Base Load Power Hub (BLPH)

SDV/BDV AND TIGHT SHUT-OFF XV VALVES

SDV/BDV AND TIGHT SHUT-OFF XV VALVES - TECHNICAL OPERATING AND MAINTENANCE MANUAL – COMPLETE

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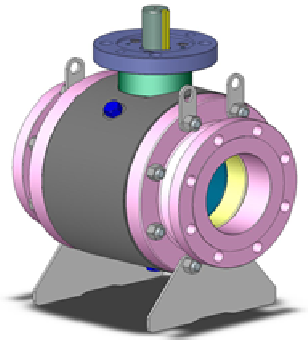
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Fluitek Valves

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INSTALLATION, OPERATION AND MAINTENANCE MANUAL



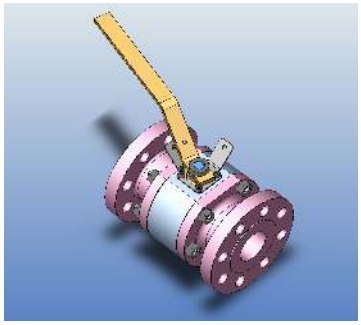
SPLIT BODY- TRUNNION BALL VALVE Type VL2-VL3

Category	Valve code	Description	Size	Class
Trunnion	VL2 / VL3	Trunnion ball valve 2 – 3 pieces	DN=>6”	150#-:-15000#



SPLIT BODY - TRUNNION BALL VALVE Type ST2-ST3

Category	Valve code	Description	Size	Class
Trunnion	ST2 / ST3	Trunnion ball valve 2 – 3 pieces	DN=<6”x4”	150#-:-15000#



FLOATING BALL VALVES Type FB2-FB3

Category	Valve code	Description	Size	Class
Floating	FB2 / FB3	Floating ball valve 2 – 3 pieces	DN=<6”x4”	150#-:-600#

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1 INTRODUCTION

This manual provides instructions for storage, inspection, maintenance, installation and operation of split body floating and trunnion mounted ball valves in two or three bolted pieces.

Fluitek Orsenigo Valves S.r.l is not liable for any damages to the purchaser, user, their employees or others, the plant and any items thereof caused due to the improper use, un-authorised operation/personnel and/or non-observance of safety regulations.

Valves service life : 25 years

2 VALVE RECEIVING

2.1 Valve appearance during receiving operations

FLUITEK ORSENIGO VALVES S.r.l.'s (FOV) valves are supplied with appropriate end-protections and/or individual weather-proof packages, which, at the same time, prevent any external agent from entering the valve.

Do not damage or alter them before installation in order not to compromise valve conformity or protection status during storage.

2.2 Packing and storage after receiving

After receiving, valves should be kept indoors.

If valves are stored outdoors they should be kept away from the ground and waterproof covers should be used if missing.

Fluitek recommends storing the valves indoors, in a dry, dust free atmosphere.

The packing material and end protectors should remain on the valve until ready for installation. If the protective coverings are removed for inspection, immediately reinstall them after the inspection.

In case of excessive periods prior to installation the valve should be kept under cover, above ground and protected by waterproof material. FOV recommend in this case to protect the outside of the valve with a light anti-rust oil.

Shel life of "package" max 3 years.

2.3 Storage instructions

a - If the valves have to be stored for a long period on site prior to their installation, they should be kept covered and dry. It is mandatory that the end plugs and original packaging are kept in good condition.

b - All the valves are supplied with end plugs, to protect the internal parts. These end plugs may not be removed during storage. If necessary for maintenance or inspection, care should be taken to replace them when the valves are returned to the store.

c- If the valve is supplied with an actuator, every electrical, pneumatic or hydraulic connection shall be kept plugged until just before the installation (refer to specific actuator instructions for further information

2.4 Scheduled maintenance during storage

In case of extended storage time, the valves should be inspected and checked as follows at least every 3 months:

- External surface inspection checking any alteration of the protective coating.
- (In case of presence of rust and/or damaged paint work, the area should be wire brushed and degreased using an appropriate chemical solvent).
- Inspection of the protective coating. (In case of damages it should be restored following the instructions given by Fluitek Orsenigo Valves according to the painting cycle used by the factory)
- Removal of the end protection plugs and without moving the ball, inspection of the internal surfaces of the valve for the complete absence of dust, rust, foreign matter and the integrity of lubricant coat.
- Cleaning and lubricating of the internal parts (best done using a nebulised lubricant).
- After cleaning and lubrication, rotate the ball by completely opening and closing the valve.
- The ball must be generally kept in the fully open position except that ball valves equipped with fail to close actuators are necessarily kept in the open position. In no case the ball should be kept in an intermediate position.
- Replace the protective end plugs.

2.5 Valve stored in pipeline during construction

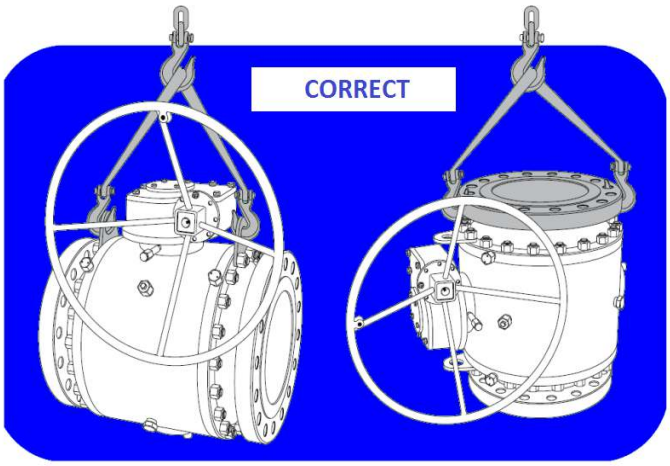
Valves mounted in pipeline during construction period and not used for indicated process will need to be protected against any type of foreign material and / or debris and / or corrosive environment inside the valve pipeline. Any open connection on valve or actuator (if mounted) during installation / construction should be carefully protected until the moment of final connection and start-up of process.

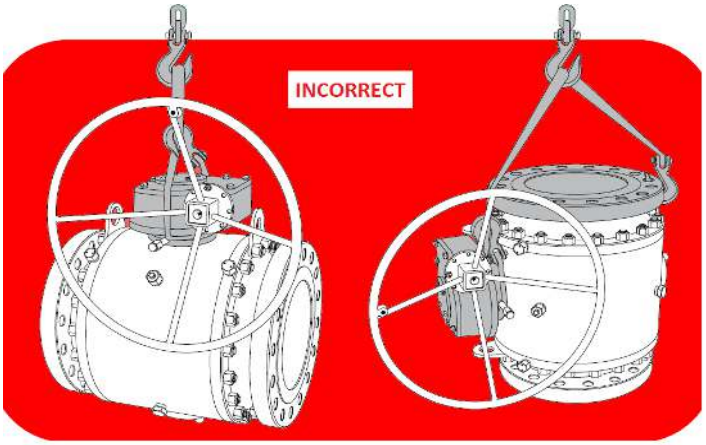
3 HANDLING AND LIFTING

When handling the valve or valve package, use appropriate equipments with regard to the valve and operator weight..

The valves may be lifted by slings or end flanges. If actuated, do not use the actuator lifting lugs or parts of the actuator. If handwheel operated, do not use the handwheel as a lifting point.

Place an approved lifting device securely around the valve body or use lifting hooks while handling the valve. Special care should be taken not to damage the lever/gearbox/actuator.





The list of possible erroneous actions during the installation of valves and accessories and methods for their elimination.

Possible erroneous personnel actions	Possible consequences	Elimination method
Insufficient tightening of the crimp pipe fitting nut	Seal failure of crimp connection	Pressure release from the system. Fitting nut tightening to recommended turning number
Over tightening of the crimp pipe fitting nut of the valves	Seal failure of crimp connection	Pressure release from the system. Fitting reassembly with using a new set of crimp rings. Fitting nut tightening to recommended turning number.
Incorrect installation sequence of crimp rings for pipe fitting of the valves	Seal failure of crimp connection	Pressure release from the system. Fitting reassembly with using a new set of crimp rings, their installation in the correct order.
Under tightening of threaded connection	Seal failure of threaded connection	Pressure release from the system. Threaded connection reassembly
Incorrect valve installation relative to fluid flow direction	The valve does not perform its functions of cutting off the medium or regulating the flow. Failure of valve elements.	Pressure relief, valve disassembly, replacement of damaged components, or sending for diagnostic testing and repair to the manufacturer. Valve reassembly in accordance with the operating manual
Installation of valves on improper medium, pressure or temperature	Failure of valves or its individual parts.	Valves disassembly, sending for diagnostic testing and repair to the manufacturer or disposal.

Criteria for the limit state.
The criteria for the limit state of valves are:

• destruction and loss of density of the material of housing parts, working under pressure.

4 INSTALLATION AND START-UP

4.1 General cautions

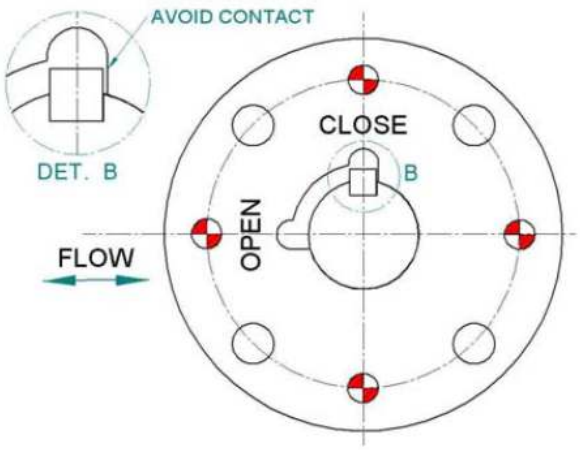
Installation must be carried out by qualified personnel aware of the standard field techniques and following the instructions contained in the Instruction manual of the valve.
The personnel involved have to be aware of the basic safety procedures, mandatory for the protection of their own safety.
All necessary information and instructions for the valve are described in this Manual.

4.2 Valve preparation and cleaning

Remove the protective end plugs and thoroughly inspect the interior of the valve and end connection for damage. Any foreign material should be removed.

4.3 Bare stem valves

If the valves are supplied with bare stem, the angular stroke of the valve must be adjusted in fully open and fully closed position acting on the mechanical stops of the operator.
Since it is necessary to have access to the valve bore, for a correct setting, this activity shall be performed when the valve is out of the line.
A groove is machined on the top flange (see figure below) where the stem key can travel for an angular stroke exceeding 90°.
NOTE: Ensure the stem key coupled with the handwheel/actuator does not travel beyond 90° in order to avoid damage to the groove.
DO NOT USE THE STEM KEY AS MECHANICAL STOP FOR THE EQUIPMENT
When the operator is supplied by Fluitek-Orsenigo Valves settings are already established in the factory and may not be modified.



4.4 Valve assembling to the piping

a- Move the valve by means of the body lugs, if fitted, or suitable eyebolts or flange holes. Never move the valve by yoke or using the lever, or the operator or some of its parts.

b- Remove the protective end caps only immediately before installation. If one end is not connected to the line for a period longer than half day, the open end should be securely sealed with a plastic or wooden cover.

c- Ball valves are generally bi-directional. However in some cases a preferential direction is indicated by an arrow or other markings in the valve body. This is a case of valves with two different seats (one seat unidirectional and one seat bidirectional) or valves with a relief hole in the ball.
BEFORE INSTALLING THE VALVE IN THE LINE, CHECK IF ONE OF THE TWO ENDS SHOULD BE IMPERATIVELY INSTALLED ON UPSTREAM SIDE

d- For flanged valves the installation will be provided by positioning the valve in the relevant space between the two flanges of the line. These must be of the same size and rating of the valve flanges.
Furthermore, the bolting (nuts and studs) shall be according to the relevant specification of the flanges. Bolting will be applied while the suitable gasket has been placed between the flanges of the valve and the ones of the line.

e- For welding ends valves take care of the following instructions:
Welding and subsequent procedures should be undertaken in respect of the maximum allowable temperature of the seals and seats
Welding should provide an adequate tolerance for the mounting of the valve to the pipeline.

f- The valve shall be installed in such a way as to avoid excessive loads transferred by the pipeline. By no means the valve should be used as pipe support or constraint.

g- At the end of installation it is advisable to lock the valve in order to avoid any movement of the ball before flushing the pipe line.

h- Special care should be taken to ensure that the ball is kept in the fully open position during its fitting to pipeline, as it was during storage.

4.5 Maintenance prior to flushing the pipeline

a- If the period between the installation of the valve and the flushing of the pipeline is longer than six months, preventive maintenance is suggested, as follows:

- Lubricate the stem with protective oil through the stem injector(if applicable).
- Lubricate internal parts (best if nebulised lubricant is used) through the lubricating plug
- Drain off the excess lubricant through the drainage plug
- Tightly close all the plugs that were unscrewed for the lubrication procedure..

b - Repeat the operation in 4.5a every six months.
c - DO NOT operate the valve during flushing of pipeline.
For more details see the attached assembly drawings.

4.6 Pipe cleaning (line flushing)

Soft seated valves are designed to handle clean fluid only (without presence of abrasive or hard particles).
Before using the valve, keep it in fully open position in order to reduce the chance of dirt and debris settling in the body cavity.
Pipe cleaning is anyway recommended even for metal seated ball valves.
Fluitek Orsenigo Valves select the material of construction and seals with regards to the service fluid indicated in the Valve Data Sheet.
If special additives are present in the flushing fluid, please ensure that those substances are mentioned in the data sheet.
In particular amines and methanol at certain concentrations can attack fluorocarbon (Viton) o-rings. However some grades of fluorocarbon have a limited compatibility with amines and methanol.
IT IS STRONGLY RECOMMENDED TO VERIFY THE COMPATIBILITY OF THE SPECIFIC FLUSHING FLUID WITH THE INSTALLED SEALS.

4.7 Hydrostatic testing of the line

If line hydro-testing is performed during start-up, some precautions shall be taken to avoid any damage of the valve internal components. The seats and the ball are designed to safely withstand 110% the maximum allowable working pressure at room temperature according to ASME B16.34 for the specified pressure class and body material.
Therefore in case the line hydro-test pressure exceeds this value,
THE VALVE SHALL BE KEPT HALF OPEN (Typically at 30° to 60° stroke)
Immediately after hydro-test, the valve should be opened again. Especially soft seats might be deformed by a long stay in partially open position.
The fluid used for hydro-testing and start-up operations shall be compatible with the metallic and non-metallic components of the valve.

In particular water without corrosion inhibitor may initiate corrosion of carbon steel valves and a chloride content exceeding 30 ppm may induce pitting corrosion of austenitic stainless steel parts.

- violation of the geometric shape of parts, that impedes normal functioning;
- impossibility of additional tightening of fittings after repeated disassembly/assembly of connections;
- a change in the condition of the surfaces of parts, that impedes normal functioning;
- permanent damage to parts, caused by aging of materials.

5 MAINTENANCE

5.1 General

Maintenance operations must be carried out by qualified personnel aware of the standard field techniques and following the instructions contained in this manual.
Furthermore the personnel involved in maintenance operations shall be made aware of the basic safety procedures, mandatory for the protection of their own health and safety. Always wear the correct safety equipment and clothing.
Always use original spare parts only.
The valve has been properly designed and manufactured to operate with satisfactory performances without substantial maintenance for at least two years and is guaranteed for the contractual requested time if all the recommended actions are properly taken.
The following table 1 shows the minimum inspection schedule to be followed in order to maintain the valve performances during the operating life time, that depends directly on the service conditions (media, temperature, pressure, etc…).
The respect of this plan is mandatory to keep the warranty active. In fact the schedule is essential for the good performances of the valve.

Table 1

.

No	***Description***	***When to be done***
M1	Adjustment of packing gland (only for adjustable glands)	When some leak are detected from stem
M2	Inspection of seals for leakage to the environment	12 months
M3	Valve stroke for smooth operation	12 months
M4	Check of bleed valve and plug tightness(where applicable)	12 months

5.2 Trouble-shooting guide

The following table 2. shows some possible trouble that might occur during the valve life and the possible actions to solve them. During the warranty period always report to Fluitek-Orsenigo Valves before taking any action.

Table 2

PROBLEM	POSSIBLE CAUSES	SOLUTION
The stem and driving device do not rotate	Gear or bearing defect	Top flange to be disassembled to access the bearing and check for any damage. Replacement of parts may be necessary. Remove gear cover and check for damage.
	Frozen gear or valve	Heat or inject anti-freeze solution into the gear.
	Over tight fire safe stem gasket (small size only)	Loosen the screws which compresses the top flange and try to operate the valve. If the stem can rotate, the gasket must be replaced with one of adequate size.
	Rough stem surface or dirt accumulation on the stem	Cover and stem to be removed to access the part for cleaning
	Bent or damaged stem.	Stem to be removed for repair or replacement. Report to FOV for analysis of root causes
Sealing surface leaking	Loose studs and nuts	Tighten studs and nuts according to recommended torque values.
	Damaged sealing surfaces	Valve to be disassembled to remove the part. Sealing surface may require refurbishment.
	Damaged o-rings or lip-seals	Replacement of seals (o-ring, lip seals graphite gaskets) in the concerned leak paths.
	Clogged sealing surface with dirt.	Valve to be dismantled to flush the sealing surface
Stem seals are leaking	Uncompressed packing (valves with graphite packing without o-rings or lip-seals),	Recompress the packing evenly
	Damaged or missing seals	Inject emergency sealant if this feature is available. (see Section 7) Seals to be installed or replaced as shown in the applicable General Assembly Drawing
	Deformed stem or presence of scores, scratches or galling	Stem to be replaced
Leakage through the valve/ball	The ball is not properly closed	Reset the operator
	Seat inserts or metal seating surfaces of ball and seat rings are damaged.	Inject emergency sealant if this feature is available. (see Section 7) Seat and ball to be removed. Report to FOV for refurbishment of contact surfaces.
	Seat to body seal is damaged	Replacement of seals
	Damaged seat pocket surface	Valve to be disassembled to remove the part. Sealing surface may require refurbishment.

5.3 Cautions

DURING MAINTENANCE OPERATIONS KEEP IN MIND THE FOLLOWING WARNINGS:

a - Graphite is very brittle: any twisting or bending should be avoided.

b - Some valves are equipped with spring energized lip-seals (part no. 71 in the drawings) in lieu of o-ring (72).
Spring energised lip Seals is very delicate, it can be subject to damage (i.e. spring squeezing or PTFE jacket pinching) during re-assembling if not done by trained engineer; assembly has to be done by slowly moving near the parts to couple.

c - The internal part of valves (ball, stem and seats) should be handled with care to avoid scratches or other damages to their surfaces.

d - All tools and equipment for handling and supporting the internal parts should be covered by a soft material.

5.4 Removal of the valve from the line

If the valve has to be removed from the line, the following actions should be taken by qualified operators:

- Carefully check for the complete absence of any pressure and medium into the line and downstream of the valve;
- Operate the valve in an intermediate position to relieve any body cavity pressure;
- Then operate the bleed valve to the fully open position.
- Care must be taken to support the valve if its size and weight are over the handling capacity. In this case suitable facilities must be used to support the valve by means of the proper lifting lugs.
- Unscrew the relevant bolting from both the side of the valve;
- Standard field techniques and procedures are satisfactory to disconnect the valve from the line.

5.5 Valve disassembling and reassembling

The instruction for disassembling and reassembling the valve are out of the scope of the present manual.
Table 2 in section 5.2 of this manual gives some indication of faults requiring disassembling or reassembling after trying any other remedial action.
However, it is always recommended to contact Fluitek-Orsenigo Valves before dismantling a valve in order to plan the specific actions required to overcome any fault.
In any case no action shall be taken during warranty period without written authorization by Fluitek Orsenigo Valves.

5.6 VALVE lubrication

For components that need to be lubricated, use grease **Chesterton 625 CXF** or similar.

6 OPERATION INSTRUCTIONS

6.1 Valve operating instructions

Valve are designed for On-Off service only and shall be kept always either in fully open or fully closed position – do not use as flow regulator (throttling service or similar).

The user shall be responsible for checking the fluid / material compatibility.

Valve is not provided with safety accessories against overpressure.
The user shall therefore protect the line where the valve is installed with suitable safety devices to ensure that the specified operational pressure/ temperature limits are not exceeded.
Pipeline pressure shock (water hammer) shall be avoided to prevent any serious damage to the valve.
Hand operated valves can be easily opened and closed by means of a force applied to the lever or gearbox handwheel. Turn 90° clockwise to close the valve and 90° counter-clockwise to open. Orientation of ball can be easily detected by the operator position: if the lever is parallel to the line the valve is fully open. If it is perpendicular to the line the valve is in fully closed position. The gearboxes are provided with a position indicator on top of the case, pointing the OPEN or SHUT position

It is advisable to turn the ball periodically in order to prevent jamming or any problem between ball and seat.
The partial operation (about 15% of the total stroke) every 3 months will ensure good seat and ball life.
This requires the valve to be operated (when it is open by lever), without any interruption to the plant's operation. Of course if the valve is normally in the closed position, it can be partially operated only if this action has been previously approved by responsible personnel.

6.2 Cautions

The end user is responsible for valve installation and use. He shall follow all instructions of this manual and operate in the range covered by the corresponding rating of the valve or specifications or data sheets.

Periodically check for any leak from all joined parts; verify the correct tightening of nuts, screw and plug where present.

Before starting any maintenance work, depressurize the line valve. Do these operations at ambient temperature and pressure, using all safety protections and appropriate tools.

6.3 Emergency Sealant Injection Procedure (ONLY FOR TRUNNION VALVES)

This procedure is applicable to all Fluitek Orsenigo Valves equipped with emergency stem and/or seat sealant injectors.
Ball valves are self-lubricated and do not need any grease or lubrication for normal operation; injection ports are provided only to stop or reduce leakage across the seats or through stem seals with valve in operation.
Sealant must be injected only when a leakage occurs.

HEALTH & SAFETY WARINING
All the operation must be performed under the responsibility of the end user or contractor and by qualified personnel due to danger intrinsically connected with pressure containing equipment.

One of the following products for oil and gas fluids can be used :
RS CLARE & CO. LTD – BTR555 – Sealant Grease
SEALWELD – TOTAL LUBE #911 – Sealant Grease
APEX INDUSTR. CHEM. LTD – ECO-SOLV – Flushing Fluids

Before using a sealant grease or any flushing please check the chemical compatibility of sealant and fluid handled from the valve.
To inject the fluid (flushing fluid & sealant) inside the valve a common pump (manual or pneumatic) can be used paying attention that the rating of the pump & related fittings must be higher than valve pressure rating.
The pressure necessary to inject the fluid must be between 5 and 8 bar higher than line pressure.

PROCEDURE FOR STEM LEAKAGE
To detect a leakage through the stem seal push safely the central button on the stem injector (needle of the check valve contained inside injector).
If a leakage is present, connect the pump to the fitting and insert a little quantity of sealant.
Stroke the valve from fully open to fully closed position 2 or 3 times to help sealant distribution around the stem surface.
If leakage does not stop it is necessary to replace stem seals. In such case refer to the proper maintenance instructions.

PROCEDURE FOR SEAT LEAKAGE
To detect a seat leakage across the seats, turn the valve from fully open to fully closed position and release the pressure trapped inside the body cavity through the vent or bleed port.
If after an initial release of pressure a continuous leakage appears, try to clean seating surface between ball and seats by injecting flushing fluid.
Before flushing close the bleeder.
During fluid injection stroke the valve a few times.
Re-test the valve to check a leak reduction.
If leak does not stop, close the valve and proceed with sealant injection (45gr each seat inch at the first time).
If leakage does not stop, repeat sealant injection reducing grease quantity of three times (all sealant conduits are full).

If leakage does not stop valve must be disassembled from line and serviced; in such case refer to the proper maintenance instructions.

6.4 Flushing Procedure (ONLY FOR TRUNNION VALVES)

This procedure is applicable to all Fluitek Orsenigo Valves equipped with proper flushing ports or emergency stem and/or seat sealant injector ports which can be used in that purpose as well.

The flushing fluid pumped through the stem and seat ports will fill the stem sealing and seat pocket areas first and then the body cavity.
In such way it help to keep the deposits off from packing in the voids of the seat rings.

a – Stroke the valve in complete closed position ;

b – Through the Vent make sure to completely release the pressure from valve body cavity ;

c - Make sure Drain port is closed

d – Connect to the flushing ports (see sketches of vent and Drain connection details at Annex A) a portable pump and inject fluid pressure (3-5 bar) to clean the body cavity from any existing resident debris, sand or solid compounds.
Once the body cavity is filled, the flushing fluid will raise though the Vent port.

e – Open the drain

f – During fluid injection, stroke the valve few times

g – Flushing operation has to be repeated till the flushing fluid is clean from any visible impurities

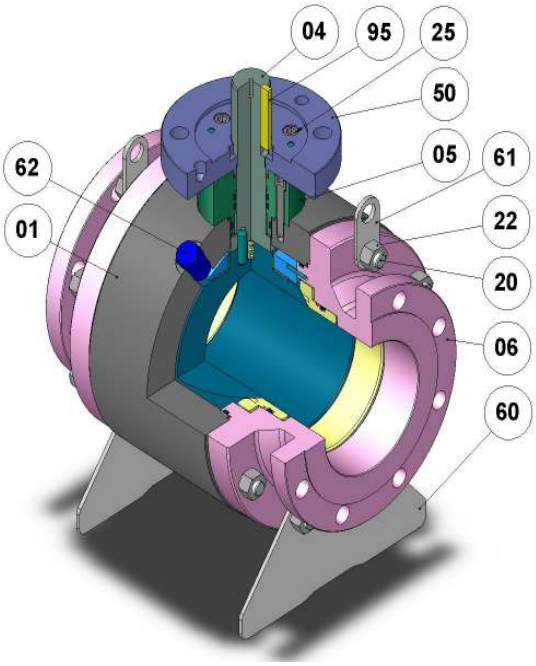
h – Make sure to drain completely the body cavity

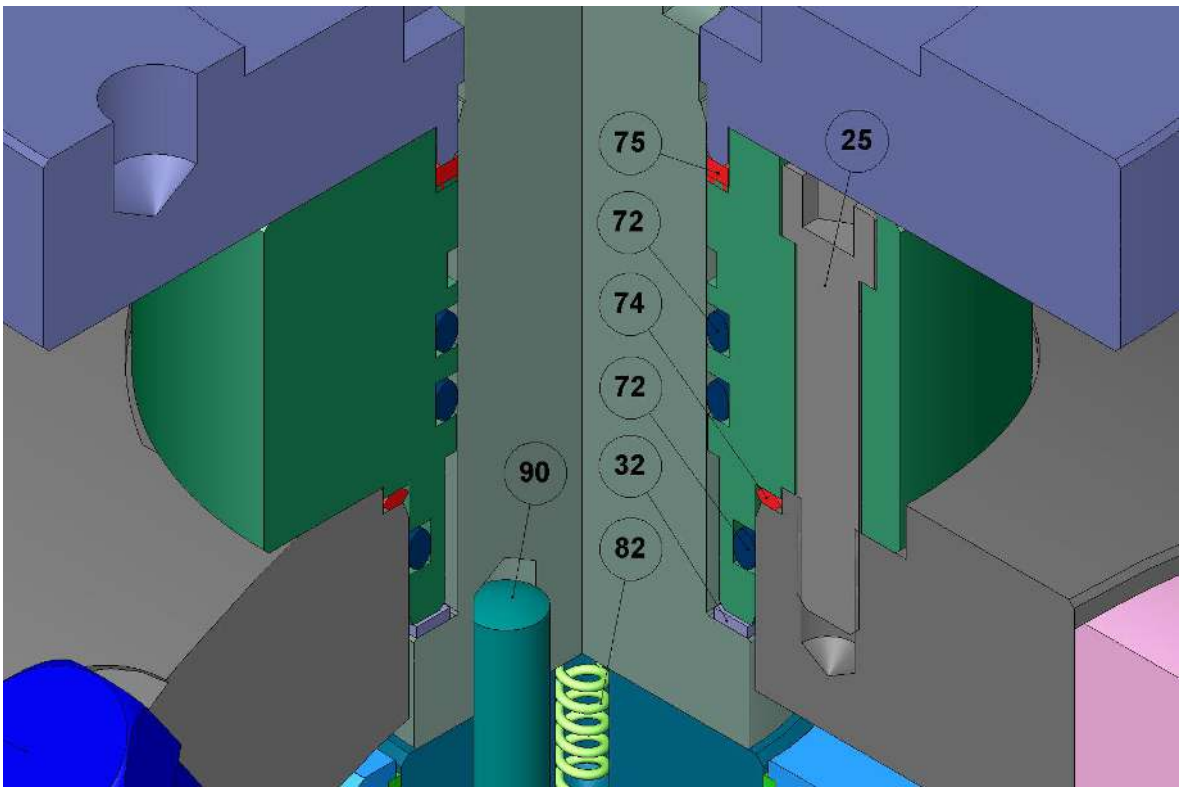
i – Dismantle the pump and close the flushing ports

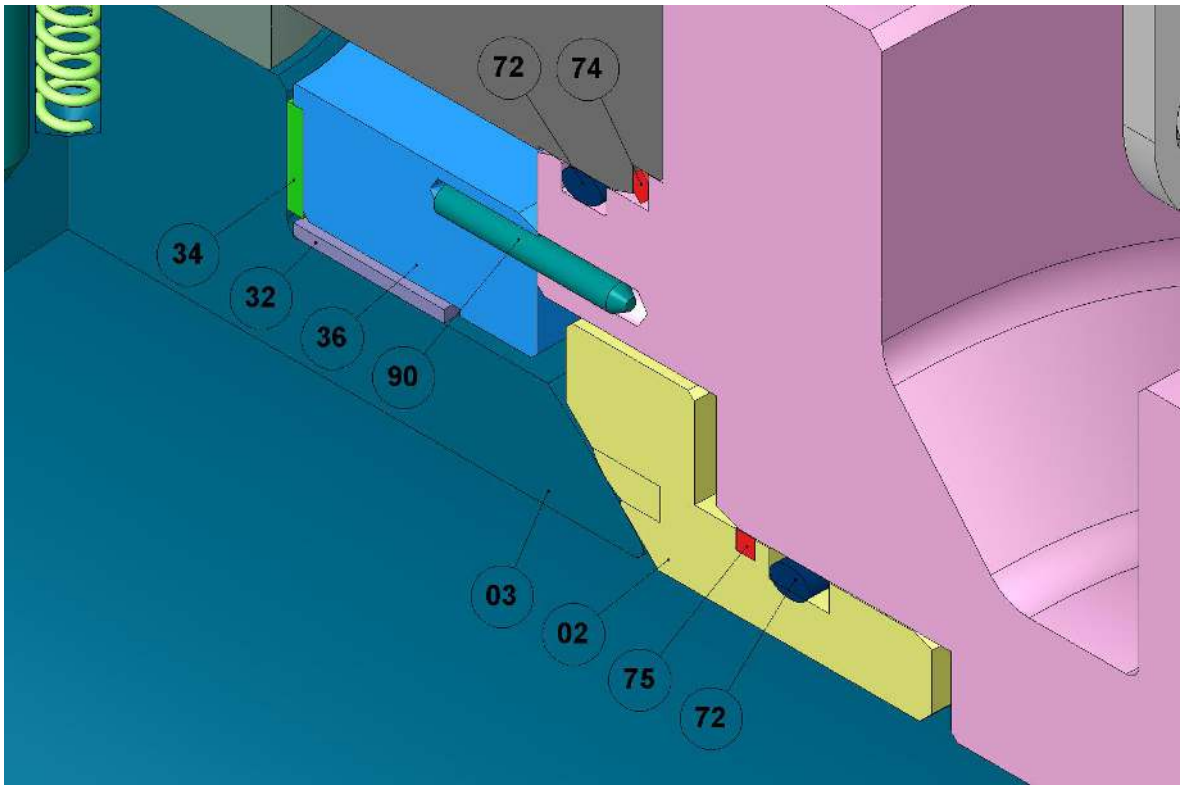
l – Close Vent and Drain flanges

Flushing fluid : Ecological solvent or equivalent (i.e. water + glycol).

7 VALVE DRAWINGS WITH PART LIST (TYPE VL2-VL3)







Part list. Parts are identified with the numbers indicated in the General Assembly Drawing.

01 – Body
02– Seat
03 – Ball
04– Stem
05– Bonnet
06 – Clousure
20– Studs
22– Nuts
25– Screws
32– Bearings
34 – Bush
36 - Spacers
50 –Cover plate
60 – Support
61– Lifting lug
62– Plug
72 – O-Ring
71– Lip-seal
74 – Gasket S.W.
75 – Gasket
82 - Spring
90 - Pin

Lip-seals are generally alternative to o-rings . Some valves may be equipped with lip-seals on some leak paths and o-ring on the others. Refer to applicable General Assembly Drawing for details

Spare parts:

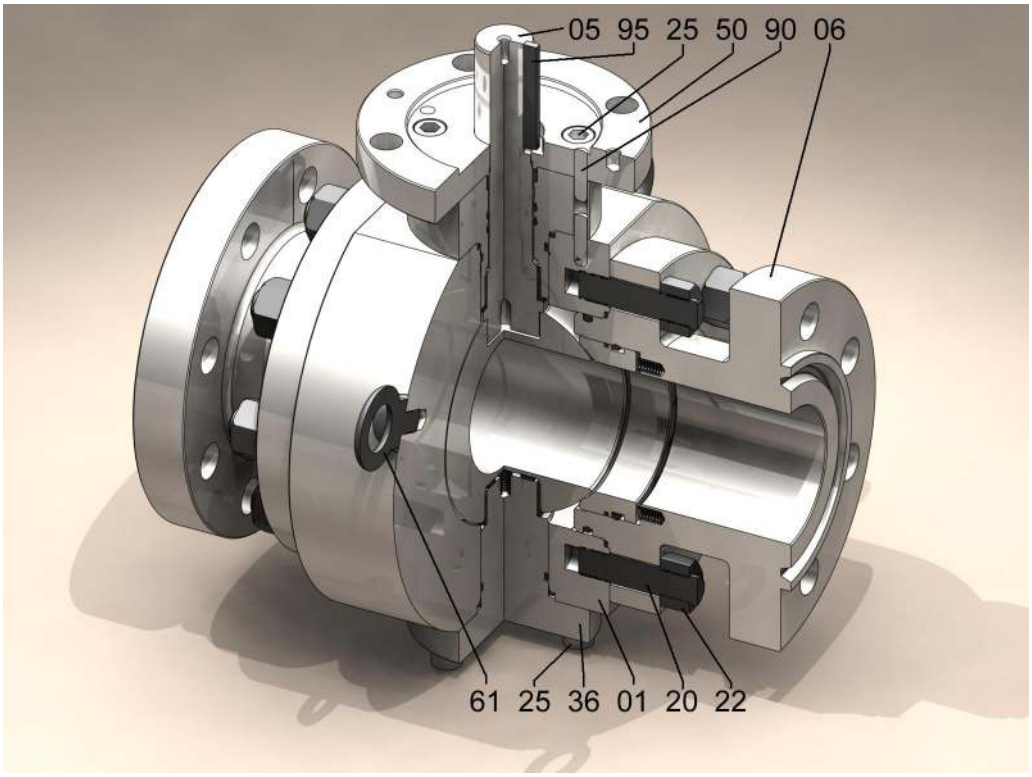
(commissioning and/or two year operations)

72– O-Ring and/or **71**– Lip-seals
74– Gasket S.W.
75– Gasket
32– Bearing
34– Bush

(to be replaced when damaged)

02– Seat
03 – Ball
04– Stem

8 VALVE DRAWINGS WITH PART LIST (TYPE ST2-ST3)



Part list. Parts are identified with the numbers indicted in the General Assembly Drawing.

01 – Body
02– Seat
03 – Ball
04– Stem
05– Bonnet
06 – Closure
20– Studs
22– Nuts
25– Screws
32– Bearings
34 – Bush
36 - Trunnion
50 –Cover plate
60 – Support
61– Lifting lug
62– Plug
72 – O-Ring
71– Lip-seal
74 – Gasket S.W.
75 – Gasket
82 - Spring
90 - Pin

Lip-seals are generally alternative to o-rings . Some valves may be equipped with lip-seals on some leak paths and o-ring on the others. Refer to applicable General Assembly Drawing for details

Spare parts:

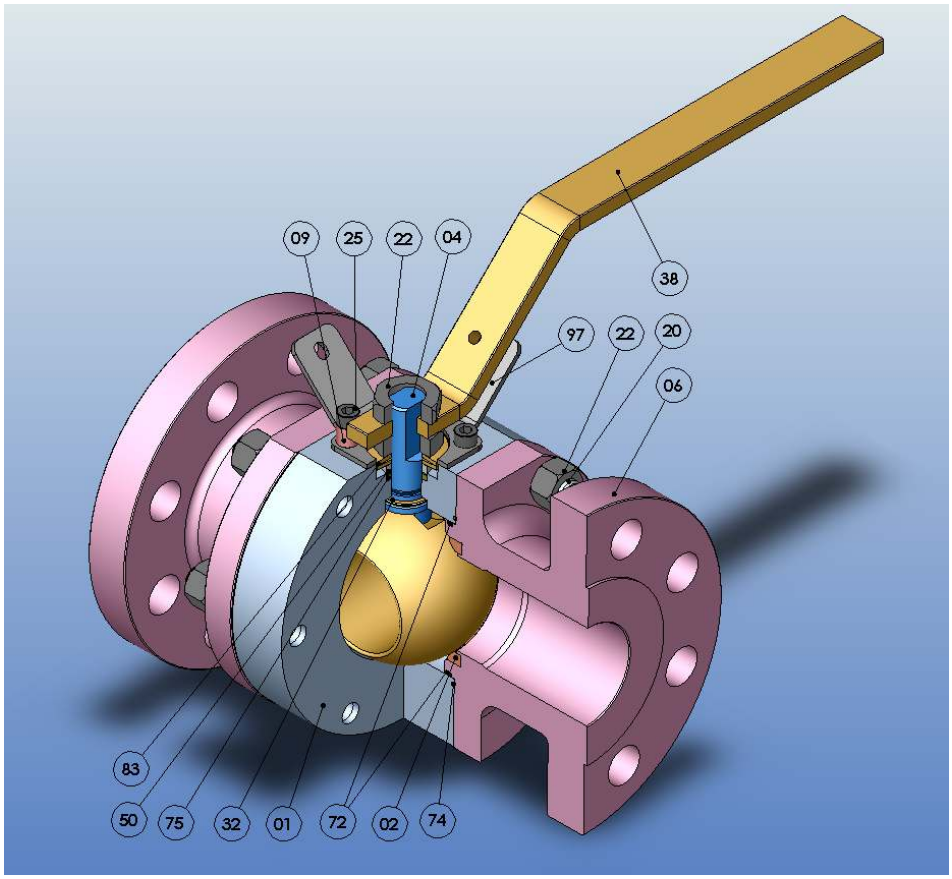
(commissioning and/or two year operations)

72– O-Ring and/or **71**– Lip-seals
74– Gasket S.W.
75– Gasket
32– Bearing
34– Bush

(to be replaced when damaged)

02– Seat
03 – Ball
04– Stem

9 VALVE DRAWINGS WITH PART LIST (FLOATING BALL VALVES)



Part list:

01 – Body
02 – Seats
03 – Ball
04 – Stem
20 – Stud
22 – Nut
32 – Bearing
38 – Lever
50 – Packing gland
71- Lip-seals and/or
72- O-rings
74 – Gasket S.W.T
75 – Packing
83 – Spring washer

Spare parts:

(commissioning and two year operation)

02 – Seats
32 – Bearing
71- Lip-seals and/or
72- O-rings
74 – Gasket S.W.T
75 – Packing

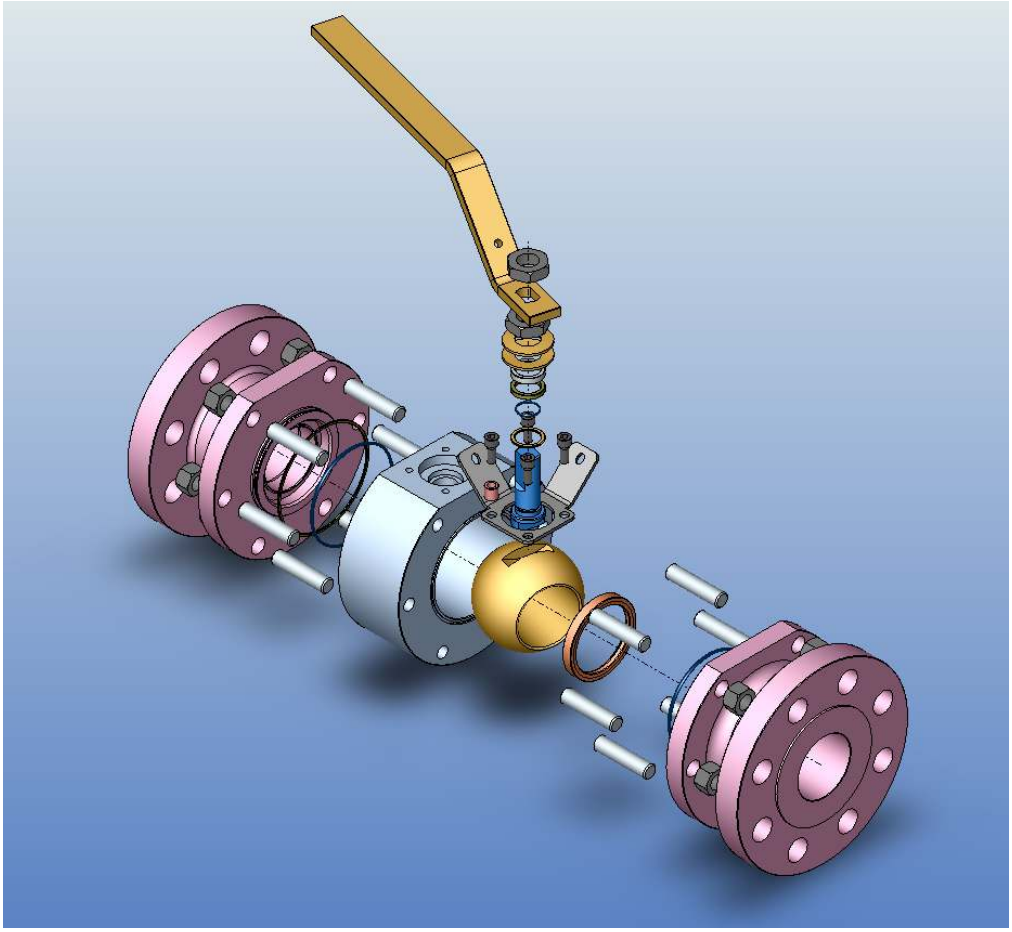
(to be replaced when damaged)

03 – Ball
04 – Stem

For small floating ball valves less than 2 in nominal diameter, it may be advisable to keep a complete valve as spare.

Lip-seals or o-rings are optional seals . Floating ball valves may be sealed by graphite gaskets only. Refer to applicable General Assembly Drawing for details

General components exploded view.



10 BOLT TORQUE VALUES

BOLT TORQUE VALUES					
BOLT		MATERIAL			
		A193-B7 A193-B16 A320-L7 A320-L7A A320-L43		A193-B7M A320-L7M A193-B5	
NOMINAL DIAM.	S	TORQUE	PRETENSIONING AXIAL FORCE	TORQUE	PRETENSIONING AXIAL FORCE
Inch.	mm^2	N*m	N	N*m	N
1/4"	21	8	6300	6	5050
3/8"	50	30	18000	24	14450
1/2"	92	75	27600	60	22150
5/8"	146	150	43800	120	35150
3/4"	215	280	64500	230	51750
7/8"	298	450	89400	360	71750
1"	391	660	117300	530	94150
1 1/8"	510	830	153000	670	122800
1 1/4"	645	1450	193500	1170	155300
1 3/8"	795	1660	238500	1340	191400
1 1/2"	963	1930	288900	1560	231850
1 5/8"	1148	2350	344400	1900	276400
1 3/4"	1342	2320	402600	2280	323100
1 7/8"	1555	4450	466500	3600	374400
2"	1787	5320	536100	4300	430250
2 1/4"	2297	7140	689100	5770	553100
2 1/2"	2865	9680	859500	7820	689800
2 3/4"	3503	12740	1050900	11280	843500
3"	4200	17000	1260000	15000	1011240
3 1/4"	4961	21400	1488300	18950	1194500
3 1/2"	5761	27000	1728300	23900	1387100
3 3/4"	6671	33640	2001300	29800	1606200
4"	7619	41800	2285700	37000	1834500