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# INTRODUCTION

In the oil & gas, petrochemical, mining and general process industries, valves are one of the most common mechanical devices on any pipe line, process plant, well head, oil & gas process rig or ship etc., and more than often are the most neglected piece of moving equipment. Usually very little attention is paid to them until it is time to operate the valve in a flow control, shut down or emergency situation.

OIL & GAS

PETROCHEMICAL

MINING

GENERAL PROCESS

# GATE PLUG BALL

Most Gate, Plug and Ball Valves on the market have lube or emergency sealing ports and fittings. These ports, veins/arteries in the valve direct flush, lube or sealant to the moving components to clean, lubricate and assist in the sealing integrity of the valve. Flush cleaning a valve prepares it for the lube/sealant. If the valve has no lube/sealant in then, they can become contaminated with pipe line process or sand etc, depending on process blocking ports or damaging seals, gumming up springs and the seal ring causing a valve to eventually fail. Also typically all valves have open void areas internally which will have pipe line process product and contaminates in them. When a valve is serviced, during the servicing procedure a valve will be cycled fully if possible, once the ports, veins/arteries and lube/sealant chambers are full, process product, contaminates and excess lube product will end up in the pipe line. It is important to meeter the amount of product being injected, this is so the service technician knows he has injected the correct amount with minimal wastage of product.

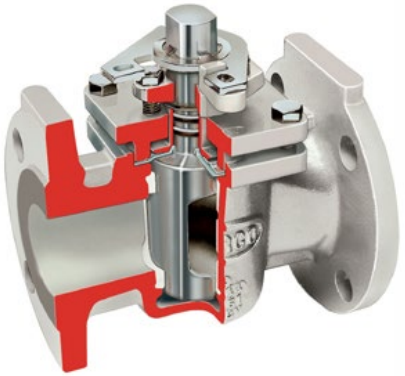
Typically a Plug Valve sealing faces are metal to metal and require a sealant to help them seal and to reduce torque required to open and close the valve.

Ball Valves can be made up of a verity of materials, for instants a metal ball with a chrome finish and PTFE/Teflon seals with springs, pushing the seal ring on to the surface of the ball, these valves are expected to seal 100% from the factory. From the factory there is no lube on ball and over time the seals can stick to the surface of the ball, when the valve is cycled it can potentially damage the seals.

A well head Gate Valve is similar, it too has metal moving parts with seals and can potentially have the same problems as the ball valve.

All of these types of valves new or used online sealing integrity and life can greatly be improved and extended with a Valve Care P.M. Lubricating sealing service, all these valves will benefit with less torque require to cycle the valve.

GATE VALVE



PLUG VALVE

BALL VALVE

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# VALVE SERVICING SCENARIOS

Before servicing any valve there, is a service protocol to be followed.

After liaising with the client on their type of valve service requirements and valve location our Service Supervisor will know the equipment, products, tooling and spare parts required and the type of service and problems his team are required to rectify.

Once on site and after a site survey, the Service Supervisor will then be able to have a toolbox meeting with his service team and the client's operator/technician to let them know the service procedure and job requirements.

In valve lubricating and sealing servicing there are many different problems that a Service Technician can face, the following is some scenarios.

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# Scenario 1: Valve easy to cycle.

This is a basic service, the Service Supervisor will assess if we have serviced this valve before or not. If they have and it was done within six months or less, they would perform a top up and full cycle of the valve if possible. If it is the first time we are servicing this valve then a full service would be conducted which would consist of flushing the valve clean, then injecting Lubricant, Cycling the valve and recording the service performed. We have a product quantity table that is used as the basic quantity for Gate, Plug and Ball valves servicing.

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# Scenario 2: Hard to cycle.

Assess what could be the problem causing the valve to be hard to cycle. Is it gear box or a valve problem? If it is a valve problem a full basic valve service would be conducted and if required the amounts of product injected could be increased, also extra cycling of the valve to assist in spreading the flush and lube inside the valve.

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# Scenario 3: Very firm or seized valve.

Gearbox problem: Inject GP grease in to its lube points. If this does not ease the gear box then remove and open up the gearbox to see if the problem can be rectified on site or if the box requires new parts that are not on hand.

**Internally seized valve: Scenario 2** would apply. However, extra time is required when servicing to allow the flush to penetrate. Flush injecting & cycling of the valve would continue until so long as the operating torque is reducing. Once an acceptable torque

level is achieved the valve should now be ready for lubricant/sealant injection. Additional cycling of the valve would continue. A valve can become stuck/seized because of inline contaminates, scale, rust or lack of lubrication service.

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# Scenario 4: Damaged fittings or cannot connect hoses.

Our team carries a variety of adaptors and fittings to adapt to different threads and connections.

If removal of the lube fitting is required then our Service Supervisor will discuss the procedure with the client's operator/technician. This is to ensure that the client's protocol is not breached.

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# Scenario 5: Product not flowing/Hoses may be connected onto the fittings but no flow of product.

This can be the result of Carbon/mild steel fittings corroding or old solidified lube products blocking the lube ports and internal check or seal/seat areas in the valve. There are some products on the market that use PTFE fillers and after time the lubricant product can solidify/harden or wash out leaving the fillers behind.

**Our products are Synthetic and will not do the above mentioned.**

As a service procedure **Scenario 1** would apply however extra time is required when servicing to allow the flush to penetrate. Also **Scenario 4**: could apply for the fittings so removing and cleaning out behind the lube fitting, and also checking that the lube fitting is clean will help to resolve the problem.

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# Scenario 6: Valve is passing.

Same as **Scenario 1** but our sealant would be used instead of lubricant and the quantities of product might be increased to achieve the required result, if extra product is required then the technician would build on this table. **Note:** The quantity of product is always counted to ensure not to inject excessive product in to the valve.

Finally if the valve is a ball valve and if required and possible, bleed the body cavity down as this will help the seals to pull in on to the ball face assisting the valve to seal.

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# Scenario 7: Valve is leaking, i.e. external leaking.

Same as **Scenario 6,** but if the required result is not achieved then depending on what the process media is, we would consider changing from our Sealant to our Super Blue Sealant and/or a body cavity fill. This is done in the open position, by doing this process the product is pushed in to both seat seal and body seal. This is not a permanent fix and the valve should be removed soon as possible & overhauled.

**NOTE: Only qualified Technicians should be performing all of the above as personnel safety is a top priority, followed by the correct service procedure applied including valves and equipment are not misused or damage.**

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# SCOPE OF WORK FOR SERVICING
# WELLHEAD XMAS TREE/PLOT VALVES
# FOLLOWED WITH INTEGRITY TESTING
# OF THE XMAS TREE VALVES

**Objective of the job:**

To inspect and perform preventive maintenance to Wellhead valves and all plot valves.

Visual inspection of the entire field area and conduct survey.

Supply all service technicians, products and service equipment required for leak off test and servicing.

Valve reconditioning and/or replacement

Assist client instructions as required.

# PROCEDURES FOR WELLHEAD VALVES SERVICING:

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- Identify jobs to be surveyed or serviced.
- Request hot or cold permit to be signed, if required.
- After tool box talk (safety briefing) approach the valve & set-up pumps which need air supply at least 100 psi.
- On the Xmas tree (wellhead); Monitor WHP's, leak test, and inspection of tree cap.
- On the flow line; leak test gate valve, check valve, and inspect choke valve.
- Equipment & data configuration sheet logging.
- An air operated liquid pump, rated at maximum 10,000 psi, is connected in to the upstream and downstream valve injection ports. Then inject a liquid valve penetrates (flush). It flushes the valve and allows the sealant to be freely by clearing the lubrication channels of old sealant.
- If valve shows sign of leak at valve stem area or bonnet, apply stem packing pellets to fittings before proceeding with valve greasing.
- If possible the valve at this time should be fully cycled a few times. If the tree cannot be closed and has to stay online, then only half cycle will do. The hoses are changed and a the valve master or bucket pump are loaded with synthetic valve lubricant or valve master sealant, which is injected into the upstream and downstream seat areas to seal the valve.
- While this injection is being carried out, cycle again the valve, only half way will do. Torque equipment tool can be attached to the valve hand wheel to cycle valve. It can deliver torque up to (+1000 nm).
- Additionally at the end of the hose is a high pressure ball valve or shut-off valve, rated at 10,000 psi, so there is no danger of any pressure coming back from the valve in to the pump. All the hoses, gauge, tee and shut-off valves are rated at 10,000 psi with the exception of the hoses, which are rated at minimum 20,000 psi internal burst.
- All of the working parts of PLI equipment are rated above specifications of the working pressure for safety reasons.
- When we start work, all of the equipment is accompanied by a service supervisor and experienced service technicians. They carry a steel box that contains spare parts, pumps, fittings, extra hoses, and hand tools which are necessary to carry out the service work.

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# SCOPE OF WORK CAN BE SUMMARISED AS FOLLOWS:

Flush valves by our fully synthetic superior flush fluid Aramco # 26-000-155 using our PLI flush high pressure pump as needed.

Lubricate valves by our fully synthetic super lubricant Aramco # 26-000-156 using our PLI high pressure master lubricant pump as needed.

Inject valves with our fully synthetic master sealant Aramco 26-000-157 using our PLI high pressure pump as needed.

Inject sealant or stem packing into stem injection nipple to stop outside leaks as needed.

There is a different service procedure for all different types of valves. The procedures can be and will be modified for leaking/passing/firm to cycle or seizing valves.

After completions of each day job a field service ticket report is filled up by Team Leader and signed by client supervisor in-charge. A service report is filled out for each Xmas tree / plot

Tagging is attached to serviced valve upon client acceptance and approval.

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# EQUIPMENT:

Field service 4x4 pick-up (Pickup truck)

PLI Power Master Open Skid Unit – 10,000 psi Lubrication sealant pump.

PLI Lightweight trolley mounted Bucket Pump (9649L or PMV) – small / compact and design that can be carried via helicopter.

PLI Flush Pump – S.S. Tank Trolley used for injecting liquid valve flush.

PLI Diesel Air Compressor - operated with spark arrestor, safe for gas valves.

Tool box for accessories & rags needed for the job.

Flush 20 liters per pail each, super lubricant 40 pounds per pail each, master sealant 40 pounds per pail each.

Air hoses, injection whips, fittings as needed.

Valve hand wheel torque tool (pneumatic)

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# OBLIGATIONS

Supply skilled specialist crew to perform the service professionally.

Supply latest equipment of skid with high pressure rating up to 10,000 psi pumps for professional job.

Supply all safety PPE gear including H2s gas detectors for our service crew.

Supply needed materials flush fluid, lubricant, and sealant needed for the job.

Mobilize and de-mobilization of crew, equipment from origin to job location onshore or offshore.

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# Training notes for servicing Ball / Plug / API through Conduit Gate Valves

# Section A: Safety and Training

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- Personnel engaged in onsite “live” Flushing, Lubrication and Emergency Sealant injection activities must understand the following points of Safety.
- Ensure all PPE equipment is used Hard Hat, Safety Glasses, Face Shield, Gloves, Overalls, Hearing Protection.
- Ensure personnel engaged in this activity have undertaken training.
- Be aware that the valve and pipeline may be UNDER PRESSURE.
- Ensure that hoses and fittings are appropriately rated.
- Be trained in risk assessment of Lubrication processes.
- Be aware of equipment downstream that may be effected with the introduction of synthetic Lubricant/sealants within a piping system, transmitters, filters, flow meters, metering systems.
- Have training in various valve types and operational requirements.
- Have undertaken training in use of high pressure injection equipment.
- Have a clear understanding and knowledge of various fitting types and what to look for.
- If possible stand away from fittings, hoses whilst under pressure.
- Never remove a fitting from a valve whilst under pressure.
- Check that fittings attached to valves are tight.
- Fittings can blow off stand clear at all times
- Always adhere to rules and regulations, never cut corners especially to save time.

**This is a potentially hazardous task HIGH PRESSURE CAN KILL**

# **Section B**: Lubricating and Sealing. What does it do? Explanation

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- Various valve types are designed with facilities to undertake Lubrication or Emergency Sealant Injection; these valves can be divided into 2 distinct Categories.
- Lubricated Plug Valves Category 1: Lubricated Plug valves either plain, regular, venture, inverted require frequent injection of lubricating Sealant to ensure smooth trouble free ¼ turn operation
- and also to provide a thin sealing membrane between the plug taper and body, the following training will show applicable lubrication points.
- API through Conduit Gate Valves and Trunnion Mounted Ball valves Category 2: These valve types are manufactured to facilitate injection of lubricant or sealant.
- There remains various opinions on “GREASING” of Category 2 type valves some companies will require lubrication of ball and gate type valves on a regular basis.
- Some manufactures design these injection points to provide 2 main functions only.
- Emergency provisions on Ball and Through Conduit Gate valves to provide isolation due to seat degradation.
- Gate or Ball valves to provide a means of methanol injection to dissolve ice formation through gas hydrates ensuring a valve does not freeze or become inoperable.
- In the case of Valves that rely on Elastomeric seals that are integral to providing a seal interface there is valuable merit in packing the seals with synthetic lubricants to eliminate age or process induced embitterment of the seals and subsequent valve failure.
- The use of synthetic lubricants to maintain seal condition in Sour applications or in services with high concentrations of H2S can maintain seal condition in an immersed service environment.

# Section C: Flushing, Purpose Objectives

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- The purpose of flushing is to ensure that injection fittings, injection ports, Ring grooves, all sealing components are free from old hardened compounds that may have been injected within a valve and solidified, hampering efforts to inject fresh sealant or lubricant.
- PLI's Liquid Valve Flush dissolves hydrocarbon deposits, loosens rust and scale deposits,
- It is imperative that personnel have current MSDS sheets on this product and
- Fully understand the correct procedure and safety requirements
- Flushing should always be carried out before the introduction of Lubricant or
- Sealant to ensure all cavities are free. This is relevant to service and conditions
- Be certain to check individual MSDS sheets to identify the flushing compounds
- used are compatible with process conditions.

# Section D Fittings Types and Uses

Button head type fitting should be replaced with a Stainless Steel Combination Vent Cap fitting

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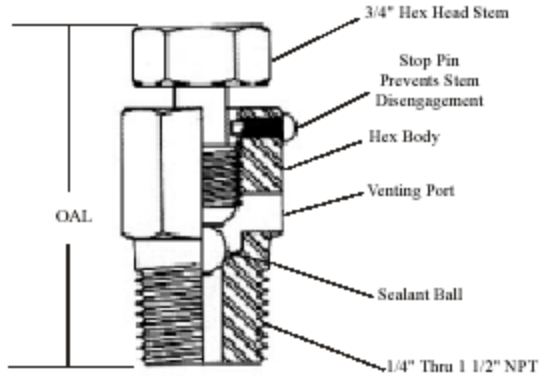
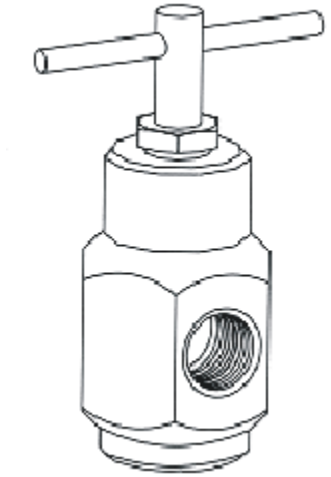



Cavity Drain fitting used extensively on trunnion mounted ball valves to "blowdown" trapped body pressure, also used on API through conduit Gate valves.
Generally available from ¼" – 1 ½" NPT 10,000 psig rated use stainless only.



Pressure Relief tool: Used to fit onto WKM / Cameron and PLI style Vent Cap fittings to safely Vent off or check for residual pressure.

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# Section E: Sealant / Lubrication / Flushing Procedures

Before any work is undertaken a careful inspection of injection fittings attached to the valve is required.

Inspect the following points.

Corrosion where the injection fitting is screwed into the valve or gland, corrosion around the threaded section of the fitting may extend into the threaded section of the valve body resulting in less thread engagement and a reduction in strength. The fitting may blowout under hydraulic pressure.

Damage to the thread connection on the fitting head, this could cause misalignment of the injection fitting on the hydraulic line inadvertently causing the check valve on the fitting to be engaged , swivel fitting attached to the whip hose should always be fitted with the isolation valve closed.

# CONTINUED

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Procedure as follows.

- Ensure all relevant permits are in place to allow work to commence
- Place pump as close as possible to valve ( ensure it cannot fall and is upright )
- Inspect valve fitting for corrosion or defects that may make proceeding dangerous and is tight.
- Ensure no defects such as nick, burrs are visible to injection hose and whip.
- Pump sufficient product through whip hoses to ensure the hose and whip are fully purged.
- Fit swivel to fitting ( ensure whip isolation valve remains closed )
- Open whip isolation valve
- Regulate pump inlet air pressure to slowly raise injection pressure.
- Inject sealant or lubricant into valve ( 11 strokes = 1pound)
- Monitor downstream pressure to see if valve is maintaining isolation.
- Valve isolated.
- Close whip
- Bleed off pressure from pump and hose.
- Ensure pressure gage is reading 0
- Disconnect swivel from fitting ( Ensure fitting does not unscrew )
- The process remains identical for gland leaks

This process is for use using PLI PM3 pump

# Section F: Equipment Types

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We have designed and manufactured different injection equipment. They are all required to undertake the same basic functions, pump and intensify highly viscous materials to high operating pressures

High volume and pressure requirements generally use diaphragm positive displacement pumps with various air ratios up to 140 : 1 to overcome very high system pressures.

In essence the equipment must be capable of the following.

Be as light weight as possible

Be ergonomically designed to easily move around plant locations.

Must have very fine pressure control ( regulation to valve )

Must be accurate in delivering required volume amounts.

Must be adequately matched ( no use using a small pump on a large Plug valve )

Must be robust and reliable in terms of operation.

Air operated (Gas Environments) electric, hydraulic types are available.

Should be capable of monitoring volume of product delivered into a valve.

Meet client safety requirements.

# CONTINUED…EQUIPMENT

**SAFETEY WHIP HOSE**

**10,000 psig Liquid Flush Pump**

**Pressure Gauge** **Isolation Valve** **Rated Hose** **Rated Swivel**

Safety Whip Hoses Must be used for flush, Lube/sealant. This is a disposable item, should a fitting fail, isolate valve and leave on fitting, replace with new fitting when system is not under pressure.

# Section G Recommended Injection Pressures based on valve ratings

Valves comprise of a PRESSURE retaining cavity, as the injection process associated with lubrication and sealant injection activities operate at very high pressures personnel engaged in this maintenance activity need to be aware of valve pressure limitations and where possible operate within these pressure boundaries.

Hydraulic loads induced by Pressure Pumps in delivering highly viscous sealants and lubricants can cause permanent plastic deformation of valve bodies and cause damage to elastomeric seals or fittings.

The table below is intended to identify Valve Pressure Classes # and Maximum Injection Pressures

| API Valve Rating # | Maximum API Valve Cold Test Pressure psig | Maximum Permissable Injection Pressure psig |
|---|---|---|
| 300# | 1125 | 1125 |
| 600# | 2225 | 2225 |
| 900# | 3350 | 3350 |
| 1500# | 5575 | 5575 |
| 2500# | 9275 | 9275 |

**Recommended Frequency of Lubrication (Plug Valves Only)**

| Frequency of Operation | Not More Than | Not Less Than |
|---|---|---|
| Over 100 times per 12 hour shift | Each Shift | Weekly |
| 10 – 100 times per shift | Daily | Weekly |
| 1 – 10 times per shift | Weekly | Monthly |
| 1 – 30 times monthly | Monthly | Quarterly |
| Less Frequently | Quarterly | Twice annually |

Other valves not applicable unless subject to freezing.
If valves are in submerged service it is imperative that schedule is adhered to.

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# SECTION G: CONTINUED

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**Volumes**
As each differing valve type, design and manufacture vary greatly it is important not to overfill valves causing potential pipe line process contamination.
Pressure rise is generally the one way of knowing if a valve is full, detection of downstream pressure drop indicates successful sealing and isolation has been obtained, a reduction in pressure reading at whip hose maybe experienced.
Valves such as Lubricated gate, Plug and Balls will require operation or stroking to ensure products distribution and products have filled all cavities and voids.

**Sealant and Lubricants: Types and Uses.**
Manufacturers of different types of valves will specify proprietary products not always available, PLI products are acceptable for use on different valve types and process conditions.
Always check process conditions and applications before using or specifying materials for injection use, some products may give better results than others

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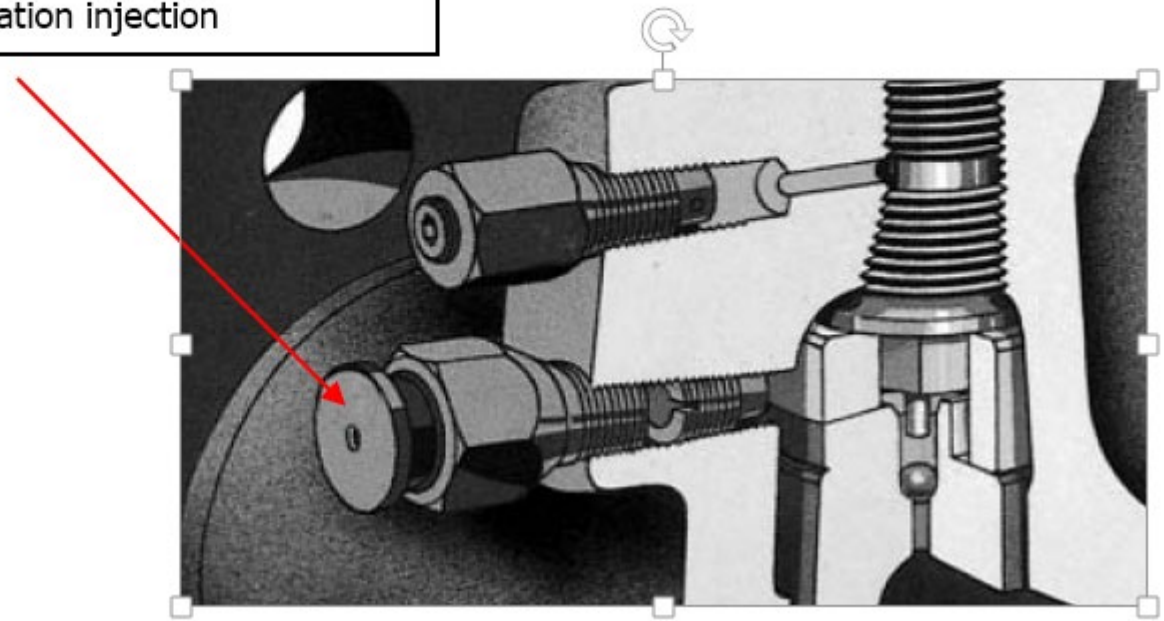
## Section H  Some Plug Valve Injection Locations

Button Head Lubricators may be fitted to stems for lubrication injection



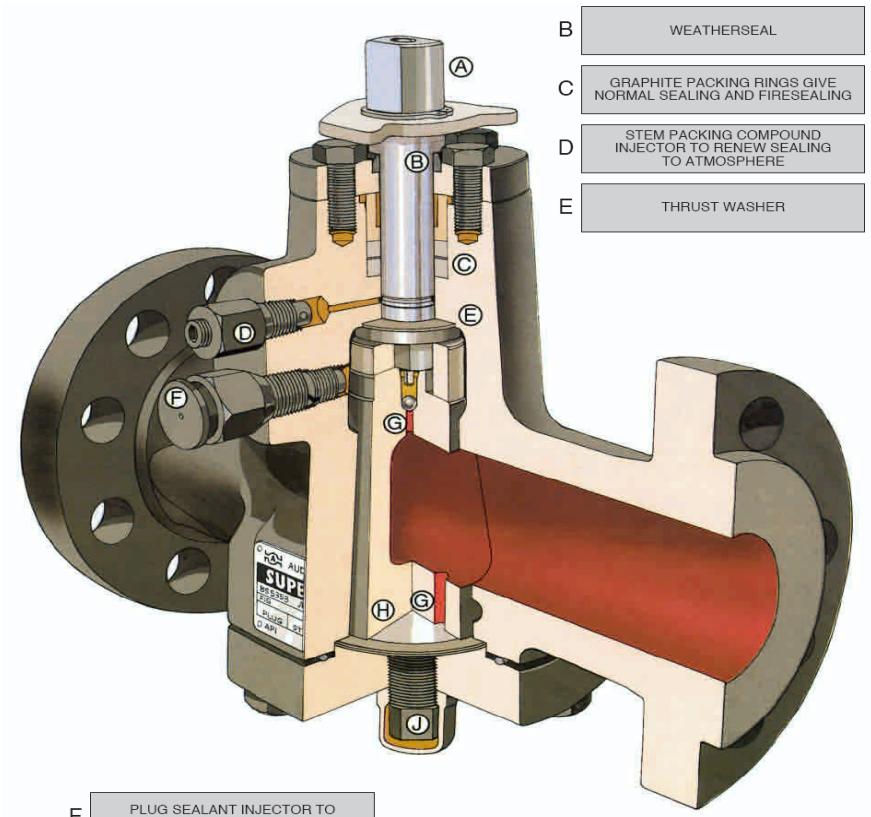
# CONTINUED

**D** plastic injection fitting may change from manufacturer
**F** sealant injection fitting for downstream sealing and lubrication valve shown with button head type fitting

## Plain Stem Design

Plain stem design used for

50-100 mm 2-4" Class 150
40-100 mm 1½-4" Class 300
40-100 mm 1½-4" Class 600




| | |
|---|---|
| A | BLOWOUT PROOF STEM: SUPER LoMu TREATED WITH DOUBLE D DRIVE FOR WRENCH |
| B | WEATHERSEAL |
| C | GRAPHITE PACKING RINGS GIVE NORMAL SEALING AND FIRESEALING |
| D | STEM PACKING COMPOUND INJECTOR TO RENEW SEALING TO ATMOSPHERE |
| E | THRUST WASHER |
| F | PLUG SEALANT INJECTOR TO RENEW SEALING TO DOWNSTREAM |
| G | PRESSURE BALANCE HOLES |
| H | PLUG WITH METAL-TO-METAL SEATING, SUPER LoMu TREATED |
| J | PLUG LOADING SCREW |

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# SECTION H: CONTINUED

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**Injection Fittings and Locations may vary from manufacturer to manufacturer**

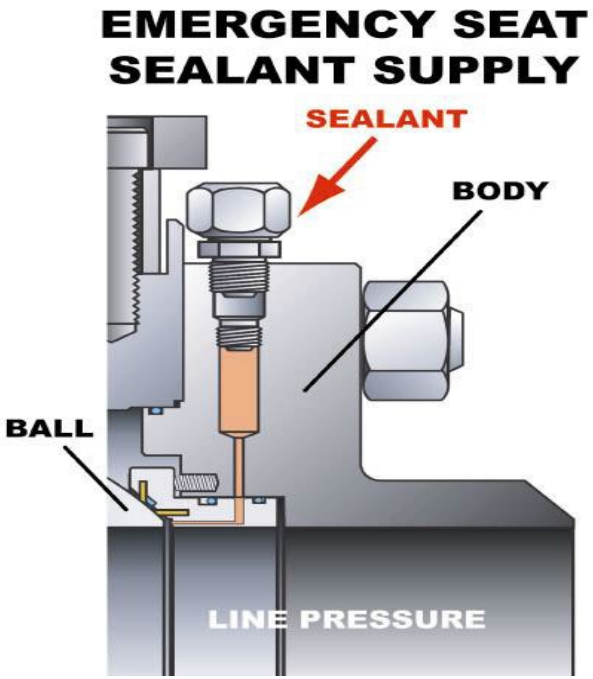
**Plastic stick Injection**

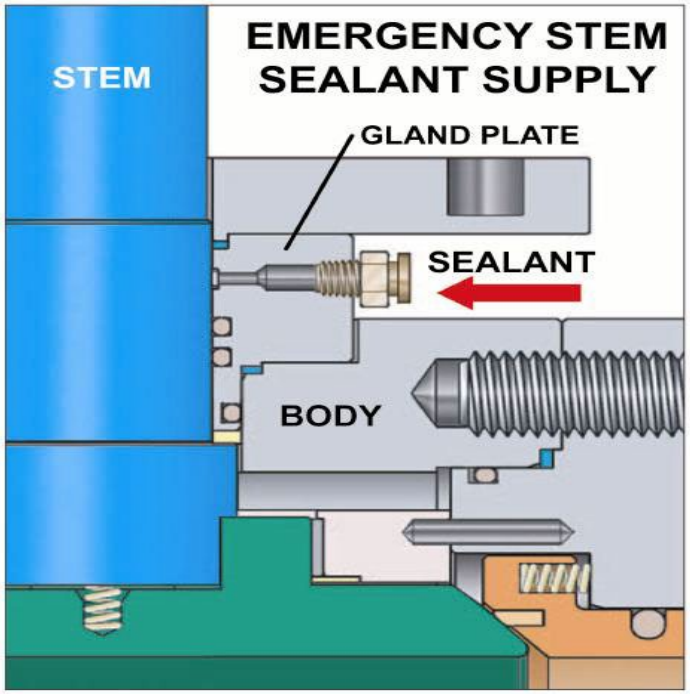
Some valve designs require the application of plastic stick injections to gland areas, reapplication to these types of valves must be done with caution

As stick packing need to be installed by the removal of a load screw, internal check valves may be corroded or damaged providing no protection for technician working on this equipment.

Ensure all PPE equipment is being used (face shield and Safety Glasses) **Stand Away from Fitting at all times**

# Ball Valve Showing Emergency Seat Injection attempting to eliminate downstream leakage




**Stem Sealant location in event of seal failure**

- Seat injection can be undertaken on both upstream and downstream seats simultaneously.
- Some ball valves may also have plastic stick injection points fitted to stem cavity as do Gate and Plug valves
- Location and design of injection fittings will change from manufacturer to manufacturer.

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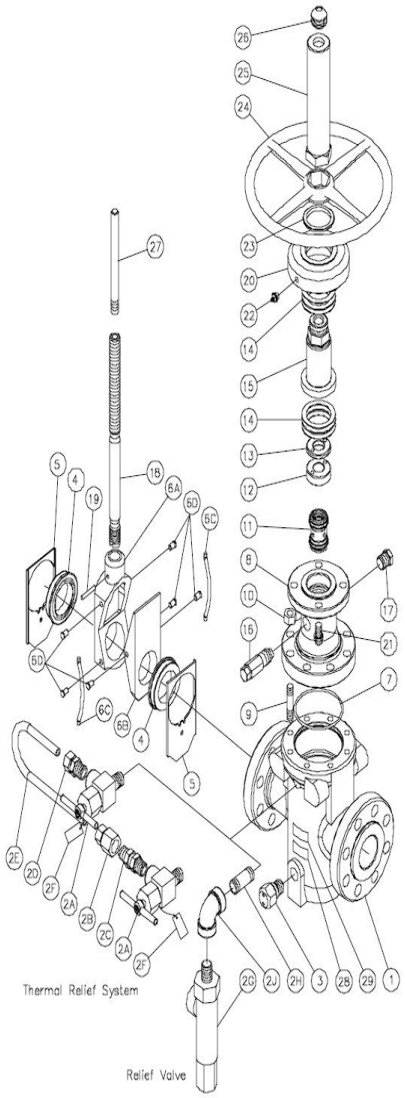
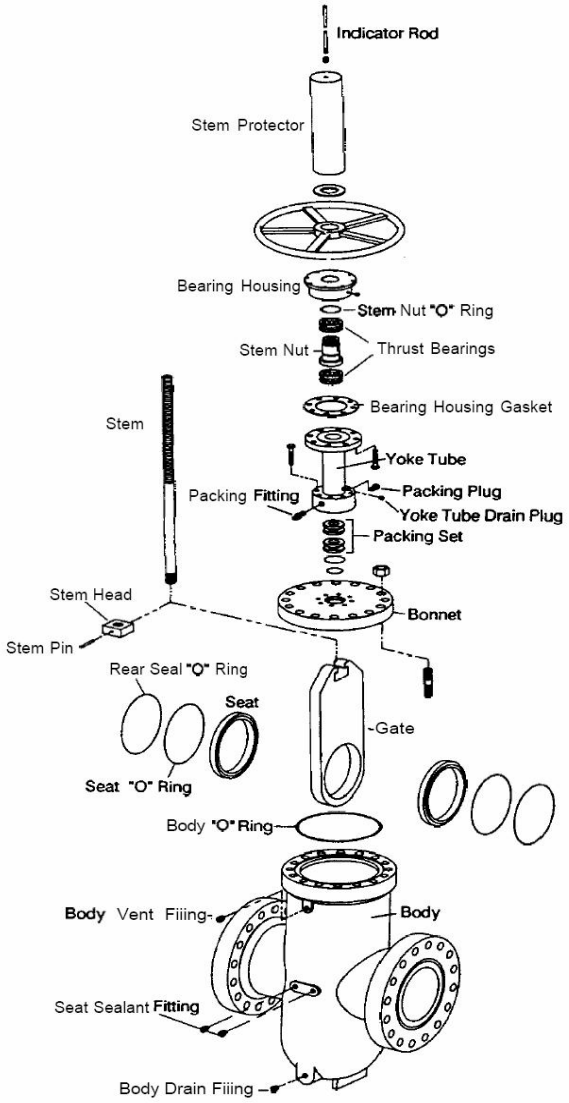
# API through Conduit Expanding Gate and Slab Gate valves




| ITEM | DESCRIPTION |
|---|---|
| 1. | Body |
| 2. | Thermal Relief Valve System |
| 2A. | Needle Valves |
| 2B. | Female Connector |
| 2C. | Check Valve |
| 2D. | Male Connector |
| 2E. | Tubing |
| 2F. | Needle Valve Caution Tag |
| OR | |
| 2. | Relief Valve with Piping |
| 2G. | Relief Valve |
| 2H. | Nipple |
| 2J. | Elbow |
| 3. | Drain Fitting |
| 4. | Seats |
| 5. | Seat Skirts |
| 6. | Gate and Segment Assembly |
| 6A. | Gate |
| 6B. | Segment |
| 6C. | Springs |
| 6D. | Spring Pins |
| 7. | Bonnet Seal |
| 8. | Bonnet |
| 9. | Studs |
| 10. | Nuts |
| 11. | Packing Set |
| 12. | Packing Retainer Nut |
| 13. | Packing Retainer Lock Nut |
| 14. | Bearings |
| 15. | Stem Nut |
| 16. | Packing Fitting Assembly |
| 17. | Packing Plug |
| 18. | Stem |
| 19. | Stem Pin |
| 20. | Bearing Housing |
| 21. | Cap Screws |
| 22. | Bearing Housing Grease Fitting |
| 23. | Weather Seal |
| 24. | Handwheel |
| 25. | Stem Protector |
| 26. | Rod Wiper |
| 27. | Indicator Rod |
| 28. | Caution Tag for Trapped Pressure |
| 29. | Nameplate |

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Tagging: It is good practice to tag a valve; this will provide the next person undertaking a remedial isolation some history on when the valve was last injected.
Tags should be securely wired to the fitting indicating the date of last injection; more complex record keeping may be kept based on client compliance requirements.

# Section I: Trouble Shooting

**Q: Pump fails to deliver lubricant or sealant**

A Check pale to ensure it is full
Insufficient air supply to pump or isolation valve closed on air inlet.
Ensure pump is bled of air
Ensure whip isolation valve is open
Ensure fitting is not defective
Ensure lube hose is not too long (keep hose as short as possible)

**Q Pressure is building up on whip gage no compound coming out.**

Answers Valve has not been flushed and injection points are solidified (Flush First)
Defective fitting attached to valve (check valve may be faulty) or another check is fitted under the fitting.
Ingress of foreign materials under fitting (do not remove if live) flush only

**Question: body has corrosion around fitting**

Answer: Deeper corrosion could be inherent check fitting for tightness and inject at lower pressures.

**Question: Can not obtain isolation on valve.**

Answer Try the Super blue sealant.
Simultaneously inject both upstream and downstream seat (Ball and Gate)
Plug may require full 180 degree plug rotation.

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# SECTION I: CONTNUED

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**Question: Existing fitting is leaking**

Fit PRT assembly to push check and release (may reposition check valve) or leave PRT or whip hose fitted and isolate remove fitting and replace when no system pressure is evident.

**Question: What does the whip hose do?**

It is designed as a safety device and should be treated as a consumable product should be left on a defective fitting if required until system has no pressure

**Equipment and Consumable Storage**

Consumable items such as Flush compounds, Sealants, Lubricants, plastic Injection products need to be stored in a dry, dust free environment.

Fittings should be stored with plastic protection covers reducing the chance of thread damage.

**Notes:** It is imperative that personnel engaged in injection and lubrication activities

have a thorough knowledge of valve design, types and operations, this knowledge

will increase the chances of obtaining isolation to valves whilst in service and providing

client satisfaction.

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# VALVE BALL RUST DETIORIATION

Valve ball rust is due to metal contamination and a damaged seat seal (see the next slides in this presentation). If this valve had regular servicing with PLI *Liquid Valve Flush* *PART NO: PLI-200-HP-VF* and lubrication using PLI *Valve Lubricant* *PART NO: PLI-200-HP-LUBE* in service would have reduced or even stopped the rusting and damage. The ball was ok and re-polished, assembled with news seats.

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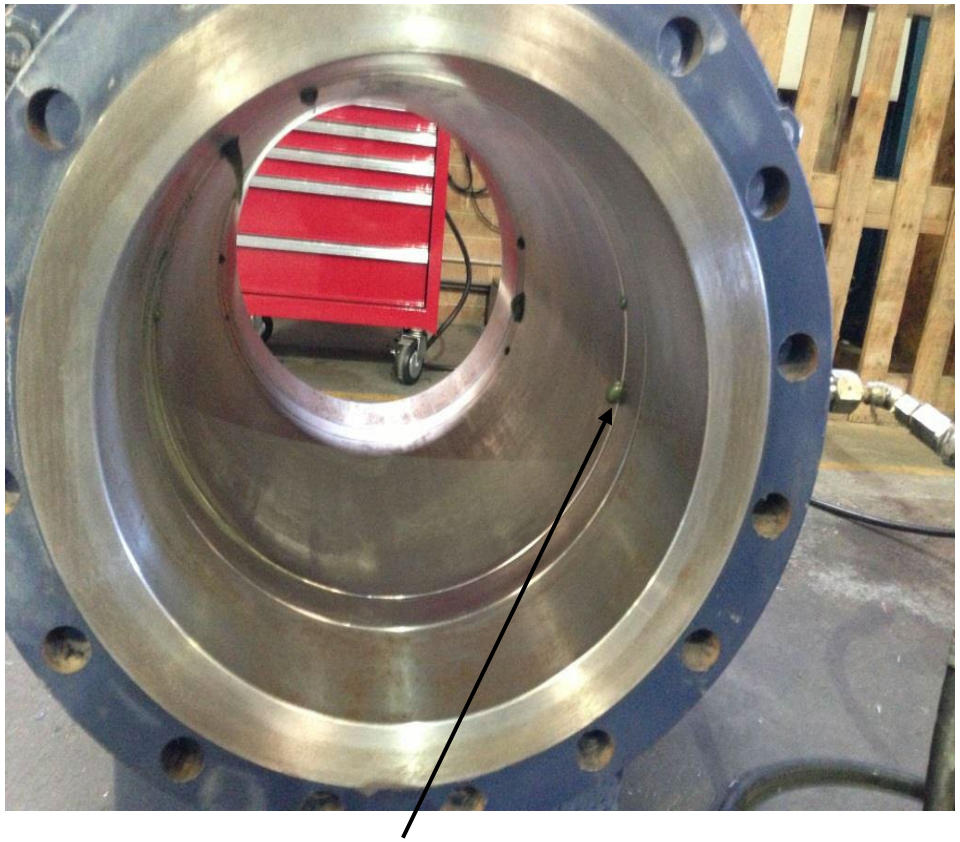
# VALVE BORE, SEAL & SEALANT

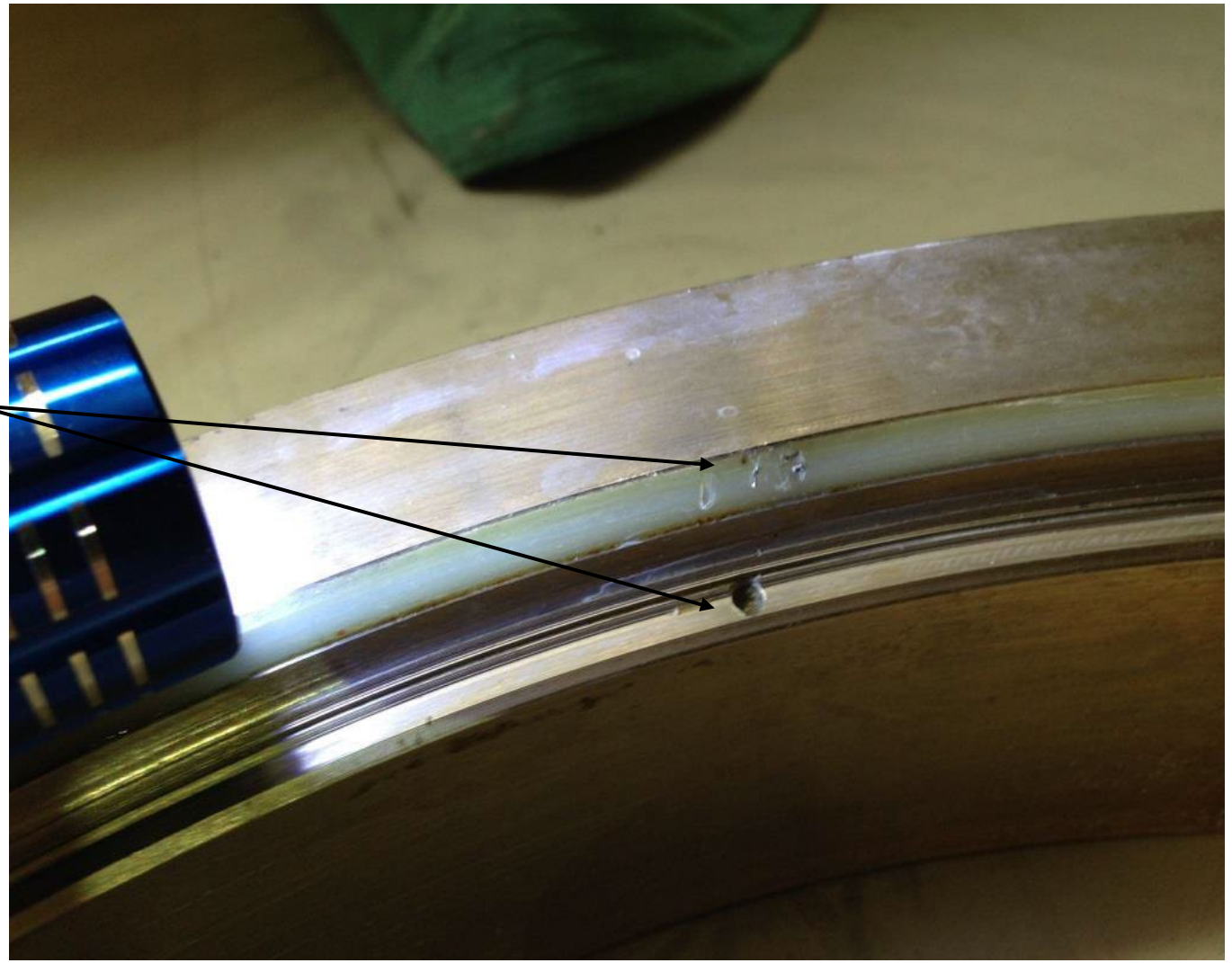
This picture  shows the bore of a valve, the valve is open.



The picture shows PLI *Valve Sealant* *PART NO: PLI-200-HP-SEAL* starting to come out the seat ring area in to the bore.

# VALVE SEAT & RING

This pictures show the holes in the seat ring and damage to the seat.



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# VALVE SEATS, SEALS, BALLS

The images below show valves rings and seals and of the ball in a closed position.

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# VALVE SEAT & SPRINGS