

INSTALLATION, OPERATION & MAINTENANCE MANUAL

For the following sizes

6" 300#

8" 300#

10" 300#

4" 600#

6" 600#

8" 600#

This manual covers the installation, operation and maintenance of all AVCO standard 11500 cryogenic series trunnion ball valves as described in the current AVCO catalog. Custom made or customer modified versions of the 11500 cryogenic series may use this manual as a general guide only.

Alloy Valves and Control**1 SECTION A. - WARNING**

- 1.1 All AVCO Valves are designed and manufactured to be installed in applications where no more than 1g of force in excess of gravity is applied to the valve in any direction. This 1g force can be an effect of Traffic, Wind or Earthquake. AVCO valves should not be used in applications that exceed 1g.
- 1.2 All piping system components are subject to certain levels of erosion and corrosion. As the valve wall thickness is the governing variable in overall service life, care should be taken to ensure that all valves and related piping components are of a suitable wall thickness for the given application. Periodic inspections should also be made as valves/components may wear over time. As a minimum, annual inspection of the Body and Bonnet wall thickness should be performed with calibrated measuring devices such as micrometers and/or ultrasonic thickness gauges. Severe applications may require additional inspection types and/or frequency. Additionally, valves should be inspected for general signs of component wear and/or damage caused by process media, i.e. steam cutting. This may include the removal of insulation and/or other coverings to ensure a proper inspection. All valves should also be cycled completely during these inspections to ensure proper operability. Care should be taken to ensure that this will not affect the operating system.
- 1.3 All AVCO trunnion ball valves are designed for operation in clean media. This media should be free of all debris and particulate matter. Debris in the media may cause damage and/or reduced performance to the valve.
- 1.4 The style, size, pressure class and material selection of all valves are the responsibility of the piping system designer. AVCO may offer suggestions in this area; however the selection process is solely the responsibility of plant designers. Plant designers should also take into account the specific effects that the process media will have on the valve wall thickness and corresponding service life and ensure that the selected material is compatible with the process media. It is the responsibility of the piping designer to ensure that valves are equipped with any necessary venting and/or draining capabilities.
- 1.5 Do not exceed 100% of the maximum pressure rating of the valve at any time during its operation. Pressure spikes beyond the valve's pressure rating are solely the responsibility of the user.
- 1.6 All manually operated AVCO valves are designed to be tightened by hand only. Do not apply excessive input torque via pipe wrenches "cheater bars" or other devices.
- 1.7 Motor operated valves should be left in their factory set condition, unless the system operating parameters dictate a change. If changes are necessary, they should be performed in small increments and then the valve operation inspected. When adjusting these settings, use only the lightest/lowest setting possible to achieve the desired performance. Excess torque and/or thrust in the motor settings, may damage or lockup the valve. Never remove a motor operator, gear operator or manual operating assembly from a valve while it is pressurized. The valve must be completely relieved of all pressure prior to this disassembly.
- 1.8 Care should be taken to ensure that electrical motors are wired correctly to the power source. Incorrect phasing of 3-phase wiring may cause valve/motor damage.
- 1.9 The operator of any valve should have an understanding of the effects of opening/closing the valve with regards to its role in the overall piping system. Operators of valves under pressure should take caution to ensure that the valve is in good operating condition prior to operating it under pressure.

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- 1.10 These valves are designed to be used at cryogenic temperatures. Care should be taken to ensure that an operator does not touch any portion of the valve other than the handwheel. It is important that all installation requirements listed in this manual are followed without exception.
- 1.11 Certain processes utilize flammable, caustic and/or otherwise unstable media. Care should be taken in these circumstances to ensure the operator is aware of the specific health and safety risks associated with that medium.
- 1.12 All AVCO trunnion ball valves should be operated within the pressure and temperature ranges listed in Table 2 of ASME B16.34. Under no circumstances should the valves be operated at conditions outside these tables.
- 1.13 All piping systems should contain independent support mechanisms and should not utilize the valve as a sole means of support.
- 1.14 The estimated total lifespan of an AVCO trunnion ball valve when installed within ideal boundary conditions is 10 years; however, this lifespan may vary widely dependent upon operating conditions.
- 1.15 All valve actuators shall be sized by referring to the specific relevant valve torque and thrust data published by AVCO. Generic or standard valve information shall not be used.
- 1.16 It is the ultimate responsibility of the piping designer to ensure that each valve is sized appropriately for the given system parameters of pressure, temperature, flow rate, velocity, pressure drop, etc. and that the proper trim is specified for the system design parameters. Additionally it is the responsibility of the piping designer to ensure that the corresponding actuator sizing data is correct for the given application.
- 1.17 All valves shall only be used within their defined boundary conditions. All standard materials of construction, including bolting are suitable for operation within the boundary conditions. Care should be taken to ensure that all valves are not operated at conditions that exceed or deviate from the defined boundary conditions. The boundary conditions must be adhered to regardless of the piping system status, including but not limited to: Start-up, hydro-testing, chemical cleaning, system flushing, etc.
- 1.18 Valves are not suitable to serve as block valves during system hydrostatic pressure tests that exceed 1.1 times the cold working pressure.
- 1.19 Care should be taken around all valves as injury or damage may occur from the leakage of cryogenic liquids, possibly at high pressure from a gasket and/or packing joint. Additionally, packing and/or gasket leaks may cause external corrosion or erosion damage to the valve.
- 1.20 It is the responsibility of the user/owner of a plant to ensure that all valve operators are ordered to meet all applicable requirements and specifications.
- 1.21 Only valves that have been certified as fire safe shall be used in piping systems that may be exposed to fire.
- 1.22 Standard graphite packing is suitable for 500ppm VOC emissions. Consult the factory if lower emissions are required.
- 1.23 When operating manual valves, gloves should be worn to minimize the risk of injury to the hands.
- 1.24 In situations where manual valves are difficult to operate due to substantial torque requirements, it is recommended that the valve be supplied with a gear or motor operator.

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- 1.25 All valves should be mounted with the stem vertical and the pipeline horizontal. For any other orientation, please contact the factory.
- 1.26 Depending upon the specific application, normal lubricants may not be sufficient for higher temperature applications. In this case, higher temperature lubricants should be used in place of the standard type.
- 1.27 All valve packing glands should be tightened in an even manner. Care should be taken to ensure that the packing gland and/or gland flange do not contact the valve stem or stuffing box during tightening.

2 Section B - Introduction/Scope

- 2.1 The purpose of this manual is to ensure that the valves supplied are properly stored, installed, operated and maintained. Proper practices regarding installation and maintenance of the product will aid in standard trouble free performance.
- 2.2 Valve specifications are marked on the body and/or name plate.
- 2.3 To identify all parts of this product and better understand the maintenance requirements, see the expanded view of the valves in the relevant submittal drawing or literature.
- 2.4 This manual covers all AVCO 11500 cryogenic series trunnion ball valves. These valves are designed within the limits of ASME B16.34. For the Operator and Mounting Topworks of these valves, the user is referred to the applicable Section in this manual. See Section G for Operation of Valves. This manual is for reference purposes only. Disassembly and maintenance of valves should only be performed by qualified personnel. Consult AVCO for specific technical support.
- 2.5 All AVCO trunnion valves are identified with a metal nameplate that is riveted to the valve. This tag is usually found on the body/bonnet joint area, end flange or on the top plate area near the handwheel.
- 2.6 When performing any work, ordering spare parts, or requesting technical support, please refer to this nameplate. The Serial number is stamped on the valve flange ends.

3 Section C - Product Transportation & Reception

- 3.1 When unpacking the valve, confirm that the valve and any accessories were not damaged during transportation.
- 3.2 If the valve or any of its accessories were damaged or lost during transportation, inform AVCO immediately.
- 3.3 Do not place the valve directly on the ground or concrete floor! PLACE THE VALVE ON A WOODEN PALLET FOR INSPECTION.
- 3.4 The valve's open/close position indicator is located on the handle sleeve for lever operated valves and on top of the gearbox for gear-operated valves.
- 3.5 Lever and gear-operated valves are delivered with the ball in the full open position. Valves are shipped with flange protectors which are designed to protect the flange face serrations and prevent the entry of foreign debris during transportation.
- 3.6 For safety purposes, pneumatic actuated valves are shipped with ball in closed position with end caps protecting serrations and preventing the entry of foreign debris during transportation. Special care must be taken to avoid damage to the surface of the ball.

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- 3.7 Do not remove the end caps or protective flange coverings from the valve until it is ready for installation. If the protective coverings are removed for examination, immediately reinstall all protective coverings after the inspection.
- 3.8 AVCO recommends storing the valves indoors, in a dry, dust free atmosphere.

4 Section D - Extended Product Storage

- 4.1 If the valves are to be stored for an extended period of time, the following procedures and steps are to be followed.
- 4.2 Spray the inside of the valve with Rust Inhibitor or equal.
- 4.3 Inject lubricant grease into the secondary seat ports for Trunion mounted ball valves.
- 4.4 Insert tablet into the valve body cavity to aid in keeping moisture out of the valve.
- 4.5 Spray a rust inhibitor on the flange facing of each end connection.
- 4.6 Install plastic or plywood flange protectors on each flange. Tape the edges of the protector with duct-tape to provide an air tight seal.
- 4.7 The product should be operated monthly to ensure lubricated areas have lubricant distributed accordingly. The valve stem should be left in a different position each month. When stroking the valve, use filtered dehydrated and lubricated air to operate the actuator.
- 4.8 All gear operators are to have grease injected in all fittings monthly.
- 4.9 For valves with actuators, the actuator should have all fluid ports or connections plugged to prevent ingress of water or dust. Coupling parts must be protected with grease or protective oil.
- 4.10 Valves should be stored in a dry, weatherproof building (preferably climate controlled).
- 4.11 When handling the valve or valve package, remember, valves are very heavy and use appropriate equipment.
- 4.12 Place an approved lifting device securely around the valve body or use lifting hooks while handling the valve. Special care should be taken not to damage the lever/gearbox/actuator.

5 Section E - Do's and Don'ts

- 5.1 Read and understand the Do's and Don'ts before valve installation, operation, or maintenance. Contact AVCO with any questions or concerns.

5.2 Do's

- 5.2.1 Use the valve for the specified application as agreed between AVCO and the purchaser/end-user.
- 5.2.2 Read this manual before installing or operating any AVCO valves.
- 5.2.3 Train employees on the safe handling and use (maintenance and operation) of the valve.
- 5.2.4 Ensure the nuts/bolts are tightened to the specified torques.
- 5.2.5 Ensure the electrical continuity of the valve.
- 5.2.6 Open or close the valve slowly to avoid a hammering effect on the valve and the pipeline.

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- 5.2.7 Always replace the damaged parts with genuine and recommended AVCO parts.
- 5.2.8 Be aware of the media type and environment (explosive, highly flammable, toxic, oxidizing, etc.) in which the valve is to be used. Protect people and the environment from any harmful or poisonous substances.
- 5.2.9 To avoid any major product/environmental damage, remove any residual hazard(s) (as applicable, or as informed by AVCO).
- 5.2.10 The valve body may be very hot or cold during use. Take all precautions to protect against burn/freeze injuries.

5.3 Don'ts

- 5.3.1 Do not exceed maximum operating conditions (pressures, temperatures, etc.) as specified on the body and/or nameplate.
- 5.3.2 Do not allow the valve to remain open at any intermediate position.
- 5.3.3 The threaded connections in the valve body for the drain and vent lines are sealed with threaded plugs. Do not remove these plugs while the valve is under pressure.
- 5.3.4 Do not modify the valve at any time, under any circumstances, unless consent or advice has been sought from AVCO.

6 Section F - Installation of Valves

- 6.1 Before installing a new valve, confirm that the specifications of the valve matches those of the intended installation area. The nameplate will provide the necessary information. If this information is missing, consult AVCO.
- 6.2 When removing the valve from storage, inspect it for damage.
- 6.3 Before installing the valve, remove the protective covering and end-caps to ensure the serrations on flange face are not damaged and the bore is clean. Clean the valve with approved solutions if necessary.
- 6.4 Prior to installation, ensure the pipeline is clean. Pipeline debris, scaling, etc. will damage the soft seat inserts of the valve and cause seat leakage during commissioning.
- 6.5 During commissioning and pipeline flushing, the valve must remain in the full-open position to prevent damage to internal parts. **Note:** To prevent damage to the valve, AVCO recommends first installing a spool piece instead of the valve while flushing the pipeline. If a spool piece is not an option, install strainers at critical locations upstream from the location to remove foreign debris. It is pertinent that the valve remain in the full-open position during flushing.
- 6.6 These ball valves are designed for unidirectional flow and it is important to ensure the installation of the valve is correct with respect to the flow direction arrow marked on valve.
- 6.7 Valves must only be mounted in the horizontal position (with stem upwards) or maximum of 45 degrees from the upright position. These valves must not be installed in any other orientation as it will lead to valve failure.

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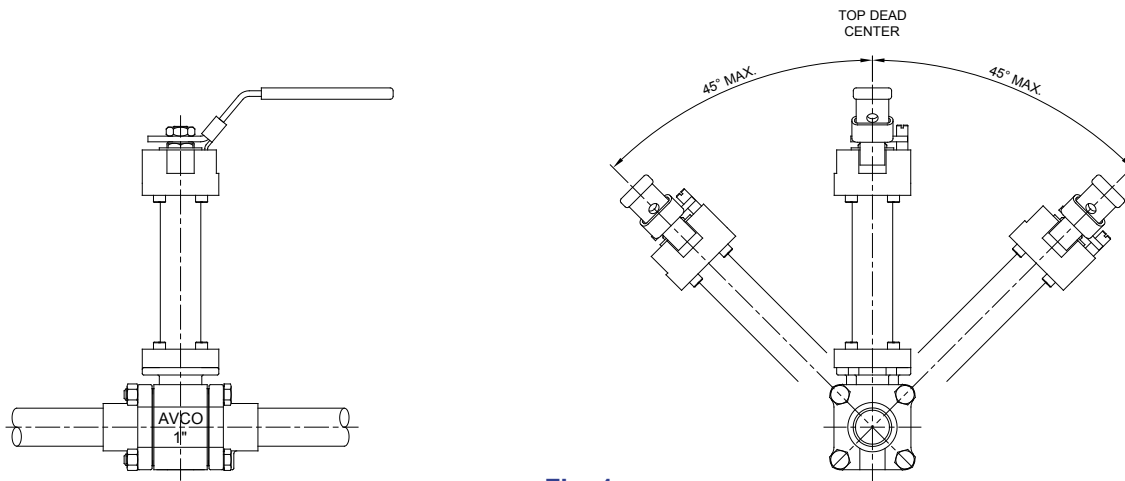


Fig. 1
Allowable Valve Installations

6.8 It may be necessary to firmly support the pipeline in order to protect the valve from excess stress and to reduce the pipeline vibrations. To facilitate servicing, it is recommended that the valve be supported by the body, using approved support devices. Do not fasten supports to flange bolting or actuator.

6.9 Flanged End Valves

6.9.1 Do not use flange bolts to correct misalignments.

6.9.2 During tightening operation, ensure that piping stresses are not transferred to the valve.

6.9.3 Over-tightening flange studs can cause damage and/or leakage at the flanges or body-to-body end joints.

6.10 Butt Weld End Valves

6.10.1 Welding operation must be performed by a qualified welder. The welding procedure should be performed according to ASME Boiler and Pressure Vessel Code Section IX.

6.10.2 To prevent seat/seal damage during welding installation, do not allow the temperature of the valve body seat area to exceed 200° F (94° C). Use thermal chalks to monitor temperatures.

6.10.3 Any damage to the seats due to temperatures greater than 200°F (94°C) can cause leakage. AVCO recommends keeping spares readily available.

6.10.4 To prevent damage to sealing surfaces and seals, ensure that weld spatter does not fall on ball and/or body seals.

6.10.5 Ensure a gap of 0.08" to 0.12" between the valve ends and pipeline as per ASME Welding Standard then tack weld the pipeline and valve ends. After proper alignment of the valve to the pipeline, complete the weld as necessary.

6.10.6 When installing, ensure that all foreign material is removed from the interior of the valve, including desiccants. Do not remove protective end coverings until immediately prior to valve installation. Do not disassemble or modify an AVCO valve in any way prior to installation. This will void the factory warranty if it occurs.

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- 6.10.7 A protective paint may have been applied to the weld ends on some valves, and it should be removed before welding, unless it is a deoxaluminite paint which acts as a welding flux and does not need to be removed.
- 6.10.8 For soft-seated valves, the temperature of the valve body should not exceed 200°F during welding to avoid damaging the soft seals. Check the temperature of surrounding areas to avoid heating valve body excessively, especially with small sizes, where a heat sink may be necessary.
- 6.10.9 Use the smallest electrodes and the minimum amperage possible consistent with approved welding procedures. This will help to minimize warpage in the seat areas. Tack welds should be ground out before completing the root pass in that area.
- 6.10.10 These valves are designed to function in a single direction. All markings should be noted on the valves. Arrows on the valves indicating flow direction should correspond with the system flow direction. **NOTE:** Ensure that all foreign material (dirt, weld slag, rocks, wood construction materials, weld rod, etc.) has been removed from the valve prior to and after installation. Foreign material is the primary cause of premature seat failures.

7 Section G - Operation of Valves

- 7.1 AVCO valves are designed for simplicity and ease of operation. To open a Ball valve, turn the handwheel in a counterclockwise direction; continue turning until interference is felt; at this point, the valve will be fully open. To close the valve, turn the handwheel in a clockwise direction; continue turning until interference is felt; at this point, the valve will be fully closed.
- 7.2 These valves were designed to operate within the pressure and temperature limits of ASME B16.34. Do not exceed these limits.
- 7.3 For Lever operated valves, the hand lever is either assembled with the valve or shipped by fastener, depending on the size of the valve or hand lever.
- 7.4 For Gear operated valves, THE GEARBOX OPEN/CLOSE ADJUSTMENT HAS BEEN MADE PRIOR TO DISPATCH AND MUST NOT BE DISTURBED. Rotation of hand wheel in the clockwise direction closes the valve. Counter clockwise rotation opens the valve (looking from the hand wheel end.) The internal details/construction of gearbox may vary as per manufacturer's standard. **Caution:** Ensure that the force applied on the hand wheel of the gearbox or lever does not exceed 265 ft. lbs. Note: Do not apply extra leverage (using pipe/bar), when the end stops or the gearbox reaches it's final setting point.
- 7.5 AVCO ball valves always close in a clockwise direction. The ball should always be rotated through 90° to the fully opened or fully closed position. **Caution:** Keeping the valve at any intermediate position should always be avoided, as high velocity through the narrow opening will produce erosion of seats, ball and the body.

8 Section H - Valve Maintenance & Inspection

8.1 External Maintenance/Inspection

- 8.1.1 It is recommended that external maintenance & inspection of the valve be performed on a frequent basis.

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- 8.1.2 Check the tightness of nuts/bolts between the body/body adapter, the bracket/stem housing, and the body/trunnion.
- 8.1.3 Ensure that the performance of the valve is satisfactory.
- 8.1.4 Check the electrical continuity of the valve.
- 8.1.5 Ensure no leakage is being observed from the valve.
- 8.1.6 Mounting studs/nuts of the worm gearbox may be checked for tightness and retightened if necessary.

8.2 Preventive Maintenance/Inspection

- 8.2.1 It is recommended that preventive maintenance & inspection of the valve be performed on a quarterly basis if possible and requires system shutdown for some aspects of the inspection.
- 8.2.2 In order to avoid failure during operation, all valves in a process plant should be periodically inspected thoroughly for wear on the ball, seats, seals, or body. If wear is discovered, AVCO recommends replacing seats, seals, gaskets, and packing with AVCO authorised parts.
- 8.2.3 The type of process, fluids involved, working conditions, and location of the valve in the process plant, will determine the frequency of the inspection/maintenance.
- 8.2.4 Preventive maintenance is essential as the failure due to lack of maintenance may cause an emergency shutdown of the plant.
- 8.2.5 Before removing the valve from the pipe, it is important to mark the relative position of the valve flange with respect to pipeline flange and the flow of direction of the valve.
- 8.2.6 Once a valve is repaired, it should undergo a complete set of tests to make sure that the valve is adequate for the original working conditions. Hydrostatic/pneumatic shell/seal tests should be carried out as per the specifications relevant to the valve. **Note:** Clean the valve carefully of all media. Inform AVCO of any dangerous media involved.

8.3 Lubrication of Worm Gear Box

- 8.3.1 Worm gear boxes are supplied with grease. Normally the grease is suitable for -20°C (-4° F) to 80°C (176°F.) For other applications, consult the Factory/Branch office.
- 8.3.2 Grease as necessary.
- 8.3.3 Grease should be changed if operated frequently, after approximately three years.
- 8.3.4 Grease should be changed if operated rarely, after approximately five years.
- 8.3.5 The primary reducing spur gear unit attached to main worm gearbox should be re-greased at least annually.
- 8.3.6 Disassembly of the gear box should be done only by experienced, trained operators

8.4 Stem Leakage

- 8.4.1 If leakage is encountered through the stem, the mount pad bolts may require tightening.
- 8.4.2 Remove the handle/lever retaining nut or screw, or remove the connecting bolts between gear box and valve mounting pad.
- 8.4.3 Remove the handle/lever or gear box.

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- 8.4.4 Tighten the mount pad bolts until the listed torque for the mount pad bolts is achieved.
- 8.4.5 Re-assemble the handle or gear box to the valve
- 8.4.6 If stem leakage still occurs, the valve stem seals/packing will require replacement.

8.5 Leakage at Body Joint

- 8.5.1 If leakage is encountered through the body joint, the body bolts may require tightening.
- 8.5.2 Check the body bolt torque and tighten to the required torque using the suggested bolt tightening sequence.
- 8.5.3 If leakage is still encountered, the body seals will require replacement and/or the mating faces may be damaged and should be inspected.

8.6 In-line Leakage

- 8.6.1 If leakage is encountered through the seat, check that the valve is fully closing and there are no restrictions preventing the full rotation to the closed position.
- 8.6.2 If full travel is being achieved then it is likely the valve seats or ball is damaged and/or worn, or the ball is incorrectly fitted and may require replacement or correction.

8.7 Leakage at Bonnet Joint

- 8.7.1 If leakage is encountered through the bonnet joint, the bonnet bolts may require tightening.
- 8.7.2 Check the bonnet bolt torque and tighten to the required torque.
- 8.7.3 If leakage is still encountered, the bonnet seal will require replacement and/or the mating faces may be damaged and should be inspected.

9 Section I - Refurbishment Instructions

- 9.1 The following instructions are based upon the valve having been removed from the pipeline and all relevant safety procedures followed.

9.2 Seat Replacement

- 9.2.1 Unscrew the nuts (item 11) from the downstream end cap (item 14). The studs (item 10) may also be removed, but not essential, however care should be taken not to damage them if left in place. The end cap can now be removed.
- 9.2.2 Remove the seat (item 1) from the end cap.
- 9.2.3 Remove the two body seal gaskets (items 15 & 16).
- 9.2.4 Check the ball (item 2) for any damage. If damage is evident, contact AVCO for further advice.
- 9.2.5 Fit a new seat (item 1) in the end cap (item 14).
- 9.2.6 Fit new body seals. We advise these be located on the end cap whilst it is out of the body.
- 9.2.7 Carefully insert the end cap, complete with new seat and seals into the body, screw on the body nuts (item 11) and tighten to the torque listed in this IOM while following the bolt tightening sequence.
- 9.2.8 It is suggested the valve be operated several times and then check the torque of the bolted body joint.

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9.3 Stem Packing Replacement

- 9.3.1 Unscrew the nuts (item 29) from the gear box. The studs (item 28) may also be removed, but not essential, however care should be taken not to damage them if left in place.
- 9.3.2 The gear box unit can now be raised upwards from the valve and removed.
- 9.3.3 Unscrew the mount pad bolts (item 25) and remove the mount pad (item 23). There is a location pin (item 27) which can remain in place.
- 9.3.4 The packing (item 24) can now be removed.
- 9.3.5 Inspect the stem for any damage within the packing location. If any damage is observed, contact AVCO for further advice.
- 9.3.6 Fit new packing (item 24) ensuring it is firmly pressed in.
- 9.3.7 Locate the mount pad (item 23) on top of the bonnet (item 21), while observing correct fitment with the location pin (item 27) and screw in the mount pad bolts (item 25) and tighten to the listed torque.
- 9.3.8 Lower the gear box (item 26) onto the mount pad, screw on the gear box nuts (item 29) and tighten.

10 Section J - Troubleshooting

- 10.3.1 The following table lists possible malfunctions that might occur after prolonged use.

Symptom	Possible fault	Actions
Leakage through a closed valve	Damaged ball surface	Replace the ball
	Damaged seats	Replace seats
	Ball might not be closed fully	Check ball Open/Close settings
Irregular ball movement	Impurities between the ball and seats or ball-body cavity and ball seats	Flush the ball from inside
		Clean the sealing surfaces and seats
Valve too hard to operate / valve torque too high	Damaged seats	Replace seats
	High application pressure/temperature	Confirm the application pressure/temperature rating
	Foreign particles in valve the seats	Clean the internals
Water hammer or noisy operation	Error in valve sizing of flow of fluid with high velocity	Confirm valve sizing with respect to flow
Leakage through stem	Gland nut loose	Tighten gland nut
	Damaged stem, stem sealing surface	Replace the stem
	Damaged stem seal	Replace the stem seal

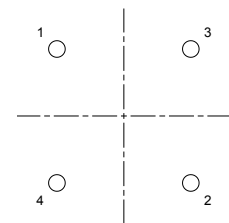
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11 Section K - Bolting Information

11.1 Bolts and nuts should be tightened until finger tight and then gradually fully tightened per the bolting sequence shown in paragraphs 8.4 through 8.8 to the torque shown in table 2. It is important that tightening be done gradually so as not to trap or pinch any part of the seats or seals and to maintain concentricity.

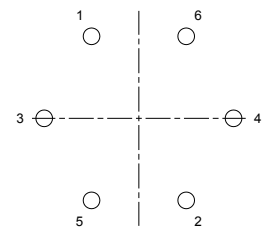
11.2 Four bolt sequence.

- 11.2.1 First round to 30% torque - 1-2, 3-4
- 11.2.2 Second round to 60% torque - 1-2, 3-4
- 11.2.3 Third round to 100% torque - 1-2, 3-4
- 11.2.4 Final checking round - 1,3,2,4



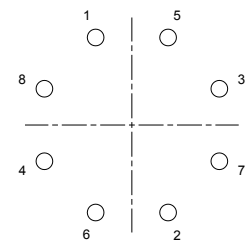
11.3 Six bolt sequence

- 11.3.1 First round to 30% torque - 1-2, 3-4, 5-6
- 11.3.2 Second round to 60% torque - 1-2, 3-4, 5-6
- 11.3.3 Third round to 100% torque - 1-2, 3-4, 5-6
- 11.3.4 Final checking round - 1,6,4,2,5,3



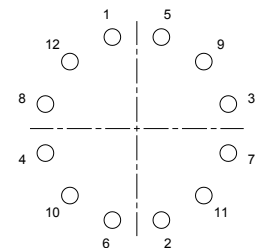
11.4 Eight bolt sequence

- 11.4.1 First round to 30% torque - 1-2, 3-4, 5-6, 7-8
- 11.4.2 Second round to 60% torque - 1-2, 3-4, 5-6, 7-8
- 11.4.3 Third round to 100% torque - 1-2, 3-4, 5-6, 7-8
- 11.4.4 Final checking round - 1,5,3,7,2,6,4,8



11.5 Twelve bolt sequence

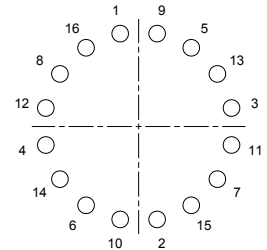
- 11.5.1 First round to 20% torque - 1-2, 3-4, 5-6, 7-8, 9-10, 11-12
- 11.5.2 Second round to 40% torque - 1-2, 3-4, 5-6, 7-8, 9-10, 11-12
- 11.5.3 Third round to 80% torque - 1-2, 3-4, 5-6, 7-8, 9-10, 11-12
- 11.5.4 Fourth round to 100% torque - 1-2, 3-4, 5-6, 7-8, 9-10, 11-12
- 11.5.5 Final checking round - 1,5,9,3,7,11,2,6,10,4,8,12



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11.6 Sixteen bolt sequence

- 11.6.1 1st round to 20% torque - 1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16
- 11.6.2 2nd round to 40% torque - 1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16
- 11.6.3 3rd round to 80% torque - 1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16
- 11.6.4 4th round to 100% torque - 1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16
- 11.6.5 Final checking round - 1,9,5,13,3,11,7,15,2,10,6,14,4,12,8,16



- 11.7 If a bolt, screw, stud or nut is damaged or lost, it should be replaced with one of exactly the same specification as that originally supplied. AVCO holds spares in stock.

Valve Size	Valve Class	Body Bolts		Bonnet Bolts		Lower Cover Bolts		Mount Pad Bolts	
		Size	Torque	Size	Torque	Size	Torque	Size	Torque
6"	300#	M18	75	M10	12	M10	12	M10	12
8"	300#	M20	75	M12	22	M10	12	M12	22
10"	300#	M24	180	M12	22	M12	22	M12	22
4"	600#	M20	75	M10	12	M12	22	M10	12
6"	600#	M24	180	M12	22	M12	22	M12	22
8"	600#	M27	270	M14	35	M12	22	M14	35

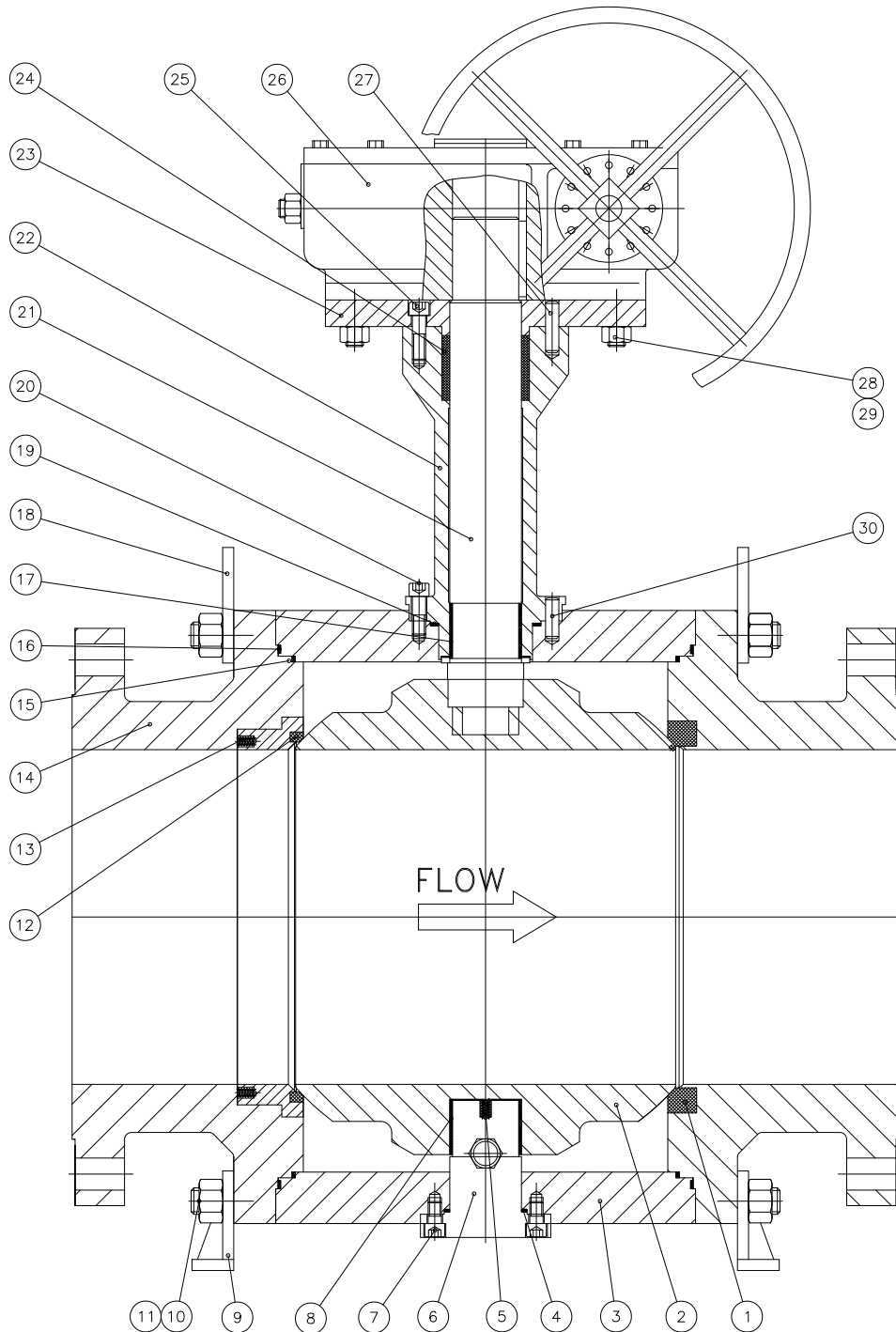
Valve Torque Settings (N.m)

12 Section L - Cv Values

- 12.1 The following table gives the Cv values for the listed valves.

Valve Size	Valve Class	Cv
6"	300#	5400
8"	300#	10000
10"	300#	17100
4"	600#	1800
6"	600#	4500
8"	600#	8900

Alloy Valves and Control



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