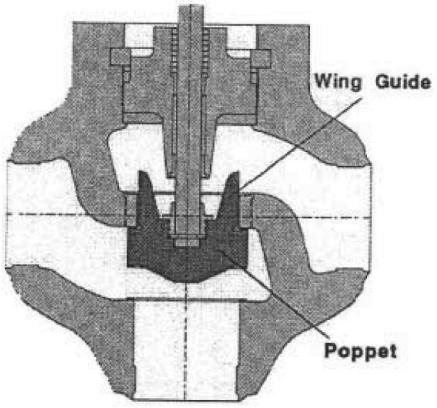
HISTORY

ATWOOD & MORRILL® 3-Way Valves have been in the power industry for many decades. These types of valves are utilized for HP & LP Feedwater Heater By-pass, Economizer Diverting and Continuous Process applications. When first manufactured the 3-Way Valves had a stem guided Poppet to allow the Poppet to seal properly. The Poppet is guided into a Spider Assembly via a Guide Stem that is located on the bottom side of the Poppet. The problem with this design is that the Spider Assembly sees pressures and flows that erodes the assembly and "washes" it away over the years. To remedy this problem we designed a Wing Guided Poppet that was engineered to have three wing guides that went on top of the Poppet to keep them out of the flow path and to guide the Poppet to the seating areas more smoothly. Although this design works well we enhanced the concept to allow for a guide that is more easily manufactured and quicker to manufacture. We now offer our new Modification to a Caged Guided Poppet as described in the following paragraphs. The two drawings below show the two older designs that you might have.

SPIDER DESIGN



WING GUIDED



Reference: ATWOOD & MORRILL® 3-Way Valves	Pages: 2 of 3

DIFFERENCES

The Caged Guided Poppet (as seen on the next page) provides the following design enhancements:

- The Cage Assembly has a 360-degree guide for the Poppet that is on top of the Poppet and out of the flow path, which prevents it from being washed away.
- The Cage Assembly guides the Poppet to the seating areas smoother with less vibration to the seating areas.
- The Cage Assembly spreads out the friction areas to a much larger area, which reduces operator load.
- The Cage Assembly eliminates the need for the field fit up of the spider assembly, which must be welded in place and then machined to accept the guide stem, which is time consuming.
- Reduces side loading of the stem.
- The Cage Assembly eliminates possible valve failure.

PARTS

The Modification Kit for the new Cage Guided Poppet includes the following new parts:

- Poppet with Cage Guide
- Stem
- Body Ring
- Poppet Nut
- Split Ring
- Socket Cap Screws & Hex Cap Screws
- Graphite Pressure Seal Ring (if desired)
- Backing Ring
- Five Ring Packing design with Spacer to Reduce Friction on the Stem
- Cover Bushing
- Lock Washers

SERVICE

Trillium has been installing these Cage Guided Modification Kits across the country utilizing our Service Personnel. We have the expertise to provide Service Personnel to refurbish your valves to assure years of trouble free performance. If you wish to explore the option of using Trillium's Service Crew please call the Service Department and we will gladly send you a proposal.

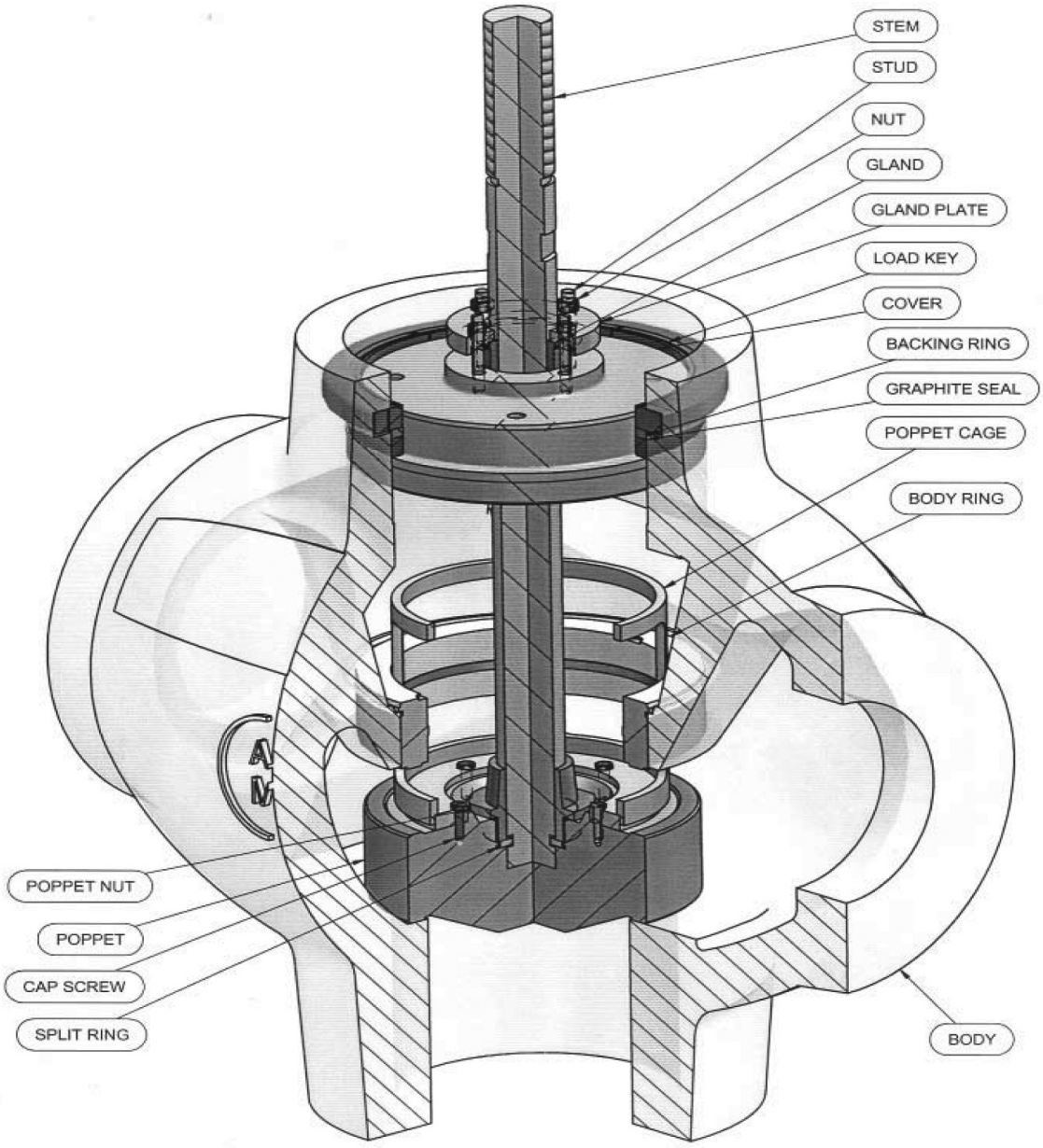
SUMMARY

Trillium highly recommends that all existing Spider Assembly 3-Way Valves in service be modified to the Cage Guided Modification Kit as described above. This Modification Kit will assure that the 3-Way Valves will provide optimal performance for many years with little maintenance. To obtain a proposal for this modification, please call the Service Department at +1 978-744-5690 or your local Sales Representative. Please have the valve tag information when calling so we can identify the valve.

Reference: ATWOOD & MORRILL® 3-Way Valves	Pages: 3 of 3

Subject: Diagram of Cage Guided Poppet

CAGE GUIDED POPPET DESIGN



Reference: ATWOOD & MORRILL® Trip Throttle Valves	Pages: 1 of 3

Subject: Trip Throttle Valves (TTV) Preventative Maintenance **Bulletin No. 5.2**

APPLICATION

Trip Throttle Valves are designed to protect steam turbines from over speed during upset conditions. The valves close quickly upon the loss of turbine lube oil pressure or a mechanical trip of the turbine. If the valve does not respond when required, the result can be a severely damaged turbine.

PURPOSE

To alert our customers to proper routine maintenance and give guidance on the minimum preventive maintenance requirements for Trip Throttle Valves.

BACKGROUND

Trillium has designed, engineered and manufactured A&M® Trip Throttle Valves for more than fifty years. Because the basic design is very robust, the valves provide many years of trouble free service. Many plants operate these valves "maintenance free". While this appears ideal, Trip Throttle Valves are intricate mechanical devices that do require periodic preventive maintenance.

Our customers often call us after the valve becomes a problem, or has failed to isolate the steam flow to the turbine. When we arrive at the site or receive the valve at the factory, the lack of proper preventive maintenance becomes apparent.

We often find broken hand wheels, missing operating instruction plates, missing or severely damaged steam strainers, inoperable balancing devices, worn, inoperable, and misadjusted trip linkages, and plugged or broken off grease fittings.

Even more concerning, we sometimes find **NON-OEM parts that DO NOT MEET our engineering or manufacturing specifications**. The combined effect of all of this neglect often renders the valves completely inoperable.

RECOMMENDATION

For the valves to remain operable and continue to provide protection, we recommend the owners of Trip Throttle Valves follow these preventative measures. The suggested frequency and inspection points are minimum.

EVERY SIX MONTHS

- Verify the valve is free to stroke by manually closing the valve approximately 10% of the stroke, then reopen the valve fully. The valve should stroke smoothly both open and closed with very little hand wheel resistance.
- For valves equipped with automatic exercising features: Verify that the valve exercises correctly and as predicted when using the exercising features.
- Visually examine the valve, paying particular attention to the area of the valve stem where it passes through the leak off bushings or packing gland. Remove any scale or residue that has accumulated in this area. We have seen cases where residue has caused the valves to bind.

Reference: ATWOOD & MORRILL® Trip Throttle Valves	Pages: 2 of 3

EVERY UNIT SHUTDOWN

- Verify that the valve operates correctly on a steam turbine trip. It should close rapidly and completely shut-off the steam flow to the turbine.
- Verify the condition of the grease fittings and lubricate all gearing with any good quality industrial EP grade grease.
- Do a complete functional test, simulating operation, after the unit is shut down and before a start-up. Simulate loss of lube oil pressure, or manually trip the mechanical linkage. At the initial start-up, perform a hot functional test to ensure there is no thermal binding.

EVERY TWO YEARS

- Open and inspect the oil operating cylinder. **If the oil trip cylinder does not function properly, the valve will not close as designed.**
- Replace all soft goods and seals.
- Inspect the cylinder bore for wear and/or gouges.
- Check the fit of any piston rings. **Our experience has shown repair** companies sometimes replace OEM piston rings with alternates. **These alternate designs can cause the valves to become inoperative.**
- Check the operating linkage making sure that it rides freely through all guides, and the pivot points still allow free movement of the parts.
- Check the trip latch point and be sure that the surfaces are not rounded and worn.
- Perform hot functional tests after restoration to ensure the valve still operates smoothly.

EVERY FOUR YEARS

Perform the two year maintenance **PLUS** confirm:

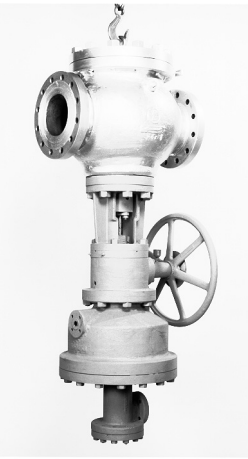
- **Main Seat Seal Weld Integrity:** verify by Seat Hydrotest or Liquid Penetrant test. Pressurize the valve inlet cavity up to the seat to line pressure (+10%) and hold for ten minutes. One should not see leakage around the main seat Outer Diameter. When using the PT test, the seal weld should only be judged acceptable if there are no linear indications, and no rounded indications greater than 1/16" in diameter.

- **Main and Pilot Seat:** Check the main and pilot seat areas for evidence of steam cutting or impact damage. Restore the seat faces to √32 RMS finish and verify good seating contact with transfer blue. **Gasket Faces:** Visually inspect the gasket seat areas of the body and covers. You should not see cuts or abrasions, and the serrated finish should still stand out above the flange face. **Always Use New Gaskets upon reassembly.**

- **Valve Stem:** Check the stem for any scoring or pitting, and verify that the stem is straight. Pay particular attention to the area of the stem that passes through the guide bushings. If the pilot seat is integral with the valve stem, it should be true and square to the stem. Replace the stem if necessary.

Reference: ATWOOD & MORRILL® Trip Throttle Valves	Pages: 3 of 3

EVERY FOUR YEARS



6” Class 600 Inverted Hydraulically Actuated Trip Throttle Valve

- Guide and Leak off Bushings: Visually inspect the conditions of the bushings, and check that the labyrinth grooves are clear of any foreign material. Make sure that the bushing retainer is still locked in place. Replace the bushings if scored.
- Poppet Guide Band and Cover Guide Bore: Visually inspect the condition of the poppet guide band and the mating surface in the cover guide bore. You should not find any scoring. If scored, restore the finishes, being careful not to remove too much material.
- Balancing Valve(s): Disassemble and inspect the balancing valve(s) found in the cover. Lap the seats in the cover using the balancing valve stem. Verify that the balancing valve stem(s) is straight, and replace if bent.
- Steam Strainer: Check the overall condition of the strainer and make sure it is not plugged and still has its original cylindrical shape. If the strainer shows evidence of impact damage or the screen is torn, replace it.
- Bevel Gear Set, Bearings, Spindle, Drive Nut and Keys: Clean and inspect the bevel gear and drive pinion teeth faces. Clean and inspect any thrust bearings. Replace worn bearings. Clean and inspect the drive spindle and drive nut. If the threads or key ways are damaged, restore the damaged area or replace the parts.
- Confirm the grease fittings are still functional and replace broken or damaged fittings. On reassembly always use new gaskets and keys and lubricate the drive gearing with good quality industrial grade EP grease.
- Tests: After refurbishment is complete, perform seat tightness and functional tests to assure that the valve is operating properly. During the initial start of the turbine, adjust the balancing valves as required for proper operation.

CONCLUSIONS

As with any complicated mechanical device, Trip Throttle Valves will protect your turbine reliably only if you do proper preventive maintenance with correctly specified parts. Trillium has a proud tradition of supplying the highest quality valves and equipment and continuing support services well after the design life has expired. We have issued this bulletin in the spirit of that tradition, and look forward to supporting your needs in the future.

SUPPORT SERVICES AVAILABLE

Trillium has all the parts, engineering, manufacturing and field technical resources needed to maintain these critical service valves. Some ways we can help include:

- Recommended Spare Parts List
- Repair Parts Kits
- Field Supervisors
- Valve Repair Crews
- Full Engineering Support
- Factory Reconditioning Service
- 24-Hour Emergency Service Assistance

WHERE TO CALL

Our service department is available 8 am – 4:30 pm EST, at +1 978 744-5690.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 1

Subject: Packing Upgrade **Bulletin No. 6.2**

PRODUCT

Improved packing system for ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valves (bled steam service).

APPLICATION

Older ATWOOD & MORRILL® valves, which have stuffing boxes designed for 6 or more packing rings.

PURPOSE

To provide an improved packing system which will offer better sealing for a longer period of time.

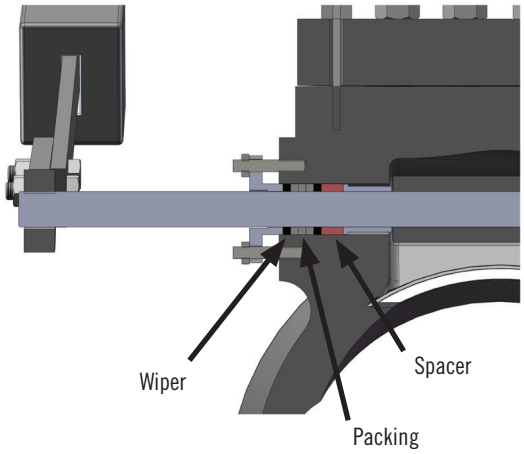
BACKGROUND

Valves designed for asbestos packing rings required 6 or more rings to get effective sealing. Modern packing systems do not have the same compressibility that asbestos did and do not work as intended in these older valves.

RECOMMENDATION

Convert older FREE FLOW™ valves to a modern Packing System using our Modification Kit. The kit includes packing, wiper rings and a spacer to provide the correct depth of packing. When possible, the kit will also be designed to limit over tightening of the packing gland, minimizing the possibility of the shaft becoming locked up by the packing.

Call our Parts and Service department at +1 978-744-5690 for price and availability. Installation by a trained technician is available.



Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 1

Subject: Mechanical Seal Replacement **Bulletin No. 7.2**

PRODUCT

New packing kit to replace mechanical shaft seals used on ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valves (bled steam service) on steam turbines.

PURPOSE

To provide a low cost alternative to mechanical seals on check valve shafts.

BACKGROUND

FREE FLOW™ Reverse Current Valves (bled steam) protect the steam turbines from overspeed caused by the energy available in feedwater heaters in case of a turbine trip. OEM Turbine manufacturers have always sought a way to assure themselves that the Bled Steam Check Valves are free swinging and can close quickly. Maintenance personnel frequently over tightened the older types of packing glands to stop small steam leaks. Mechanical pump seals were specified by one turbine manufacturer as a way to provide low friction sealing for the valve shaft. However, maintenance and replacement of these seals has proven to be expensive and time consuming.

New packing materials and proper maintenance procedures offer a cost effective method to provide low friction shaft sealing.

RECOMMENDATION

When mechanical seals require repair or replacement, consider replacement with a soft packing kit designed to fit your ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve. The kit includes all hardware and packing necessary to convert your valve to soft packing.

Call our Parts and Service department at 978-744-5690 for price and availability. Installation by a trained technician is available.

Reference: ATWOOD & MORRILL® MSIV	Pages: 1 of 2

Subject: ATWOOD & MORRILL® Main Steam Isolation Valves For BWR Power Stations **Bulletin No. 8.2**

APPLICATION

Main Steam Isolation Valves are utilized to assure tight shut-off of the Main Steam Lines. These valves were designed for Fail Safe operating reliability, design simplicity, tight shut-off, low-pressure drop and ability to open against differential pressure.

PURPOSE

To advise users of the ATWOOD & MORRILL® designed Main Steam Isolation Valves of the recommended frequency of maintenance. Years of experience have proven the reliability of these valves. These valves have seen an estimated 25 million hours of service. Based on this service we have developed a knowledge base of maintenance areas. This technical bulletin has been written to provide our recommended frequency of maintenance or inspection to insure continued operability.

RECOMMENDATION

These recommendations are based on experience derived from technical phone support, utility feedback, engineering design knowledge and on-site field representation.

EVERY REFUEL OUTAGE:

- With the valve stem in the open (retracted) position check stem for scoring and cleanliness.
- With the valve still in the open position, check the air cylinder, control panel and air supply lines for leakage.
- Measure valve stroke and check tightness of stem jam nut.
- Inspect closing springs for cracks or signs of deformation.
- Ensure all external bolting is secure.
- Measure packing gland plate for proper alignment and look for signs of leakage.
- Measure lower spring plate alignment and guide pin clearance.
- Inspect cover to body flange for indications of leakage.
- Look for oil leaks around the hydraulic dashpot cylinder, piping and speed control valves.
- Check limit switches for proper contact and operation.
- Perform valve closure and observe for smooth operation.

Standard replacement parts should be on hand consisting of cover gaskets, packing sets, locking tabs or plates and stem assembly.

Reference: ATWOOD & MORRILL® MSIV	Pages: 2 of 2

EVERY FOURTH REFUEL OUTAGE:

In addition to recommendations for **Every Refuel Outage**, perform the following:

- Refurbish air cylinders and control panel components. Use new seals for assembly.
- Remove packing. Inspect stem and stuffing box. Rework if necessary and replace packing.

Standard replacement parts should be on hand consisting of cover gaskets, packing sets, locking tabs or plates and stem assembly.

EVERY FIFTH REFUEL OUTAGE:

- Perform complete valve disassembly.
- Perform visual and dimensional inspection.
- Advisable to replace the inner and outer springs.

Replacement parts to complete this maintenance should consist of cover gaskets, packing sets, locking tabs or plates, air cylinder repair kit, inner and outer springs and stem assembly.

TRILLIUM Valves USA™ strongly recommends that a qualified service representative be involved whenever visual and dimensional inspections are performed. Moreover, questions involving dimensions or wear acceptance should always be resolved by a Trillium qualified service representative in conjunction with your site system engineer.

GENERAL

Be careful of out-dated or inaccurate information derived from non-controlled drawings or unqualified service suppliers that can lead to inaccurate inspection activities and results. There are many design variations from plant-to-plant and many components have been modified. This has made it necessary to revise many recommendations and contend with a growing number of incorrect interpretations and misunderstandings of critical requirements. Please feel free to contact Trillium regarding any of your MSIV conditions or questions.

Design Improvements and Product Upgrades List:

- One-piece forged stem
- Nose guided poppet
- Poppet anti-rotation
- Floating pilot poppet
- Pilot poppet anti-rotation
- Welded pilot poppet assembly
- Back-seated cover modification
- Enhanced stem guidance system
- Redesigned dashpot metering system
- Live loaded packing
- Torque nuts for cover
- Air cylinder alignment tooling
- Power up-rate designs

Reference: ATWOOD & MORRILL® Compressor Check Valves	Pages: 1 of 4

Subject: Preventative Maintenance **Bulletin No. 9.2**

APPLICATION

Protection of Large Critical Service Compressors in Refineries and Hydrocarbon Process Plants.

PURPOSE

To alert refinery operating and maintenance personnel of the need and importance of proper maintenance and testing for these critical service valves. These recommendations are based on experience derived from technical phone support, utility feedback, engineering design knowledge and on-site field representation.

BACKGROUND

The A&M® Compressor Check Valve is used on large size compressors and air blowers used in Fluid Catalytic Cracker Regenerators (FCC) and control loops, coker heaters, wet gas compressors, ethylene compressors and other high energy systems. In FCC applications, the check valve prevents reverse flow of catalyst fines which can damage the compressor and start fires outside the compressor inlet. Similar damage can occur in coker heater applications. In ethylene applications high energy can reverse the compressor rotation if backflow occurs. If multiple compressors supply a process, failure of the driver for one compressor can result in flow reversal and backward rotation of the unit with serious damage if the check valve binds.

Reports from Insurance companies and field service personnel have identified a lack of basic maintenance and testing for these valves as the most likely cause of failure. The most critical thing is the regular exercising of the valve. This will confirm that the valve is free to operate.

MAINTENANCE FACTORS

The following factors are the most common reasons for the compressor check valve to bind:

1. **Packing Friction:** Over tightening of the packing gland can cause the valve to bind. Care should be taken when replacing the packing or tightening the gland. The gland should be pulled down evenly, not cocked or tipped, such that it does not press on the valve shaft or body stuffing box. The gland should not be pulled down so tightly that the packing impedes the free and easy movement of the valve shaft. Whenever the packing gland nuts are adjusted the valve shaft must be checked to assure it is free to move and is not bound. Packing and grease lubrication sticks should be routinely replaced during extended shut down periods or once every two years.

2. Corrosion and foreign debris between the piston rods of the dashpot and air cylinder may cause or contribute to binding. When valves are located outdoors and subject to the effects of weather, the protective bellows should be inspected to assure that moisture or debris does not corrode or contaminate the shafts and piston rods. Damaged bellows must be replaced and corrosion corrected to assure proper operation of the valve. Weekly exercising of the valve utilizing either the test feature on the air cylinder or the lever arm. (Note: Test feature is a hand test valve piped between the air inlet and the exhaust port of the cylinder. This may or may not have been ordered with the valve. Trillium will be able to supply this if so desired.)

   Periodically check the dashpot oil (during and prior to winter operation) to assure no water has mixed in with the oil. If water enters the oil in these mechanisms, it can freeze rendering the check valve stuck in the open position.

3. Damage to the air cylinder and dashpot piston rods may occur due to improper adjustments or repeated severe closures. If the dashpot or air cylinder piston rods are bent, they should be replaced.

RECOMMENDED PREVENTATIVE MAINTENANCE GUIDELINES

CAUTION: KEEP HANDS AND HEAD AWAY FROM LEVER AND WEIGHT.
VALVE MAY BE TRIPPED AT ANY TIME BY CONTROL SYSTEM.

WEEKLY - and after initial installation and after every valve re-assembly:

1. Exercise the valves utilizing either the test feature on the air cylinder or manually move the lever arm. Exercising the valve demonstrates that it is operating freely.
2. Each valve should be exercised to insure that it is in perfect working condition before start-up and after shutdown as well as during operation under flow.

   FAILURE TO EXERCISE THE VALVE IS THE LEADING CAUSE OF VALVE BINDING AND COMPRESSOR DAMAGE. IF THE VALVE DOES NOT MOVE WHEN EXERCISING IS ATTEMPTED, THE VALVE WILL NOT PROTECT THE COMPRESSOR.

   AN EMERGENCY SHUT DOWN AND REPAIR SHOULD BE SCHEDULED.

3. Valves with side air cylinders and outside lever(s) should be exercised in the same manner using an air test valve if so equipped. They can also be tested by manipulating the outside lever toward closing and observing that the shaft and disc rotate freely.

Reference: ATWOOD & MORRILL® Compressor Check Valves	Pages: 3 of 4

EVERY TWO YEARS:

1. Visually inspect the bellows to assure that they will adequately protect the air cylinder, dashpot rods and valve shaft from moisture and foreign debris. If the bellows are damaged schedule replacement at the first available time.
2. Clean the air cylinder and dashpot of all foreign debris to eliminate possible binding between caps and piston rods.

EVERY FOUR YEARS:

3. Remove the valve cover to visually inspect the internal condition of the valve. Perform a paper test between the seat and disc as outlined in the Trillium Instruction Manual. Visually inspect the piston rods to assure they have not been bent from a severe closure and misalignment. Replace packing, grease fitting and cover gasket in accordance with the Trillium manual.

4. Completely disassemble the valve and visually inspect the internal condition of the valve. Carefully inspect the shaft and bushings for indications of wear, corrosion and damage. Replace the protective bellows for the valve shaft, dashpot and air cylinder piston rods:

   - Check the disc arm for bending or wear in the post area
   - Check disc post for straightness and excessive wear
   - Replace the air cylinder tube
   - Replace the protective bellows, gaskets, shaft packing and grease sticks
   - There are two areas within the valve to inspect for signs of wear: between the shaft and the two bushings and between the disc arm and the disc post. If signs of wear are visible, record the dimensions as a bench mark to assess the wear rate of internal valve components. This will help determine how often to replace components or disclose wear patterns which should be investigated further.

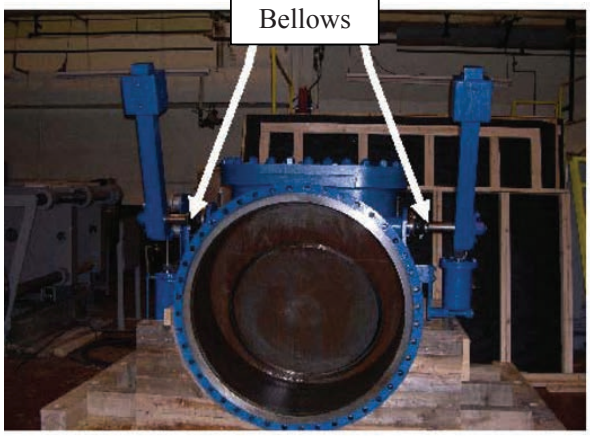
5. Replace the air cylinder seals, dashpot oil, oil seal and gasket. A history of very high operating temperatures may require more frequent replacement. Air cylinder repair kits are available from TRILLIUM Valves USA™ Clean the air cylinder and dashpot rods of all foreign debris to eliminate possible binding between caps and piston rods.

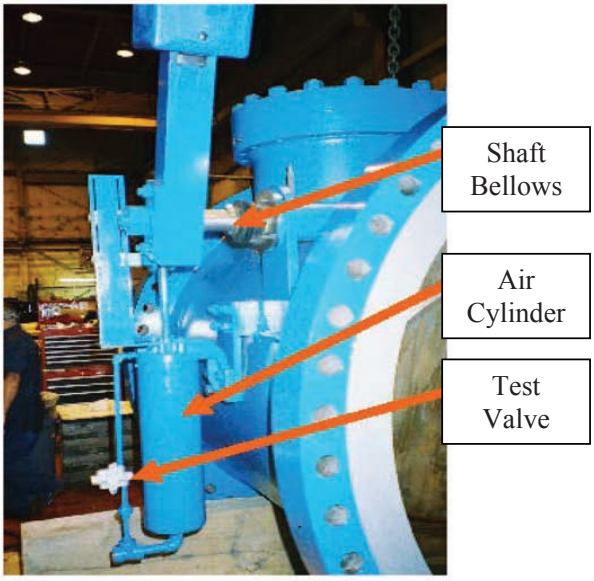
GENERAL MAINTENANCE

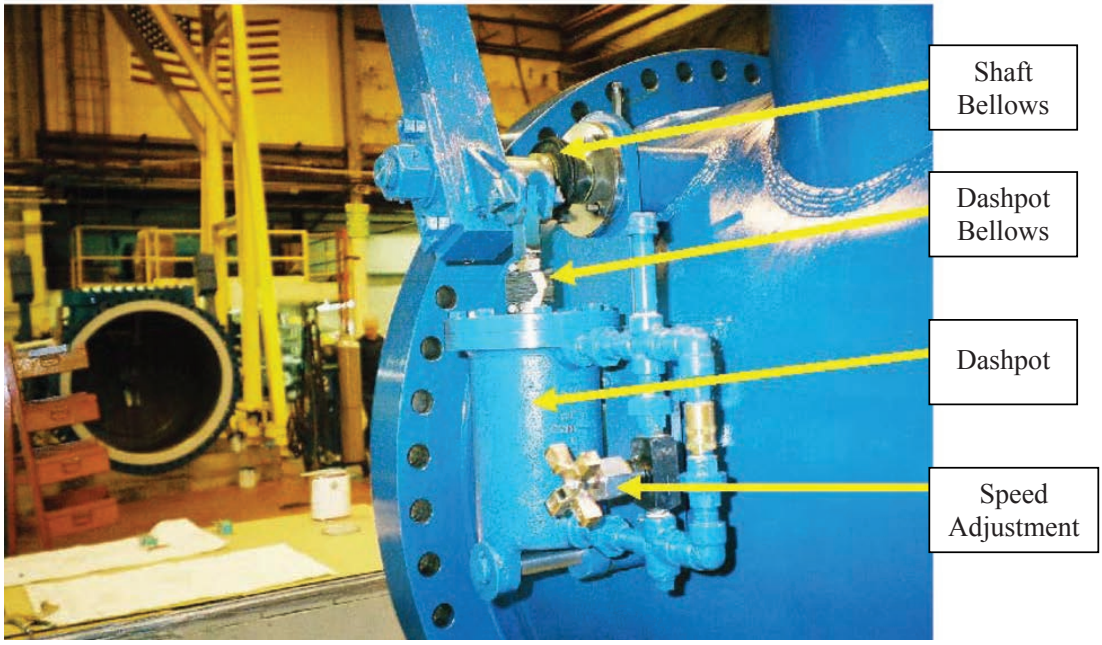
1. Seal or packing replacement, inspection or repair of the valve internals can be accomplished without removal of the main valve body from the line.
2. Check the condition of the valve before disassembly. Thoroughly inspect the valve shaft and all other exposed moving parts. Paint or other foreign matter such as dirt, rust or scale can greatly hamper the smooth operation of the valve.
3. Clean the surfaces wherever possible. Inspect the joints, connections and stuffing boxes where persistent leakage may occur.

Reference: ATWOOD & MORRILL® Compressor Check Valves	Pages: 4 of 4

DETAILS







Reference: Three Piece MSIV Stem	Pages: 1 of 2

Subject: Three Piece MSIV Stem Issues **Bulletin No. 10.2**

PROBLEM The three piece MSIV stem has been an issue since the original design of the MSIV. The original design incorporated a stem with a threaded on top spring seat with tack welds at the interface of the two parts. When it was discovered that the tack weld cracked, a dowel pin and then a taper pin was used to lock the two parts together. These too have failed with the result of the top spring holder coming loose and loosening the solid connection between the poppet and stem. The two pictures below illustrate the results of the parts separating.

This is not a safety issue as the valve will still close and seat tightly, but it does allow for accelerated internal wear.

SOLUTION The solution to the problem was to manufacture the stem from a one piece forging. This eliminated the screwed and peened connection, which completely eliminates the possibility of the spring holder loosening. This redesign also incorporates the anti-rotation lugs as part of the forging, which also eliminates the past practice of welding them on the edge of the spring holder.

The appearance and shape of the new redesigned stem is identical to the old fabricated stem and the form, fit and function are unchanged.

This is now a proven design enhancement and has been in service for many years with no problems. This design is in use in most of the valves in the U.S. and is now our standard offering for the latest ABWR MSIV design.

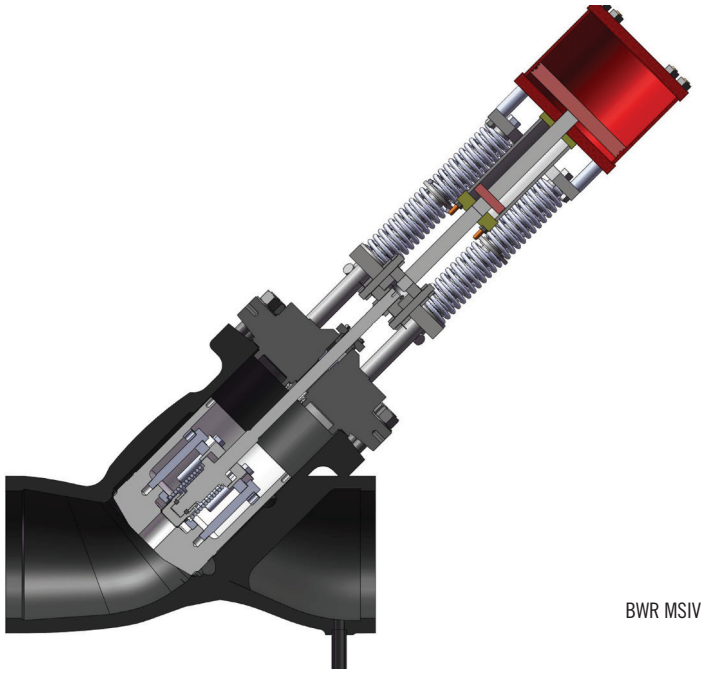
Due to the vastly improved design of the one piece forged stem and its continued successful service life, we have decided that we will no longer manufacture or supply the three piece fabricated MSIV stem after March 31, 2007.

This decision was made when we were informed this fall that for the second outage in a row a plant found that the spring holders on their MSIVs were loose. This was discovered by the unusual stroke characteristics exhibited during valve testing which necessitated disassembly of the valves.

Should your valve still use the three piece stem assembly and you wish to continue with that design we will accept orders for them until the March deadline, therefore you must order the stems that you feel will be consumed for the life of the valve before that cut-off date.

Should you wish to change the stems in your valves to this proven design we will work with and assist you in any way possible with the engineering evaluations required completing the design change.

If you have any questions or require more information, please contact us at +1 978-744-5690.



BWR MSIV

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 1 of 2

Subject: Possible Shaft Corrosion Issues **Bulletin No. 11.2**

ISSUE

TRILLIUM Valves USA™ is issuing this bulletin as a cautionary measure to alert our customers of possible shaft corrosion issues in our FREE FLOW™ Reverse Current Check Valves.

TRILLIUM Valves USA™ has recently seen a small number of cases where the valve shaft and packing chamber have been severely corroded. Each case of course is unique; however, all of the cases shared some common points:

- The operating temperature exceeded 400ºF.
- The flowing media is steam.
- The valve shafts rotate and do not move in and out of the valve in operation.
- Valve Shaft Material was either 400 series SST or 17-4PH.
- The braided graphic yarn packing or wiper rings contained PTFE.
- The packing might have been over-tightened and damaged.

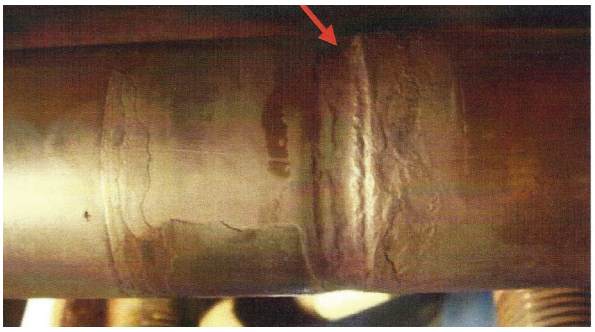
During our investigation of these cases we discovered that the graphic yarn braided wiper and packing rings that were used in manufacturing the product contained PTFE, even though the manufacturer's literature makes no mention of the PTFE. The packing manufacturers we spoke to have said that the PTFE content can be as high as 20%. The PTFE is used by the packing manufacturers to improve manufacturability, and to minimize packing friction. Unfortunately, these rings are rated by the packing manufacturers for steam service conditions up to 1200ºF, and when subjected to temperatures above approximately 400ºF the PTFE begins to sublimate into its constituent elements. One of the constituents of PTFE is fluorine gas, which in the presence of steam condensate can form a hydrofluoric acid solution that will vigorously attack the valve shaft and packing chamber surfaces.

According to some of the graphitic yarn packing manufacturers we spoke to, breakdown of the PTFE can be accelerated if the packing is damaged during installation by overtightening, or by the use of lubricants in installation of the packing. Fortunately, in most applications, the fluorine gas escapes from the packing chamber and the valve continues to operate normally. However, in some cases it appears that the gas did not escape and it has combined with the condensed steam and severely corroded the valve shaft and packing chambers.

These graphitic yarn packings have been used by TTRILLIUM Valves USA™ and the valve industry in general for many years. It is possible that you might have valves operating at your plant that have packing or wiper rings that contain PTFE.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 2 of 2

EXAMPLE OF SHAFT CORROSION:



WHAT YOU SHOULD DO:

You should verify that the issue does not exist in your FREE FLOW™ Reverse Current Valves operating in steam service with temperatures above 400ºF by:

- Checking the valve documentation to see if graphite packing is specified.
- Check packing gland areas for signs of leakage.
- Verify that the valve shaft is still free to rotate using the air cylinder exercise feature. Smooth rotation of the shaft would indicate that the packing is sound and corrosion has not initiated.
- At next availability, inspect shaft and packing gland area for signs of corrosion and replace packing suspected of containing PTFE.
- Verify that maintenance procedures do not require use of additional lubricant during packing installation.

We advise that you use appropriate PPE and engineering controls for handling the packing, which could potentially be saturated with Hydroflouric acid solution.

For further details or assistance, please feel free to contact our Field Service Department at +1 978-744-5690.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 1 of 11

Subject: FREE FLOW™ Steam Extraction Inspection Guideline **Bulletin No. 12.2**

FREE FLOW™ Reverse Current Valves provide important protection for steam turbines. They provide years of trouble free service in severe conditions. Because of their durability, they are often overlooked during routine maintenance. The severity of repeated operation of it during a steam turbine trip can result in damage to the valve, which prevents it from protecting the steam turbines.

This inspection guideline illustrates some of the conditions, which must be corrected to assure that the valve continues to protect the steam turbine. A detailed instruction manual is available upon request, by calling +1 978 744 5690

Disc Inspection Criteria-

- Disc to disc post perpendicularity must be checked to assure that the disc is free from damage resulting from cumulative severe flow reversals. Such damage as illustrated below will either prevent the valve from seating or could lead to material failure of the disc post. Failure of the disc post would allow the disc assembly to separate allowing the disc post, disc nut and disc to travel down the pipeline. Should this condition exist the disc should be replaced to eliminate possibility of material failure and to assure disc seating. **See Illustration A**

- Distortion of the disc as shown in the attached figure is indicative of years of cumulative severe closures resulting in fatigued material. Should this condition exist the disc should be replaced to eliminate possibility of material failure and to assure disc seating. **See Illustration B & C**

- The disc assembly is manufactured such that the disc is allowed to find its seat by maintaining a clearance of .031 to .061 between the Disc Washer and the Disc Arm. Without this space the disc will not be able to find its adjustment into the seat thus keeping it from seating properly. **See Instruction Manual Figure 7**

- Visually inspect seats to determine if seat cracking has started to occur. Should seat cracking be present the disc should be replaced or the seat should be completely machined off and replaced. **See Illustration D**

Disc Arm Inspection Criteria-

- The disc assembly should stroke roughly 45 degrees from the closed to open position. A stop is provided to position the disc in the full open position. After many years of service or turbulent service the disc stop will start to wear. Severe wear can lead to disc assembly damage or body damage resulting in valve failure. Additionally wear of the disc stop may be such that the disc stop may rotate far enough to wedge between the body and prevent the valve from closing.

  To check for this condition perform a visual inspection to assure that the edges of the disc stop are smooth and not distorted with sharp edges. Verify that the disc assembly in the open position does not contact the body. Verification of this should be performed at the two extremes of pulling the disc off center, as far to the right and left as possible to assure it cannot contact the body. Contact with the body will damage the body wall and could allow the valve disc to become stuck in the body. Should this condition exist, weld repair of the stop and grinding and blending can be accomplished to assure that the disc has traveled 45 degrees plus or minus 10 degrees between the open or closed positions. See Illustrations E, F & G

- After many years of service the cumulative effect of severe closures can distort the disc arm resulting in breakage or failure of the disc assembly to seat. Inspection of the disc arm can be accomplished by the following two inspections.

  With a straight edge, place the straight edge against the back edge of the reinforcement web of the disc arm. Visually inspect for a visual bend in excess of a 1/16-inch. (Taking into account the cast surface).

  Should this condition exist the Disc arm material has been stressed and must be replaced. Due to stresses and material fatigue no attempt should be made to straighten the disc arm. See Illustration H

Disc Arm to Bushing Clearance-

- There are two body bushings in the shaft journal of the valve body, one on the right hand side and one on the left hand side. The disc arm is located between these two bushings. With the valve cover off and the valve in the assembled condition an inspection should be conducted to assure that there is a clearance of .030 to .090 between the disc arm and each set of bushings. Care should be taken to assure that the disc assembly is centered while taking this measurement. This clearance is required to assure that the valve disc arm does not thermally lock to the bushings due to thermal expansion differences between the body, bushings and disc arm. Your valve may have spacers in between the disc arm and bushings in any event the .030 to .090 gap must be maintained. See Figure 6 in the Instruction Manual

Bearing Cover Interference-

- The bearing cover and area between the bearing cover and shaft should be visually inspected to assure that a washer/spacer has not been added. There have been several occasions where the end user has modified their valves by installing a washer/spacer in this area in an effort to center the disc. As the valve is packed the shaft is forced against the bearing cover. The end user was not aware that once the valve comes up to pressure that the shaft would be forced back into position. The use of washers/spacers will cause the valve to thermally lock preventing the valve from closing. Any washers or spacers must be removed. See Illustration I & J.

Seating-

- Valve seating can be checked by lifting the disc arm and disc assembly just enough to insert a .003 feeler gauge between the body and disc seats. Make sure that the feeler gauge does not have any sharp edges that could cut the seating surface. Lower the disc assembly onto the body seats. The feeler gauge should be firmly retained between the seats. This should be repeated at four points 90 degrees apart. If at any point the feeler gauge pulls out, the disc is not seating properly. This is indicative of the disc seats not being flat or the disc assembly is incorrectly set up. To remedy this, the seats should be checked for flatness. If the seats are not flat, proceed with appropriate lapping. In the event that the seats are flat, the disc assembly must be looked at for readjusting the disc spacers. See Figures 5 & 7 in the Instruction Manual.

- Inspect the seating surface of the body and disc to determine if they require attention. Visually inspect seats to determine if seat cracking has started to occur. Should seat cracking be present the disc should be replaced or the seat should be completely machined off and replaced. Any scratches or pitting from foreign matter would be from lapping.

Shaft-

- It is essential that the shaft run out on the portion of the shaft inside the valve have no more than a .003 to .005 total indicated run out.

- Visually inspect the packing area for any signs of steam cutting or galling marks.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 4 of 11

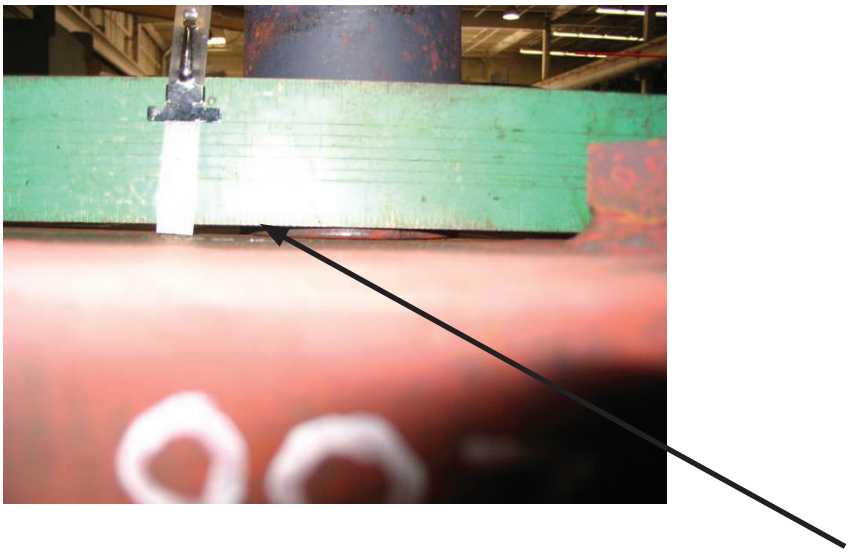


Illustration A
Illustrates a disc that has dished out from damage resulting from cumulative severe closures.

Illustration B
Illustrates a disc post that is bent out of position from damage resulting from cumulative severe closures.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 5 of 11

Illustration C
Disc post has lifted off the disc plate due to damage resulting from cumulative severe closures.

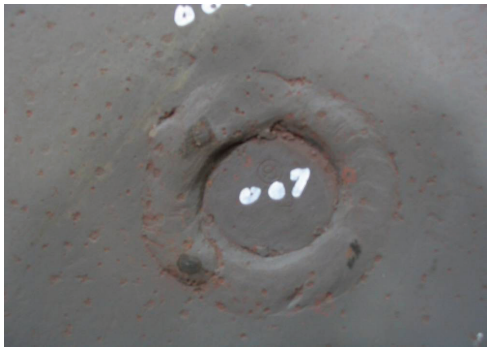


Illustration D
Visually inspect disc side opposite disc post for visual cracks.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 6 of 11

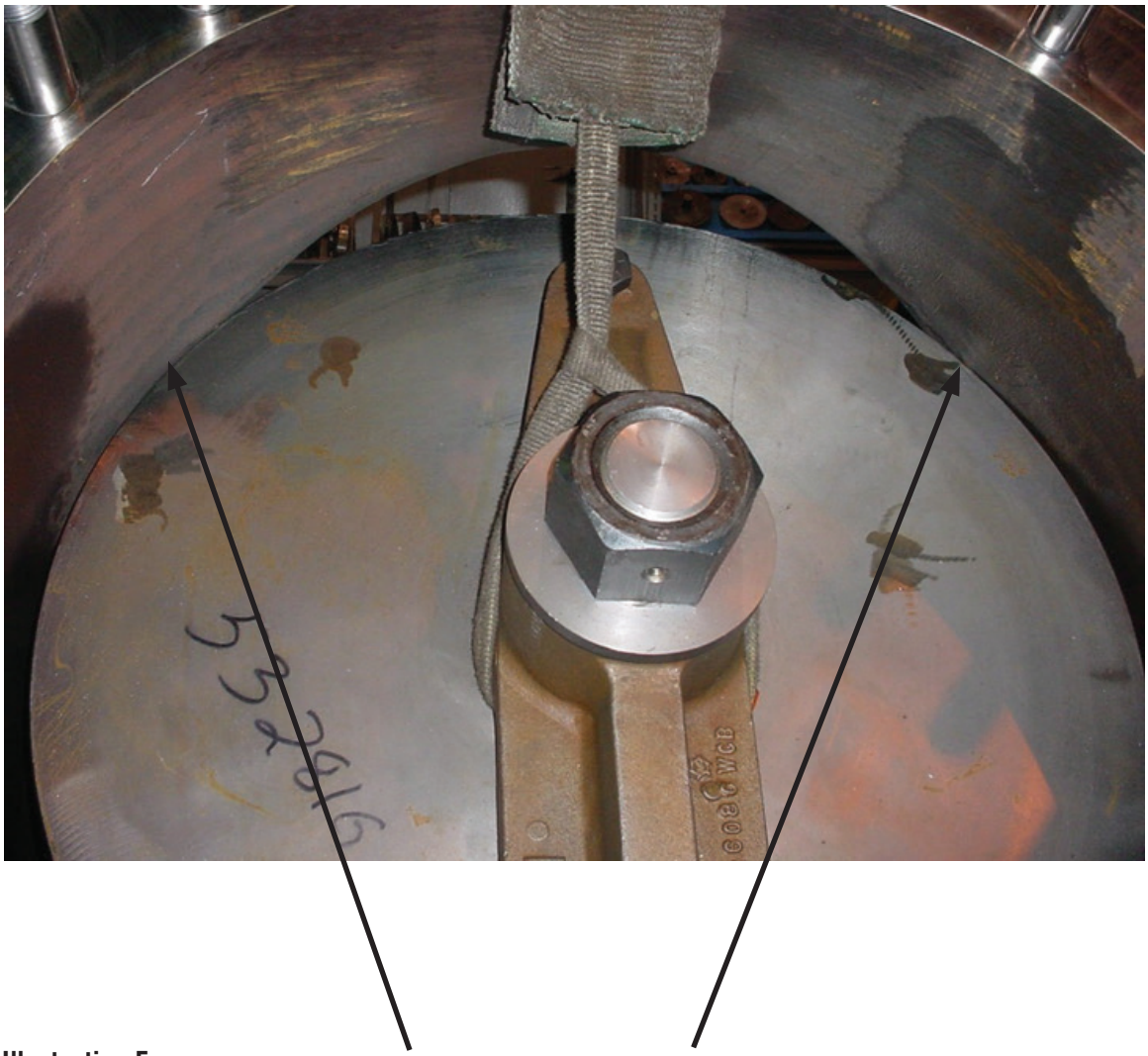


Illustration E

Areas shown above must not be in contact with valve body. A minimum of 1/8" should be maintained between body and disc.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 7 of 11

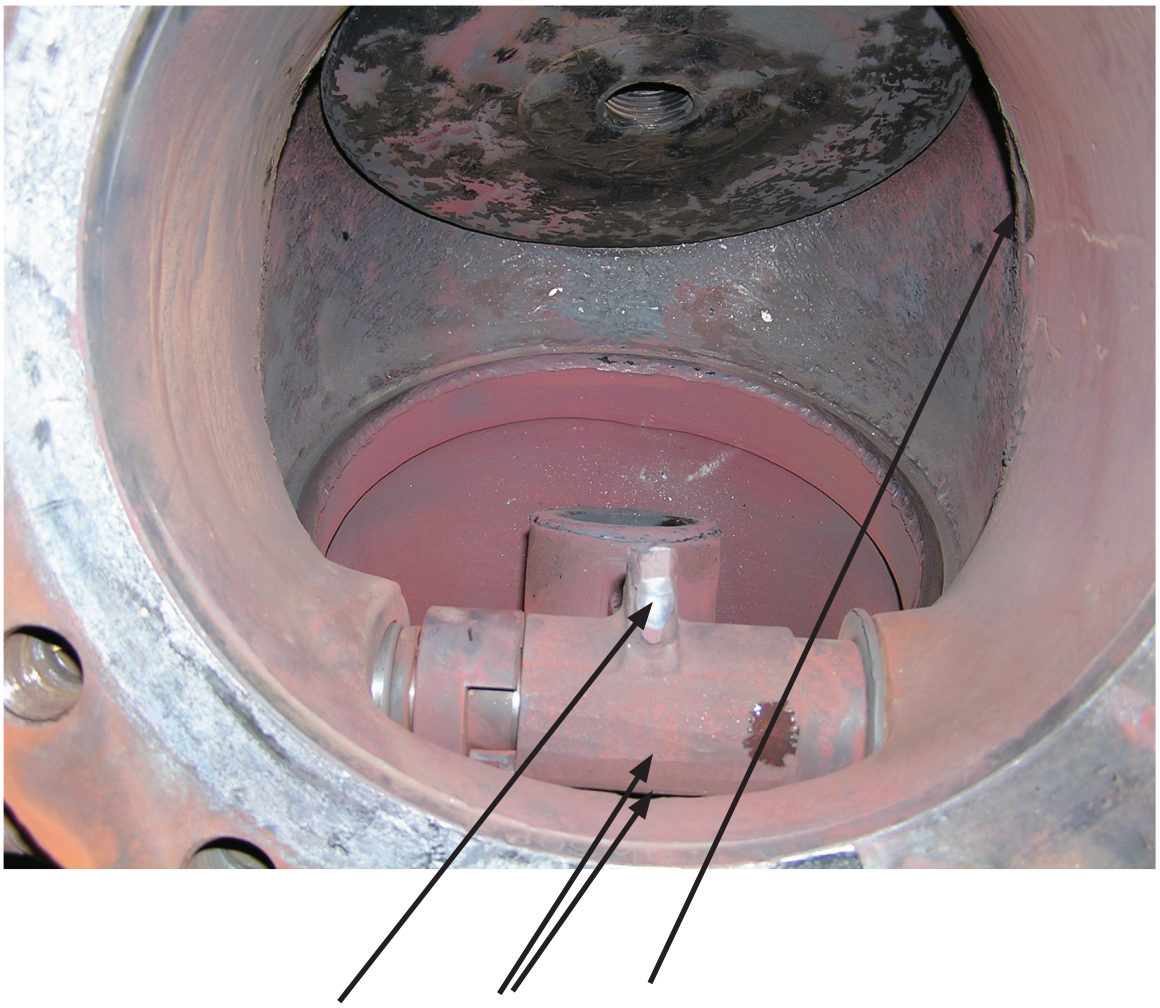


Illustration F

Disc Stop must be smooth and allow for 45 degree swing without over travel which could lead to stop wedging into the body wall at either the contact point of the stop to body area or the body wall area closest to the disc open position. The above disc is illustrative of a failure from this contact.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 8 of 11

Illustration G
Illustration of disc stop worn beyond acceptable smooth transition to prevent over travel and body to disc contact.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 9 of 11

Illustration H
Illustrates a disc arm that is bent out of position from damage resulting from cumulative severe closures.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 10 of 11

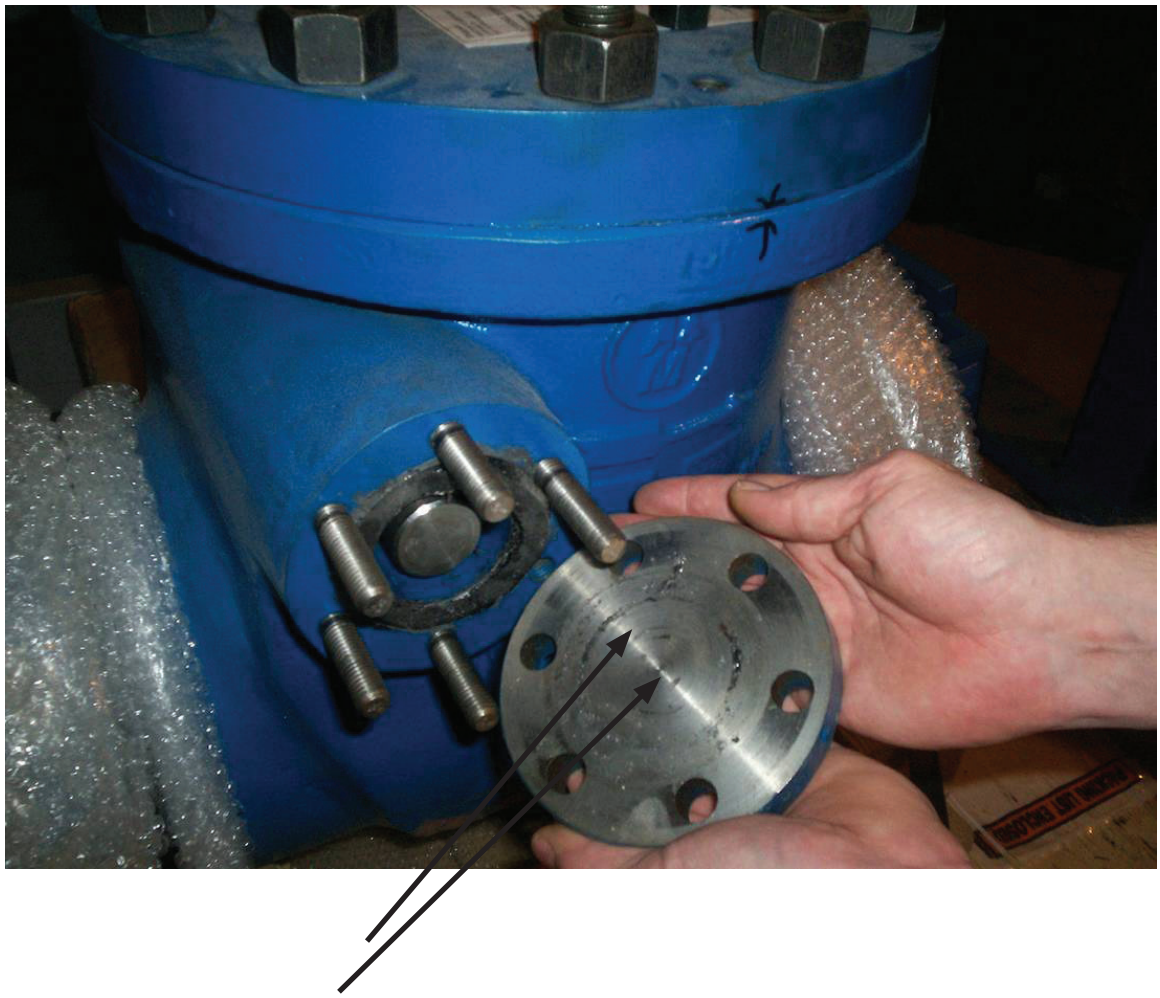


Illustration I

This cover should not have a spacer welded on it or between the bearing cover and shaft. A gap of a 1/32" minimum clearance between the cover and shaft must be present. This clearance is measured with the shaft pulled as far to the opposite side of the valve from this cover surface. Failure to have this clearance could result in thermal lock up of the shaft to bearing cover, keeping the valve from closing.

Reference: ATWOOD & MORRILL® FREE FLOW™ Reverse Current Valve	Pages: 11 of 11

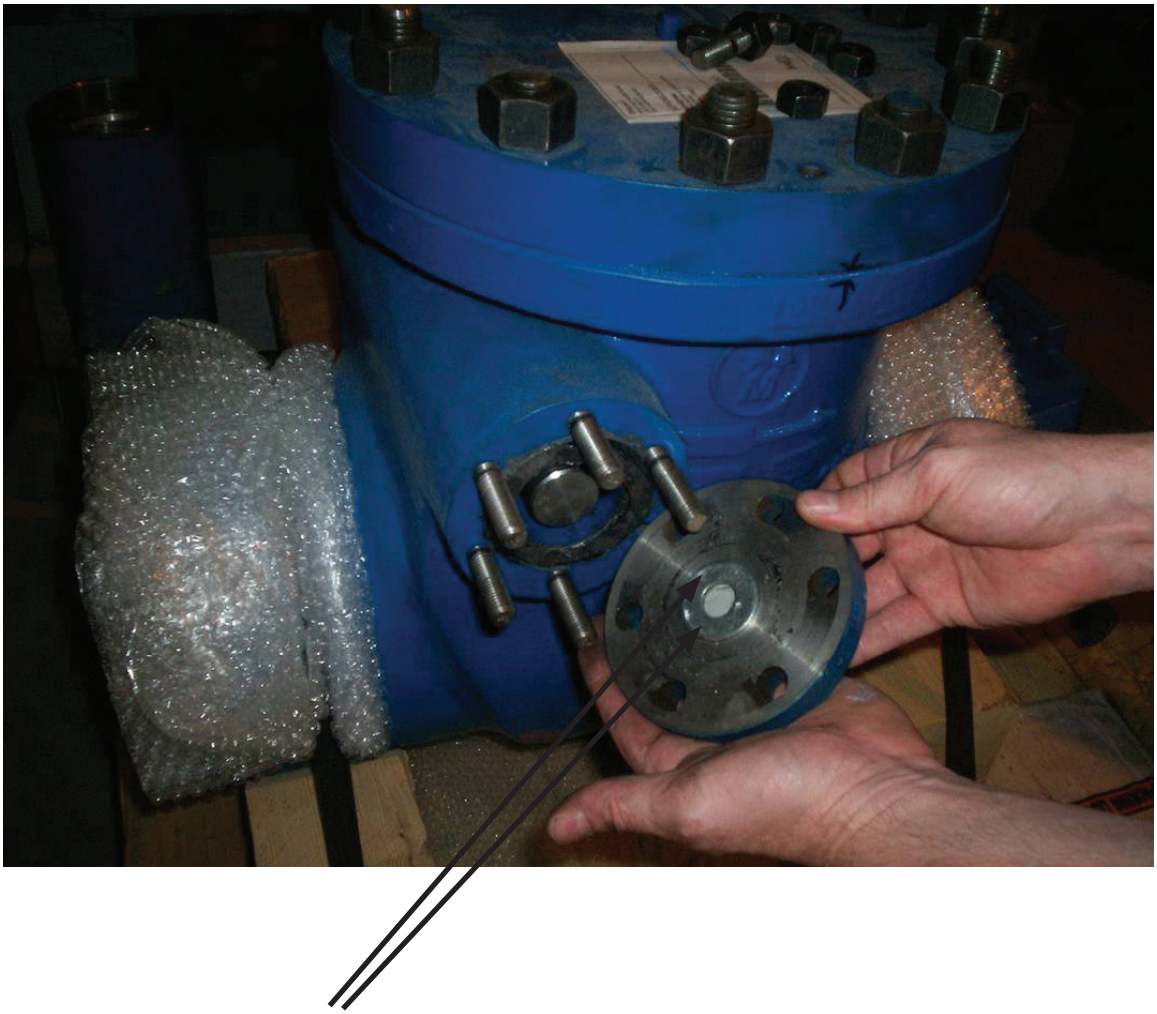


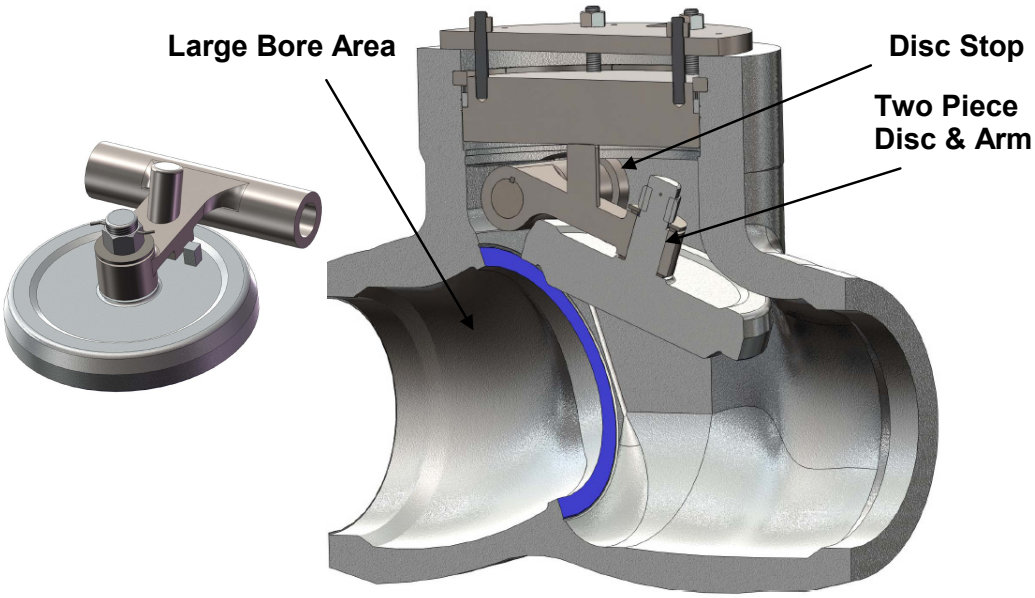
Illustration J

This represents the washers or spacers we have seen at various sites. These have been added in an effort to center the disc assembly. Personnel add these as they notice that the shaft is moved towards the bearing cover while installing the packing. Spacers and washers should never be added. The shaft will shift back when pressure is established in the valve causing a pee shooter effect on the shaft.

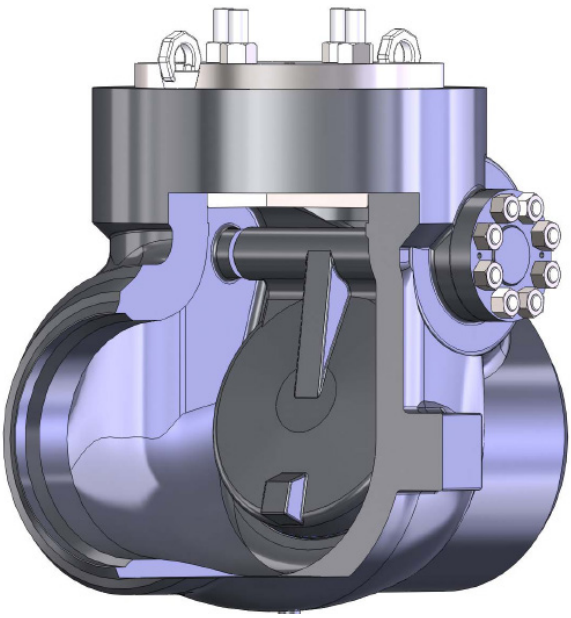
ATWOOD & MORILL® BWR Nuclear Feed Water Check Valves

Bulletin No. 14.2

TRILLIUM Valves USA™ has manufactured safety related Feed Water Check Valves for the Nuclear Industry for over 60 years. The Feed Water Check Valve is engineered to provide tight shutoff at a reversal of flow and to perform its containment isolation function. Current valve design provides low pressure drop due to a large unobstructed flow area producing a high Cv. The disc assembly is either a single piece disc and arm or a two piece disc and arm. A 20º body seat angle is utilized to allow the disc assembly to close faster during a reversal of flow (i.e. the seat angle allows for less travel to the closed position compared to a vertical seat). Stainless 300 or 400 series (if there are ALARA concerns) or Stellite* 21 material is used on the seats. The disc assembly may also be supplied with an optional temperature limited EPDM resilient seal. ATWOOD & MORRILL® proven leak tight seating design ensures repeatable success in Local Leak Rate Testing (LLRT).



Single Piece Disc & Arm



* Stellite is a trademark of Deloro Stellite Company.

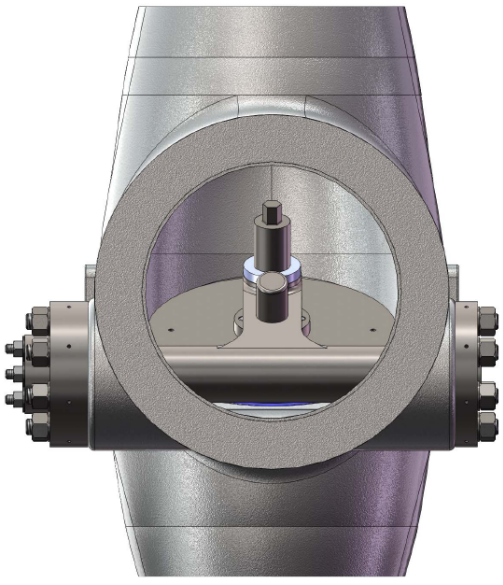
In November 2010 Trillium installed two modification kits to Detroit Edison's Fermi NPP's inboard 20"-900# Feed Water Check Valves. The modification included the following:

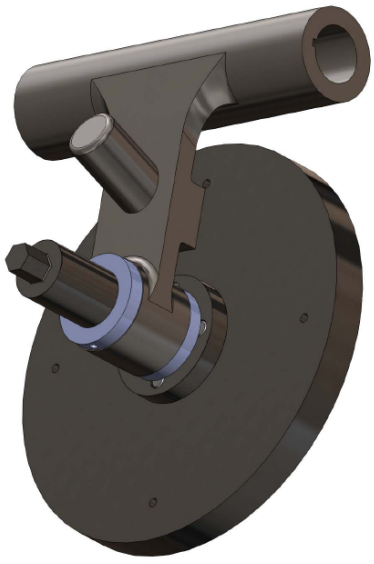
- Upgrading the disc & arm from a fixed single piece to an articulating two piece design
- Eliminating the air cylinder assembly
- Eliminating the through shaft design
- Hex head shaft used as an exercising feature accessible through a cover in one of the bearing housings

The two piece disc and disc arm arrangement with hard faced seating or stainless surfaces have been used successfully in many critical applications including feed water service. Hard faced or stainless seats endure system conditions better and longer than resilient seats. Maintenance on hard faced or stainless seats is straight forward and easy to perform by qualified personnel. A two-piece design is self-aligning as long as initial fit up is correct and flat conditions exist; it will ensure years of good performance from the valves. Trillium assured flat conditions on the seats were maintained by engineering a special lapping tool that would guarantee perfect geometry between the body and disc seat. After the valve was disassembled Trillium reassembled the valve complete without the disc and inserted our special lapping tool through the disc arm bore area (see pictures below). To obtain a highly polished flat seat the crew used lapping paper up to 600 grit.

Another feature of the modification was ensuring tight fitting clearances between the disc arm bore and disc post so the disc does not hit and slide at the twelve o'clock position. This feature prevents wear between the seats and also prevents post to disc arm bore wear. To ensure that correct fit up is obtained; the new disc arm bore must be set up precisely perpendicular with the body seat upon installation.

Simplifying the design by removing the air cylinder and through body shaft mitigates the potential for closure issues as a function of eliminating packing friction and the associated cylinder/ shaft linkage.





LLRT Results

Detroit Fermi

As left results in November 2010

- B2100F010A 1.77 SCFH (835 SCCM)
- B2100F010B 0.047 SCFH (22 SCCM)

Results from tests in March 2012

- B2100F010A 0.16 SCFH (76 SCCM)
- B2100F010B 0.14 SCFH (66 SCCM)

Trillium has also performed an alike modification to Taiwan Power Company's Kuosheng NPP 18"-1300# Feed Water Check Valves with great success as well.

As found results in October 2011

- 2AA-HV-109 6040 SCCM
- 2AA-HV-110 Greater than 6000 SCCM

As left results in October 2011

- 2AA-HV-109 737 SCCM (1.56 SCFH)
- 2AA-HV-110 28.3 SCCM (0.06 SCFH)

Note: on the 2AA-HV-109 valve, due to time constraints complete lapping could not be performed

As found results in March 2012

- 1AA-HV-109 Greater than 6000 SCCM
- 1AA-HV-110 Greater than 6000 SCCM

As left results in March 2012

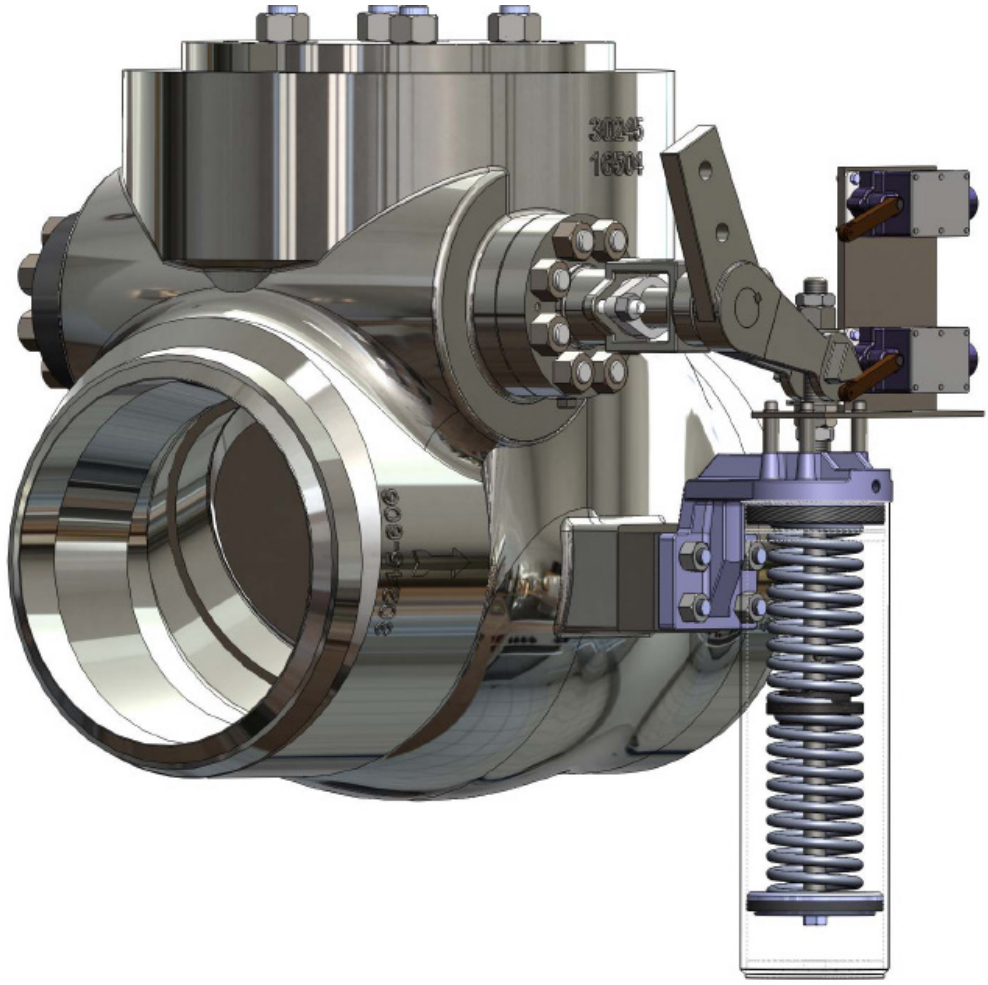
- 1AA-HV-109 750 SCCM (1.58 SCFH)
- 1AA-HV-110 690 SCCM (1.56 SCFH)

Comment: 40 - 60 hours of lapping by trained personnel should be anticipated to get a fine surface finish.

Conclusion

If the plant is experiencing LLRT issues with A&M® Feed Water Check Valves, you may want to consider purchasing new ATWOOD & MORRILL® Feed Water Check Valves. In manufacturing, the same engineering solutions are used in the above modifications to assure that the valves will enjoy years of favorable LLRT results. TRILLIUM Valves USA™ offers a wide range of materials and accessory options. Optional non-cobalt hard facing materials are available to address ALARA considerations. If ATWOOD & MORRILL® Feed Water Check Valves are installed presently and you would like to look at different modification solutions, please contact us anytime.

Kuosheng's Feed Water Check Valve



TRILLIUM Valves USA™ – Solutions for Hardened Containment Vent System (HCVS) Applications

Bulletin No. 15.2

The Nuclear Regulatory Commission (NRC) held a public meeting on 2 May 2012 to discuss how some U.S. nuclear power plants will implement NRC Order EA-12-050 regarding installation/upgrade of systems to vent pressure from reactor containment buildings.

BWR plants will need to begin formulating plans to harden the existing containment vents (Mk I plants) or install new vent systems where none existed before (Mk II plants).

After receipt of NRC Interim Staff Guidance in Aug 2012, licensees will be required to submit a comprehensive plan for compliance with the directive by 28 Feb 2013. Affected plants are expected to have the HVCS in place and functioning by 31 Dec 2016.

In order to comply with this directive, utilities are required to have systems that:

- perform under prolonged Station Black Out (SBO) conditions minimizing reliance on operator action
- are capable of remote operation/control; or local manual operation
- are capable of venting 1% of licensed/rated thermal power and maintaining containment pressure below the primary containment design pressure
- minimize exposure to hazards and radiological consequences
- provide real time status updates from outside containment
- have provisions for inspection, maintenance and testing
- are of a “seismically rugged design.” (HCVS and components).

Trillium has a proven track record of superior performance in HCVS applications with the installation of TRICENTRIC® triple offset butterfly valves.

- 30+ years of excellent service in operating BWR and PWR nuclear power plants
- Over 2,000 valves installed in nuclear plants worldwide in a wide variety of applications
- Considered the industry standard for specialized service applications in U.S. nuclear power plants.

TRICENTRIC® triple offset butterfly valves are designed, manufactured, tested and qualified in accordance with ASME QME-1, GL 89-10 (NRC Generic Letter) for Actuator Sizing, GL 96-05 for Periodic Verification Testing, ASME B16.34 and ASME Section III.

TRICENTRIC® triple offset butterfly valves have:

- a robust shaft design to support a full range of AOV and MOV actuator torques
- long-life, maintenance free, metal seats make TRICENTRIC® a safe and reliable choice for vent & purge applications
- a triple offset design allows non-interference seating to reduce wear
- tight shutoff at high temperatures (fire safe API 607)
- torque seated design ensures leak tight performance.

Trillium Sales Representatives, Sales Engineers and Product Engineers stand ready to assist each plant in developing a response to this Order. To discuss the specific design requirements of your plant, contact your Trillium Sales Representative or send your specifications to valvesusa@trilliumflow.com

FREE FLOW™ Reverse Current Valve

Bulletin No. 17.1

For Moisture Separator Reheater Drain Tank Service

Overview:

The moisture separator reheater (MSR) is employed in the nuclear steam cycle in conjunction with its saturated steam turbines. They are used in pressurized water reactors, pressurized heavy water reactors, light water graphite reactors, gas cooled reactors, fast breeder reactors and boiling water reactors.

Moisture separator reheaters are key components in the steam cycle and are installed between the high pressure turbine outlet and the inlet of the low pressure turbine to remove moisture from the steam and reheat before it enters the low pressure turbines. MSR's play a significant role in increasing the thermodynamic efficiency of nuclear power facilities and also protect the low pressure turbine blades from corrosion.

The steam supplied to nearly all nuclear units is dry, but at or near saturation conditions. Reheating of the steam is possible; however, the maximum reheat temperature is limited to the saturation temperature of the steam at the turbine inlet. This temperature is usually about 545° F as compared to 1,000° F reheat temperature for fossil units. The result is that nuclear units operate with wet steam throughout all, or nearly all, of the steam path. At the HP turbine exhaust the steam may have as much as 15% moisture. Operation with wet steam causes inefficiency and erosion.

Moisture Separator Reheaters are large vessels with special panels which force the wet steam to follow a zigzag path. These panels are made up of chevron plates. The water droplets cannot follow the same path since they are much denser than the steam. The droplets fall out and are drained from the vessel. These moisture separators can remove all but a small fraction of (less than 1%) the moisture in the steam.

Potential Problem:

A sudden loss of pressure within the MSR can cause the water down stream of the check valve to flash to steam. This sudden expansion causes a flow reversal which increases the Drain Tank level to or above the trip point. If the Dump Valve does not reduce the level within 10 seconds, the turbine is tripped. For this to occur, the check valve is either not closing quick enough or possibly leaking. With an improperly designed system, incorrectly sized check valve, or increase flow after a system uprate, the potential for turbine trips is real and costly.

Check valves, when installed in the normal drain path (to the feedwater heaters) should be located close to the branch point for the dump line to minimize the amount of saturated water upstream of the check valve. Installation at or near the feed-water heaters, just upstream of the control valves, is not recommended. Two-phase flow anywhere in the lines upstream of the level control valves can produce pressure pulsations and uncontrollable level oscillations in the drain tank. It is important that only single phase liquid exist upstream of the level control valves. Piping configurations that permit long runs are susceptible to flashing during rapid power reduction. The large volume of water in this line contributes to level excursions in the MSR drain tanks which may result in plant trips or near trips due to high moisture separator liquid levels.

Proposed Solution:

Install an ATWOOD MORRILL® FREE FLOW™ Reverse Current Valve

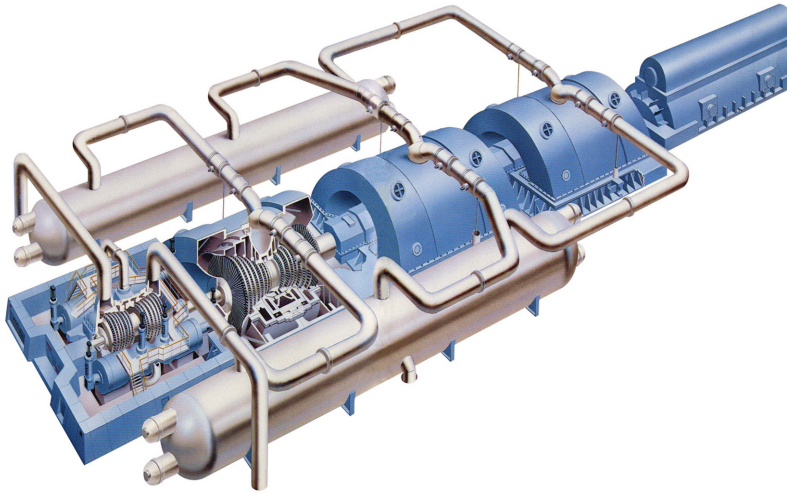
Features & Benefits:

- 30° Inclined body seat and 45° disc swing angle results in effortless opening and reduced closing angle resulting in faster closing
- Counterbalanced disc assembly for low flow conditions which allows easy opening and reduces pressure drop.
- Positive closing via side mounted air cylinder, if required, enhances basic swing check design by assuring rapid closure before flow reversal.
- Center of gravity of the disc assembly causes a positive seating moment; therefore, the weight of the disc is always acting to hold the disc firmly to the seat.
- Self aligning disc and disc arm assembly with disc anti-rotation feature
- Wide flat seats and rugged disc and body design eliminate seat deformation resulting in long trouble free service
- Adjustment of disc stop to ensure valve disc is stable and in the full open position (against the stop)
- Correctly sized valve for the specific service conditions.
- Various material and accessory options to assist with erosion/corrosion and operational issues within the MSR piping system

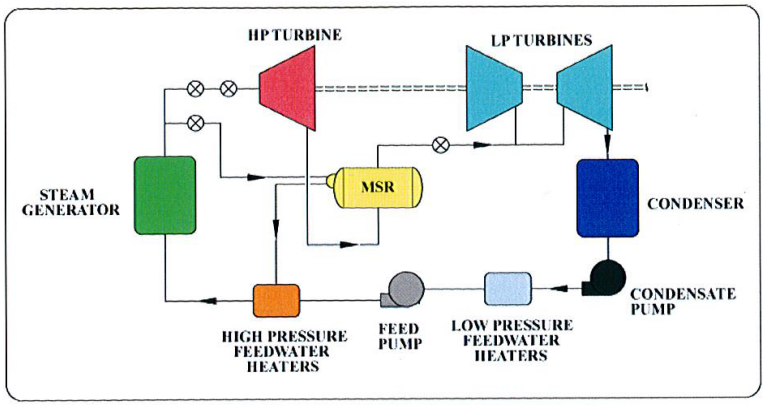
Summary:

1. MSR must handle an aggressive two-phase flow, both on shell-side and tube-side. The wet steam (water content appx 13%) occurring in the HP turbine upstream of the LP turbine inlet has to be dried and reheated.
2. Influence of MSR on plant efficiency is determined by three factors: (1) residual moisture, (2) terminal temperature difference (TTD) and (3) pressure drop.
3. Flashing within the MSR can cause sudden expansion and flow reversal, which increases the drain tank level potentially resulting in turbine trip.
4. Operating GenOne nuclear power plants have experienced issues with MSR performance, affecting plant efficiency and increasing the potential for erosion/corrosion of system components.
5. Due to changes in process conditions or operating modes during the service life of many plants, the steam fed to the MSR no longer conforms to the original design specifications. Hence, either more heated steam is required to evaporate the residual moisture or wet steam is admitted to the LP turbine. Both can cause considerable reduction in power output and erosion/corrosion damage.
6. Benefits of properly sized and operating MSR: MWe gain and LP Turbine blade life

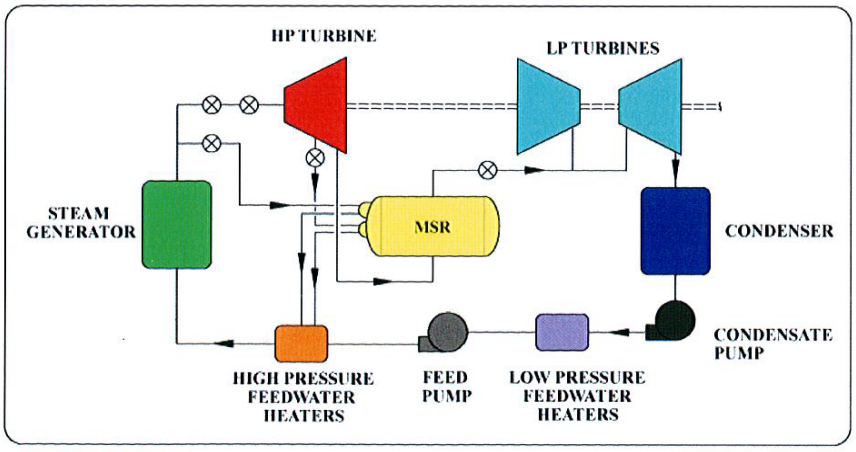
AP 1000 Turbine showing Moisture Separator Reheaters



https://cstools.asme.org



Typical Cycle with Single Stage MSR



Typical Cycle with Two Stage MSR

Mitigation of the Potential for Stem Failures in Wye Globe Main Steam Isolation Valves

Bulletin No. 27.3

APPLICATION

Wye Globe Main Steam Isolation Valves for BWR's and PWR's

PURPOSE & SCOPE:

To address concerns per NRC Information Notice 92-60: Valve Stem Failure Caused by Embrittlement, regarding the low threshold temperature for stem embrittlement in applications of 600° F and above. This bulletin is provided to alert operating nuclear plants of our recommendation to replace MSIV stems after ten years as a preventive maintenance measure. This ten year recommendation is a conservative estimate based on operating experience.

The scope of this bulletin addresses concerns with our standard stem/poppet configuration, when the stem is manufactured from ASME SA564 Gr. 630 (H900 through H1150) material. This material has performed well in ATWOOD & MORRILL® MSIV applications, and was selected for its ability to mitigate damage due to galling. The recommendation is a precautionary measure to avoid failures (in 17-4 PH material) due to the potential of stem embrittlement as a contributory factor in deterioration of the stem. Note that Trillium Flow Technologies™'s MSIV population has not suffered any stem failures in valves that have been modified (poppet stabilization).

BACKGROUND

There have been three recent, related MSIV stem failures; one in France, one in Slovenia and one at Plant Vogtle in the US. The failure at Plant Vogtle was not a Trillium design and is not a Wye Globe Valve. (That particular MSIV was a Wedge Type Gate Valve. The design and operating parameters associated with that failure are very different from Wye Globes.) For example, the tensile and shear loads are significantly greater on Wedge versus Wye Globe Valve designs.

The failure in France was on a Wye Globe MSIV that was manufactured by Delas (in France). This design differs from the Trillium design in the method of stabilizing the poppet. Trillium's current design includes 360° support of the poppet, providing greater surface contact area. Flatness can be confirmed by verifying total indicated run–out. The Delas method of stabilizing the poppet utilized three posts attached to the top of the poppet. If there is any wear on any one of the posts, the poppet will be side loaded which would put added stresses on one side of the stem. The intent of the Trillium design (poppet modification) is to eliminate poppet movement, vibration and the resultant cyclic fatigue (failure root cause).

The failure in Slovenia was a non-stabilized Wye Globe Valve, which was a Trillium designed and manufactured valve (manufactured prior to the poppet stabilization design modification). The failure of that stem was directly related to the valve not having a stabilized poppet assembly, allowing for fluid born vibration with secondary effects that may have occurred as a function of thermal embrittlement of the ASME SA-564 Gr. 630 H1100 stem.

MSIV POPPET STABILIZATION:

Poppet Stabilization for Flow: The unmodified design does not provide sufficient restriction to keep the poppet stable under flow, thus creating stress cycles on the button area of the stem. Note: Not all of the MSIV's have the button design as some have a solid pilot configuration. Trillium has modified the poppet assembly to backseat the main poppet on the cover; the stem provides a pre-tension load that holds the poppet against the seat under flow (see Figure 2). The units with stem failures were back seated on the stem to the cover, not stabilized on the cover (as does the present modified design). In the stem back seated configuration, the poppet was not supported to restrain the flow forces. These flow forces cause a vibration that is transmitted to the stem button region. The stem button, below the annular key groove, sees a compression load from the annular key acting downward onto this surface. Under non-flow conditions, the key produces a combined tensile load and moment based on the weight of the poppet from gravity. Figure 1 illustrates the Free Body Diagram for this condition, including the poppet mass acting downward due to gravity. The poppet mass was then divided into load tensors that would act upon the stem assembly. The resisting forces and moment required by the annular key groove are displayed on the stem.

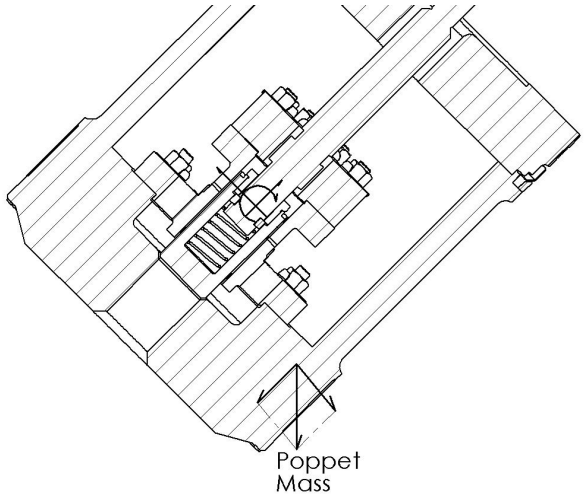


Figure 1: Free Body Diagram with Gravity Only

When steam flows through the MSIV, it will create an upward force that can lift the poppet and create the free body diagram shown below. The flow load vector will be perpendicular to the axis of the poppet. Depending on the flow rate, sufficient force can be generated to overcome the gravitational load and force the poppet against the upper ribs. Figure 2 shows the Free Body Diagram for this condition, including the poppet mass acting downward due to gravity and the flow acting perpendicular to the shaft. The resisting forces and moment required by the annular key groove against the flow load are displayed on the stem.

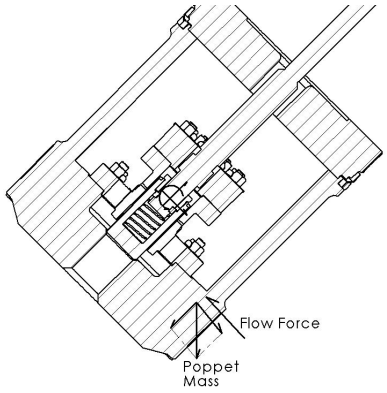
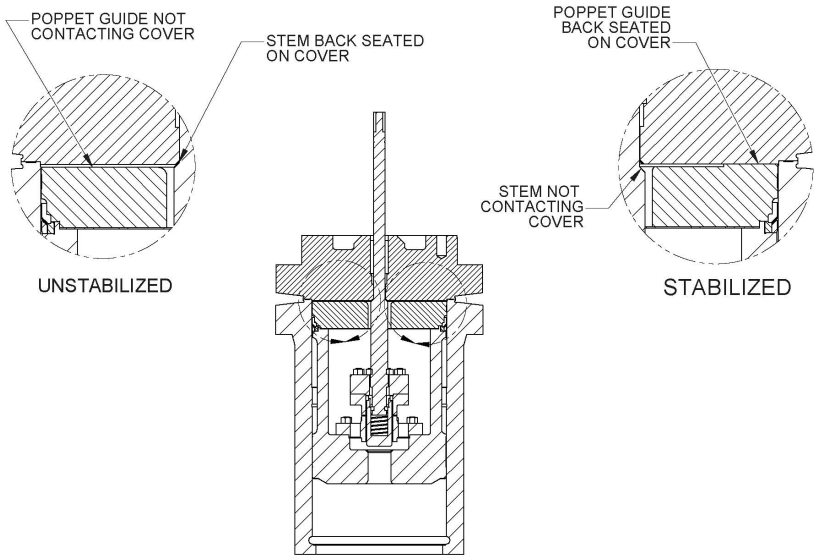


Figure 2: Free Body Diagram with Gravity and Flow

Based on historical inspections of MSIVs, it has been determined that flow creates an unstable lifting force based on the shedding of eddies around the poppet. This causes the loads on the button to oscillate between the two states shown in Figures 1 and 2. The stress changes eventually fatigue the stem button area potentially causing a shear of the stem at this location.

To eliminate the possibility of stem breakage resulting from flow induced vibratory fatigue, Trillium has provided a poppet stabilization modification as a design improvement. This modification stabilizes the poppet by pulling it tightly against the cover and eliminating the stem back seat feature. The figure below provides a detail of the stabilized stem/poppet assembly as opposed to an unstabilized stem/poppet assembly.

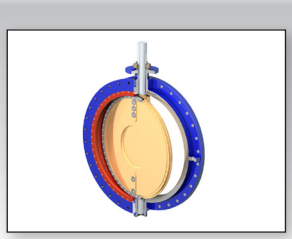


CONCLUSION:

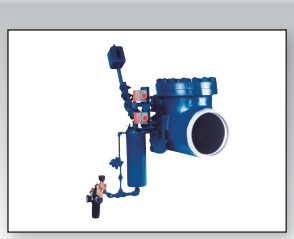
Trillium's operating experience on MSIV's that have been modified in the field to include the stabilized poppet supports a ten year life expectancy for stems made with SA 564 Gr. 630 H900-H1150 (17-4 PH) material. Trillium recommends the replacement of stems that have been in service for ten years. In addition, MSIV's should be inspected to determine if they have been modified to include the stabilized poppet design, and evaluated as to the length of time that the stem has been in service.

Valve Product Offering

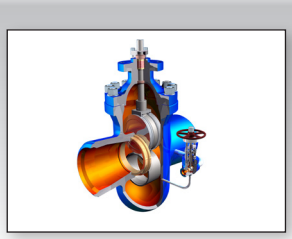
Bulletin No. 16.2



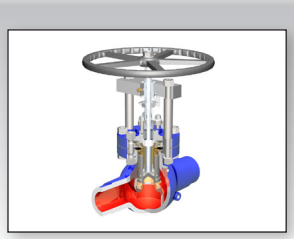
BUTTERFLY VALVES



CHECK VALVES

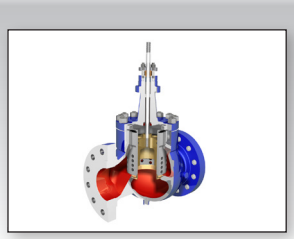


GATE VALVES



GLOBE VALVES

PRESSURE RELIEF VALVES



CONTROL VALVES

PLUG VALVES

ENGINEERED SERVICES AND SUPPORT

BALL VALVES

DIAPHRAGM VALVES

Trillium - Valve Product Ordering

Valve Type		Product Description	Trillium Brand
Check		Cold Reheat	ATWOOD & MORRILL®
		Compressor	ATWOOD & MORRILL®
		Dual Plate	ATWOOD & MORRILL®, BDK™
		FREE FLOW™ Reverse Current (water & steam)	ATWOOD & MORRILL®
		Positive Closing	ATWOOD & MORRILL®
		Reheat Stop	ATWOOD & MORRILL®
		Shelf	ATWOOD & MORRILL®
		Spring loaded feedheater bypass	HOPKINSONS®
		Swing (water & steam)	ATWOOD & MORRILL®, HOPKINSONS®, BDK™
		Testable	ATWOOD & MORRILL®
		Lift Check (T and Wye Pattern)	ATWOOD & MORRILL®, BDK™
Quarter Turn	Ball	Two Piece	BDK™
		Three Piece	BDK™
		Trunnion	BDK™
	Butterfly	Control	BATLEY VALVE®
		Concentric	BATLEY VALVE®, BDK™
		Double Offset / High Performance	BATLEY VALVE®, BDK™
		Triple Offset	TRICENTRIC®
		Turbine Accessory Valves	ATWOOD & MORRILL®, Blakeborough®
	Plug	PTFE Sleeved or Lubricated	BDK™
Multi-Turn	Gate	Knife	BDK™
		Main Steam Isolation Valve	ATWOOD & MORRILL®, HOPKINSONS®
		Parallel Slide	ATWOOD & MORRILL®, HOPKINSONS®
		Rotary (subsea)	Blakeborough®
		Wedge	HOPKINSONS®, BDK™
	Globe	Drain	HOPKINSONS®, BDK™
		Main Steam Isolation Valve	ATWOOD & MORRILL®
		Stop	ATWOOD & MORRILL®
		Stop Check (T and Wye Pattern)	ATWOOD & MORRILL®, BDK™
		3 Way Bypass	ATWOOD & MORRILL®, HOPKINSONS®
		Air Operated Stop Check	ATWOOD & MORRILL®
		Air Pilot / CO_2 valve	ATWOOD & MORRILL®
	Diaphragm	Diaphragm	BDK™
Pressure Relief	Control	Desuperheater	Blakeborough®
		Globe & Angle	Blakeborough®
		Severe Service X-Stream	Blakeborough®
		Steam Conditioning / Turbine Bypass	Blakeborough®
	Safety Relief and Pilot Operated	Atmospheric	ATWOOD & MORRILL®, SARASIN-RSBD®
		Change-over	SARASIN-RSBD®
		Pilot Operated	SARASIN-RSBD®
		Spring Loaded	SARASIN-RSBD®
		Single and Compact Integrated	SEBIM®
		Tandem Relief	SEBIM®

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Consult Trillium Salesperson or Agent regarding the most appropriate valve for your specific application.
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Notes

Notes

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