

Discussion Paper for Modifying Pipeline Engineering Standards for Sealant Injection Fittings in Pipeline Valves.

August 10, 1994

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This paper is written from the perspective of a professional valve maintenance technician. It describes some of the problems experienced while attempting to service pipeline valves during routine maintenance contracts and emergency valve sealing operations at production facilities, plants and pipelines in Canada, USA, Russia, South America, Europe, Asia, Africa & the Middle East.

It is very dangerous to attempt to remove sealant fittings from valves that are under pressure. Dangerous and defective designs can be safely replaced when pipelines are taken out of service and drained of product and pressure.

Many of the problems can be eliminated by incorporating modifications in the engineering standards when new valves are ordered or when used valves are repaired.

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PART ONE - Function, Purpose & Application of Sealant Fittings.

- Sealant Injection Fittings are primarily a one way check valve designed to provide for the periodic injection of viscous valve lubricant/sealants into pipeline valves, without allowing the product flowing through the pipeline to escape.

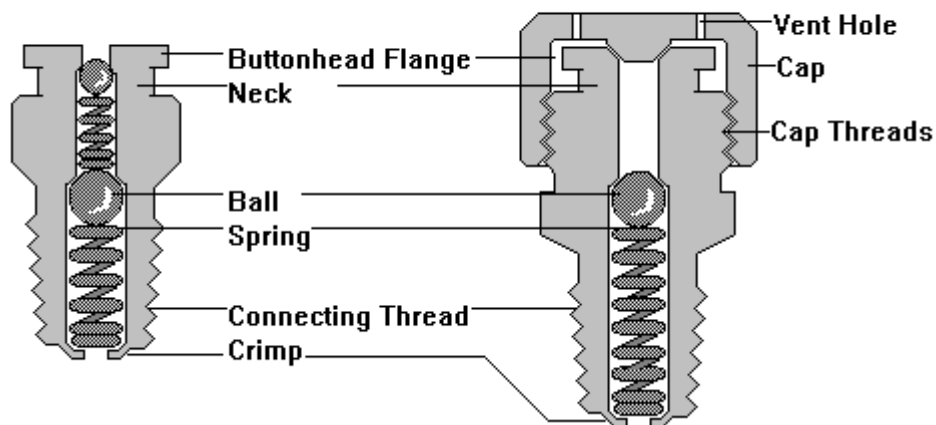
- In the absence of any recognized industry standards, many unusual and dangerous designs have been placed into service in pipelines around the world. These fittings may be installed at the valve manufacturing facility, repair shop or by valve technicians at the valve site from existing warehouse inventory.

- With the current emphasis on preventing pipeline losses for economic, environmental and safety reasons, a standard needs to be developed and implemented. This paper is intended to provide information based on actual field conditions in order that an informed discussion may begin.

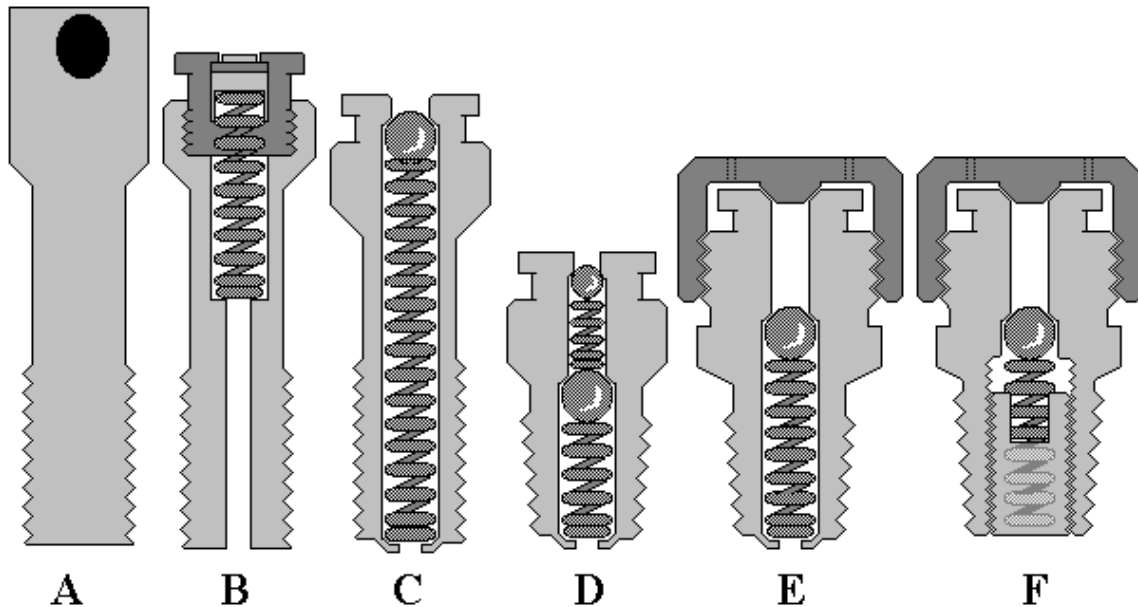
- With the rapid expansion of new pipelines combined with the pipeline company's need for competitive prices and quick deliveries, valve manufacturers from all over the world are now being utilized. In order to make a valve less expensive, many manufacturers provide the least expensive sealant fittings without regard for the safety or convenience of the technician who has to service the valve. If not specifically requested, many manufacturers will install pipe plugs instead of sealant fittings and/or body vent fittings.

- Many sealant fitting manufacturers are located in North America, the majority of North American made fittings conform to uniform dimensional tolerances. For this reason, these dimensions should be considered standard so that pump attachments and emergency accessories already in use can continue to be utilized.

Sealant Injection Fitting Terminology



EVOLUTION OF THE SEALANT INJECTION FITTING



- A - Bolt Type Plunger**
- B - Two Piece Combination Fitting**
- C - One Piece Combination Fitting**
- D - Double Ball Check One Piece Fitting**
- E - Single Ball Check Capped Fitting**
- F - Threaded Cage "Flow Wolf" Capped Fitting**

A: Bolt Type Plunger Fitting.

Found in early designs of plug valves, used to push sealant "sticks" into the plug valve for lubrication & sealing purposes. This style may still be installed on some makes of new plug valves.

B: Two Piece Combination Fitting.

The bolt-plunger type fitting was modified to include a buttonhead connection. Can be found with either giant buttonhead or small buttonhead connections. This style may still be installed on some makes of new plug valves.

C: Giant Buttonhead "Combination" Fitting.

Typically found on plug valves designed for dual purposes. Can be connected via giant buttonhead to injection pumps or can be utilized as a plunger to push "stick" sealant into the valve. Can be found with single ball check or flapper check in both one piece or two piece body designs.

Common connecting non-tapered thread designations:

Fine Thread: - 1/4- NPS, 3/8-18 NPS, 1/2-14 NPS, 3/4-14 NPS.

Coarse Thread: - 7/16-16 UNC, 1/2-13 UNC, 3/4-10 UNC.

D: Giant Buttonhead Sealant Injection Fitting.

Typically found on ball valves for seat sealant injection and stem sealing purposes. May be either single or double ball check. Can be found with flapper checks instead of ball check in either two piece body or one piece body designs.

Common connecting tapered thread designations: 1/4-18 NPT, 3/8-18 NPT, 1/2-14 NPT

E: Giant Buttonhead Sealant Injection Fitting with Metal Cap.

Available in a wide variety of standard & non-standard designs. Typically found in ball and gate valves for seat sealing and stem sealing purposes. Single ball check, and metal cap are common for this style of fitting. Blow down tools may fit some styles. Screw-on style couplers designs vary depending on valve manufacturer.

Common connecting tapered thread designations: 1/4-18 NPT, 3/8-18 NPT, 1/2-14 NPT

E: Flow Wolf Threaded Cage Style Fitting.

Designed for use in ball, gate and plug valves for seat sealant injection and stem sealing purposes. Single ball check, one piece body construction are standard. A metal cap provides an additional metal-to-metal seat, to prevent leakage when cap is tightened in place. Vent holes in cap warn the technician that the check valve is leaking, before the technician completely un-screws the cap.

The standard blow-down tool can be attached via the cap thread that sends a stinger down to un-seat the ball check. This allows the technician to test if the lower “internal” check valve that is screwed into the valve body is holding. If it is holding, the technician may safely remove and replace the damaged or faulty sealant fitting.

Common connecting tapered thread designations:

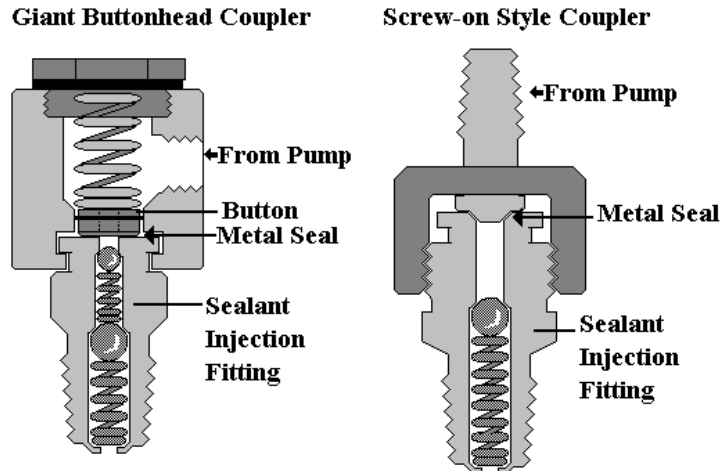
Tapered Threads: - 1/4-18 NPT, 3/8-18 NPT, 1/2-14 NPT

Non-Tapered Threads: - 1/4 NPS, 3/8 - 18 NPS, 1/2 -14 NPS, 3/4 - 14 NPS.

Cap Thread: 1-14 UNS. Taper angle for metal seat: 60 degrees.

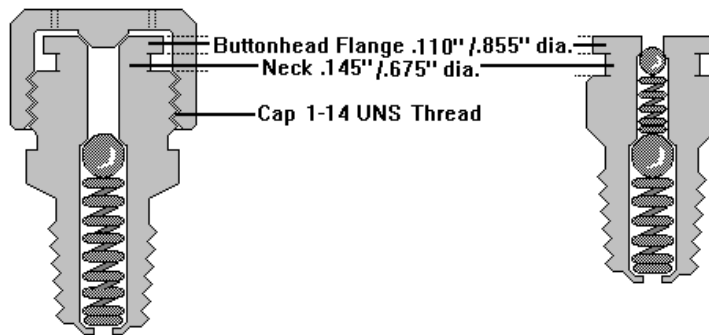
The Valve Technicians Concern:

Regardless of where the valve is manufactured, there is no guarantee that the sealant fittings will conform to attachments for existing pumping equipment. In many cases, operators wait until after the pipeline is commissioned before they attempt to service the valve. Then they discover that the sealant fittings are non-standard. In most cases the pipeline must be drained both upstream and downstream before the sealant fitting can safely be replaced.



In order for the technician to service the valve, a sealant injection pump must be connected. The two most common pump connections are the giant buttonhead which slips on over the buttonhead or screw-on style coupler which threads onto the cap threads.

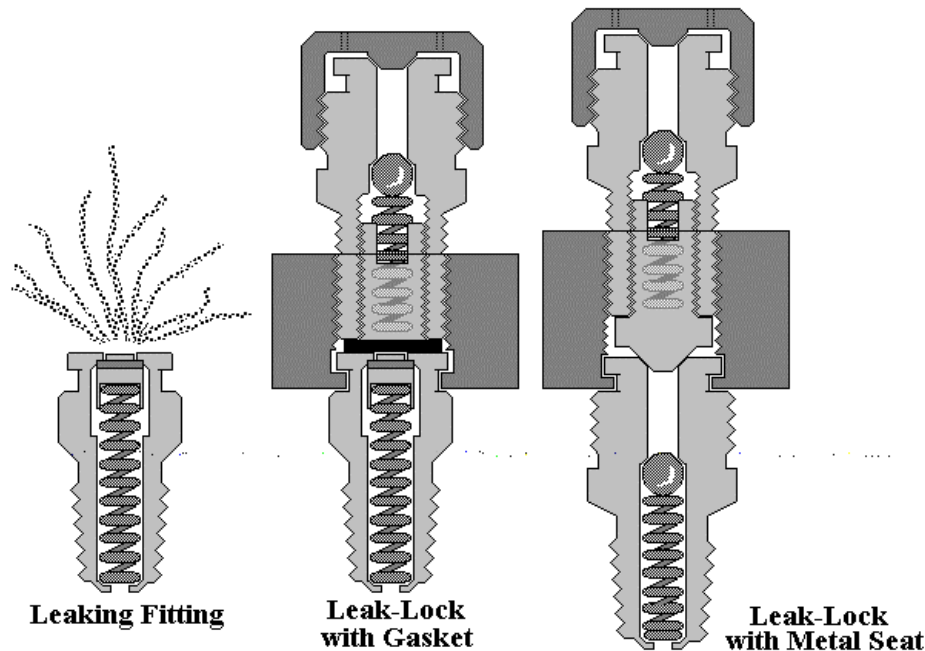
CRITICAL SEALANT FITTING DIMENSIONS



In the absence of any recognized manufacturing standard, many existing fittings do not conform to the critical tolerances as illustrated above.

We have had many experiences where these tolerances were not followed, resulting in field personnel having to custom make special adapters simply to service the valve. In some cases the diameter of the buttonhead or the neck were oversized, preventing the use of existing giant buttonhead couplers. In other cases, the cap threads were non-standard preventing the use of existing screw-on style couplers.

A wide variety of adapters and special tools may be utilized in order to inject valve cleaners, lubricants and sealants into leaking valves in an emergency. If these products can not be injected into the valve, then the technician must travel upstream and/or downstream and attempt to seal the next valve on the pipeline. This can result in having to drain long sections of pipeline before an adequately sealing valve can be located. The cost of venting or collecting the product in the line makes the small additional price for ordering valves with the correct sealant fittings relatively insignificant.



In the event that the check valve in the sealant fitting fails, leakage to atmosphere will result. In a compressor station, production platform, metering station or pump station this can lead to an emergency shut down, fire, or even an explosion. A Leak-Lock adapter can be attached and tightened, a seal is obtained with a gasket or metal seal. The leak is then stopped and the technician can still inject lubricant/sealant into the valve. This type of leakage is more common with flapper check type fittings but can happen to any style of fitting. The critical tolerances must be adhered to for this adapter to be utilized.

Service Applications & Performance Criteria:

- A sealant injection fitting must provide for:

Containment of pipeline contents at various pressures.

- Low pressure gas distribution systems from 1 - 150 psi.
- Intermediate pressure pipelines from 150 to 600 psi.
- High pressure pipelines 600 psi to 2240 psi, wellhead pressures to 5,000 psi and higher.

Containment of pipeline contents in a variety of services:

Processed Gases & Gas Liquids - Natural gas (methane), ethane, butane, propane, sour gas, hydrogen, nitrogen, etc. High pressure gas liquids are extremely prone to leakage to atmosphere through sealant fittings.

Refined Hydrocarbons: Gasoline, diesel fuel, jet fuel, aviation gas, refined oil.

Field Production and Gathering Systems: Water, brine, crude oil, raw natural gas, sour gas, sour crude, carbon dioxide, condensate, produced hydrocarbons in combination with sand, drilling mud, production enhancing acids & specialty chemicals.

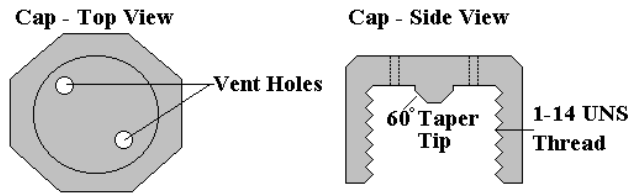
High pressure sealant injection.

Existing sealant injection equipment (manual guns & pumps) are designed to produce 10,000 psi to 15,000 psi injection pressure with little effort. Power operated pumps can deliver sealant at high velocity and high pressure. Sealant viscosity is greatly affected by outdoor temperatures, high injection pressures are common in cooler climates, particularly in spring and fall when most valve maintenance occurs.

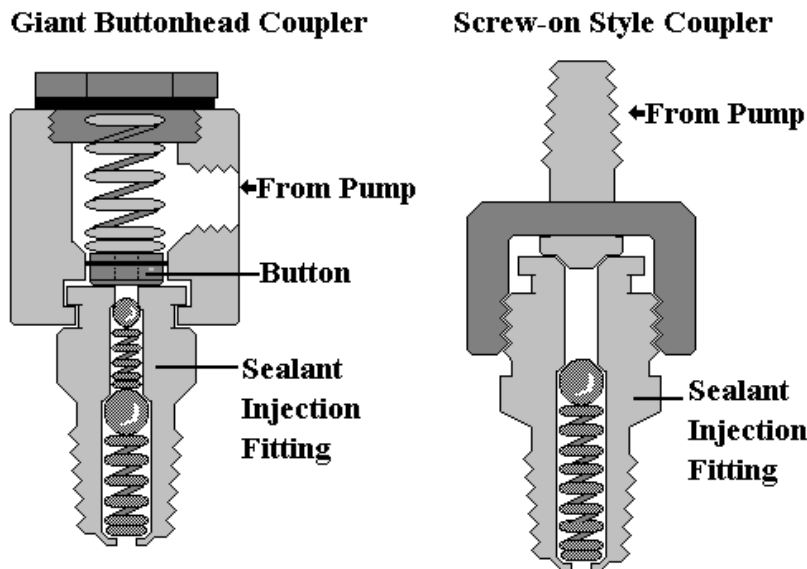
Leak Prevention - The sealant fitting should be equipped with a metal cap.

A metal cap should be placed over the buttonhead to prevent paint, old dried sealant, sand, grit or other contaminants that adhere to the buttonhead from being injected through the fitting and into the valve. These solid contaminants can also prevent the check valve from functioning properly, leading to the escape of pipeline contents.

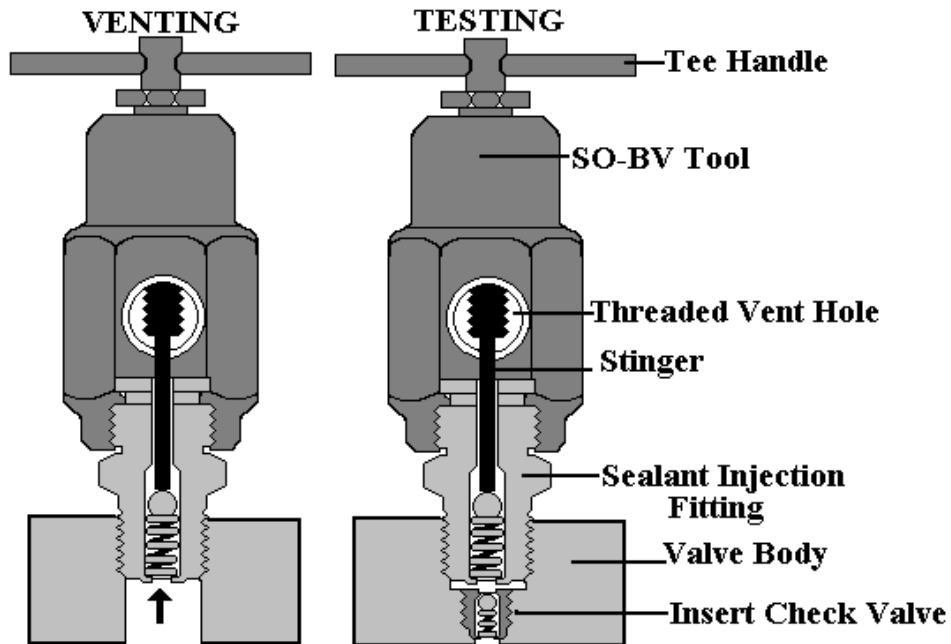
The metal cap should be equipped with tip that will allow for a reliable metal-to-metal seat when cap is screwed onto fitting. The metal cap should be equipped with vent holes to warn the technician that the check valve is leaking, before the technician removes the cap completely.



Compatibility - The “buttonhead” flange on the top of the sealant fitting must connect to existing pumping equipment. Dimensional tolerances must be adhered to in order for existing pumping equipment to be connected in an emergency.



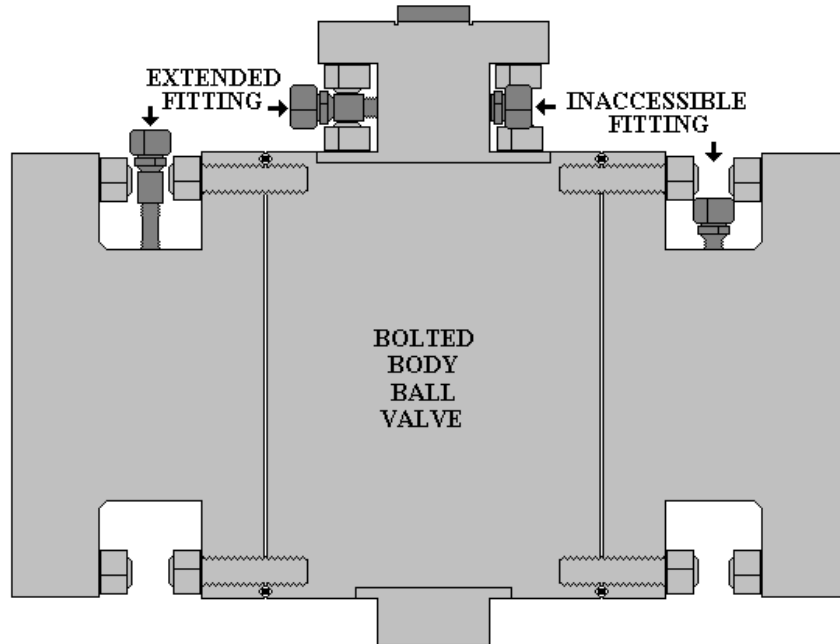
The threads that connect the cap to the sealant fitting should conform to dimensional tolerances so that pumping equipment with screw-on style couplers can be connected in an emergency. This is critical in gathering systems where hydrates can collect in the valve body resulting in the need to inject methanol under high pressures.



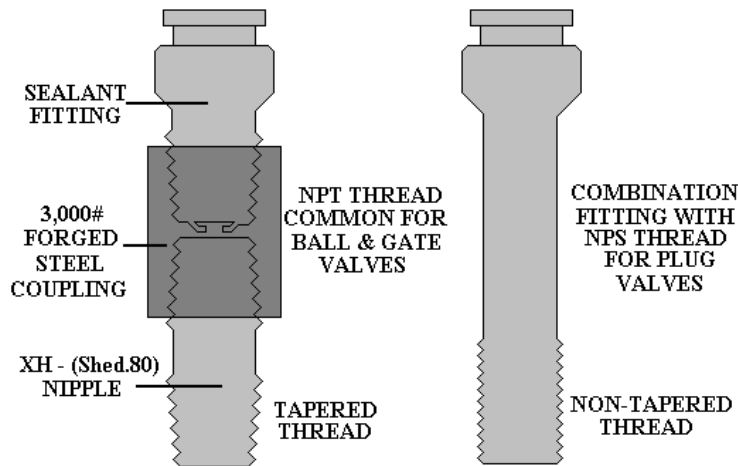
The threads on the cap and fitting should also adapt to conventional Blow-Down Tools. These tools screw onto the fitting, a tee handle on the tool is screwed in and a stinger is extended to the check valve in the sealant fitting. This allows for the technician to test if the lower “insert” check valve is holding.

API Gate Valves are usually equipped with two capped fittings without insert check valves. In this instance, the blow down tool is utilized to vent the body cavity of hydrates and other contaminants that may collect in the valve body. API gate valves are normally filled with a light grease to prevent hydrates from collecting in the valve body. The Blow Down Tool is attached to one fitting, grease is injected through the other fitting. The tool is utilized to vent, while filling, to prevent the body cavity from being over pressured.

When using the Blow Down Tool, the technician should always attach a stabbing valve (full port 1/2” 3,000 # ball valve & sched.80 nipple) to the threaded vent hole on the tool **BEFORE** turning the tee handle and un-seating the check valve in the sealant fitting. In many cases hydrates may collect on the check valve preventing it from re-seating after the stinger is withdrawn. The technician can close the ball valve to contain the leakage, then inject a small quantity of warm grease or sealant. The technician can then test if the check valve is holding before removing the tool.



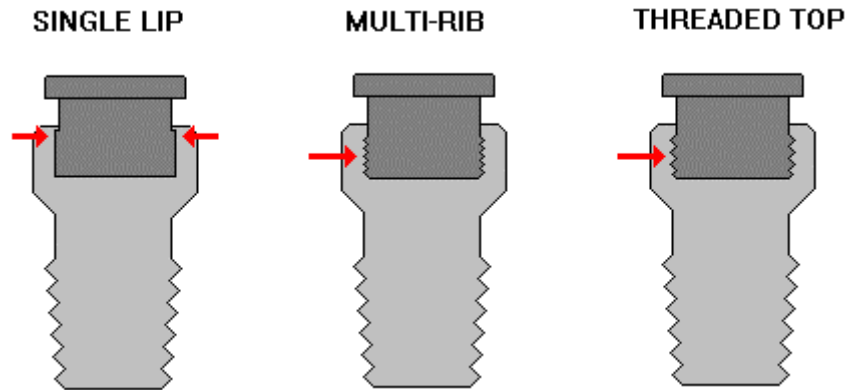
The sealant fittings should also be located in a position for easy accessibility for the valve technician. As illustrated above, some valve manufacturers position the fittings in difficult locations, usually due to bolting patterns for flanges and gearboxes. In some cases, the fittings were extended but the valve manufacturer used only low pressure pipe nipples. The collar (coupling) was 3,000# forged steel, but the pipe nipple was only thin wall schedule 40 pipe. The nipple burst during hydrostatic testing of the pipeline.



Another common mistake occurs when thread types are mismatched. The NPT thread is common to most ball & gate valves. When a valve has insulation applied, a longer fitting is required to extend through the insulation. An inexperienced technician may install the longer combination fitting with NPS threads (non-tapered) not realizing the threads in the valve body are NPT. When this occurs a very dangerous situation is created. The fitting is secured by only two or three poorly fitting threads. The threads may leak or fail when the pipeline is pressured up or when sealant injection pressure is applied.

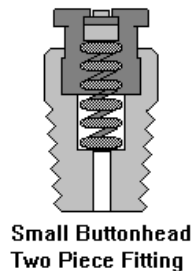
PART TWO - Examination of Defective or Non-Standard Designs

Two-Piece Buttonhead Fittings:



The two most common designs of two piece fittings are illustrated above. These styles of fittings have come apart, resulting in the loss of the check valve apparatus, leakage to atmosphere, and injury to valve technicians. The screwed top can un-screw as a result of vibration along the pipeline. The pressed-on top can come apart at relatively low injection pressures due to the small lip that holds the pieces together. Two piece fittings are intended for lubricating large non-pressurized bearing cavities such as conveyor belt systems, not high pressure pipeline service

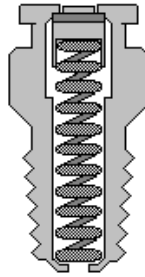
These designs have an obvious flat flapper check (vs. round ball check) that can be seen on the buttonhead flange. Not all flat flapper check fittings are two piece, there are some manufacturers of one piece flat flapper check fittings. The presence of the flapper check should make the valve technician cautious in his approach to servicing the valve.



The small buttonhead fitting does not conform to dimensional tolerances for existing sealant pumping equipment. A different coupler or custom adapter must be utilized in order to service the valve. This style of fitting is not designed for high pressure pipeline service.

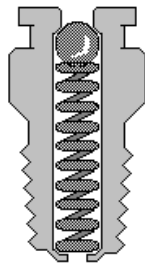
A modified Leak-Lock adapter has been designed that fits the small buttonhead. The Leak-Lock nut is machined with a smaller opening to fit the small buttonhead. The top fitting on the Leak-Lock features a giant buttonhead so the technician does not need to change the coupler on the sealant pump (P/N D-FWLL#2).

One Piece Buttonhead Fittings

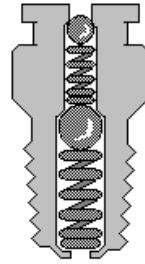


**One Piece Fitting
with Flapper Check**

The flapper check style fittings have a tendency to leak more often than a ball check style fitting. This usually occurs as a result of paint, old dried sealant, dirt or sand getting caught between seating surfaces of the flapper.

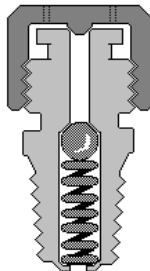


**One Piece Fitting
Single Ball Check**



**One Piece Fitting
Double Ball Check**

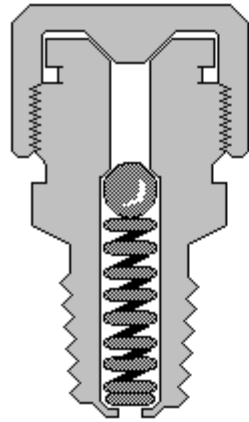
The one piece buttonhead fitting with double ball check is quite common. The one piece design will not come apart under normal working conditions. In 1/4" npt sizes, the wall thickness at the top of the threads is very thin and prone to breaking off when a tool is dropped or if someone stands on the fitting. The small spring in the top check is prone to plugging off. When the upper spring collapses it can also prevent the lower check valve from seating properly, resulting in product leakage to atmosphere. High injection pressures can also straighten the bottom crimp that holds the ball/spring mechanism in place. Loss of the check valves can also lead to leakage to atmosphere.



**Note:
Small Buttonhead
Small Cap Threads**

The Sealant Fitting illustrated above features a small buttonhead top and small metal cap. The small buttonhead does not conform to dimensional tolerances for exiting pumping equipment and blow down tools.

Typical Defects with Non-Standard Fittings



Cap: - Unique Thread

- Hex Shaped Thread
- No Vent Holes

Buttonhead:

- Too Large O.D.
- Flange Too Thick
- Rough Surface on Top
- Top Hole Too Large

Warning: A valve technicians greatest risk of personal injury is because of defective and non-standard sealant fittings. The absence of standards has lead to a lack of quality control at some fitting manufacturing facilities, some sealant fittings may be assembled without check valves or with poorly cut threads.

The capped fitting illustrated above is common to large diameter ball and gate valves. In the absence of international standards, many manufacturers supply fittings that do not conform to the dimensional tolerances previously mentioned.

Many Asian and European valve manufacturers utilize NPT threads for the connecting thread but use a metric or other non-standard thread for the cap.

Some European Manufacturers - Oversized Hole & Non-Standard Cap Threads.

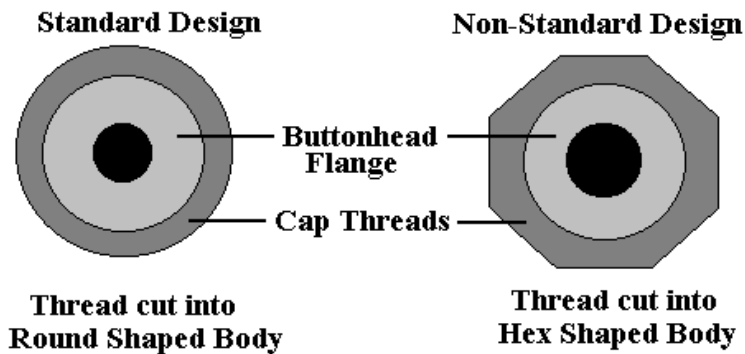
The hole on the top of the buttonhead is oversized. Some sealant injection equipment may utilize a style of buttonhead coupler where the coupler “button” also serves as a check valve to prevent spillage of sealant when the pump is disconnected. When the coupler is slipped onto the sealant fitting, the “button” is pushed up into the coupler and sealant can flow into the fitting. When attached to this European fitting the button does not get pushed up, it falls into the oversized hole. An inexperienced valve technician will pressure the pump up and assume the valve has been serviced when in fact, no sealant entered the valve.

The cap threads are non standard. In order to safely change out the sealant fitting, a blow down tool should be attached to the cap threads to test if the insert check valve is holding. Unfortunately, if the cap threads are non-standard the existing blow down tools can not be utilized.

German & French Manufacturers - Non-Standard Cap Threads

These fittings have a non-standard metric cap thread, this prevents the use of existing blow down tools and screw-on couplers.

Sealant Fitting with Cap - Top View



Some Italian and North American made valves utilize capped fittings with hex thread cut onto the fitting vs. the round thread commonly used. This prevents the use of existing blow down tools and screw-on couplers.

Several UK manufactured valves may have two piece giant buttonhead fittings. These fittings have been known to come apart at relatively low injection pressure. Some UK made valves have buttonheads that are oversized, preventing the use of conventional giant buttonhead couplers and Leak-Lock adapters.

Eastern Europe- These fittings have a non-standard cap thread, this prevents the use of existing blow down tools and screw-on couplers. To remedy the problem, a local machine shop drilled a hole in the top of the existing metal cap and threaded a giant buttonhead fitting into the cap, then back welded to secure the fitting in place.

Asian Made Ball Valves - In this instance the manufacturer produced a poor copy of the previously mentioned Hex Threaded style fitting. The thickness of the buttonhead flange prevented existing giant buttonhead couplers from being connected. The hex thread prevented the use of blow down tools and screw-on style couplers. In other Asian made valves, the neck of the buttonhead was oversized, preventing the attachment of the conventional giant buttonhead coupler.

Valve manufacturers and valve technicians should take great care when installing sealant fittings. It is common practice to wrap the connecting thread with Teflon tape. If too much tape is applied, or if the tape is applied improperly, the excess tape will become caught up in the insert check valve. This will plug the sealant passages and prevent lubricant/sealant from entering the valve.

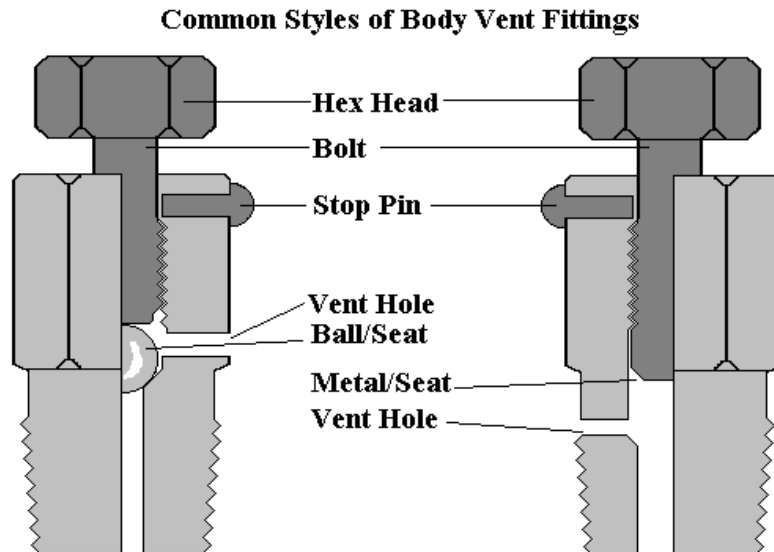
PART THREE - Effects of Corrosion on Sealant and Body Vent Fittings.

Sealant Injection Fittings and Body Vent Fittings commonly found on valves are subject to corrosion. Unless stainless steel is specifically ordered, most valves come equipped with carbon steel fittings with a zinc or similar plating applied to the external surfaces. This thin layer of plating wears off and the exposed metal surface begins to corrode.

In the case of the giant buttonhead fitting, the technicians ability to connect the sealant pump depends on the quality of the finish on the surface of the buttonhead flange. The button in the coupler makes a metal-to-metal seal with the top surface of the buttonhead flange. If corrosion pitting has occurred, the technician will be unable to achieve a seal.

In the case of sealant fittings with a metal cap, the thin plating wears off and the cap threads rust, preventing the removal of the cap.

The zinc or similar plating is applied to the external surfaces only. If corrosion pitting affects the inside surface where the ball check seats, the sealant fitting may leak pipeline contents to atmosphere.



In the case of body vent fittings, corrosion is a major concern. Water collects in the threaded portion of the bolt causing corrosion. In coastal areas and offshore, corrosion caused by salt water spray & mist will render these devices inoperable in a very short period of time. Water also enters the body vent fitting through the vent hole adding to the corrosion and pitting of internal seating surfaces.

Most of these types of corrosion related problems can be avoided by specifying Stainless Steel Sealant Injection Fittings and Body Vent Fittings. Other mechanical weaknesses can also be avoided by standardizing on stainless steel sealant fittings and body vent fittings. See the attached Fitting Failure Analysis report for a broader understanding.

Part Four - Destructive Testing Existing Designs of Sealant Fittings

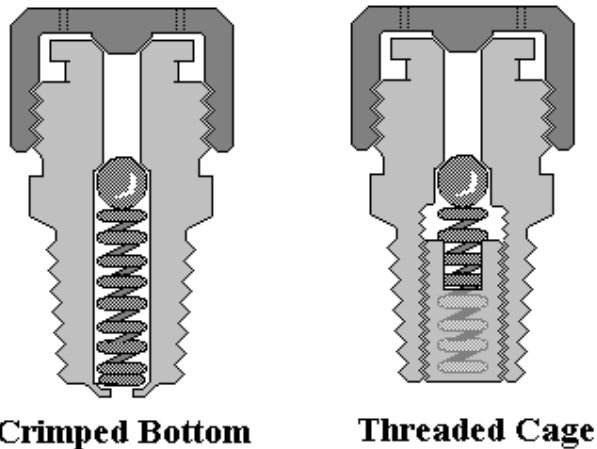
In order to gain a better understanding why sealant fittings fail, a series of tests were conducted at an independent metallurgical laboratory.

The attached “Failure Analysis of Sealant Injection Fittings used in Ball, Gate and Plug Valves” report describes in detail the forces required to:

- a) blow the check valve mechanism out of conventional fittings.
- b) cause metal fatigue by screwing the fitting into the valve.
- c) compare force measured in Newton’s, Foot Pounds of Torque and Pressure in pounds per square inch.

A second series of test were conducted at the same facility. The fitting samples were immersed in a sour solution as per NACE TM-01-77 (90). Specimens were destructively tested at 15 and 30 day intervals. Measurements were taken to determine the force required to blow the check valve mechanism out of conventional mild carbon steel, 4140, stainless steel materials.

As a result of the testing, it was determined that a great number of potentially dangerous designs are currently in service. The new threaded cage designs tested offer significant improvements in overall performance, mechanical strength and safety factors.



Check Valve Failure Testing of Sealant Injection Fittings.

Sealant fitting check valve failure and escape of pipeline contents is a common occurrence. In addition to paint and other particulate matter being injected into the fitting, failure can also occur as a result of mechanical failure of the crimp that holds the check valve in conventional fittings in place.

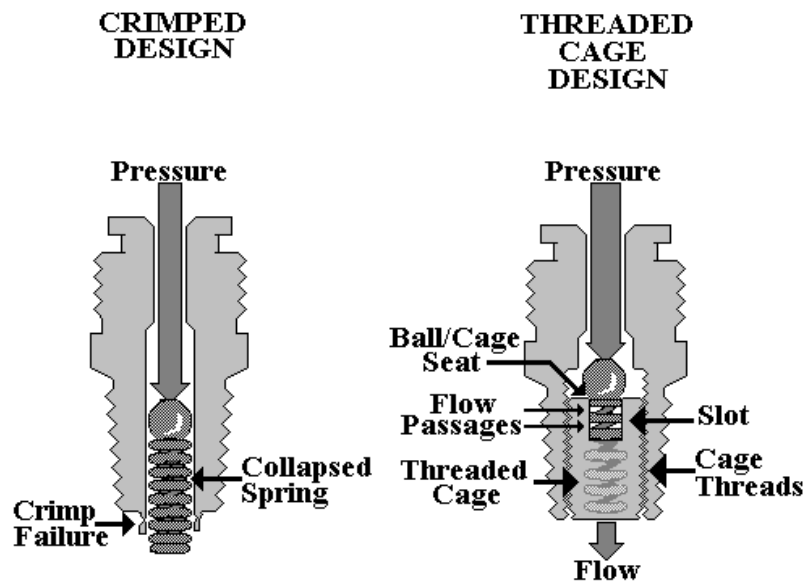
Leaking fittings can lead to a hazardous situation. In buildings, this may cause an emergency shut down, triggering of halon systems, fire or even explosion.

In sour service pipelines this can lead to the release of poisonous hydrogen sulfide gas and personal injury or even death.

Occasionally sweet gas fields may gradually turn increasingly sour. The connected gathering systems, processing plants and pipelines could also be subjected to these small amounts of hydrogen sulfide gas. This may also lead to check valve failure in carbon steel fittings.

In some designs, after the spring has been fully compressed, it may fail to resume its original shape when sealant injection is stopped. This may also lead to the escape of pipeline contents to atmosphere.

In order to determine how mechanical check valve failure occurs, a series of destructive tests were performed on a variety of sealant fittings, insert check valves and packing injectors.



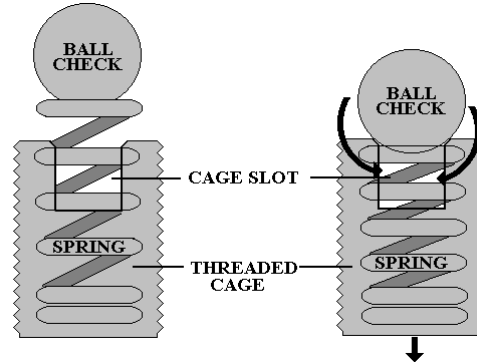
In the first series of tests a steel probe was inserted through the top of the sealant fitting, making contact with the ball check. A load was applied and measurements taken on the amount of force required to push the ball check out of the bottom of conventional crimped fittings and threaded cage fittings.

A second series of tests were conducted after immersing the fittings in a sour solution. Similar tests measured the effects of hydrogen embrittlement and sulfide stress corrosion cracking.

Fitting designs with a threaded cage for retaining the ball were found to exhibit significant improvements in overall strength. This is attributed to the load being spread over a greater area, as a result of the many threads. Fitting designs with the conventional crimp were found to be substantially weaker and as such, more prone to failure.

When sealant is injected a high pressure and/or high velocity, the spring on the ball check assembly collapses. This is more likely to happen in northern climates when the lubricant/sealant is cold and consequently more viscous. This may also occur when injecting heavier sealants such as “stick” type sealants or emergency sealants with bridging agents.

When sealant passages close off through the spring, this leads to a rapid increase in sealant injection pressure. The increased pressure may result in the check valve assembly being “blown” out of the fitting.



The threaded cage fitting features a reverse seat on the top of the threaded cage, above the slot. This prevents the spring from collapsing and provides for the flow of sealant at lower injection pressures.

The mechanical strength is increased as a result of the cage threads displacing the load forces over a greater surface area. This significantly reduces the risk of the check valve mechanism being lost.

Effects of hydrogen embrittlement and sulfide stress corrosion cracking are minimized as a result of the threaded cage. This greatly increases the safety factor in pipelines carrying sour gas and crude oils.

The threaded cage is also being incorporated into new designs of packing injectors and insert check valves.

An additional series of tests were performed to measure the mechanical strength of the body of one piece fittings. This was accomplished by screwing the fitting into a steel plate. A torque wrench measured the torque applied at time of failure. The fittings failed (broke off) at the top of the connecting thread which is consistent with reported failures in the field.

The tests determined that sealant injection fittings in **1/4”NPT sizes - made from carbon steel** were the weakest. Unfortunately, the vast majority of valve manufacturers utilize this size & type of fitting and so there are a great number of these fittings currently in service.

Overall mechanical strength can be greatly improved by utilizing 316 stainless steel instead of carbon steel or utilizing a larger thread size such as 3/8” NPT or 1/2” NPT.

Part Five: Factors Contributing to Valve Seal Leakage

The vast majority of minor seat damage to ball, gate and plug valves occurs at start-up as a result of utilizing dirty water for hydrostatic testing and debris left in the pipeline after construction including sand, dirt, line scale, welding slag, welding rods, etc.

During initial hydrostatic testing, the pipeline is filled with water and tested at high pressure to test the integrity of the welded seams and flanges. In many cases the valves are left in the open position. Assuming the valve seals perfectly, the body cavity would not be under pressure. This pressure differential causes these contaminants to be drawn into and embedded in the soft seals in the valve seats. As the valve is cycled, the contaminants create tiny scratches on the polished ball and seat rings, causing a slight leak in the valve.

Prior to hydrostatically testing the pipeline, the valves may be cycled to the 1/2 closed position to avoid the problem previously described with pressure differential in the valve body. In some cases, not all valves are returned to the full open position before scraper pigs are launched. The pig then hits the 1/2 closed ball, usually at sufficient velocity to severely damage the ball and seat seals.

By the time the operator takes possession of the pipeline, many of the valves may have slight leakage problems. The valve manufacturers can prove the valve sealed perfectly when the valve left their factory and may not feel responsible for any warranty claim.

Many pipeline companies have discovered that most of this type of minor seal damage can be avoided. They have the valve manufacturer fill the seat sealant system, including sealant riser pipe assemblies, with an insoluble lubricant/sealant at the factory, after the hydrostatic testing is complete. This also pushes any water that may have leaked into the seat sealant system or sealant riser assembly out of the valve, before internal corrosion can begin. The presence of lubricant/sealant will also lubricate the contaminants and reduce their abrasive effect when the valve is cycled. These types of minor seal damage are more common in natural gas pipelines than liquid products pipelines. In a liquids pipeline, the sealing surfaces are always wet, this helps the valve to seal. In a dehydrated natural gas pipeline, these seals are dry, leading to minor seat leakage unless fresh lubricant/sealant is injected periodically into the valve.

A series of experiments were conducted at a valve manufacturing plant. A 12" 600 class Grove B-5 ball valve was intentionally damaged and tested with 1000 psi nitrogen gas to simulate typical gas pipeline conditions. The size and location of the seal damage varied on each test. A gas turbine meter measured the flow rate of the gas leaking past the seat seals. Various grades of sealant were utilized and the results are described in the "GROVE B-5 BALL VALVE SEALANT EVALUATION REPORT" attached.

For additional information regarding safe valve maintenance procedures, we have prepared a 90 page illustrated training manual "The Handbook of Valve Lubrication and Maintenance" available through Sealweld Corporation - Calgary, Alberta, Canada.