

Installation, Operation and Maintenance Manual of Trunnion Mounted Ball Valves (TMBV)



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Note:

This manual shall be read in conjunction with manual LTV-566 - "Instruction, Operation and Maintenance Manual - Important Points".



L&T Valves

L&T Valves Limited (formerly Audco India Limited) is a wholly owned subsidiary of L&T and one of the largest valve manufacturers in the world.

The company has two modern manufacturing facilities, in Coimbatore and Kancheepuram, in Tamil Nadu, India. The company leverages its world-class capabilities in design, quality assurance and manufacturing to ensure that their products consistently meet customer expectations.

Product Range:

- Gate, Globe & Check Valves
- Valves for Power
- Pipeline & Process Ball Valves
- Triple-offset Butterfly Valves
- Rubber lined Butterfly Valves
- Valves for Water Service
- Double Block & Bleed Plug Valves
- Control Valves
- Customized Solutions

Designs for the valves are created by an experienced team of valve experts who have a deep understanding of user-industry processes. An extensive manufacturing and quality assurance infrastructure ensure that world-class designs are transformed into high performance products. Every phase of manufacture is governed by an institutionalized environment, health, and safety policy.

L&T Valve's distribution network spans across the globe, partnering some of the largest valve distribution companies in the world. In India, L&T Valves has a presence in every industrial centre through a network of offices, stockists, automation centers and service franchisees

Trunnion mounted ball valves (TMBV)

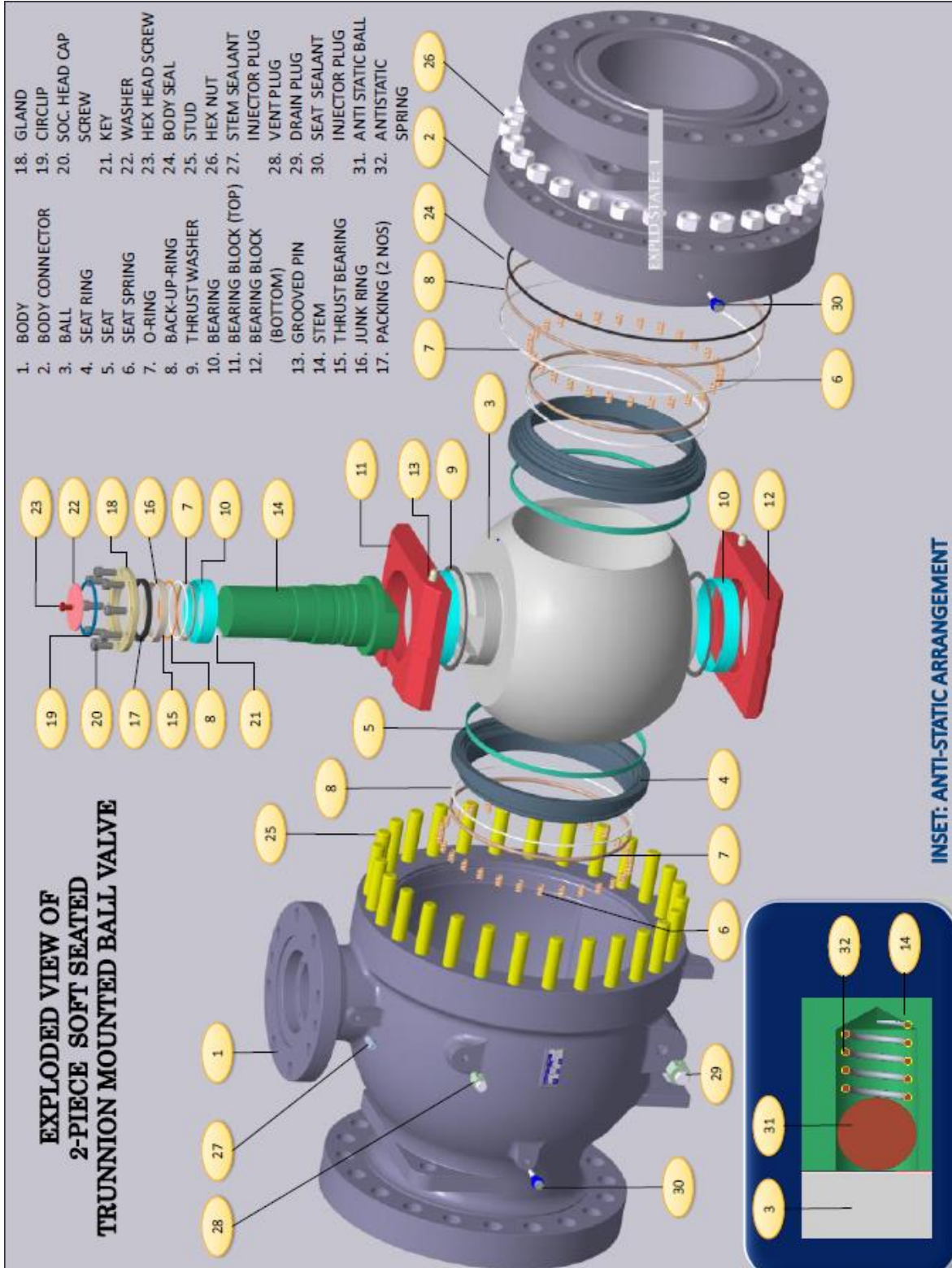
The L&T Trunnion Mounted ball valves come with side entry type, two-piece & three piece, bolted & welded type body constructions and with flanged (Raised face / Ring type joint / Flat face) and butt weld ends with or without pup piece. Typical exploded view is shown for two-piece & three-piece body construction. For actual construction details of valves supplied, please refer the General Assembly Drawing (GAD) submitted. The salient features of L&T Trunnion Mounted Ball Valves are listed below.

- **Double block and bleed**
This is a standard feature in L&T Trunnion mounted ball valves (TMBV), which enables checking the leak tightness of the valve seats in the open and closed positions, after installation.
- **Cavity pressure relief**
L&T TMBV has seats designed to relieve any excessive pressure that builds up in the valve body cavity automatically into the flow path.
- **Anti-blow-out stem**
L&T Trunnion mounted ball valves are designed with anti-blow-out stem arrangement in which the stem is inserted from inside the body.
- **Sealant injection**
Sealant injection system is provided for seat and stem regions for emergency shut off / leak arrest on valves of sizes 8" and above for full bore valves and 10" and above in case of reduced bore valves.
- **Optional features**
L&T also provides Trunnion mounted ball valves with Double piston design, which allows the downstream seat to seal with pressure acting from the upstream side of the valve. It aids in better sealing even during leakage through upstream seat.
L&T Trunnion mounted ball valves can also be provided with extended stem/drives for buried service valves.

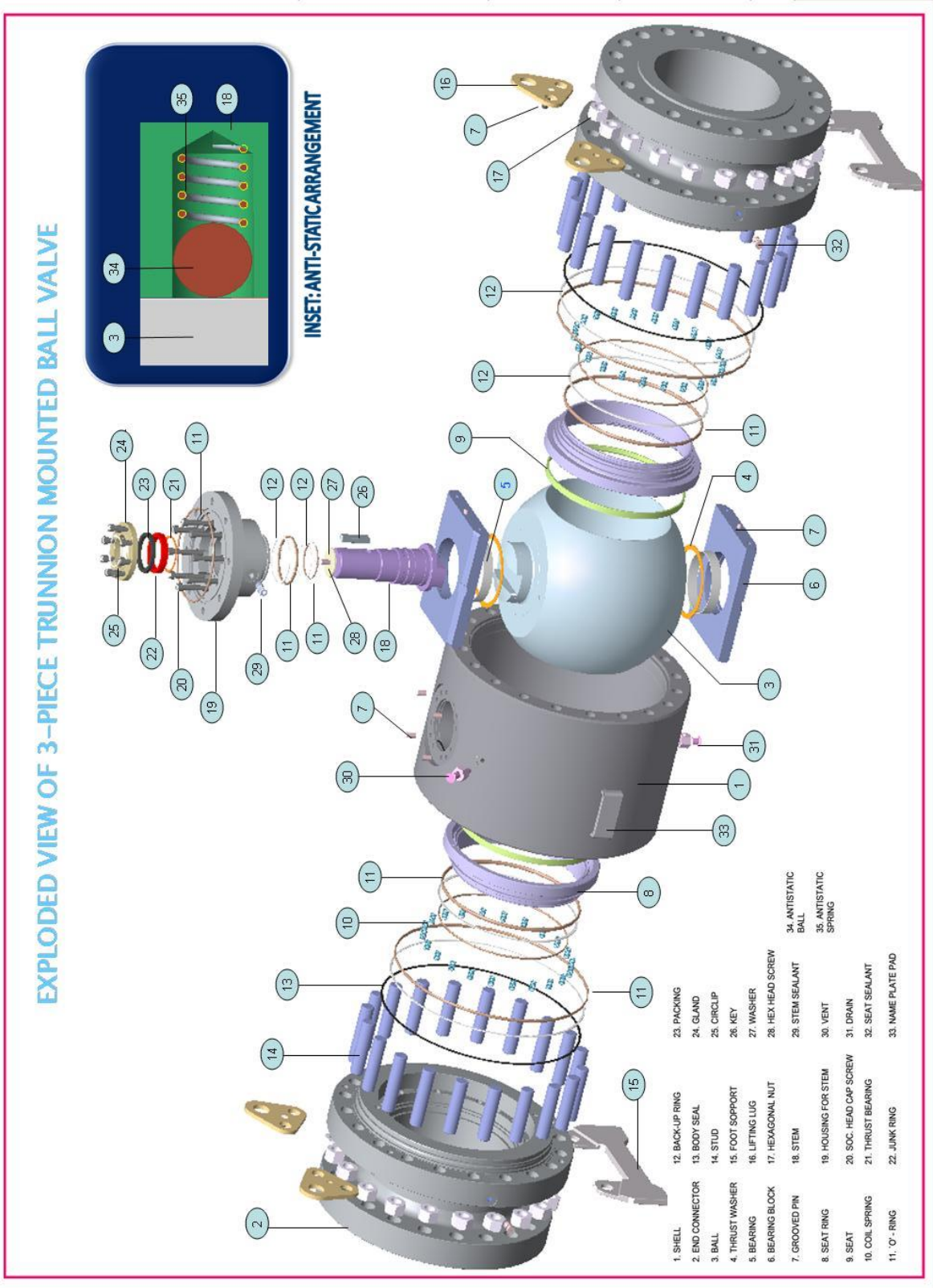
Range

| Size | Class Rating |
|----------|--------------|
| 2" – 56" | 150 |
| 2" – 56" | 300 |
| 2" – 56" | 600 |
| 2" – 36" | 900 |
| 2" – 24" | 1500 |
| 2" – 20" | 2500 |

Exploded View



Exploded view of Trunnion Mounted Ball valve-2 Piece (Typical)



Exploded view of Trunnion Mounted Ball valve-3 Piece (Typical)

Delivery

L&T Trunnion Mounted Ball Valves are shipped with the balls in fully open position for the protection of the ball and seat ring surfaces (except for valves fitted with suitable actuation for fail close applications, in which case, valves are shipped in fully closed condition).

- Please check the packing slip attached to the packing container.
- The valve identification details can be found on the Identification plate and on the body of the valve as cast lettering. A typical Identification plate is shown in Fig. 1.

| API 6D | | BALL VALVE | | QSL | DBB | |
|-------------------|-------------|-------------------|-----------|-----|-----|--|
| SIZE | | DN 200 (NPS 8) | | | | |
| CLASS | 600 | CAT No | TRA633G | | | |
| 102.1 bar @ -20°C | | 87.6 bar @ 200°C | | | | |
| 1480 psig @ -4°F | | 1268 psig @ 392°F | | | | |
| BODY | WCB | DS No | XX-XXXX | | | |
| STEM | F316 | TAG No | XX-XXXX | | | |
| BALL | F316 | S No | XX-XXXX | | | |
| SEAL | VITON | DATE | 07 / 2022 | | | |
| SEAT | F316 / PEEK | | | | | |



Fig. 1 - Identification plate location & view of a typical Identification plate

- The valves are supplied with end protectors covering the ports to avoid damage to the internals due to the presence of any foreign particles before installation.
- Hand wheels for gear operated valves are usually dismantled and packed separately. The key is kept in its slot and held in position using an adhesive tape.

CHECK

- Tag numbers and details of valves upon delivery
- Valves thoroughly for any damages during transit.
- Condition of end protectors.
- Extension lines and column, if any.



In case of any discrepancies in the above-mentioned details or in case of any kind of damage to the valve on delivery, please contact L&T for assistance.

Note:

Refer Appendix C for valves with CE & ATEX certification requirements.

Handling and Storage

Handling

- Instructions provided on the caution stickers stuck on the valve shall be strictly adhered to.
- Valve shall be properly supported and secured before moving, to prevent possible damage to the valve or property, or harm to personnel.
- Do not drag the valve on the ground while transporting. A minimum of *one foot* height from the ground is to be maintained while moving the valve.
- Valves shall not be slung around the valve port for transportation. Lifting lugs are provided for this purpose on valves of size 8" and above. For other small size valves, the valve may be slung around the valve body at the neck of the end flange.
- If the valve end protectors are opened for any checking or testing, the same preservation and protection shall be done after the checking or testing.

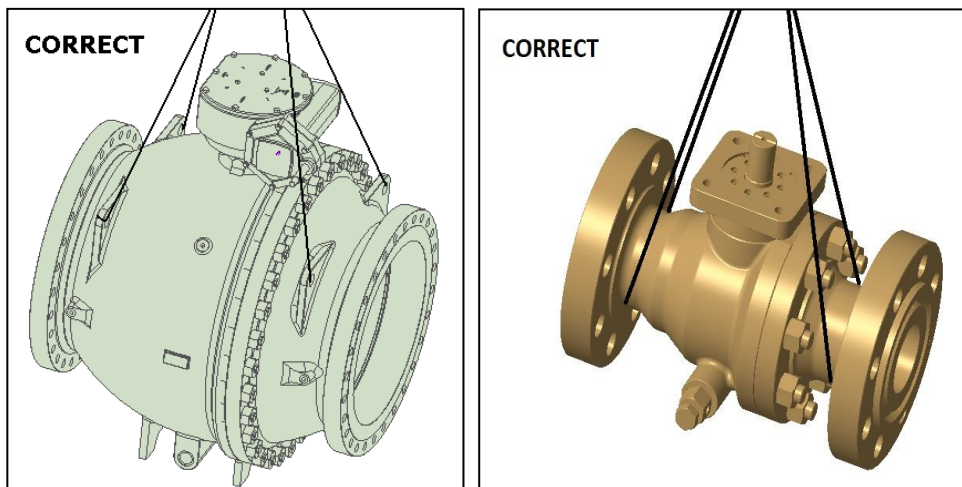


Fig. 2 (a) - Proper valve handling.

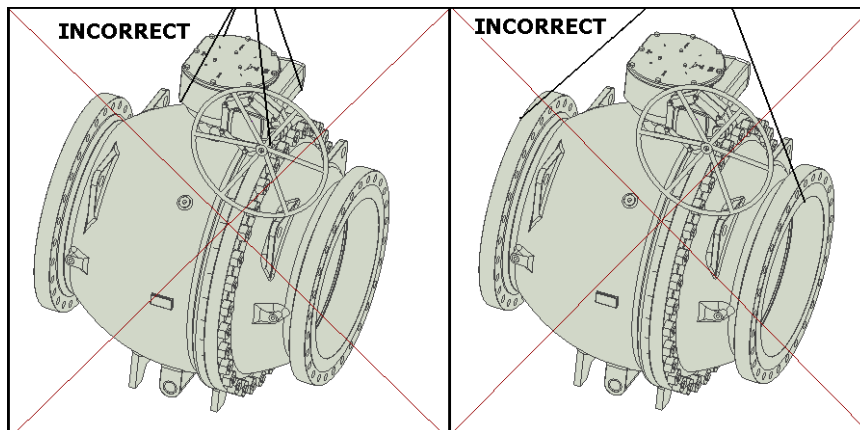


Fig. 2 (b) - Incorrect valve handling



Fig. 3 - Handling a valve with welded pup piece.

- The crane wire should not be slung around the actuator/gear unit to avoid any load acting on it. Also, ensure that while handling the valve, no external load acts on the actuator/gear unit. Gear unit lifting hook should not be used for lifting the valve.
- Valves shall not be handled with the hand wheel keyed / fixed to the gear unit. The hand wheel shall be dismantled before handling and transporting the valve.
- Extreme care shall be taken to check that the sealant fittings, body drain & vent fittings, stem, gear units etc. are not bent, pinched, or damaged during handling.

Notes:

Refer Appendix D for Center of Gravity details.

While using the lifting points on the valve, take care of the safe working load limit of these points, as mentioned in Appendix E.

Storage

- Clean the valves and ensure that end protectors are in place before the valves are stored, as dry contaminants like dust, sand, grit etc. can scratch the metal seating surfaces and the soft inserts, leading to leakages on full pressure operation.
- Valves shall be stored in a covered area which is dust-free, least humid, and well ventilated.
- The valve shall always be maintained in an ambience with temperature higher than the dew point temperature at the storage location, so as to avoid collection of water droplets on the valve surface.
- Do not keep the valve directly on the floor. Valve shall be placed on a wooden pallet such that it is at least at a height of *6 inches* from the floor.
- Care should be exercised not to damage the extended portions of the stem housing, gear unit / actuator during storage.
- Do not apply tar, grease, or any other material inside the valve, as it could impair the performance of the valve.

CAUTION



Improper storage and/or handling may cause ball/seat damage or deformation of stem or seat, which will affect sealing and operational torque of the valve.

DO NOT



- Store the valve outdoors.
- Store valve without end protectors.
- Place or drag the valve on the ground/concrete floor.
- Place valve in positions that may damage the valve or its accessories.
- Sling the valve with direct contact with actuator/gear unit during handling.
- Operate the valve without cleaning it properly.

Planning & Responsibilities

When installing or maintaining valves,

- Conduct a risk assessment and eliminate or reduce hazards to an acceptable level.
- Work in accordance with health and safety rules of worksite.
- Wear all necessary personal protective equipment.
- Never use a valve on application which exceeds its prescribed operating parameters. Refer to L&T Valves for further information
- The valve shall not be subjected to frequently occurring disturbances
- End user to ensure there are no external disturbances (e.g., Shocks, vibrations, electromagnetic fields etc.)
- Misuse of valves / valve components are strictly prohibited.
- Maximum surface temperature of the equipment will be same as the line media temperature. The end user must take account of the line media temperature.
- If the processes or environments wherein the valves are used in are likely to cause temperatures (high or low) that may cause injury to personnel if touched, then adequate insulation / protection must be fitted.
- Adequate safety measures shall be made for valves similar to pipelines.
- Due to variety of duties in which these valves can be employed, it is the end user's responsibility to ensure the compatibility of media with the material of construction of the product for each specific application (i.e., corrosion and erosion which may affect integrity of the pressure containing envelope).
- Before valves are installed in areas which may be subject to seismic activity or extreme climatic conditions, consult L&T Valves with data.
- All exposed parts shall be cleaned to prevent dust deposit or insulation is needed similar to pipeline.
- Valves should be protected by other devices to prevent over-pressurisation. (i.e., caused by temperature, fire etc.).

Valve Installation

General

- Carefully unpack the valve and check for tags or identification plates, etc.
- If the Identification plate and/or tag is lost or destroyed during shipment or while in storage or if it is not legible, contact your distributor or the factory for assistance before installing the valve.
- Look for any special warning tags or plates attached to or accompanying the valve and if any, take appropriate action.
- L&T Trunnion Mounted Ball Valves are bi-directional valves and can be installed for flow in either direction.
- Valves with gas over oil actuators shall be mounted / stored only with the flow bore in the horizontal orientation, as shown in figure 4.



Fig. 5 - L&T TMBV with Gas over oil actuator

- It is recommended to remove all foreign particles from the pipeline by flushing it with a suitable fluid. Corrosion inhibitors shall be added to the flushing medium to prevent any corrosion due to trapped fluids. Use suitable solvents for cleaning the flow bore. Avoid using chemicals.

CAUTION



If the valve is not cleaned or if cleaning is done only after valve installation, the valve cavities may form a natural trap in the piping system and any impurity not dissolved or washed out by the flushing fluid / line fluid may settle in such cavities and adversely affect valve performance.

- Remove the end protectors and protective sheath within the flow bore of the valve, wherever provided.
- After removal of end protectors, thoroughly clean the valve ports/cavities and ensure that the flange gasket faces are free from dust or debris.
- Gasket contact faces of the valve and pipe flanges shall be inspected thoroughly for scratches / defects. Scratches, if any, shall be corrected by grinding the surface or by rubbing with emery sheet without affecting the finish of the serrations.
- After cleaning, operate the valve for at least two complete cycles before installing.
- The valve shall be in the open position during installation process, except in case of fail close valves, in which case additional care shall be taken not to damage the ball surface by any debris.
- The pipes must be properly aligned, and provisions made to minimize stresses from thermal expansion. Always review pipe manufacturer's recommendations.
- In cases of pipes with long overhangs, adequate support/ jacks shall be provided at the flange ends of the pipe so as to avoid bending of pipes due to weight of the valve.
- Refer Appendix - B for special considerations to be taken during installation of valves with extended stem.

Flanged ends

- Refer section A1 for applicable standards.
- Align the bolt holes of the valve end flange and pipe flange.
- Insert gasket (not supplied with the valve) and tighten the bolts. Flange bolts shall be tightened evenly, using a torque wrench, in cross rotation to prevent damage to flanges.
- Bolts should be lubricated for ease of installation.
- For sequence of tightening of bolts, refer section A2.

CAUTION



The improper alignment of the pipe and the valve during installation can lead to unbalanced tightening of the flanges which may cause excessive stress on the bolts and lead to leakage.

- For larger flanged valves, which are provided with foot support, supporting base / pedestal shall be placed beneath the valve after the alignment and bolting of the pipe and the valve flanges. The foot support need not be bolted to the floor.

Welded ends

- Refer section A1 for applicable standards.
- Pipe ends must be machined to make them smooth, clean, and free from burrs.
- Keep the valve in open position before installation. If the valve must remain in the closed position, extra care should be exercised to avoid weld spatter falling on the ball surface.
- Alignment of the valve with the pipe must be as accurate as possible so as to get most favorable condition for weld deposition.
- All welding should be in accordance with any code or jurisdictional regulations applicable to the construction of the piping system.
- Local post weld heat treatment (PWHT) on the weld and heat affected zone (HAZ) shall be carried out if required by the procedure.

CAUTION



Temperature in excess of 100°C in the seat ring area will result in seat damage. Temperature indicating crayons or laser temperature indicators shall be used to monitor and control the temperature in this area during welding.

DO NOT



Do not stress-relieve welds as the temperature in the O-ring seal region can exceed 100°C, leading to failure of seals. If stress relieving is required as per the piping code, the valve shall be purchased with transition / pup pieces.

Cleaning and Testing

- Clean the pipeline by flushing the system with a compatible liquid, to remove any dry contaminants, sand, dirt etc. that may be present so as to avoid any minor leakages due to scratches formed on the sealing surfaces by these contaminants
- While testing the pipeline ensure that the media is clean and free from sand, dirt, pebbles etc. Add corrosion inhibitors to the testing media to avoid any internal corrosion of the valve.
- Operate the valve once to check for smooth operation.
- If no obvious problems are observed, the test pressure may be applied, and leak tightness and operability may be checked.

CAUTION



- Faulty installation may lead to valve and/or pipeline damage.
- Avoid contact with the valve closure element during cycling.
- During shell test, the valve shall be in partially open position so as to prevent the seat from being subjected to the shell test pressure.

CHECK



- Installation of the valve as per the piping drawing.
- End protectors are not removed before installation.
- General pipe and valve cleanliness.
- Face to face / end to end dimensions.
- Conformance of piping connectors with relevant standards or norms
- Parallelism of piping flanges or piping connectors
- Alignment of the bolt holes of the pipe and valve flanges.
- For availability of sufficient space for the valve and its accessories and for easy operation.
- The suitability and efficiency of valve and accessories supports

Valve Operation

General

- The operational life of the valve can be maximized if the valve is used within the rated range, in accordance with the pressure, temperature, and corrosion data.
- For understanding the internal construction, refer to the general assembly drawing of the valve.

CAUTION



Trunnion mounted ball valves are quarter-turn valves, i.e., 90° rotation of the ball makes the valve either fully open or fully closed.
L&T Trunnion mounted ball valves are not intended for throttling service. These valves shall be used for full flow of fluid and/or for complete shut-off of the line only. Use of these valves with ball in partially open condition would wear out / erode the ball and seats.

- Trunnion Mounted Ball Valves do not rely on stem actuating force to provide tight shut-off. They require correct positioning of the closure element to seal properly. Closing travel shall not be stopped until a positive stop is reached.

Actuation

- **Mechanism:** The stem of the valve is rotated using a wrench/handle for small valves and by a gear unit in case of larger valves. Hydraulic/pneumatic actuators can also be used for the purpose. A flat-milled projection of the stem, called the tang, engages with a slot milled on the ball, so as to rotate the ball with the stem.

CAUTION



Do not peek inside or keep hands in the ball cavity / internals of an installed valve. A remotely actuated valve might get closed without warning.

- **Wrench-operated** valves shall be opened or closed, by turning the handle by a quarter turn (90 degrees).
 - ❖ Valve in Open Position - the handle is in parallel (in-line) with the valve or pipeline.
 - ❖ Valve in Closed Position - the handle is perpendicular (crossed) with the valve or pipeline.

- **Gear units** are provided on valves for easier operation. Usually, clockwise operation is for closing and counterclockwise for opening of the valve. The position of the valve can be noted using the position indicator provided on top of the gear unit. The number of turns will depend on the gear unit used. The gear units are of self-locking type, i.e., the line fluid will not make the closure member to rotate. The gear units have mechanical stopper screws for setting the exact open and close positions which are factory set.

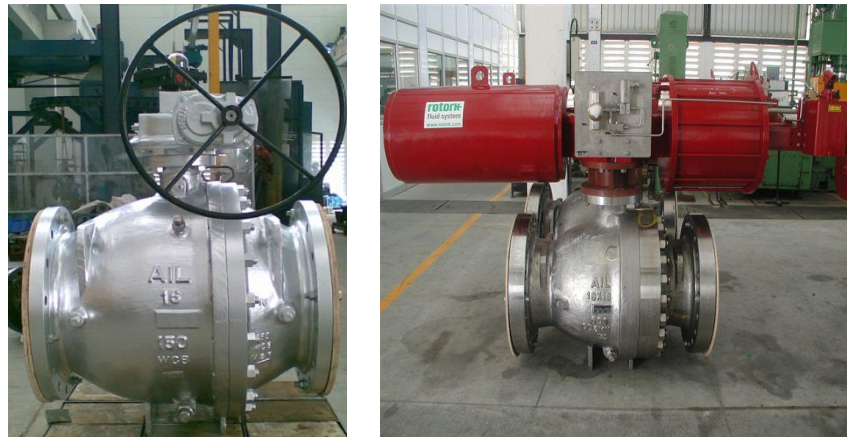


Fig. 6 - L&T TMBV with Gear unit & Gas actuator

- **Electric actuators**, which give a multi-turn output, are fitted on the gear unit. The actuator drives the gear unit which in turn rotates the stem. Electrically actuated valves are provided with declutching mechanism for manual operation of the valve. For electric actuators, L&T recommends adhering to the instructions as per actuator manufacturer's manual.
- **Pneumatic/gas/hydraulic/gas over oil actuators** are fitted directly on the valve, without a separate gear unit, as these actuators have built-in quarter turn mechanisms. For actuators, L&T recommends adhering to the instructions as per actuator manufacturer's manual.

CAUTION !

In case, valves are supplied as bare stem, as per customer requirements, ensure that connecting devices for actuators does not exert any radial loads on the valve stem, as it may lead to bending of the stem and excessive loading on the ball. This in turn can cause the torque to increase and may lead to failure of seats too.

Sealing

- Trunnion mounted ball valves are upstream sealing valves. Both the seat ring assemblies are capable of axial movement in the pipeline. The seat rings are kept pressed to the ball by means of seat springs.
- Additional sealing is provided by the line fluid, which further presses the seat ring on to the ball. This aids the double block and bleed feature for L&T Trunnion mounted ball valves, in fully open and fully closed position.

Cavity relief

- L&T Trunnion mounted ball valves are provided with cavity pressure relief feature. In the event of buildup of pressure in the valve cavity, the seats push back, and the cavity pressure gets relieved to the flow passage.

Sealant Charging

- For emergency leakage arrest, sealant injectors are provided on valves of sizes 8” and above for both metal seated and soft seated valves. (Option of sealant injector for size 6” is also available as special case.) Stem sealant injectors are located in the body-stem housing for arresting stem leakage and seat sealant injectors are placed near the cover flanges / butt-weld ends on both body and body-connectors for arresting leakage at ball-seat sealing region.
- Stem: Special graphite-based thick sealant can be screwed inside after removing grub screw in the sealant injector. This sealant forms a packing around the stem and hence seals the region above it from any line media. Once this packing is injected, online replacement of the top ring is possible. Refer maintenance sections for procedure.
- Seat: The sealant charged passes through the injector, a check valve and through a small hole into the seat ring and reaches the seating surface of the seat ring, which contacts the ball. The charge gets uniformly distributed through a circular groove. This provides emergency sealing. Refer ‘Maintenance’ section for procedure.

For sealant to flow onto the valve, enough sealant at sufficient pressure has to be first injected to overcome the line pressure, to fill any cavities in the sealant chamber and grooves, and to overcome the flow resistance through the valve sealant system. The maximum injection pressure shall not exceed 6,000 psi for Class 150-1500 and 10,000 psi for Class 2500.

Fire safety

- In the event of fire, the soft seals may burn out. In this condition, the spring-loaded seat housing will make contact with the ball to provide a fire-safe metal sealing. Valves are designed to meet the fire safety requirements of reputed standards like ISO 10497, API 607 and API 6FA.

DO



Ensure that the valves in the pipeline affected by a fire are replaced as soon as possible for satisfactory performance.

CAUTION



- Use the valve only for applications for which it is designed / recommended for, so as to avoid unexpected failure of the valve.
- Suspended particles in the line fluid may damage the soft components in the valve.

Do's and Don'ts

| Do's | Don'ts |
|--|---|
| Before taking valve for erection, make sure that is cleaned properly from inside and outside and there are no foreign particles or metallic chips sticking on to sealing element | DO NOT install a valve in the pipe line without the operating mechanism |
| While installing the operator make sure that the valve is in fully closed position | DO NOT attempt forcible assembly of actuator on to the valve shaft, In case of any difficulty in proper matching of the key-ways, refer to the detailed instructional manual |
| Make sure to remove the entire rust preventive on the machined surface in the flow area before a valve is put in the pipe line. | DO NOT hammer actuator surface to drive it in |
| Carefully read the identification plate details and install the valve in the right place and for the correct duty conditions for which it is designed and manufactured. | DO NOT use adaptor, actuator body and gear box casting as lifting points |
| Make sure to supply rated voltage and frequency to the electrical actuator. | DO NOT operate electrically operated valves from fully open or fully closed position for initial starting. Make sure to bring them to mid-travel position by hand operation and check phase for reversal, if any, correct the phase reversal immediately. Note that none of the safety devices like limit switch, torque switch etc., will be effective in case of wrong phase connecting to the actuator |

Maintenance

Introduction

- For enhanced life of the valve and better operability, L&T recommends periodic inspection and maintenance of the valves as per the procedure explained below.
- The frequency of observation depends on the application. L&T recommends that the valves be inspected every 50 cycles or three months (whichever is earlier) for smooth operation and leak free performance. This is recommended for stored valves also.
- It is advisable to maintain a record of the performance of the valve.
- Use genuine L&T spare parts only for maintenance and replacements.

Double block and bleed and Cavity flushing procedure

- Keep the valve in fully open or fully closed position.
- Open the vent side valve.
- Open the drain provided in the bottom of the valve and drain the cavity fluid completely.
- Allow flushing medium (compatible/inert fluid like nitrogen) into the body cavity through the vent hole, allowing for drainage through the drain valve. This prevents accumulation of dirt/debris in the body cavity which could lead to erosion of internal sealing surface.
- Close the vent valve and allow the flushing fluid to be drained completely.
- Check for any leakage through the seat sealing region. Refer to 'Troubleshooting section if required.

CAUTION !

- Fluids draining out of the drain and vent plugs may be at a high pressure. L&T recommends that the medium be bled out slightly for reducing the pressure. For the purpose drain and vent plug assemblies are provided with a bleed facility. Hence before removing the drain / vent plugs, unscrew the outer screw to bleed out the fluids in the drain partially.
- When assembling back the drain / vent valves, ensure that the threads are not damaged. Replace the plugs in case the threads are damaged.

Operability & torque

- Check for ease of operation of the valve.

Stem leakage

- Any major leakage at the stem region can easily be detected by observing unexpected pressure drop in the pipeline.
- Low leakage rates of the fluid in the stem region may be detected using soap bubbles, after removing the actuator / gear unit. For valve with stem sealant injector, the leakage can be detected at the stem sealant area without removing the gear unit.

Sealant charging

- Sealant may be charged if some passing of media is found across the seats.
- Always disconnect the electrical supply to the electrical actuator before carrying out any maintenance activity on the valve/actuator.

Study carefully and understand the instructions outlined in the installation, operation & maintenance manual of the valve & actuator before taking up any maintenance.

CAUTION !

For your safety, it is important that these precautions be taken before removal of the valve from the line or before dismantling.

- De-pressurize the line before removing the bolting.
- Wear protective clothing or equipment appropriate for the line fluid.
- Ensure cavity pressure is relieved.
- Cycle the valve several times before dismantling to relieve pressure completely

Gear stopper adjustment procedure

- Loosen the stoppers to allow additional rotation of the valve stem.
- Open the drain/vent valve in the center cavity for above ground valves and in the extension housing for buried valves.
- The pressure will be released from the center cavity of the valve.

- Once the flow of media has stopped through vent/drain (except for the leakage past the seat), rotate the valve in either direction from the original stop settings to locate a point where the leakage stops.
- Rotate clockwise and counterclockwise to locate two points where the leakage begins. Mark both the locations and operate the valve to a position halfway between the two marks. Tighten the stopper in the gear unit to set CLOSE position and tighten the lock nut to prevent the stoppers from loosening.
- Close the vent valve. Actuate the valve to fully open position and ensure that flow bore in the ball and body are aligned. Tighten the other stopper in the gear unit and tighten the lock nut to prevent the stoppers from loosening.

Stem seal replacement procedure

CAUTION



It is desirable that the valve (both bore and cavity) be relieved of pressure prior to seal replacement. If it is not possible, get in touch with L&T or their authorized service representative for additional information.

- Ensure that no pressure is trapped inside the valve and exercise the following steps for replacing the stem seal.
- Mark the open and close positions of the gear unit and remove it; preferably without disturbing the mechanical stopper screws in the gearbox.
- Remove the key and its retainer screw and washer, if provided.
- Loosen all the hexagonal cap screws which holds the gland and remove the gland from its place & clean the packing area.
- Inspect the stem bore on body and stem for damage like scratches and correct them by rubbing with emery sheet.
- Insert a new set of graphite packing and place the gland over it.
- Tighten cap screws uniformly to a torque depending on the size of the screw.
- Pressurize the system and check for leak using soap bubbles.
- Re-assemble the key and gear unit. Ensure that the positions of the stoppers are correct.

Secondary sealant injection procedure - Stem

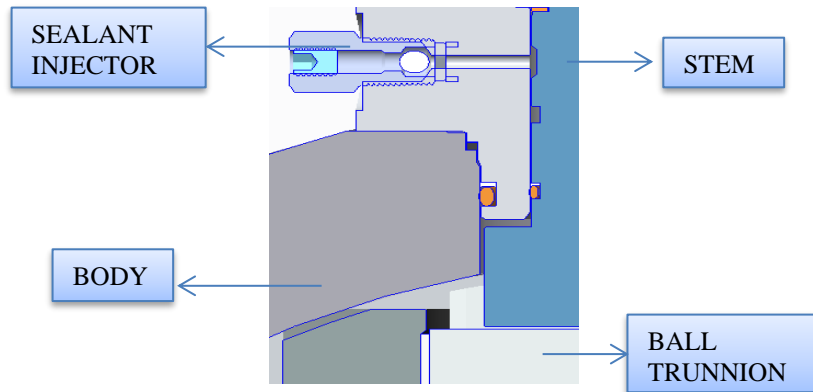


Fig. 7 - Stem sealant injection

- Remove grub screw & insert graphite-based sealant.
- Place the grub screw and tighten. Tightening will pressurize the sealant in the stem.

Secondary sealant injection procedure - Seat ring

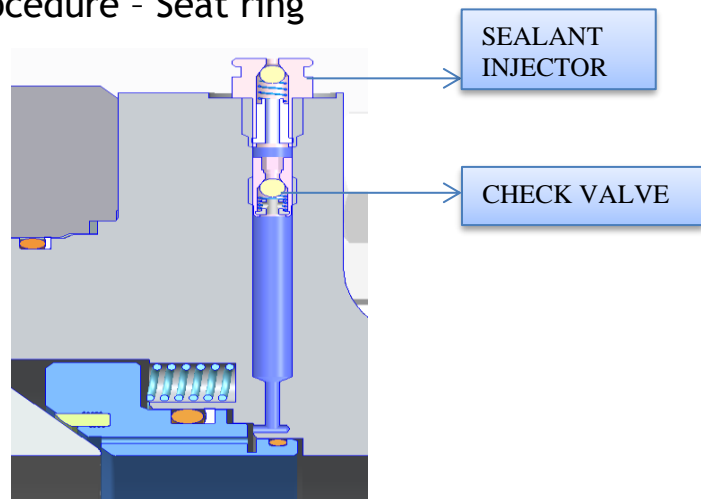


Fig. 8 - Seat sealant injection

CAUTION !

Before injecting sealant into the valve, ensure the valve is fully open or close.

- The sealant shall be charged using a sealant gun.
- Attach the gun loaded with sealant on the sealant injector (fixed on the valve) (Fig.7.) and charge the sealant.
- While charging, try rotating the ball through a small angle (say 10°) and return it back to its original position.
- Remove the gun. The check valve will prevent the back flow of the sealant.
- Check and ensure that there is no leakage across the seats.

EXPERTS NOTE

Sealant to be used is Nordstrom 1033 sealant. This is available in bulk, gunpak and stick grades (generally for stem sealant).

This can be used for liquid and gaseous aliphatic hydrocarbon service suitable for gasoline, kerosene, fuel oils, crude distillates, aviation fuel, jet fuel, and natural gas at a temperature range of -40°C to +260°C.

For other specific flow media, consult L&T.

CAUTION !

Nordstrom 1033 sealant is not suitable for use with aromatic solvents, strong acids and alkalis, and steam.

Dismantling and Assembly Procedure

Dismantling procedure - TMBV - 2-Piece Construction

CAUTION



Once dismantled the soft seals, packing and o-rings shall be changed. Ensure they are available.

- Depressurize the line and open the valve to drain the line.
- Before removal from the line, cycle (open and close) the valve to relieve residual pressure in the body cavity.
- Valves shall be slung properly before loosening flange bolts.
- Place the valve on a platform or base and transport to the repair shop.

- Before dismantling, cycle (open and close) the valve several times to clear it of fluid; then flush with water.
- Close the valve completely and remove handle/gear unit.
- Secure the body in a suitable clamping device, without damaging it.
- For bolted joints, loosen the body-body connector interface bolting and remove the body connector.
- Remove the seat ring from the body and body connector.
- Lift the ball/bearing block sub assembly using a nylon rope or using eyebolts (for large sizes). If the ball is intended for reuse, place it on the seat ring and suitably cover it so that it is not damaged.
- Remove the key from the stem.
- Remove gland bolts from the valve body. Remove the packing and clean the packing area. Take care not to damage sealing surfaces on body or gland.
- Carefully push valve stem down into the valve body and withdraw it through the open end and remove the thrust bearing from stem.

CAUTION

- Before removal of the valve, ensure that the line is fully depressurized.
- Improper handling may cause ball/seat damage or deformation of stem or seat, which will affect sealing and operational torque of the valve.
- Ensure that the dismantled components are kept in a clean place so that there will be no damage to the components.

Assembly procedure - 2-Piece Bolted Construction

- Inspect and clean all parts to make sure they are free of dust, grit, or other material. New set of O-rings and seals shall be used once the valve is dismantled.
- Apply a good lubricant compatible with the fluid service, such as silicone grease, to bearing blocks, seats, seal, ball, and stem.
- Refer to the exact seat ring design, as per the General assembly drawings and assemble it accordingly.
- Assemble the seat sealing elements to the seat rings.
- Place a coil spring in the body bore and place one seat ring into the body. Insert the seat ring assembly so that it rests on the coil springs.
- Assemble thrust bearing, O-ring, and backup ring on the stem. Carefully insert upper end of stem into body of valve and manoeuvre into the opening in top of valve.
- Assemble the thrust washer and bearing blocks onto the ball. Check if the clearance between the bearing block and ball is minimum (i.e., it is not very loose)
- Rotate stem so that stem bottom is lined-up axially with the valve and ball and bearing blocks can be fully inserted.
- Place ball-bearing block assembly into the body
- Repeat the steps for end connector similar to that of body.
- Place the connector on the body by aligning the studs along the bolt holes on the connector flange. Ensure the graphite rope and the O-ring does not get damaged in the process.
- Tighten the interface flange bolting as mentioned in the section A2.
- Insert the junk ring, packing and gland into the stem bore in this sequence. Ensure that the junk ring sits on the step provided within the stem bore. Don't tighten the packing gland bolts completely.

- Mount the gear unit or actuators, as applicable, onto the cover flange and bolt them securely. Brackets may be used for actuator mounting, whenever applicable.
- In case the drain and vent plug assemblies are dismantled, clean the threads of the plugs, and assemble the plugs. Ensure that the sealant injectors are assembled on the threaded sealant charging holes.
- Cycle valve open and closed to turn ball slowly with a gentle back and forth motion, building gradually to a full quarter turn. By rotating slowly, the seat lips will assume a permanent seal shape against the ball and prevent damage to the seals.
- After assembly, the valve shall be tested for leakage across the seats and through the stem seals.

CAUTION

- Improper handling may cause ball/seat damage or deformation of stem or seat, which will affect sealing and operational torque of the valve.
- Faulty installation may lead to valve and/or pipeline damage.
- Ensure that the soft parts are changed once they are removed from the valve.
- Avoid contact with the valve closure element during cycling.

Assembly procedure - 2-Piece Welded Construction

- Place the body such that the flow bore is vertical, and it rests on the end connections (flanged, butt-weld ended). Ensure that the end connections are placed on a suitable pad on the floor to avoid any damage to the finished ends.
- Clean the inner bores of the body with a thinner. Ensure that the sealing area on the body is free from dirt and grit.
- Coat the coil springs with a suitable silicon grease and place the coil springs into the holes provided on the body bore.
- Place the seat ring sub-assembly into the bore on the body. The seat ring may be slung for handling purposes for smaller sizes
- Ensure that the seats and the O-rings are not damaged during handling and assembly of the seat-ring sub-assembly. The seat housing is to rest on the spring.
- Clean the stem sealing surface on the body and remove any grit or dirt present in the stem bore of the body.
- Insert the stem bearing (if applicable) into stem housing from inside the body. Mild force may be required to push the bearing into the body.

- Insert the stem sub-assembly into the stem housing from inside the body.
- Lower the ball carefully into the body till it seats on the body seat-ring. THIS ACTIVITY IS ONE OF THE MOST IMPORTANT STEPS IN THE ASSEMBLY AND HENCE SHALL BE DONE WITH EXTREME CAUTION.
- Clean the interface joint area of the body and connector with a thinner. Ensure that the interface joint area on the body & connector is free from dirt and grit.
- Place the connector sub-assembly on the body.
- One pass root welding alone shall be done on interface joint between body and connector.
- Valve shall undergo double block & bleed test using air to ensure the seat performance before full assembly of the valve.
- After testing, place the valve such that the flow bore is horizontal, and the valve shall rest on the foot support (if provided) or on a V-stand.
- Insert the junk ring, packing and gland into the stem bore in this sequence.
- Lift the stem and place the circlip to hold the shaft from coming down. Ensure the circlip is not bent excessively during insertion.
- Now tighten the gland bolts until the gland butts against the body step. The tightening sequence shall be followed as per annexure A.
- It is important that packing gland shall be symmetrically mounted / tightened around the stem. This will prevent the shaft or the gland from binding when the valve is operated.
- Place the key into the keyway and tape it if required. Secure it using washer on the stem and tighten it using a screw.
- Place the non-asbestos type of gasket on the stem housing flange, with holes coinciding with that on the flange.
- Join the body-connector interface joint by welding as per relevant QA welding process.
- Mount the gear unit or actuators, as applicable, onto the cover flange and bolt them securely. Brackets may be used for actuator mounting, whenever applicable.
- Rotate the ball slowly for a full quarter turn. This will help seat assume its permanent position and shape against the ball and the body. A fast-turning motion may damage the seat before it has a chance to form a proper seal.
- After assembly, valve shall be cycled 2 to 3 times to ensure smooth operation of valve.

- In case of drain and vent plug assemblies, clean the threads of the plugs and assemble the plugs. Ensure that the sealant injectors are assembled on the threaded sealant charging holes.
- All accessories like vent, drain etc. shall be fitted to the valve before testing.
- After testing, valve end flanges shall be covered with end protectors to avoid damages on end flange during valve handling.

EXPERT'S NOTE

L&T's Interface welded Trunnion Mounted Ball Valves are completely sealed type valves. These valves are welded together using submerged arc welding techniques to provide good quality, leak resistant welds. L&T Interface welded valves cannot be dismantled at site and hence the serviceability of these valves is restricted to replacements of stem seals and sealant injection at seats and stem seals for leak arrest/emergency shut off.

Dismantling procedure - TMBV - 3-Piece Construction

CAUTION



Once dismantled the soft seals, packing and o-rings shall be changed. Ensure they are available.

- Depressurize the line and open the valve to drain the line.
- Before removal from the line, cycle (open and close) the valve to relieve residual pressure in the body cavity.
- Valves shall be slung properly before loosening flange bolts.
- Place the valve on a platform or base and transport to the repair shop.
- Before dismantling, cycle (open and close) the valve several times to clear it of fluid; then flush with water.
- Close the valve completely and remove handle/gear unit.
- Secure the body in a suitable clamping device, without damaging it.
- For bolted joints, loosen the body-body connector interface bolting and remove the body connector.
- Remove the seat ring from the body and body connector.

- Lift the ball/bearing block sub assembly using a nylon rope or using eyebolts (for large sizes). If the ball is intended for reuse, place it on the seat ring and suitably cover it so that it is not damaged.
- Remove the key from the stem.
- Remove the gland bolts from the valve body. Remove the packing and clean the packing area. Take care not to damage sealing surfaces on body or gland.
- Carefully push the valve stem down into the valve body and withdraw it through the open end and remove the thrust bearing from stem.

CAUTION

- Before removal of the valve, ensure that the line is fully depressurized.
- Improper handling may cause ball/seat damage or deformation of stem or seat, which will affect sealing and operational torque of the valve.
- Ensure that the dismantled components are kept in a clean place so that there will be no damage to the components.

Assembly procedure - 3-Piece Bolted Construction

- Inspect and clean all parts to make sure they are free of dust, grit or other material. New set of O-rings and seals shall be used once the valve is dismantled.
- Apply a good lubricant compatible with the fluid service, such as silicone grease, to bearing blocks, seats, seal, ball, and stem.
- Refer to the exact seat ring design, as per the General assembly drawings and assemble it accordingly.
- Assemble the Stem and stem housing sub-assembly
- Insert the stem sub assembly into the stem housing. Mild force may be applied while inserting the stem into the housing. Ensure that the O-rings are not damaged during the process.
- Assemble the thrust washer and bearing blocks onto the ball.
- Place the seat ring sub-assembly into the bore on the connector.
- Now install the end connector over shell / body, taking care of the position of the holes for the grooved pin in the end connector. It shall be in line with the centerline of the stem.
- Place the ball-bearing block sub-assembly into the body.
- Place the connector on the body by aligning the studs along the bolt holes on the connector flange and the grooved pin on the body/shell with hole on the connector.

- Place the non-asbestos type of gasket on the shell / body, with holes coinciding with that on the body. Insert the stem - stem housing sub-assembly into the bore on the body.
- Insert the junk ring, packing and gland into the stem bore in this sequence. Ensure that the junk ring sits on the step provided within the stem bore.
- Place the gland bolts and tighten them until the gland butts against the body step. Tighten the interface flange bolting as mentioned in the section A2.
- Mount the gear unit or actuators, as applicable, onto the cover flange and bolt them securely. Brackets may be used for actuator mounting, whenever applicable.
- In case the drain and vent plug assemblies are dismantled, clean the threads of the plugs and assemble the plugs. Ensure that the sealant injectors are assembled on the threaded sealant charging holes.
- Cycle valve open and closed to turn ball slowly with a gentle back and forth motion, building gradually to a full quarter turn.
- After assembly, the valve shall be tested for leakage across the seats and through the stem seals. Instructions given for handling, installation, cleaning, and testing given shall be strictly followed.

Assembly procedure - 3-Piece Welded Construction

- Place shell sub-assembly such that the flow bore is vertical and the connector rests on the end connections are placed on a suitable pad on the floor to avoid any damages to the finished ends.
- Clean the holes for the coil springs by blowing air into them. Ensure that the machined holes are free from dirt.
- Coat the coil springs with a suitable grease and place the coil springs into the holes provided on the connector.
- Place the seat ring sub-assembly into the bore on the connector
- Place the ball-bearing block sub-assembly into the body.
- The ball shall be positioned in the 'port closed' state during the assembly.
- Clean the spring holes provided on the second connector and coat the springs with suitable grease. Place the springs into the holes provided.
- Place the second seat ring sub-assembly on the connector bore
- Place the connector sub-assembly on the shell.

- Clean the interface joint area of the shell and connector with a thinner. Ensure that the interface joint area on the shell & connector is free from dirt and grit.
- One-pass root welding alone shall be done on interface joint between shell and connector.
- Valve shall undergo double block & bleed test using air to ensure the seat performance before full assembly of the valve.
- Fit the grooved pins on the holes provided on the neck. Ensure the dowel pins are inserted completely into the holes.
- Place the non-asbestos type of gasket on the neck, with holes coinciding with that on the neck. Insert the stem - stem housing sub-assembly into the bore on the body.
- Coat the stem housing bolts using a suitable anti-seize agent such as Molykote and bolt the stem housing to the neck tightly.
- Insert the junk ring, packing and gland into the stem bore in this sequence
- Place the gland bolts and tighten them until the gland butts against the body step. The tightening sequence shall be followed as per appendix A.
- Place the key into the keyway and tape it if required. Secure it using washer on the stem and tighten it using a screw.
- Place the non-asbestos type of gasket on the stem housing flange, with holes coinciding with that on the flange.
- Join the shell-connector interface joint by submerged arc welding as per relevant QA welding process.
- Mount the gear unit or actuators, as applicable, onto the cover flange and bolt them securely. Brackets may be used for actuator mounting, whenever applicable.
- After assembly, valve shall be cycled 2 to 3 times to ensure smooth operation of valve.
- Rotate the ball slowly back and forth a full quarter turn. This will help seat assume its permanent position and shape against the ball and the body. A fast-turning motion may damage the seat before it has a chance to form a proper seal.
- In case of drain and vent plug assemblies, clean the threads of the plugs and assemble the plugs. Ensure that the sealant injectors are assembled on the threaded sealant charging holes.

Troubleshooting:

- The table below lists common problems encountered with L&T trunnion mounted ball valves, the probable causes, and recommended remedy to the problems. However, judgment and experience must be applied when working on the valves in actual field site conditions.
- The maintenance procedures shall be followed.

| Sl. No. | Problem | Possible cause | Recommended |
|---------|--|-------------------------------------|--|
| 1 | External leakage at body connector joint | Bolts loose / failure | Replace/ tighten bolts (ref. Appendix-A) |
| | | Body seal failure | Dismantling of valve |
| 2 | Quick increase of valve leakage in closed position | Wrong adjustment of end stops. | Adjust stopper screws / limit switches (Ref. Maintenance portion) |
| | | Damage of sealing surfaces. | Sealant injection would provide emergency sealing / Dismantling (Ref. Maintenance section) |
| 3 | Leakage through gland | Damage on stem seals. | Stem seal replacement / Stem sealant injection (Ref. Maintenance section) |
| | | Loose gland bolting | Tighten the gland cap screws till it butts on the valve body, after removing the gear unit (if any). |
| 4 | Progressive increase of the torque or Sticking points along stroke | Deposits on the surfaces. | Flush cavity in open position / Dismantling ((Ref. Maintenance portion) |
| | | Blockage of the seats | Charge sealant and rotate by small angles till the operation is smooth. |
| 5 | Drop in line pressure / minor leakage | Wear out of seat | Check impurities in the line fluid. Seat sealant injection (Ref. Maintenance portion) |
| 6 | Leakage under fire* | Nonmetallic parts burned off. | Sealant injection / Dismantling- replace valve /soft parts during periodic maintenance. (Ref. Maintenance section) |
| 7. | Difficult to operate when operated after long duration | Gripping of ball and seats | Charge sealant to both seats and try to break open manually. (Ref. Maintenance section) |
| 8 | Sealant Fitting leakage | Check Valve is not seating properly | Clean or replace the Check Valve after de pressurizing line. |

Table 1 - Trouble shooting check list

- It may be noted that under fire valve may not seal completely, though the leakage rates are expected to be within limits set by standards.
- Allowable leakage for soft seated valves is zero. For metal seated valves allowable leakage as per ISO 5208

APPENDIX A

TECHNICAL INFORMATION

A1. References

Pressure-Temperature Ratings:

| | |
|---------------|--|
| ASME B16.34 * | Valves - Flanged, Threaded and Welding End |
|---------------|--|

Face to face dimensions:

| | |
|-------------|--|
| API 6D | Specification for Valves |
| ASME B16.10 | Face-to-Face and End-to-End Dimensions of Valves |

End connections:

| | |
|-------------|--|
| ASME B16.5 | Pipe Flanges and Flanged Fittings (NPS ½ through NPS 24) |
| ASME B16.47 | Large Diameter Steel Flanges (NPS 26 through NPS 60) |
| MSS SP-44 | Steel Pipeline Flanges |
| ASME B16.25 | Buttwelding Ends |
| ASME B31.4 | Pipeline Transportation Systems for Liquids and Slurries |
| ASME B31.8 | Gas Transmission and Distribution Piping Systems |

Fire Test:

| | |
|-----------|--|
| API 6FA | Specification for Fire Test of Valves |
| API 607 | Fire Test for Soft Seated Quarter-Turn valves |
| ISO 10497 | Testing of valves - Fire type-testing requirements |

*Limited by non-metallic parts

A2. Tightening Sequence & Torque

The tightening sequence for all possible number of bolting is beyond the scope of this manual. However, the star logic to be followed is explained below:

- A2.1. Tighten the first four nuts in the sequence shown in Fig.8. This helps in correct location of the mating parts. Apply the torque in two stages, as mentioned below.
- A2.2. Using a wrench, tighten the nuts numbered 1,2,3,4 with a torque equal to 60% of the rated torque value (Refer table 2 or 3), followed by tightening the same nuts with remaining 40% in the same sequence.
- A2.3. Tighten the other bolts in the sequence shown in Fig.9, the same way.

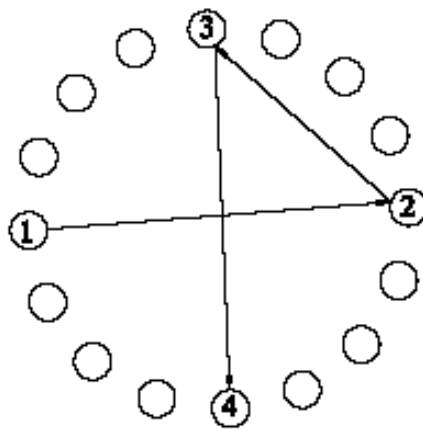


Fig.8. Initial tightening

- A2.4. The sequence goes clockwise around the bolt pattern.
- A2.5. Tighten to torque specified in the table finally, in the same sequence.
- A2.6. Ensure the recommended torque in all bolting.

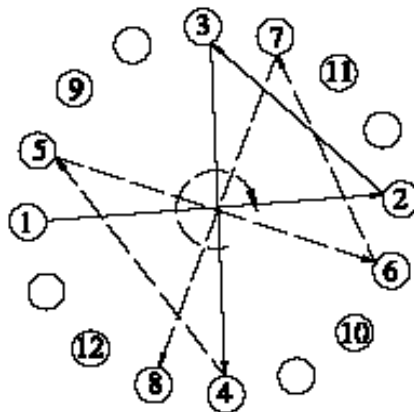


Fig.9. Sequence of tightening

| THREAD SIZE, in | TORQUE , lbf.ft (TOLERANCE:+10%, -0) | |
|-----------------|---|--------------|
| | B7/B7M/L7/L7M/B16 | (B8/B8M)CL.2 |
| 1/4 | 6 | |
| 5/16 | 10 | |
| 3/8 | 20 | |
| 7/16 | 30 | |
| 1/2 | 55 | |
| 9/16 | 65 | |
| 5/8 | 100 | 90 |
| 3/4 | 190 | 170 |
| 7/8 | 290 | 260 |
| 1 | 390 | 360 |
| 1.1/8 | 570 | 470 |
| 1.1/4 | 800 | 650 |
| 1.3/8 | 1100 | 750 |
| 1.1/2 | 1400 | 950 |
| 1.5/8 | 1800 | 1200 |
| 1.3/4 | 2300 | 1500 |
| 1.7/8 | 2800 | 1850 |
| 2 | 3400 | 2250 |
| 2.1/4 | 4900 | 3250 |
| 2.1/2 | 6600 | 4400 |
| 2.3/4 | 8800 | 5800 |
| 3 | 11500 | 7600 |
| 3.1/4 | 14000 | 9400 |
| 3.1/2 | 16400 | 11800 |
| 4 | 30075 | 20050 |
| 4.1/4 | 36210 | 24140 |
| 4.3/4 | 50879 | 33920 |

Table 2. Tightening Torque Values (inch series)

| THREAD SIZE | TORQUE, Nm (+20%) | THREAD SIZE | TORQUE, Nm (+20%) |
|-------------|-------------------|-------------|-------------------|
| M4 | 2 | M30 | 943 |
| M5 | 4 | M33 | 1262 |
| M6 | 7 | M36 | 1636 |
| M8 | 18 | M39 | 2109 |
| M10 | 34 | M42 | 2628 |
| M12 | 58 | M45 | 3290 |
| M14 | 92 | M48 | 4029 |
| M16 | 140 | M52 | 4966 |
| M18 | 196 | M56 | 6277 |
| M20 | 273 | M60 | 7800 |
| M22 | 375 | M64 | 9550 |
| M24 | 473 | M70 | 12640 |
| M27 | 688 | M72 | 13000 |

Table 3. Tightening Torque Values (Metric series)

APPENDIX B

SPECIAL CONSIDERATIONS IN VALVES WITH EXTENDED STEM

- In valves with extended stem, do not sling around pipes provided for draining venting and sealant injection, while handling. See Fig. 9.
- Throughout the installation process, support for the extended stem (housing) should be maintained.
- After installation, fill the extension column with compatible oil to prevent internal corrosion, if required. This can be filled through the opening in the extension column which are plugged with a 3/8" NPT plug. When the plug is assembled, ensure that the threads of the plug are not damaged.
- Check whether the sealant charging pipes are connected properly and filled with sealant.

CAUTION !

Instructions indicated for handling shall be strictly followed to avoid damage to valve components resulting in malfunction of the valve.

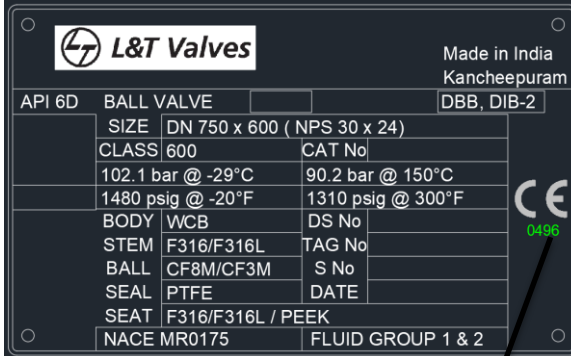



Fig. 9 - Handling a welded end valve with an extended stem

APPENDIX C

FOR VALVES WITH CE & ATEX CERTIFICATION REQUIREMENTS

- Each valve has a stainless-steel name plate fixed to the body. The nameplate is marked with details of "figure number", along with various other details such as the materials of construction, limiting temperatures, pressure rating as shown below.



| | | |
|---|-----------------------------|-------------------------------|
|  L&T Valves | | Made in India Kancheepuram |
| API 6D | BALL VALVE | DBB, DIB-2 |
| SIZE | DN 750 x 600 (NPS 30 x 24) | |
| CLASS | 600 | CAT No |
| | 102.1 bar @ -29°C | 90.2 bar @ 150°C |
| | 1480 psig @ -20°F | 1310 psig @ 300°F |
| BODY | WCB | DS No |
| STEM | F316/F316L | TAG No |
| BALL | CF8M/CF3M | S No |
| SEAL | PTFE | DATE |
| SEAT | F316/F316L / PEEK | |
| NACE | MR0175 | FLUID GROUP 1 & 2 |

According to PED 2014/68/EU

Fig. C.1 - 'CE' Marking Name Plate

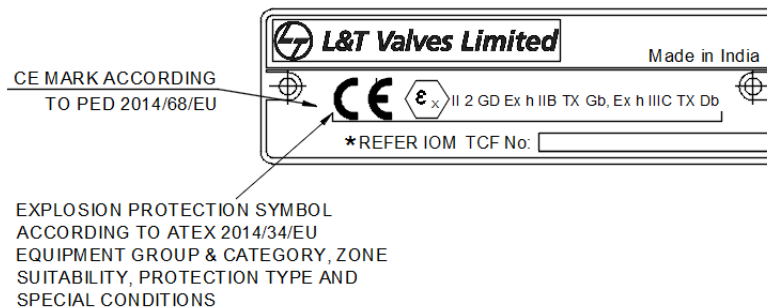


Fig.C.2 - ATEX Name Plate

Definition of name plate marking above:

- 'II' = Equipment group
- '2' = Equipment category
- 'G' = Gas zone suitability (Zones 1 & 2)
- 'D' = Dust zone suitability (Zones 21 & 22)
- 'h' = Ex-marking code (BS EN ISO 80079-37:2016)
- 'X' = Special conditions (BS EN ISO 80079-36:2016).
- Special Condition: X**

Surface temperature: As per BS EN ISO 80079-36:2016 clause 11.2.f, the temperature class or maximum surface temperature cannot be marked on the product as it is dependent on the operating conditions. However, the maximum allowable operating temperature for the product is marked on the nameplate.

- Material tractability markings are hard marked on the valve body.



When installing or maintaining valves

- Observation shall be made for safety codes and working practices relevant to gas zones 1 & 2 and dust zones 21 & 22 (as defined in EN 1127-1:2011).
- The equipment shall not be subjected to frequently occurring disturbances.
- End user to ensure there is no external disturbances (e.g., Shocks, vibrations, electromagnetic fields etc.)
- Misuse of valves / valve components are strictly prohibited.
- If the processes or environments that the products are used in are likely to cause temperatures (high or low) that may cause injury to personnel if touched, then adequate insulation / protection must be fitted.
- Adequate safety measures shall be made for valves similar to pipelines.
- Before equipment is installed in areas which may be subject to seismic activity or extreme climatic conditions consult L&T Valves with data.
- Maximum surface temperature of the equipment will be same as the line media temperature. The end user must take account of the line media temperature.
- All exposed parts shall be cleaned to prevent dust deposit or insulation is needed similar to pipeline.
- This equipment should be protected by other devices to prevent over-pressurization. (i.e., caused by external fire etc.).
- End user to ensure that the accessories (actuator, limit switches, solenoid valve, etc.) if fitted with valve are of ATEX qualified as per the directive.
- Valves are not suitable for terminal connections. In such cases, valves shall be fitted with blind flanges.

APPENDIX D

CENTER OF GRAVITY DETAILS

D1. Two-Piece Construction

| Size NPS | Pressure Class | Centre of Gravity | | |
|-------------|----------------|-------------------|---------|--------|
| | | x [mm] | y [mm] | z [mm] |
| 2 | 150-600 | 10 ± 5 | 10 ± 5 | 0 ± 5 |
| | 900-1500 | 10 ± 5 | 10 ± 5 | 0 ± 5 |
| | 2500 | 10 ± 5 | 10 ± 5 | 0 ± 5 |
| 3 | 150-600 | 5 ± 10 | 10 ± 5 | 0 ± 5 |
| | 900-1500 | 15 ± 5 | 10 ± 5 | 0 ± 5 |
| | 2500 | 15 ± 5 | 10 ± 5 | 0 ± 5 |
| 4 | 150-600 | 10 ± 5 | 10 ± 5 | 0 ± 5 |
| | 900-1500 | 25 ± 5 | 15 ± 5 | 0 ± 5 |
| | 2500 | 25 ± 5 | 15 ± 5 | 0 ± 5 |
| 6 | 150-600 | 15 ± 10 | 15 ± 10 | 0 ± 5 |
| | 900-1500 | 25 ± 10 | 15 ± 10 | 0 ± 5 |
| | 2500 | 30 ± 10 | 15 ± 10 | 0 ± 5 |
| 8 | 150-600 | 15 ± 10 | 35 ± 15 | 0 ± 5 |
| | 900-1500 | 40 ± 10 | 25 ± 15 | 0 ± 5 |
| | 2500 | 50 ± 10 | 25 ± 15 | 0 ± 5 |
| 10 | 150-600 | 20 ± 10 | 35 ± 15 | 0 ± 5 |
| | 900-1500 | 60 ± 10 | 30 ± 15 | 0 ± 5 |
| | 2500 | 80 ± 15 | 30 ± 15 | 0 ± 5 |
| 12 | 150-600 | 20 ± 10 | 35 ± 15 | 0 ± 5 |
| | 900-1500 | 50 ± 15 | 30 ± 15 | 0 ± 5 |
| 14 | 150-600 | 25 ± 15 | 35 ± 15 | 0 ± 5 |
| | 900-1500 | 55 ± 15 | 25 ± 15 | 0 ± 5 |
| 16 | 150-600 | 25 ± 15 | 35 ± 15 | 0 ± 5 |
| | 900 | 55 ± 15 | 25 ± 15 | 0 ± 5 |
| 18 | 150-600 | 25 ± 15 | 30 ± 15 | 0 ± 5 |
| 20 | 150-600 | 25 ± 15 | 20 ± 10 | 0 ± 5 |
| 24 | 150-600 | 35 ± 15 | 25 ± 15 | 0 ± 5 |
| 30 | 150-600 | 35 ± 15 | 25 ± 15 | 0 ± 5 |

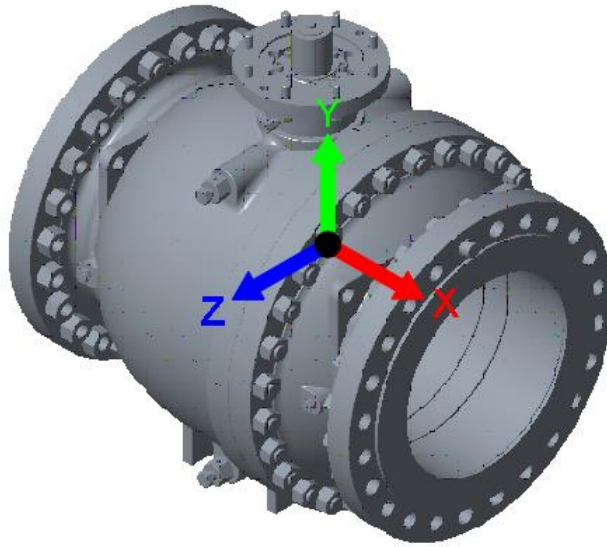


Fig.E.1 - Axes for Center of Gravity

D2. Three-Piece Construction

| Size NPS | Pressure Class | Centre of Gravity | | |
|-------------|----------------|-------------------|---------|--------|
| | | x [mm] | y [mm] | z [mm] |
| 6 | 150-600 | 0 ± 5 | 15 ± 10 | 0 ± 5 |
| | 900-2500 | 0 ± 5 | 15 ± 10 | 0 ± 5 |
| 8 | 150-600 | 0 ± 5 | 35 ± 15 | 0 ± 5 |
| | 900-2500 | 0 ± 5 | 20 ± 15 | 0 ± 5 |
| 10 | 150-600 | 0 ± 5 | 35 ± 15 | 0 ± 5 |
| | 900-2500 | 0 ± 5 | 30 ± 15 | 0 ± 5 |
| 12 | 150-600 | 0 ± 5 | 35 ± 15 | 0 ± 5 |
| | 900-2500 | 0 ± 5 | 30 ± 15 | 0 ± 5 |
| 14 | 150-600 | 0 ± 5 | 35 ± 15 | 0 ± 5 |
| | 900-2500 | 0 ± 5 | 25 ± 15 | 0 ± 5 |
| 16 | 150-600 | 0 ± 5 | 35 ± 15 | 0 ± 5 |
| | 900-2500 | 0 ± 5 | 25 ± 15 | 0 ± 5 |
| 18 | 150-600 | 0 ± 5 | 30 ± 15 | 0 ± 5 |
| | 900-2500 | 0 ± 5 | 15 ± 10 | 0 ± 5 |
| 20 | 150-600 | 0 ± 5 | 35 ± 15 | 0 ± 5 |
| | 900-1500 | 0 ± 5 | 15 ± 10 | 0 ± 5 |
| 22 | 150-600 | 0 ± 5 | 25 ± 15 | 0 ± 5 |

| Size NPS | Pressure Class | Centre of Gravity | | |
|-------------|-------------------|-------------------|---------|--------|
| | | x [mm] | y [mm] | z [mm] |
| 24 | 150-600 | 0 ± 5 | 25 ± 15 | 0 ± 5 |
| | 900-1500 | 0 ± 5 | 15 ± 10 | 0 ± 5 |
| 26 | 150-600 | 0 ± 5 | 20 ± 15 | 0 ± 5 |
| | 900 | 0 ± 5 | 15 ± 10 | 0 ± 5 |
| 28 | 150-600 | 0 ± 5 | 20 ± 15 | 0 ± 5 |
| | 900 | 0 ± 5 | 10 ± 10 | 0 ± 5 |
| 30 | 150-600 | 0 ± 5 | 20 ± 15 | 0 ± 5 |
| | 900 | 0 ± 5 | 10 ± 10 | 0 ± 5 |
| 32 | 150-600 | 0 ± 5 | 25 ± 15 | 0 ± 5 |
| 34 | 150-600 | 0 ± 5 | 25 ± 15 | 0 ± 5 |
| 36 | 150-600 | 0 ± 5 | 25 ± 15 | 0 ± 5 |

APPENDIX E

SAFE WORKING LOAD DETAILS FOR EACH LIFTING POINT OF THE VALVE

E1. Two-Piece Construction

| SIZE (NPS) | CLASS | SWL (kg) |
|------------|-------|----------|
| 4 | 300 | 345 |
| | 600 | 415 |
| 6 | 150 | 1305 |
| | 300 | 1040 |
| | 600 | 1040 |
| | 900 | 695 |
| | 1500 | 1215 |
| | 2500 | 2085 |
| 8 | 150 | 1040 |
| | 300 | 1040 |
| | 600 | 1040 |
| | 900 | 1040 |
| 10 | 150 | 695 |
| | 300 | 1040 |
| | 600 | 2085 |
| | 900 | 3130 |
| | 1500 | 6090 |
| 12 | 150 | 1040 |
| | 300 | 1040 |
| | 600 | 2085 |
| | 900 | 2785 |
| | 1500 | 2610 |
| 14 | 150 | 2085 |
| | 300 | 2085 |
| | 600 | 2085 |
| | 900 | 6090 |
| | 1500 | 9400 |
| 16 | 150 | 2085 |
| | 300 | 2085 |
| | 600 | 2085 |
| | 900 | 6965 |

| SIZE (NPS) | CLASS | SWL (kg) |
|------------|-------|----------|
| 18 | 150 | 2610 |
| | 300 | 2610 |
| | 600 | 2610 |
| 20 | 150 | 2610 |
| | 300 | 3130 |
| | 600 | 3655 |
| 24 | 150 | 5220 |
| | 300 | 6265 |
| | 600 | 8355 |
| 26 | 600 | 12535 |
| 30 | 600 | 15670 |

E2. Three-Piece Construction

| SIZE (NPS) | CLASS | SWL (kg) |
|------------|-------|----------|
| 8 | 150 | 2085 |
| | 300 | 1040 |
| | 600 | 1040 |
| | 900 | 1180 |
| | 1500 | 1390 |
| | 2500 | 3130 |
| 10 | 150 | 695 |
| | 300 | 1040 |
| | 600 | 1040 |
| | 900 | 1040 |
| | 1500 | 1460 |
| | 2500 | 3130 |
| 12 | 150 | 1040 |
| | 300 | 1040 |
| | 600 | 2085 |
| | 900 | 2610 |
| | 1500 | 5220 |
| | 2500 | 6265 |
| 14 | 150 | 1390 |
| | 300 | 1390 |
| | 600 | 1670 |
| | 900 | 3480 |
| | 1500 | 2400 |
| | 2500 | 7835 |

| SIZE (NPS) | CLASS | SWL (kg) |
|------------|-------|----------|
| 16 | 150 | 1565 |
| | 300 | 2085 |
| | 600 | 2085 |
| | 900 | 3655 |
| | 1500 | 5570 |
| | 2500 | 8355 |
| 18 | 150 | 2085 |
| | 300 | 2085 |
| | 600 | 3130 |
| | 900 | 4525 |
| | 1500 | 6090 |
| | 2500 | 12535 |
| 20 | 150 | 2610 |
| | 300 | 2610 |
| | 600 | 2610 |
| | 900 | 3130 |
| | 1500 | 8355 |
| 22 | 150 | 1740 |
| 24 | 150 | 3480 |
| | 300 | 5570 |
| | 600 | 3480 |
| | 900 | 7835 |
| | 1500 | 16715 |
| 26 | 150 | 3655 |
| | 300 | 3480 |
| | 600 | 6965 |
| | 900 | 10445 |
| 28 | 150 | 3655 |
| | 300 | 5570 |
| | 600 | 4875 |
| | 900 | 11490 |
| 30 | 150 | 6265 |
| | 300 | 3480 |
| | 600 | 11145 |
| | 900 | 13580 |
| 32 | 150 | 7835 |
| | 600 | 9400 |
| 34 | 150 | 8705 |
| 36 | 150 | 8705 |
| | 300 | 9575 |
| | 600 | 14625 |

E3. Use of Eyebolts

| EYEBOLT SIZE | SWL (kg) |
|---------------------|-----------------|
| M8 | 40 |
| M10 | 60 |
| M12 | 100 |
| M16 | 160 |
| M20 | 250 |
| M24 | 400 |
| M30 | 620 |
| M36 | 1000 |
| M42 | 1600 |
| M48 | 2000 |
| M56 | 2500 |
| M64 | 4000 |



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