

Installation, Operation, and Maintenance Manual

API 6D Two - Piece Cast Trunnion Mounted Ball Valve – Atlas Series





API 6D Two - Piece Cast Trunnion Mounted Ball Valve Atlas Series

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1 SCOPE

The following instructions are very important for the maintenance, disassembling and assembling of C&C Atlas series end entry two-piece trunnion ball valves.

The instructions make references to valves with emergency sealant injectors and with back up rings for high pressure service. As the above-mentioned features are not standard, in some cases these parts may not be found, or may be found partially during the disassembling of the valves.



We recommend that this entire document be read prior to proceeding with any installation or repair.

1.1 RESPONSIBILITY FOR VALVE APPLICATION

The End User is responsible for ordering the correct valves for the intended application. C&C Valves are to be installed in observance of the pressure rating and design temperature. Prior to installation, the valves and nameplates should be checked for proper identification to be sure the valve is of the proper type, material, and is of a suitable pressure class and temperature limit to satisfy the application requirements.



Do not use any valve in applications where either the pressure or temperature is higher than the allowable working values. Also, valves should not be used in service media if not compatible with the valve material of construction, as this may cause premature failure.

1.2 RECEIVING INSPECTION, HANDLING AND STORAGE

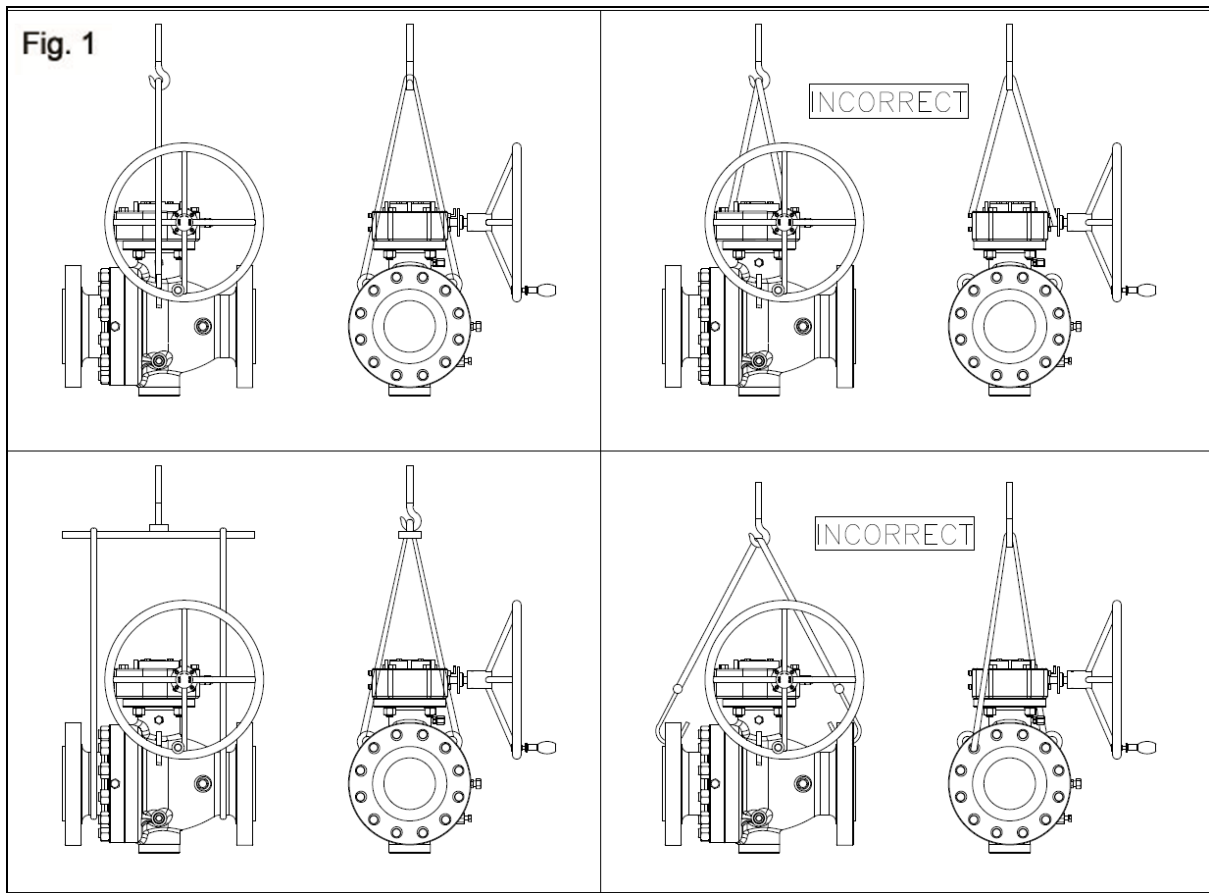
On arrival at site, an accurate checking must be carried out in order to verify if any damage has occurred during transportation.

- Compliance to purchase order requirements.
- Correct type, pressure class, size, body, trim & seal material and end connections (This information may be found on the nameplate or may be stamped on the body of the valve)
- Each C&C valve has unique serial number hard stamped on the closure of the valve. (This shall be always be quoted for any enquiry related to a particular valve)
- Condition of valve paint and location of required Mylar tags.
- End protectors on valve end are in place with a nonporous moisture barrier between the cover and the metal flange or welding end.
- Valve are shipped in the fully open position with wooden or plastic covers to protect the ends from ingress of foreign materials.

It is recommended that lifting devices that are rated for the valve weight should be used when lifting any C&C Valves. C&C Atlas series ball valves 6" full bore and larger are provided with lifting lugs integral to the valve body. Operators like gearboxes or actuators may have their own lifting points that are intended and designed to bear the load of the operator only. Operator lifting points **shall not** be used to lift the valve/operator assembly.

Recommended handling procedure when lifting with slings is shown in **figure 1**.

- Pallets, boxes, crates are provided with lifting/piling indications that shall be followed at all times.
- Operator lifting points shall not be used to lift the valve.
- Other lifting equipment provided with hooks can be used instead.
- Chains shall not be used instead of slings using procedures in **figure 1**.
- Lifting equipment's safe working load (SWL) shall always be double checked prior to any lift.
- During lifting/handling always keep valve flange protection in place to avoid foreign material from entering the valve bore
- Pay attention, as not to damage the valve paint during lifting/handling procedures.



Special care to the marking applied on the crates, and particularly to piling instructions, must be taken during storage/stowage of the box containing the valves. Unless otherwise agreed, CNC wooden boxes are not suitable for storage/stowage one on top of the other. Non-observance of crate handling markings could result in the serious injury of people and damages to the goods.



Do not store valve without end protection to prevent from ingress of foreign materials



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- Whenever possible valve shall be stored indoors and out of weather. When stored without wooden box, care must be taken not to put stainless steel valves and/or components in contact with any carbon steel components and/or structures to avoid cross contamination. Also, grinding of carbon steel components near stainless steel valves shall be avoided.
- For open air storage, special precaution should be taken to avoid both package and valve damage by environmental factors. Wooden boxes shall have minimum protection, using cellophane or similar sheets without tears/holes adequately fixed and the boxes lifted from the ground. Box condition shall be checked maximum every two months.
- For storage periods over two months in un-covered areas, CNC does not take any responsibility unless this requirement has been agreed on the purchase order.
- Lubrication during storage is not recommended.

2 BILL OF MATERIAL

ITEM	Component	ITEM	Component
1	Body	24	Segment Ring Retainer
2	Closure	25	Stem Keys
3	Ball	26	Stem Pins
4	Stem	27	Stem Retaining Pin
5	Trunnion Support	28	Stem Fire Safe Seal
6	Seat Rings	29	Gland Flange
7	Seat Inserts	30	Gland Pin
8	Fire Safe Seat Seal	31	Cap Screws, Gland Flange
9	Seat O-Rings	32	Trunnion O-Ring
10	Seat Back up Rings	33	Trunnion Gasket
11	Springs	34	Trunnion Thrust Washer
12	Body O-Ring	35	Trunnion Bearing
13	Body Gasket	36	Cap Screws, Trunnion
14	Body Studs	37	Seat Injection Fittings
15	Body Nuts	38	Stem Injection Fitting
16	Antistatic Plunger/Ball	39	Check Valve
17	Antistatic Spring	40	Bleed Fitting
18	Stem Thrust Washer	41	Gear Stud
19	Stem Bearing	42	Gear Nut
20	Lantern Ring	43	Gear
21	Stem O-Rings	44	Lever
22	Stem Back up Rings	45	T-Lever
23	Segment Ring	46	Cap Screw, T-Lever

NOTE: Quantities of the valve components depend on valve sizes and classes. Valve sales drawing available upon request shall specify quantities.

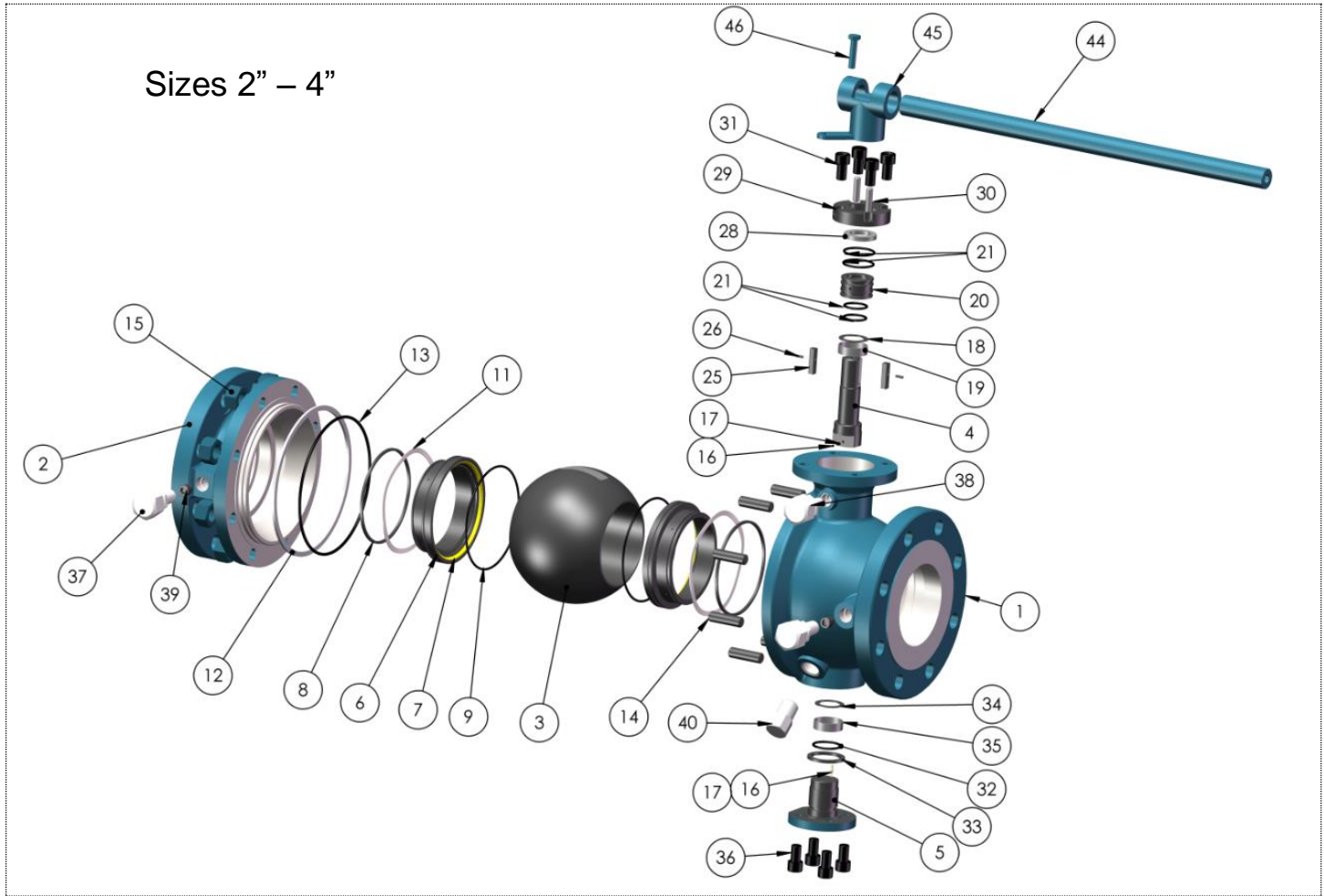


Figure 2: Atlas Series Ball Valve

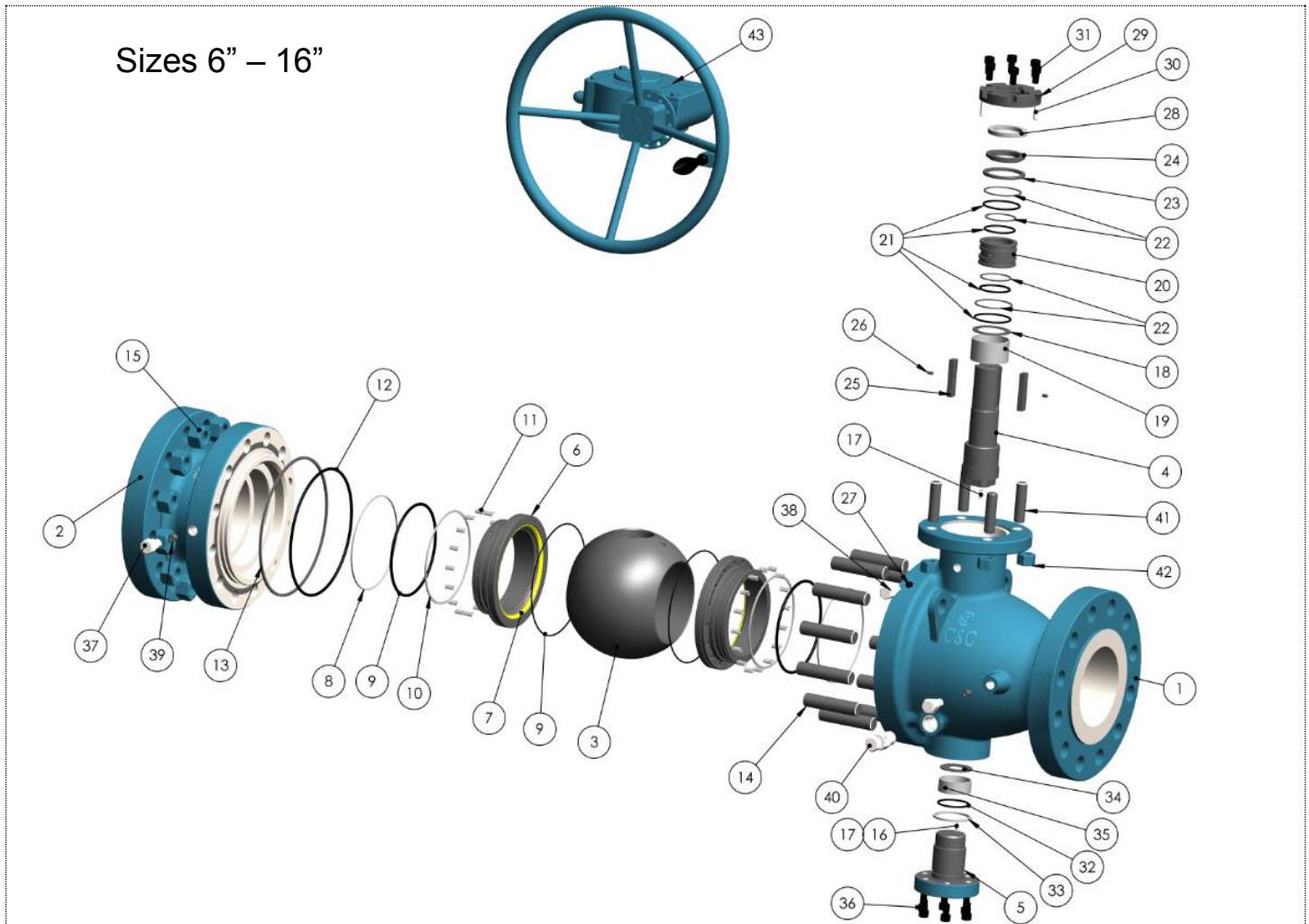


Figure 3: Atlas Series Ball Valve

3 INSTALLATION

Valves, as delivered, are ready for installation once valve flange protectors are removed and rust preventative grease wiped off flange gasket surfaces. A light solvent may be used to fully remove grease residue.

Install valve in system using proper size and type mating flanges and appropriate gaskets (for RF) or seal rings (for RTJ). Valve design allows for line flow in either direction.

The pipeline where the valve is to be installed shall be clean, free from sand, welding slags, debris, pieces of wood and/or any other foreign material that can damage the valve seats during operation.

Actuator and Gear stops are pre-set at the factory and should require no further adjustments. With the exception of 'fail-safe closed' valves, all other valves are shipped in the open position. Valves should not be closed until the bore of the valve has been cleaned of all debris.

3.1 NAMEPLATE

Nameplates provided on the products are designed to either advise operators of residual hazard or provide information regarding the valve. Hiding or removing such information can be very dangerous to personnel operating or maintaining the valve.

3.2 HIGH TEMPERATURE SERVICE

Some valves do have operating temperatures that can be very dangerous to people or animals. To avoid any kind of injuries operators must ensure the valve surfaces that reach such temperatures are suitably protected against accidental contact.

Operators are recommended to always provide an efficient protection/insulation of the valve surfaces that may be touched by personnel and/or animals and that exceed, in lower or in higher, the human tolerable limits (as a suggestion use -4°F through +140°F).

3.3 LOW TEMPERATURE SERVICE

Prior to exposure to freezing temperatures, it is highly recommended the valve be drained. Water that may be trapped in the body cavity could freeze and impair the operation of the valve or damage the valve. If the valve has a grease fitting in the lower drain, a sufficient amount of antifreeze injected into the body cavity via the lower drain grease fitting will prevent accumulated water from freezing. It is also advisable to inject a sufficient amount of valve lubricant into the grease fittings of valve and operator (if present) prior to extended cold temperature exposure.

4 OPERATION

4.1 INITIAL START-UP/COMMISSIONING

Once installed in the line the valve should be left either in the fully open or fully closed position, depending on the start-up/commissioning operation.



Do not leave the valve in partially open position for a long period. Ensure the pipeline is free of any debris such as sand, tools, welding slag or weld splatter and rod ends. This will damage the valve ball and seats during the start-up/commissioning operations.

4.2 NORMAL OPERATING ACTIVITY

The valve is designed for on/off service only. Pressure - temperature limits are stated on the valve nameplate. Do not use valve for flow control neither in the partially open position nor for throttling service, as these could lead to premature failure. The valve can be operated from the fully open to the fully closed position by acting on the hand wheel/lever (clockwise to close). When the stem flats or keyway are perpendicular to the fluid bore, valve is closed. Positive stops and arrow indication are provided on handles and gear operators.

4.3 DOUBLE BLOCK AND BLEED OPERATION

When pressure is applied to both ends of a closed valve, each seat will be forced against the ball, creating a double block. The hex head bleed fitting (40) provides a safe and convenient method for checking closed valve seat sealing effectiveness.



Before opening the bleed fitting, note orientation of the exhaust hole in the bleed valve. Never open bleed fitting while valve is exposed to line pressure.

4.4 BODY CAVITY RELIEVING SYSTEM

Trunnion mounted ball valves do have a body cavity where pressure can be trapped in a closed volume. Under this circumstance, any increase of the contained fluid temperature or any degradation of the contained fluid can result in an uncontrolled pressure increase of the trapped fluid potentially above the design pressures of the valve.

To avoid the above scenario, all of the C&C trunnion mounted ball valves are provided with one of the following body cavity relieving systems (depending on the design of the seats):

- **Self-Relieving Seats:**

The design of a self-relieving seat is such that when the pressure in the body cavity exceeds the rated pressure of the valve, not to exceed 1.33 times the maximum operating pressure (MOP) then the seat will automatically disconnect from the ball and allow pressure equalization between the body cavity and the pipeline. When one or both of the seats are of the Self Relieving type, there is no need for any other type of body cavity relieving systems.

- **Pressure Relief Valve:**

When both of the seats are not of the self-relieving type (i.e. both of the seats are of the Double Piston Effect Type), the body cavity must be protected from overpressure by means of a Pressure Relieving Valve (PRV) set to relieve excess pressure.

The standard PRV connected to the body cavity has been pre-set and tested in the factory to relieve at approximately of 1.33 times the maximum operating pressure (MOP) of the valve.

It is a mandatory requirement to keep body cavity pressure relieving system functioning correctly. Failure of the body cavity pressure relieving system can lead to failure of the valve pressure containment capability with consequent injuries to personnel, damage to the environment and loss of production.

5 MAINTENANCE

Maintenance personnel performing this operation shall be fully trained to handle pressure-containing equipment. Opening pressure containing equipment without having released all of the internal pressure and having safely isolated the pipeline where the valve is assembled can lead to serious injury or even death of the personnel involved. **DO NOT PROCEED IF IN DOUBT. ALWAYS DOUBLE CHECK.**

Some pipelines may contain fluids that are dangerous or lethal to human beings, animals and to the environment. Always check with the HS&E manager before releasing any fluid to the atmosphere.

5.1 VALVE MAINTENANCE IN OPERATION

5.1.1 STEM LEAKAGE

The C&C Atlas series valve is provided with a stem sealant injector, stem leakages can be temporarily stopped by injecting sealant into the stem fitting (38).

To replace all the stem O-Rings (21), it is necessary to depressurize the line and to disassemble the stem-lantern ring group as per instructions in para 6.1.

5.1.2 SEAT LEAKAGE

If the valve has been provided with emergency seat sealant injection fittings (37), seat leakage can be temporarily eliminated or, at least, considerably reduced by injecting sealant when the valve is in a fully closed position. Seat sealant fittings (37) are located in the body (1) and closure (2). Disassembling the valve and replacing the seat seal can eliminate seat leakages.

5.2 SCHEDULE OF ROUTINE MAINTENANCE

Valves are designed for a maintenance free life of 2-10 years depending upon severity of service. Routine maintenance consists of injecting lubricant through the groove or channel inside the valve leading to seal points around the ball thus topping off the lubricant. In order to guarantee efficient valve operation, the valve shall be inspected on a regular basis during the operation and subject to scheduled maintenance. Qualified person shall do all maintenance work.

Valve Sizes	Lubricant by valve size (ounces)
2"	2
3"	2
4"	2
6"	3
8"	3
10"	3
12"	3
14"	4
16"	4
18"	4
20"	6
24"	8

5.3 VALVE CLEANING

Valve cleaning is required when the valve does not seal properly and becomes hard to operate. Valve cleaners are products that contains detergent, sealant and oils. They clear channel/passage where old grease may have hardened. Inject cleaner through the seat injection fitting (37), leave it for three-to-four hours. If possible, cycle the valve to evenly distribute the cleaner in the ball seat contact area. This procedure is often successful in freeing seized, or hard to turn valves.

Note: Always replace the valve cleaner with equal quantities of Lubricant after cleaning

5.4 EMERGENCY REPAIR

- All C&C Atlas series valves are designed to operate without lubrication. Sealant injection can be used to stop/reduce leakage across the seats and/or through the stem seals as an emergency temporary solution. Furthermore, there is no guarantee that after the injection of the sealant the valve seats or stem seal will seal perfectly.

- Sealant must be injected only when leakage occurs. See table 1 for volume of sealant required by valve size.
- Prior to injecting sealant, it is suggested to flush the seat with flushing fluid and set the valve to the fully closed position.



Improper Selection of the lubricants may cause incompatibility of the soft components of the valve with the products injected. The end user is responsible to use the correct lubricants.

- A valve, which requires continuous heavy sealant injections, shall be either replaced or repaired immediately.



Injection fittings should not be removed if there is pressure in the line. Injection fittings should never be painted.

6 DISASSEMBLY AND REASSEMBLY INSTRUCTIONS

6.1 DISASSEMBLY

To disassemble two piece end entry trunnion ball valves, no special tools are needed. A torque wrench or bolt tightening tool is required to tighten nuts during reassembly. For tightening torque please refer to section 8.

- In case the valve is in operation, first, release the pressure from the line. For a complete disassembly, the valve must be removed from the line.
- Open the cavity bleed fitting (40) to discharge the residual pressure and operate the valve to the fully open position. Always use the safety plug or bleed fitting provided either at the drain connection to release the body cavity pressure.



To avoid possibility of being struck by liquid or foreign solid materials, position yourself so the hole of the bleed fitting is pointing safely away from you.



Never unscrew the flanged connections with residual pressure in the line.



Be careful not to injure personnel performing this operation. Always wear safety gloves, shoes and glasses.

- Remove the valve from the line.
Before disassembling the valve, it is important to mark all the parts, in order to correctly reassemble the valve.
- The valve shall be positioned to have the flow axis along the horizontal axis and the upper part shall be easily accessible.
- Remove the valve operator, after having removed the gear studs (41) and nuts (42), which are connected with the valve, remove/pull the actuator carefully until it is completely disconnected from the stem (4).

- During this operation, particular care shall be paid not to damage both the stem (4) and the key (25).
- Remove the stem key (25).
- Unscrew the body nuts (15), leaving a few on closure for easier handling.
- Turn the valve and rest it in one end flange. In this way, the valve bore will be in vertical position.
- Pay attention not to damage the surface of the flanged end.
- Unscrew the remaining body nuts (15) left on the closure (2).
- Lift carefully the closure (2) paying attention not to damage the body O-Ring (12) and body gasket (13) which can follow the closure or stay in the body cavity.
- Unscrew the gland flange caps screw (31) and remove the gland pins (30) from the gland flange using eyebolts fitted in the threaded hole in the pins.
- Remove the stem fire safe seal (28).
- Unscrew the trunnion cap screws (36).
- Extract trunnion (5) from the body (1) and remove the trunnion O-Ring (32) and trunnion gasket (33).
- Welded connections shall not be removed.

Stem Retained in the body design (2"-4" for all pressure class up to 1500)

- Remove the ball (3) from the body (1) by using nylon rope or strap without damage
- Remove the stem (4) from the body through end entry.
- Extract the lantern ring (20) from the body (1) through top.
- It is possible to remove the stem injection fitting (38) for cleaning.

Stem Retaining Pin design (6" & larger for class 150 and 300)

- Remove the stem injection fitting (38). Using an allen wrench, unscrew the stem retaining pin (27) provided inside the fitting (38).
- Extract the stem (4) and lantern ring (20) group from the body.
- Remove the ball (3) from the body (1) by using nylon rope or strap without damage.

Segment Ring Design (8" & larger for class 300 and 6" & larger for class 600, 900 and 1500)

- Remove the segment ring retainer (24) and extract the segment ring (23).
 - Extract the stem (4) and lantern ring (20) group from the body.
 - Remove the ball (3) from the body (1) by using nylon rope or strap without damage
 - Place the ball (3) on a wooden block.
- Extract the seat ring (6) from the body (1) and closure (2). Seat seal can be either O-Rings (9) or an insert (7).
It is not possible to remove seat insert (7), if found damaged, new seat rings (6) with inserts shall be used during reassembly.
 - Remove trunnion thrust washer (34), where provided, if damaged only. Trunnion bearing (35) may be removed using an extractor.
 - Remove stem thrust washer (18), and stem bearing (19) from the stem (4).
 - Remove the seat O-Rings (9) and the fire safe seat seal (8).
 - Remove the stem O-Rings (21) from the lantern ring (20).
 - Remove the seat springs (11) from their housing in the seat (8) or in the body (1) & closure (2), where provided.

6.2 RECONDITIONING

- The metallic parts can be cleaned using cloths wet with the cleaner.
- To clean the O-Rings and gaskets use dry, clean cloths. If possible, it is recommended to wash the O-Rings with soap and water, rinsing with clean water.
- After cleaning components be sure that there are no damaged parts and, particularly, there are no scores on metallic surfaces in moving or sealing areas. Also, check the condition of the O-Rings and back-up rings, making sure that they have not been damaged.
- Replace any damaged parts.
- Lubricate O-Rings and metallic surfaces, which come into contact during the ball movement with VALTEX 2000 grease. The stem /trunnion bearing (19)/ (35) are self-lubricated and do not require any additional lubrication.

6.3 REASSEMBLY

- (a) To reassemble the seat group in the body (1) and closure (2) proceed as follows:
- Put the body gasket (13) and O-Ring (12) into their housing in the closure (2). The body O-Ring (12), seat O-Rings (9), stem O-Rings (21) and trunnion O-Ring (32) must be fitted stretching them slightly. Any damage on these O-Rings can cause breakages during the valve assembly.
 - During reassembling, refer to markings applied before disassembling.
 - Insert the seat springs (11) into the seats (6) or body (1) and closure (2), where provided.
 - Insert the seat O-Rings (9) and seat the fire safe seals (8), where provided
 - Press the seat assembly (6) into the body (1) and closure (2)
 - When pressing the seat into the body and closure, pay attention that the seat moves correctly, parallel to the body and closure surfaces. For this operation, we recommend using clamps and a rubber hammer.
 - It is not possible to replace the seat insert (7) only.
- (b) Assemble the stem/lantern ring group as follows:
- Insert in the upper part of the stem (4) into the stem thrust washer (18) and stem bearing (19).
 - Assemble to the stem O-Rings (21) on lantern ring (20).
 - Insert the stem (4) into the lantern ring assembly.
 - Insert the upper gland pins (30) in the body (1).
 - Insert the stem fire safe seal (28).
- (c) Turn the valve bringing the stem axis in the vertical position.
- (d) Fit the stem/lantern ring group following the markings made before disassembling. If parts are correctly aligned, reassembly shall be easy.
- (e) Reinstall the ball (3) into the body (1).
- (f) Reassemble the segment ring (23) and segment ring retainer (24), if provided.
- (g) Completely tighten the body studs & nuts (14 &15), of the valve, gland flange cap screws (31) and trunnion cap screws. Refer to section 8.
- (h) Be careful not to over-torque the nuts and cap screws. Damages to the threads can cause the flanged joint to fail under pressure and injury personnel performing test operation.
- (i) Insert the stem drive keys (25) on the stem (4)
- (j) Reassemble the segment-retaining pin (27), if provided.
- (k) Reassemble seat injection fitting (37), when provided; stem injection fitting (38), and the cavity bleed fitting (40).
- (l) Reassemble the gearbox operator (43), if provided ensuring that all the marks previously made correspond and using only part of the fixing studs (41) and nuts (42). Carry out some opening and closing operations, verifying the perfect functioning of the operator and the valve.

For either gear operated valves or actuated valves, make sure that both the travel ends act when the valve is fully open and closed.

7 PROPER VALVE TESTING

Always perform an API 6D pressure test before re-installing the valve into the line to verify that the maintenance operation have been satisfactorily performed and to re-certify pressure containment capability of the valve.



Installing the valve in the line without pressure testing could cause leakage of production fluid and, potentially hazardous situation.

7.1 SHELL TEST

There shall not be any leakage under the pressure when ball is partially open and both ends are blanked. Testing pressure is 1.5 times the maximum operating pressure. Test duration are 2min for 4" and under valves, 5min for 6" to 10" valves, 15min for 12" to 18" and 30min for 20" and larger.

- (a) Fit the vent valve and set it in open position.
- (b) Operate the valve to the half-open position.
- (c) Fill in the valve with the fluid (Venting the air through the vent valve)
- (d) Close the vent valve and apply pressure in accordance with maximum operating pressure of the pipeline.
- (e) Visually check the outside of the ball valve for leakage.
- (f) Depressurize the valve.

7.2 HYDROSTATIC SEAT TEST

Valves are to be subjected to a hydrostatic seat test. There is to be no leakage under test pressure. Test pressure is to be applied to the appropriate end of the valve. Testing pressures 1.1 times maximum operating pressure. Test durations are 2min for 4" and under valves, 5min for 6" to 18" and 10min for 20" and larger valves.

- (a) Operate the valve to the fully close position and open the vent valve.
- (b) Pressurize one side in accordance with max operating pressure of the pipeline.
- (c) From the body vent or bleed fitting, check for possible seat leakage.
- (d) Repeat same operations as per points (b) & (c) on opposite side of the valve.
- (e) Depressurize the valve.

7.3 DOUBLE BLOCK AND BLEED (DBB) TEST

If the valve seats have DBB function, then the seat test shall be performed as follows:

- (a) With the valve unseated and partially open, the valve cavity shall be completely filled with test fluid.
- (b) The valve shall then be closed and the vent valve opened to allow excess test fluid to overflow from the valve – cavity test connection.
- (c) The test pressure shall be applied simultaneously from both ends.
- (d) Seat tightness shall be monitored from the cavity connection.
- (e) Depressurize the valve.



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7.4 SUPPLEMENTAL AIR SEAT TEST

The seat test specified in 7.2 shall be repeated at the test pressure between 80 psig and 100 psig using air as the test medium.

8 BOLTS TIGHTENING TORQUE

Table 2: Recommended Bolt Torque							
Bolt Size		Torque Values (Inch-lbs.)		Bolt Size		Torque Values (Inch-lbs.)	
Inch	Metric	B7	B7M	Inch	Metric	B7	B7M
1/4	M6	62	53	1-1/4	M30	10798	9824
5/16	M8	142	124	1-3/8	M36	15002	14028
3/8	M10	248	221	1-1/2	M39	19799	18587
7/16	-	416	381	1-5/8	M42	25800	24286
1/2	M12	602	549	1-3/4	M45	32394	27756
9/16	M14	903	841	1-7/8	M48	39607	34695
5/8	M16	1204	1106	2	M52	49210	41634
3/4	M20	2168	2036	2-1/4	M56	71957	61761
7/8	M22	3629	3469	2-1/2	M64	99571	86914
1	M24	5532	5222	2-3/4	M68	134531	113113
1-1/8	M27	7877	7125	3	M76	175245	147808
Note: Tightening Torque Values \pm 10%							

9 TROUBLESHOOTING

Issue	Possible Cause	Solution
Valve will not open or close	<ol style="list-style-type: none"> 1. Improper setting of gear or actuator stops 2. Ice inside operating device 	<ol style="list-style-type: none"> 1. Reset travel stop. 2. Remove operating device cover and check for ice. Remove and replace as necessary
Valve hard to operate	<ol style="list-style-type: none"> 1. Foreign material in line/valve 2. Lack of lubrication 	<ol style="list-style-type: none"> 1. Flush line to remove debris. Clean the valve – see valve cleaning procedure. 2. Lubricate seats utilizing sealant injection fittings (37)



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	3. Gear hard to operate or stuck	3. Check gear. Lubricate or replace.
Leak around the seat	<ol style="list-style-type: none">1. Foreign material between seat and ball.2. Valve not fully closed3. Worn or damaged seat inserts and/or ball.4. Worn or damaged seat O-Ring seals	<ol style="list-style-type: none">1. Clean and lubricate seats – see Valve cleaning and emergency repair section.2. Check the gear operator for fully closed position.3. Disassemble the valve and replace damaged component(s)4. Disassemble the valve and replace the O-Ring.
Leak around the stem	<ol style="list-style-type: none">1. Worn or damaged O-Ring seals	<ol style="list-style-type: none">1. Grease the stem. Disassemble the valve and replace the O-Rings
Leak around trunnion	<ol style="list-style-type: none">1. Worn or damaged trunnion O-Ring and/or gasket2. Trunnion cap screws not properly tightened	<ol style="list-style-type: none">1. Disassemble the valve and replace the O-Ring and/or gasket.2. Tightened cap screws to specified torque.
Leakage from bleed or injection fittings	<ol style="list-style-type: none">1. Foreign material in the fittings2. Fittings are loose	<ol style="list-style-type: none">1. Inject small amount of cleaner to flush foreign materials2. Tighten fittings.



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