# azbil

# Diaphragm Control Valve Model: VDC, VAC, VST,VAA ANSI Class 600 or under

**User's Manual** 



**Azbil Corporation** 

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# Safety Guide

### 1: Nomenclature of parts

Diagrams with the control valve terminologies and words used in this manual are shown below. Please familiarise yourself with these definitions before using the device.



Figure S-1 Nomenclature of globe valve



Figure S-2 Nomenclature of butterfly valve

#### 2: Safety precautions

Please read this section before using the valve to ensure proper handling.

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If the stated procedures are not followed as specified, a potentially hazardous situation may arise, which could result in death or serious injury.

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Failure to observe these cautions may create dangerous conditions that could result in injury to the personnel and/or in physical damage to the device.

### 3 : Verification of Valve Specifications and Precautions on Storage

#### 3-1 : Unpacking

Control valve is a precision equipment. Handle it with care to avoid damaging it.

When unpacking, check that the following items are in the crate:

- Main valve body, actuator and accessories as ordered,
- Additional equipment as ordered. Installation options

#### 3-2 : Verification of specifications

Please check and see if that the process flow fluid conditions, and valve Tag No. agree with the specifications that were ordered. The nameplate of each product are found as shown below. (Other products have their nameplates attached to the identical positions.)



Figure S-3 Position of nameplate on V Series

#### **Compliance with Regulations**

This product complies with the directive below.

Pressure Equipment Directive (PED) 2014/63/EU

#### **Requirements for workers (installation, operation, maintenance)**

To ensure safety, only specialists who are skilled in instrumentation work should carry out the installation, operation, and maintenance of this device.



When storing the control valve, pay attention to the following precautions:

- A control valve that has been packed in a cardboard box should be stored indoors at normal temperature and humidity.
- A control valve that has been packed in a wooden crate should be stored indoors at normal temperature and humidity as a rule. In the event outdoor storage, open the crate, verify the specifications of the unit and cover it with a polyethylene protective sheet to guard against precipitation.
- When storing a used valve, follow the procedures described below:
  - (1) Flush out the process fluid from inside the valve body and dry,
  - (2) When there is a possibility of the valve body rusting, preservation treatment should be given,
  - (3) To prevent water from getting into the instrument, cover pneumatic tubing connection and electric connector with watertight caps or tape. Also, protect the connector threads,
  - (4) Place a flange cap onto the end of the pipe connecting surface (flange face, butt welding connections) to avoid any possible damage.

### 4 : Installation

### 4-1 : Installation environments

# $\triangle$ caution

- Ensure sufficient space for easy and safe operation and maintenance of the control valve.
- Avoid installing the valve in a location where vibration or external stress may impair proper valve functions. If necessary, make appropriate provisions against these.
- Consider providing a support for the valve, so that the process piping is not burdened with the excessive weight of valve, or provide supports on the upstream and downstream pipe runs.
- Provide a cover or protective fence around the valve installation, when a valve is installed facing a path or if physical contact with valve is expected.



- Do not install a valve where it is submerged under the water, or snow or freezing may take place.
- Provide a wall for protection against heat radiation.
- Provide measures to protect the valve against salt spray or corrosive atmosphere.
- To stop operation of the Flowmeter:
  - Switch the control equipment connected to the flowmeter to manual control.
  - To turn the power to the converter off.

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• In order to guard against accident while handling the valve, always wear safety gloves, goggles and safety shoes.

Prior to installation work, follow the items of caution as described below:



- Check and confirm that there is no external damage to the valve (body, actuator, accessories).
- Check and confirm that there is no damage on pipe connecting flanges or butt welding connections.
- Ensure that the temperature of welded part of pipe has been reduced before proceeding.
- Make sure that the flanges on pipe have been chamfered.
- Remove dust, sand, welding spatter or any other foreign matter from the pipe and clean out pipe. Any foreign matter will damage the valve seat and reduces shut-off characteristics.
- Ensure that upstream and downstream pipe supports are sufficiently strong. Otherwise, the valve's weight may cause leakage from flange connections.





• Operation of valve over and beyond the rated pressure or connection other than recommended of specified connection may cause damage or leakage which may result in serious injury.



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#### 4-2 : Installation work

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- Ensure that centers of upstream and downstream pipes are aligned when pipe installation has been completed. Any mis-alignment of pipe will distort the valve and will cause leakage from the connections. (Gasket)
- Make sure that the face to face dimension of pipe flanges is equal to face to face dimension of valve body plus gasket thickness.
- When installing a butterfly valve on a pipe, keep the valve body (vane or disk) in the fully closed position. When lifting a valve using the eyebolts on the actuator, make sure that the rated weight of the bolt does not exceed the limit given in the instruction manual. A load in excess of the limitation will cause damage to actuator or will result in air leakage.

• Use proper gaskets for pipe flanges. Otherwise, process fluid may leak. Always use new gaskets for pipe flanges that will meet process fluid specifications,

temperature and pressure conditions. Otherwise process fluid leakage may occur.

• When flushing pipes, keep valve in the fully open position and do not stroke valve. Welding spatter or foreign matter may damage valve.



### 4-3 : Pneumatic piping and electric work

- Pneumatic tubing should be sized so as not to cause dropping of air pressure when the control valve is in operation. Pneumatic tubing should have an allowance in bend (use specialized tool) and the parallel tubing should be clamped together.
- Only qualified persons should do electrical work in accordance to electrical facility engineering standards.
- Cable connections should be made to conform to the facility's conditions. A suitable adaptor or packing should be selected to suit the outer dimension of the completed installation.
- When using seal tape on pneumatic tubing, do not apply tape on the first two threads from the tip of connector. This may block the air passage and cause malfunction of the valve.
- When using liquid packing (seize lock) on pneumatic tubing, care should be exercised so the liquid does not leak into tubing. It may block the air passage, resulting in valve malfunction.
- Avoid electrical work in rainy weather or at a time of high humidity. Any intrusion of water into connector or terminal will cause rusting and electrical leakage.
- Covers of accessories such as the positioner are provided with a seal packing (gasket). Exercise care so as not to misplace or lose them while electrical work is in progress.
- Exercise care so as not to lose fixing screws of accessories such as the positioner. When tightening screws, ensure that packing is in place and tighten screws with an even torque.
- Cable threads and conduit seal should be tightened so as to ensure that water does not get in.



### 5 : Caution on disassembly and reassembly

### 5-1 : Disassembly

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- When disassembling a springincorporated positioner, follow the prescribed procedure in removing bolts and nuts. Otherwise, the spring may pop out and could resulting in physical injury.
- When the eye-bolts of actuator are used to lift the valve from the pipe, ensure that the weight limit given in manual is adhered to. Otherwise, there is the danger of dropping the valve,
- When removing the trim (inner valve) from the body, ensure that the proper type of specialized tool is used. Refer to the instruction manual for the tools that should be used. Otherwise, the trim may be damaged.

- Before disassembling the valve, ensure that the pressure within piping has been reduced to atmospheric pressure. Flow out of process fluid may cause physical injury.
- When disassembling the valve, flush out the interior of the valve or replace the fluid inside. Residual process fluid may cause physical injury,
- Do not disassemble the pneumatic actuator with supply air on. Compressed air may cause physical injury.



#### 6: Assembly



- When assembling the spring loaded actuator, adhere to the order of assembly procedure; install bolts and nuts as instructed. Disregard of procedure may result in malfunction.
- When installing a butterfly valve on a pipe line, fully close the valve (vane or disk). Tighten flange bolts and nuts diagonally and with even torque.
- When installing the valve body, always use new gaskets. Old or reused gaskets may cause leakage
- When assembling trim (inner valve), ensure that specialized tools are available and use only those which meet specifications.

Follow assembly procedure



Install butterfly valve in fully closed position



Tighten diagonally



Replace packing / gasket



### 

 When assembling the valve, tighten bolts and nuts at a torque as specified in instruction manual. Any damage or corrosion on the bolts or nuts may cause destruction of control valve which will lead to physical injury. Always replace defective bolts and nuts with new ones.

#### 7: Maintenance and inspection

Adhere to the following warnings and cautions while conducting maintenance or inspection.

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If there is leakage from a valve, do not come close to the valve until safety is assured of. A serious accident or physical injury may occur depending on the type of fluid.

- Check the gland daily and ensure that there is no leakage from it. Check valve operation daily, and confirm that it is not hunting.
- Make sure that there is no abnormal vibration or noise during operation,
- When the valve is repaired or disassembled, old parts should be properly disposed of as industrial waste. Otherwise, they may contaminate the environment.



Figure S-4

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# Chapter 1 : General

This manual covers the instruction for the Cage type Double Seated Control Valves (Model VDC), Cage type Angles (Model VAC), Top Guiding SIngle Seated Control Valves (Model VST) and Acorn type, Angle Control Valves (Model VAA).



Model: VDC Cage type Double Seated Control Valve (Rating: ANSI 600lb or Less)



Model: VST Top Guiding Single Seated Control Valve. (Rating: ANSI 600 lb. or Less)



Made: VAA Acorn type Angle Control Valve (Rating type Angle 600lb or Less)



Model: VAC Cage type Angle Control Valve (Rating: ANSI 600 lb. or Less)

### 1-1: Specification of Control Valves

The basic model number, valve size, pressure rating and other related specifications of the control valve is indicated on its nameplate. (See Figure 1.) Please confirm that the process flow condensations the specifications match before installation.

DATE	C
TAG NO.	1999 - 1993 - 1993 - 1993 - 1993 - 1993 - 1993 - 1993 - 1993 - 1993 - 1993 - 1993 - 1993 - 1993 - 1993 - 1993 -
PROD. NO.	
MODEL	GREASE
SIZE	LIFT
RATING	
BODY	
TRIM	
PLUG	
GASKET	
PACKING	
ACTUATOR	
SPRING	
RANGE	
POSITIONER	
SUPPLY	
AIR TO	VALVE
TOK	YO JAPAN

Figure 1-1 Nameplate

#### 1-2: Construction

Control Valves consist of two major sections - valve body and diaphragm actuator. Different combinations of valve body and actuators, type of connections, types of materials and other specifications result in a control valve that optimally suits the requirements of process flow control.

### 1-3 : Valve Body Section

The valve body section consists of a bonnet, a valve plug, a cage or a seat ring, and other trim parts. The bonnet is assembled to the valve body with stud bolts, nuts and with gasket, to provide a pressure - tight valve body section. The valve plug in the valve body is moved up and down by the actuator through the valve stem, thereby varying the opening formed between the plug and cage or seat ring to control the amount of flow. (See Figures 1-2 through 1-5.)

#### 1-4 : Actuator

The actuator is a spring - loaded diaphragm motor. It converts a pneumatic input signal into a mechanical positioning force with its spring and diaphragm, in order to drive and hold the valve plug at a position corresponding to the pneumatic input signal. (See Figure. 1-6, 1-7.)

**~Note** *"Air- O-Motor"* is Azbil Corporation's trade name for its diaphragm motors (Models VA1 to 5).



Figure 1-2 Model: VDC Cage type Double Seated Control Valve (Rating: ANSI 600 lb. or less)

Item no.	Parts	Item no.	Parts
1	Valve stem	13	V Packing retainer
2	Stud bolt	14	V Packing spring
3	Nut	15	Blind plug
4	Packing flange	16	Packing ring
5	Yoke nut	17	Stud bolt
6	Bonnet	18	Nut
7	Gasket	19	Gasket
8	Valve plug	20	Valve body
9	Cage	21	Drain plug
10	Packing follower	22	Lubricator
11	V Packing Holder	23	Latern ring
12	V PTFE packing	24	Packing



Figure 1-3 Model: VAC Cage type Angle Control Valve (Rating: ANSI 600 lb. or less)

Item no.	Parts	Item no.	Parts
1	Valve stem	13	V Packing retainer
2	Stud bolt	14	V Packing spring
3	Nut	15	Blind plug
4	Packing flange	16	Packing ring
5	Yoke nut	17	Stud bolt
6	Bonnet	18	Nut
7	Gasket	19	Gasket
8	Valve plug	20	Valve body
9	Cage	21	Drain plug
10	Packing follower	22	Lubricator
11	V Packing Holder	23	Latern ring
12	V PTFE packing	24	Packing



Figure 1-4 Model: VST Top guiding Single Seated Control Valve (Rating: ANSI 600 lb. or Less)

Item no.	Parts	Item no.	Parts
1	Valve stem	15	V packing spring
2	Stud bolt	16	Blind plug
3	Nut	17	Packing ring
4	Packing flange	18	Stud bolt
5	Yoke nut	19	Nut
6	Bonnet	20	Valve plug
7	Pin	21	Seat ring
8	Guide bushing	22	Valve body
9	Gasket	23	Drain plug
10	Guide ring	24	Lubricator
11	Packing follower	25	Lantern ring
12	V packing holder	26	Packing
13	V PTFE packing	27	Guide
14	V packing retainer		



Figure 1-5 Model: VAA Acorn type Angle Control Valve (Rating: ANSI 600lb or less)

Item no.	Parts	Item no.	Parts
1	Valve stem	15	V packing spring
2	Stud bolt	16	Blind plug
3	Nut	17	Packing ring
4	Packing flange	18	Stud bolt
5	Yoke nut	19	Nut
6	Bonnet	20	Valve plug
7	Pin	21	Seat ring
8	Guide bushing	22	Valve body
9	Gasket	23	Drain plug
10	Guide ring	24	Lubricator
11	Packing follower	25	Lantern ring
12	V packing holder	26	Packing
13	V PTFE packing	27	Guide
14	V packing retainer		



Model VA1R, VA2R, and VA3R, Reverse Acting Actuators

Figure 1-6



Model VA4R, and VA5R, Reverse Acting Actuators.

Figure 1-7 Actuators (Air-0-Motor)

# Chapter 2 : Installation of a Control Valve

When installing a control valve, please observe the following:

- Before installation, ensure that scales, welding chips or any other foreign materials have been cleaned out of the process pipe to which the control valve is to be connected.
- While installing the control valve ensure the process fluid flow direction matches with the flow direction indicated on the connecting flanges of the valve body.
- Install the control valve, in a position such a position that its actuator is positioned vertically.
- Exercise caution so that no edges of the gaskets connecting the pipe extrude into the process pipe. Make sure the selected gasket material is suitable for the process fluid.
- Take adequate measures to avoid applying large force to the control valve by the process piping. Take care when tightening flange bolts to avoid biased tightening which may cause undesirable mechanical stress.
- After installing the control valve and before connecting the air pipe to the actuator, below the air tube with clean compressed air to remove dust and other foreign material from inside the air pipe.
- Sufficient space shall be provided above the actuator for its removal.
- Install the control valve in a place where the ambient temperature does not exceed the specified temperature limit of the actuator.
- Check that the actuator pointer, positioner and manual handwheel (if provided) are installed in the correct direction.

To change the mounting direction of the actuator, proceed as follows: Apply a pneumatic pressure of approximately 60 kPa (0.6 kgf / cm<sup>2</sup>) to the diaphragm so that the valve lift is set at a mid-position of its range. Loosen the yoke clamp nut with a wrench Swivel the overall actuator to the correct position, and then securely tighten the yoke clamp nut with a wrench. Release the pneumatic pressure applied to the diaphragm. In case of a control valve that has a bellows seal, however, disconnect the actuator stem from the valve stem and then loosen the yoke clamp nut and swivel the actuator section. For details, see Chapter 5. "Disassembly and Reassembly of a Control Valve."

# Chapter 3 : Inspection and Maintenance of Control Valves

For the inspection and maintenance of a control valve, also refer Chapter 4. "Adjustment."

#### 3-1 : Inspection Before Starting Operation.

Before starting operating of the control valve, check & confirm the following to ensure all conditions are correct and secure.

- Confirm that the flow direction marked on the control valve conforms with the process fluid flow direction.
- Confirm that the bolts and nuts of the diaphragm are securely tightened.
- Confirm that bonnet clamp bolts are securely tightened.
- Confirm that the yoke clamp bolt is securely tightened.
- Confirm that the clamp bolts of any accessory devices (positioner, regulator valve, etc.) are securely tightened.
- Confirm that the air connection to the actuator is securely tightened and there is no air leak.
- Confirm that the bolts of the stem connector that connect the actuator stem to the valve stem are securely tightened.
- Confirm that the actuator stem and valve stem are not warped or show any other sign of defect.
- Confirm that the control valve smoothly operates within its full lift scale range.
- Confirm that the actuator spring is correctly compressed.
- · Confirm that gland packing bolts are sufficiently tightened.
- If the control valve employs asbestos packing, it is recommended to lubricate it with the lubricator.
- If the control valve has a manual handwheel, check that the pointer of the operation nut is at AUTO position and the handwheel is locked.

#### 3-2: Periodical Inspection and Maintenance

Periodically inspect and perform maintenance service to the control valve for the following:

- Check that there is no air leak from between the diaphragm case and diaphragm.
- Check that there is no process fluid leak from the bonnet and flanges.
- Check that the yoke clamp bolt is not loose.
- Check that there is no air leak from the air piping of the actuator.

- Check that there are no loose bolts on the stem connector which connects the actuator stem to the valve stem.
- Check that the actuator stem and valve stem are not warped and show no sign of damage.
- Check that valve operation is smooth and valve lift is correct
- Check that the control valve does not generate any abnormal sound or vibration.
- Check that there is no leak from the gland packing section. If the control valve has a lubricator, periodically lubricate and tighten the gland packing section.
- If the Control valve has a manual handwheel, check that the pointer of the operation nut conforms with the AUTO position and that the handwheel is locked.

# 3-3: Lubrication of Gland Packing (for valve with asbestos packing) (See Figure.3-1)

For a valve which employs asbestos packing, a lubricator is supplied being mounted on the bonnet. For lubrication, be sure to use the correct type of lubricant grease as indicated on the nameplate. (If the valve is with V-teflon or a similar type of gland packing which requires no lubrication, the column for grease on the nameplate is blank).

To lubricate gland packing, proceed as follows: Fill the lubricator with fresh grease. Loosen the lubricator handwheel and then squeeze grease into the gland packing by turning the squeezer screw. If gland packing cannot be fully lubricated even when the squeezer handle is inserted as far as it goes, tightly close the lubricator handwheel, retract and take out the squeezer screw, fill the lubricator with fresh grease once more, squeeze grease into the gland packing by setting and turning the squeezer screw, and then fully close the lubricator handwheel. Repeat this procedure until gland packing is fully lubricated with grease.

Be sure to securely tighten the lubricator handwheel when the lubrication work is finished. It is recommended to tighten slightly more the packing flange bolt slightly more after lubrication work is finished.



Figure 3-1 Lubricator

### Chapter 4 : Control Valve Adjustment

Generally the diaphragm control valve does not require adjustment. However, when it is disassembled and reassembled for overhaul or parts replacement, adjustment should be made as described below:

#### 4-1 : Lift Adjustment

#### For direct acting actuators:

Connect the air tubing to the diaphragm chamber while the stem connector is disengaged to supply compressed air to the chamber.

Push down the valve stem and make the valve plug touch on the valve seat.

Next, apply air pressure up to  $5\sim10\%$  (min. 1%) of the rated lift (check name plate for lift rate) from the reference position of no air in the chamber then fix the pressure at this position. The index on the scale should be set at SHUT at this point.

Connect the actuator stem to the valve stem with the stem connector.

Increase air pressure to the diaphragm chamber and verify the valve lift is more than the rated lift range and the valve seat and plug touch each other. Make sure that this contact takes place while in the SHUT position.

#### For reverse acting actuators

Connect the air tubing to the diaphragm chamber while the stem connector is disengaged to supply compressed air to the chamber.

Push down the valve stem and make the valve plug touch on the valve seat.

Apply air pressure to the diaphragm chamber until the actuator stem stops.

Next, reduce the pressure in the diaphragm chamber until the lift is  $5\sim10\%$  above the rated lift range (min. 1 mm) then fix the pressure at this position. The index on the scale should be set at SHUT at this point.

Connect the actuator stem to the valve stem with stem connector at this position.

Reduce the air pressure to the diaphragm chamber and verify if the valve lift is more than the rated lift range (min. 1 mm) and the valve seat and plug touch each other.

Make sure that this contact takes place while in the SHUT position.

### 4-2: Spring Compression Adjustment

This adjustment must be made after lift adjustment.

#### **Direct acting actuator**

Connect air tubing to the diaphragm chamber to supply compressed air.

Apply low end of the pressure as specified on the name plate to the diaphragm chamber, and adjust by tightening the spring to ensure that the index on the scale starts to move below OPEN; and when the higher end pressure is applied to the diaphragm chamber, the index shows SHUT.

Tightening of spring adjuster can be made easily with no air pressure to the diaphragm chamber.

#### **Reverse acting actuator**

Connect air tubing to the diaphragm chamber to supply compressed air

Apply low end of the pressure as specified on the name plate to the diaphragm chamber, and adjust by tightening the spring to ensure that the index on scale starts to move beyond SHUT, and when higher end pressure is applied to the diaphragm chamber, the index shows OPEN.

Tightening of spring adjuster can be made easily with no air pressure to the diaphragm chamber.

#### 4-3: Positioner Adjustment

Make this adjustment after both lift adjustment and spring tightening adjustment have been completed.

CM2-AVP300-2001

Single acting electro/pneumatic valve positioner:

Model: AVP300, 301

OM2-8310-0200

Single acting electro/pneumatic positioner: Model HTP

#### OM2-8313-0100

Single acting electro/pneumatic valve positioner: Model HEP15, 16, 17



Figure 4-1 Actuator (Reverse acting type)

### Chapter 5: Disassembly and Reassembly

Before disassembling the control valve, ensure to shut off the flow from the process pipe to release pressure from inside the control valve, and wait until it cools off.

#### 5-1: Disassembly

- (1) If control valve is of a reverse- acting type, apply pneumatic pressure to the diaphragm that will place the pointer at a position slightly above the SHUT point on scale. This indicates that valve plug is not seated on the seat ring.
- (2) Loosen the stem connector and disconnect the actuator stem from the valve stem.
- (3) Release the air from the diaphragm and disconnect the air connection.
- (4) Remove the yoke clamp nut with a wrench. Remove the actuator from the valve body.
- (5) Remove the bonnet clamp nuts, loosen the gland packing flange nut, and then remove bonnet from the valve body.
- (6) For model VDC or VAC Valve, remove valve plug from valve body. Next, remove gasket (upper) and pull out the cage by hand or use a cage removing tool\*. Next, remove gasket (lower) and spiral gasket.

Of split-type cage valves, the cage (lower) is coupled to the valve body by means of screw thread. Remove it by unscrewing it using a split type cage clamping/ removing tool\*. The split - type cage valve has no spiral gasket.

- (7) For Model VST or VAA valve, remove gasket (upper) and remove valve plug. In this case, for Model VST or VAA valve, remove the guide ring also. Then remove the gasket (lower). To remove the seat ring, use a seat ring clamping/ removing tool \*.
- \*: Available as option tool.

#### 5-2 : Reassembly

To reassemble the control valve, follow the procedure in reverse order of the assembly procedure of (a).

When assembling, thinly apply a sealing agent to the seat ring, sealing the surface outside of the cage, and gasket.

However, do not apply any sealing agent to oil-inhibited valves.

(1) To mount the seat ring of Model VST, VAA or VAV valve, use a seat ring clamping/removal tool.

Next, set the valve plug on the seat ring to which the valve stem has been assembled. Place gasket (lower), guide ring, and gasket (upper) in the due order.

(2) For Model VDC or VAC valve, insert the spiral gasket at first. (Do not reuse the removed gasket. Always use a fresh gasket.)

Next, place gasket (lower), cage, and gasket (upper) in the due order. Lastly, insert the valve plug into the cage.

Split -type cage valve employs no spiral gasket. Mount cage (lower) directly onto the valve body using the cage clamping/removing tool.

- (3) Mount bonnet. When securing nuts, turn all bolts by hand as far as possible and then uniformly tighten them with a wrench, avoiding biased tightening which will cause mechanical stress.
- (4) Insert gland packing into gland section. For assembly procedure, see Chapter 5 "Parts Replacement", subsection 5-1 "Replacement of Gland Packing".
- (5) Mount actuator on to the valve body. Securely tighten yoke clamp nut with a wrench.
- (6) Connect actuator stem and valve stem with stem connector. For this assembly procedure, see Chapter 6 "Control Valve Adjustment", Item (a) "Lift Adjustment".
- (7) Secure air connection to the actuator.

#### 5-3 : Disassembly and Reassembly of Bellows-sealed Valve

- (1) Follow the disassembly procedure in Item (a), steps (1) through (5) for a regular valves.
- (2) Remove the bellows flange gasket (upper)
- (3) Remove the hex nut of the bellows flange. When doing this, securely hold bellows seat with wrench so that no unreasonably large force is applied to bellows.
- (4) Remove bellows flange and gasket (lower), by evenly striking the bellows seat from above.
- (5) Loosen the extension bonnet nuts and remove extension bonnet.
- (6) Pull out the valve plug upwards. the valve plug and stem are integrated with the bellows, bellows seal, and pin.
- (7) For further disassembly, follow the same procedure as that of Item (a), steps (6) and (7) for a regular valve.
- (8) To assemble the control valve, follow the reverse order of the above disassembly procedure in reverse order. Make sure to hold the bellows seat with a wrench when tightening the hex nut of the bellows flange, lest unreasonably large force should not be applied to the bellows.



Figure 5-1 Cross section of Control Valve (Model: VST for example)



Figure 5-2 Cross Section of Valve Body of Model VDC (unit-structure cage type)



Figure 5-3 Cross Section of Valve Body of Model VDC (split cage type)



Figure 5-4 Cross section of bellows seal bonnet

## Chapter 6 : Parts Replacement

#### 6-1: Replacement of Gland Packing

Before servicing the control valve, ensure to shut the flow in the process pipe, to release pressure from inside the control valve, and wait until it cools off.

#### 6-1-1 : Replacement of Yarn packing

Remove the actuator from the valve body. Disassemble the valve by following the procedures explained in Chapter 4. "Disassembly and Reassembly," Item (a) Disassembly, Steps (1) through (4).

Undo the packing flange nuts. Remove the packing flange and packing follower. Use the packing hook to remove a packing.

To remove packing lower than the lantern ring, unscrew the clamp nuts of bonnet, remove the bonnet valve body, and then take out the lantern ring and packing.

Mount the bonnet on the valve body. Insert fresh packing, piece by piece, the cut ends of piece shifted by 90 to 180 degrees of angle from that of the adjoining one.

Each time as you insert a piece of packing, securely press it with the packing retainer.

Determine the number of pieces of Yarn Packing that is necessary so that the lubrication hole is positioned lower than the lantern ring.

After inserting a sufficient amount of the packing, place packing follower and the packing flange, and secure packing flange nuts.

For the reassembly of a valve after packing replacement, follow the procedures in chapter 5. "Disassembly and Reassembly," Item (b) "Assembly," from Step (5) and further.

#### **Replacement of V PTFE Packing.**

Remove the actuator from the valve body. Disassemble the valve by following the procedures explained in Chapter 4. "Disassembly and Reassembly," Item (a) Disassembly, Steps (1) through (4).

Unscrew the packing flange nuts. Remove the packing flange and packing follower, and V packing holder use a packing hook to take out the V PTFE packing.

Insert fresh packing, with its V-shape groove positioned downward. (Insert this in the reverse attitude for a control valve used for vacuum service.) Place the packing follower and the packing flange, and secure packing flange nuts.

For reassembly of valve after packing replacement, follow the procedure explained in Chapter 4. "Disassembly and Reassembly", Item (b) "Assembly," Steps (5) and further.



Figure 6-1 Yarn Packing







Figure 6-3 Yarn and "V"PTFE, Combined Packing

#### 6-2 : Replacement of valve plug and Cage of VDC or VAC Control valve.

To replace the valve plug and cage of Model VDC or VAC control valve, follow the procedure explained in Chapter 4. "Disassembly and Reassembly".

Whenever possible replace the valve plug and cage as one unit. When replacing the valve plug and cage as a unit, it is recommended to unite plug & cage prior to disassembling the valve, so that the replacement work can be finished quickly.

The valve plug and valve stem are also recommended to be replaced in as a pair. When the valve plug or valve stem alone is required to be replaced, remove the molded fillet from the valve stem end using an electric drill or some other tool, and disconnect the valve stem from the valve by unscrewing it.

Insert the new stem into the valve plug, weld overall circumference of the valve stem end, and inspect the straightness of the valve stem. If the trim material is of a special type, use welding rods of the applicable type.



Figure 6-4 Body and Cage trim



Figure 6-5 Trim of Split Cage

#### 6-3: Replacement of valve plug and seat ring of VST, VAA, or VAV Control Valve

For disassembly and reassembly procedures of the control valve, see Chapter 4. It is recommended to replace the valve plug and seat ring as a together.

To connect a valve stem to a valve plug, proceed as follows: Fully screw the stem into the plug. Drill a hole in the plug with an electric drill. Following the guide hole which is provided on the plug, ream the hole with a 1/50 tapered reamer, and drive a tapered pin into the hole.

Unite the valve seat at this stage so that the valve plug, gasket (lower) and guide ring are assembled together.



Figure 6-6 VST Valve Body and Trim

#### 6-4 : Diaphragm Replacement of Diaphragm Motor (See Figure 1-6, 1-7.)

Always after removing the stem connector and disconnecting the actuator stem from the valve stem, turn the spring adjuster counterclockwise to fully slacken the spring.

#### 6-4-1 : Direct- acting Type

#### (a) For VA1D, VA2D OR VA3D

Disconnect air connection. Turn the spring adjuster clockwise until the spring is fully slackened. Remove hex clamp bolts of the diaphragm case assembly and then remove diaphragm case (upper). Take out cotter pin and remove slotted nut. If the actuator stem also rotates while doing this, hold it by applying a wrench to pointer lock nut. Remove stopper and replace diaphragm.

After reassembling the valve, compress the spring. For this, follow the procedure explained in Chapter 6. "Control Valve Adjustment", Items (b) "Spring Compression Adjustment".

#### (b) For VA4D OR VA5D

Disconnect air connection. Turn the spring adjuster clockwise until the spring is fully slackened. Remove hex clamp bolts of the diaphragm case assembly and then remove diaphragm case (upper).

Pull out cotter pin and remove slotted nut. If the actuator stem also rotates while doing this, hold it by applying a wrench to the pointer lock nut. Remove the stopper and diaphragm plate. Replace diaphragm.

After replacing diaphragm, assemble the actuator following the above procedure in the reverse order.

After reassembling the valve, compress the spring. For this, follow the procedure explained in Chapter 6. "Control Valve Adjustment", Items (b) "Spring Compression Adjustment".

#### 6-4-2 : Reverse - acting type.

#### (a) For VA1R, VA2R or VA3R

Disconnect air connection. Remove hex clamp bolts of the diaphragm case assembly and then remove diaphragm case (upper). Take out cotter pin and remove slotted nut. If the actuator stem also rotates while doing this, hold it by applying a wrench to pointer lock nut. Remove stopper and replace diaphragm.

After replacing the diaphragm, assemble the actuator following the above procedure in the reverse order.

Disconnect air connection. Remove hex clamp bolts of the diaphragm case assembly and then remove diaphragm case (upper).

Remove clamp nut of the diaphragm plate. If actuator stem also rotates while doing this, hold it by applying a wrench to the pointer lock nut. Remove diaphragm plate and replace diaphragm

To reassemble, follow the above procedure in the reverse order. After reassembling, apply a sufficient amount of adhesive agent (semi-dry adhesive agent for metals) to prevent air leak.

### 6-5: O-ring Replacement of Diaphragm Motor (See Figure 1-6, 1-7.)

#### 6-5-1 : For VA1R, VA2R or VA3R

Disconnect air connection. Turn spring adjuster clockwise until the spring is fully slackened. Remove stem connector and disconnect actuator stem from valve stem. Remove pointer lock nut and pointer by turning them. Remove hex bolt of the diaphragm case assembly. Remove diaphragm case (upper). Lift out diaphragm, diaphragm plate and actuator stem together. Remove "O-ring" with a marking - off pin or like. Replace "O- ring". During the replacement process, thoroughly clean the groove in which "O - ring" is fitted and sparingly apply silicone grease to the groove. To reassemble, follow the above procedure in the reverse order. After reassembly, adjust the valve lift and spring compression. For adjustment, follow the procedure explained in Chapter 4.

#### 6-5-2 : For VA4R or VA5R

Disconnect air connection. Turn spring adjuster clockwise until spring is fully slackened. Remove hex clamp bolts of the diaphragm case assembly and then remove diaphragm case (upper).

Remove clamp nut of diaphragm plate. If actuator stem also rotates while doing this, hold it by applying a wrench to the pointer lock nut. Remove the diaphragm plate and replace diaphragm

Remove the bolt on which O - ring is positioned. Remove O - ring from the bolt using a scrubber or other tool.

Position the new O- ring. Before doing this, thoroughly clean the groove for the O-ring and sparingly apply silicone grease to groove.

To reassemble, follow the above procedure in the reverse order. After reassembly, adjust the spring compression. For adjustment, follow the procedure explained in Chapter 6. "Control Valve Adjustment", Item (b) "Spring Compression Adjustment".

### 6-6: Disassembly and Assembly of Model PSA6 Actuator

### 6-6-1 : General

#### Structure

This actuator consists of a cylinder, spring unit, lift stopper, spring retainer, hexagon stay, yoke, manual handwheel and a single action positioner.

For an external view of the a Actuator, refer to Fig. 4-18, Exterior of.PSA6R.



(1)Without manual handwheel (2) With manual handwheel

#### Figure 6-7 Exterior of PSA6R

#### Assembly on Valve Body

Assembling nuts integral to the valve body connect the yoke and valve body. The stem connector connect the actuator's rod and valve stem.

#### **Pneumatic Tubing**

The tubing is connected to a single action positioner when used as a control valve. Refer to the following instruction manuals for details of single action positioners.

Pneumatic positioner (Model HTP)	No. OM2-8310-0200
Electro-pneumatic positioner (Model HEP)	No. OM2-8310-0100
Electro-pneumatic positioner (Model AVP300/301)	No. CM2-AVP300-2001

#### Calibration

This actuator does not need calibration.

When connecting the valve stem of the valve body with an actuator's rod with stem connector, due adjustment should be made to set the valve plug on the seat ring. Then screws on actuator's scale plate are loosened, and the stroke and index matched to properly position the scale plate.



When automatically operating an actuator with manual handwheel, verify that the AUTO/MANUAL switchover pin is inserted into the pin holder, to chain is engaged on the handwheel and the indicator is in AUTO position before starting operation.

When disassembling and assembling, always hold the actuator in an upright position (spring unit on top and yoke on bottom)

While eyebolts are used to suspend the actuator, the assembled valve should not be suspended by eyebolts.

#### 6-6-2 : AUTO/MANUAL Switchover of Manual Handwheel

Refer to Figure 6-8 for details of AUTO/MANUAL switchover of handwheel.

With an actuator with AUTO/MANUAL switchover functions, switchover between automatic operation and manual operation by handwheel are available.

AUTO/MANUAL switchover can be made at any optional moment during operation.



Figure 6-8 AUTO/MANUAL switchover scheme

![](_page_44_Figure_4.jpeg)

Figure 6-9 Operator's instruction label

#### Procedure

- Step 1) Pull out AUTO/MANUAL switchover pin out of holder and disengage chain, which binds the handwheel to the wheel
- Step 2) Verify the label on handwheel and turn the handle to the direction of SHUT and lower slide screw.
- Step 3) Match the round holes of slide screw and actuator's rod, and insert pin. Push it all the way in and fix it there.
- Step 4) Verify OPEN, SHUT arrows on label, and turn the handwheel to either direction to open or close the valve. The turning torque should be under 127N (13kgf)
- Step 5) When the handwheel does not turn any further, check valve opening and stop operation.

## 

Do not apply undue force on valve when it reaches mechanical stop. Otherwise valve stem may be damaged. Refer to Chapter 10, Trouble shooting for remedial action.

Step 6) To resume automatic operation, remove the switchover pin, turn handwheel until the slide screw stop reaches AUTO position (refer to Figure 6-10 below). Run the chain on the pin through in order to restrict handwheel movement and fix the pin on holder. Resume automatic operation after verifying this condition.

![](_page_45_Figure_11.jpeg)

Figure 6-10 Disassembly and Assembly of Actuator

#### 6-6-3 : Disassembly of Actuator < Disassembly Procedure>

Disassembly procedure of actuator is described herein. Refer to Figures 6-11 for information.

- 1. Marking and protection
- Step 1) Match mark on spring retainer on the top of actuator, lift stopper, cylinder and cylinder assembling yoke boss.
- Step 2) Wrap PVC tape on rod bushing to protect sealing parts, guide bushing.

- 2. Removing slide screw detent
- Step 1) Loosen hexagon head bolt 50 and hex nuts 51 which fasten slide screw detent 49
- Step 2) Remove slide screw detent 49
- 3. Removing spring retainer
- Step 1) Loosen hexagon nuts 2 and eye nut 1 on the top of actuator and remove.
- Step 2) Lift spring retainer 17 straight up and remove.
- 4. Removing lift stopper and spring unit
- Step 1) Loosen hexagon stay 4, 9 (four) which fasten lift stopper 20 and cylinder 21 and remove
- Step 2) Raise lift stopper 20 straight up and remove.
- Step 3) Install eyebolts on threaded holes on the spring retainer 59 which is located on the top of spring unit (M12 x 2) and lift spring unit (approximately 120 kg) up with a crane.
- Step 4) While suspended by crane, remove piston's 57 sealing parts (tape liner 7, O-ring 8)
- 5. Removing slide screw and cylinder
- Step 1) Turn slide screw 34 by hand and extract from the bottom
- Step 2) Loosen hexagon head bolts 12 (four) which fasten cylinder and manual handwheel and remove.
- Step 3) Lift cylinder up straight and remove.
- 6. Removing worm unit
- Step 1) Remove in the sequential order of bearing holder 27, single column angular bearing, (upper) 32, worm wheel 33, and single column angular bearing (lower) 32.
- Step 2) Loosen hexagon head bolts 12 (four), which fasten gear, case 30 and yoke and remove.

![](_page_47_Figure_2.jpeg)

![](_page_47_Figure_3.jpeg)

![](_page_48_Figure_2.jpeg)

No.	Parts nomenclature
1	Eye nut
2	Hexagon nut
3	Spring washer
4	Hexagon stay (long)
5	O ring
6	Piston unit
7	Tape liner
8	O ring
9	Hexagon stay (short)
10	Seal washer
11	Spring washer
12	Hexagon head bolt
13	Round bushing
14	Dust seal
15	Wearing
16	Name plate
17	Spring retainer
18	Rain shield cap
19	O ring
20	Lift stopper
21	Cylinder
22	Rod packing
23	Guide bushing
24	Dust seal
25	Scale plate
26	Truss screw, small
27	Index
28	Stem connector
29	Yoke
30	Gear case
31	Bearing holder
32	Single column angular bearing

Table 6-1 Parts reference List

No.	Parts nomenclature
33	Worm wheel
34	Slide screw
35	Locking pin
36	Handwheel
37	Operating instruction label
38	Spring washer
39	Locknut
40	Single column bearing
41	Worm shaft
42	Кеу
43	Gear case cap
44	Dust seal
45	Hexagon head bolt
46	Spring washer
47	Truss screw, small
48	Indicator
49	Slide screw lock
50	Hexagon head bolt
51	Hexagon nut
52	Hexagon nut
53	Stopper retainer
54	Spring (large)
55	Spring (small)
56	Spring stopper
57	Piston
58	Rod
59	Spring receptacle
60	Stopper
61	Detent nut
62	Spring washer
64	O ring

Figure 6-12 Spring Unit

### 6-6-4 : Disassembling Spring unit

#### <disassembly procedure>

Disassembly procedure of spring unit is described herein.

Refer to Figure 6-12 for disassembling information.

Disassembling is not required if only piston's sealing parts (tape liner, O ring) are replaced.

- 1. Removing spring unit
- Step 1) Loosen hexagon nuts 52 (four on top) and remove
- Step 2) Remove stopper retainer 53
- Step 3) Evenly loosen hexagon nuts 52 (four on bottom) until tension of springs 54 and 55 becomes zero.

# $\triangle$ caution

Follow disassembly procedure of spring unit when removing bolts and nuts. Otherwise, flying out of spring may cause injury.

- Step 4) Remove spring retainer 59
- Step 5) Remove springs (large 54, small 55)
- 2. Removing piston unit
- Step 1) Loosen stopper 60 and remove
- Step 2) Loosen detent nut 61 and remove.Take advantage of double width of rod 58.
- Step 3) Remove spring washer 62, O-ring 61.Exercise care so as not to damage O ring with rod's screw.
- Step 4) Separate rod 58 from piston 57.

### 6-6-5 : Assembling Actuator

#### <Caution during Assembly>

- Refer to the chapter of inspection items during disassembly and check, the parts for abnormalities. If found, replace or repair as required.
- O-ring of sliding parts should always be replaced at the time of periodic disassembly. If O-ring on the fixed part is deformed or damaged, or scarred during disassembly, replace it.
- Clean O ring, oil seal, wearing, tape line O-ring recess and apply plenty of lubricant.
- Ensure that no dust or dirt from maintenance work prior to disassembly remains on sliding part of cylinder and guide bushing.

#### 6-6-6 : Assembly of Actuator with Manual Handwheel

Refer to Figure 6-11 for assembly information.

- 1. Assembly procedure, manual handwheel and cylinder assembly
- Step 1) While yoke 29 is in upright position, place gear 30 and temporarily fasten with hexagon head bolts 12 (four)
- Step 2) Apply lubricant on single column angular bearing (top and bottom) and assemble in the sequential order of bearing (lower) 32, worm wheel 33, bearing (upper) 32 and bearing holder 31. Refer to the Figure 4-24 below for details.
- Step 3) Insert and screw in from the bottom slide screw 34 with tape liner 13 assembled on. Apply lubricant on threaded parts of slide screw 34.
- Step 4) Assemble slide screw 34 with slide screw detent 49, hexagon head bolt 50 and nut 51.
- Step 5) Apply lubricant on rod packing 22 and dust seal 24 and assemble on cylinder 21.
- Step 6) Place cylinder 21 on gear case 30 and temporarily fasten by hexagon head bolts 12 (four) and seal washer 10.
- Step 7) Use rod 58 to set the position of cylinder by ensuring that the rod moves smoothly and tighten by the torque as shown in Table 4-5. If the rod does not move smoothly, tap cylinder or gear case with plastic hammer and set the position.

![](_page_50_Figure_18.jpeg)

Figure 6-13

- 2. Assembling piston unit, lift stopper and spring retainer
- Step 1) Install eyebolts on threaded hole (M12 x 2) on the top of spring retainer 59 on the piston unit, suspend by crane and lift upward.
- Step 2) While suspended upward, assemble lubricated O ring 8 and tape liner 7 on piston 57.
- Step 3) Assemble piston unit in cylinder 21 from the top. See to it that the round hole of rod 58 appears to the front.
- Step 4) Assemble lift stopper O-ring 5 in the slot on the top of cylinder 21.
- Step 5) Insert lift stopper 20 from the top and fix by hexagon stay 4,9 (four). Screw in on the ones of the same length diagonally.
- Step 6) Assemble so that the hexagon stays 4,9 are fit into bolt holes of spring retainer 17.
- Step 7) Fix spring retainer with hexagon head nuts (four)
- Step 8) Install eye nuts 1 (two) on hexagon stay 4

#### 6-6-7 : Assembly of Actuator without Manual Handwheel

When assembling actuator without manual handwheel, follow the procedure in Chapter 4-3-3-5. Assembly of actuator with manual handwheel" disregarding the inapplicable parts of the actuator.

#### **Major Replacement parts**

Actuator's parts have been designed to withstand prolonged usage. However, it is recommended that the following parts be replaced in the intervals as given below: Tape liner Every five years

Bushing	"			
Seal washer	"			
Dust seal	"	(to be re	placed when disas	sembled)
Rod seal	"	(	"	)
O ring	"	(	"	)

#### **Tightening Torque of Actuator Assembly**

Table below shows the tightening torque of actuator assembly. Refer to Figure 6-14, tightening torque of actuator's threaded parts.

Key No.	Size	Tightening torque [N-m] {kgf/cm}
1	M14	80-120 {800 – 1200}
2	M20	270-360 {2700 – 3650}
3	M24	300-410 {3050 – 4150}
4	M14	80-120 {800 – 1200}
5	M12	50-60 {500 - 600}

#### Table 6-2 Tightening Torque of Bolt and Nuts of Actuator

![](_page_52_Figure_4.jpeg)

Figure 6-14 Tightening Torque Actuator Thread.

# Chapter 7 : Manual Handwheel (Side Handwheel of Actuator)

#### 7-1: Operation Method

#### (a) Manual Operation

Undo the handwheel lock (the fork -shaped lock for VA1 to VA3 or the chain lock for VA4 and VA5). Turn the handwheel in the direction indicated the arrow. As you turn the handwheel clockwise, the valve moves in the closing direction regardless of whether it is a direct - acting or reverse - acting type. The arrows on the handwheel indicates the direction for valve SHUT and OPEN function.

#### (b) Automatic Operation

For the automatic operation, turn the handwheel such that the pointer of the operation bolt indicates the AUTO position. Then, lock the handwheel.

#### 7-2 : Installation

- (1) A side mounted handwheel can be installed even when the valve is set for automatic operation. To install the handwheel, proceed as follows:
- (2) Turn the handwheel of the manual operation assembly so that the pointer of the operation bolt indicates the AUTO position.
- (3) Remove the bolt (s) (one bolt in case of VA1 to VA3; three bolts in case of VA4 or VA5) which clamp the two levers. Widen the gap between the two levers.
- (4) Install the manual drive assembly on the mounting pad at the back of the Air-O-Motor, with the mounting bolts.
- (5) Hang the smaller holes at the end of the levers on to the pointer base and the other larger holes at the other end on to the base of the operation nut. Secure the lever clamp bolt.
- (6) When in automatic operation, set the pointer of the operation nut to the AUTO position and lock the handwheel.

#### 7-3: Disassembly and Reassembly

Before disassembling the manual drive assembly, ensure that the handwheel is set at the AUTO position.

- (1) Undo the bolt (s) (one bolt in case of VA1 to VA3; three bolts in case of VA4 or VA5) which clamp the two levers. Remove the levers from the pointer base.
- (2) Remove the mounting bolts of the manual drive assembly and detach it from the Air-O-Motor.
- (3) Remove the handle lock nut and then remove the handwheel.

- (4) Remove the handwheel from the manual drive assembly by evenly striking the drive shaft in the handwheel direction.
- (5) Remove the stop ring (using a special tool) and the bearing.

To assemble the manual drive assembly, follow the above disassembly procedure in the reverse order.

![](_page_55_Figure_5.jpeg)

Figure 7-1 Side Handwheel

# Chapter 8 : Trouble shooting

Symptom	Cause / Verification / remedial measures	
Valve Operation unstable	Valve capacity is too large (Reduce Cv)	
Hunting at fully closed position	For single valve, direction of flow is wrong	
Supply air pressure fluctuates	Check if other line is using excessively large volume of air. (Pipe capacity, restriction, air supply source capacity)	
Supply air pressure fluctuates	Check if other line is using excessively large volume of air. (Pipe capacity, restriction, air supply source capacity)	
Signal pressure fluctuates	Check for abnormal controller output	
Hunting continues even on constant signal	Hunting by positioner itself (Check, repair or replace positioner)	
	Impact by process fluid pressure (Insufficient torque of actuator. Replace actuator with larger size one)	
Valve vibrates	Check and see if the pipe on which the valve mounted is vibrating (Enhance support)	
Vibration at any opening (Abnormal noise noticed)	Search for other source of vibration	
Intermittent vibration	Erosion of plug and guide (Replace parts)	
	Change in Process fluid condition (Modify orifice or Cv coefficient)	
	Change plug type (Change of characteristics)	
Valve operation sluggish	Leakage on pneumatic pipe	
Valve fails to operate	Air leakage from actuator	
	Foreign matter adhering on plug's guide	
	Hardening of gland packing (Increased hysteresis)	
	Faulty positioner (Try on other line's positioner)	

Symptom	Cause / Verification / remedial measures	
Fluid leaks out of gland	Check for loose packing flange	
	Is grease volume sufficient ?	
	Are there any scars on valve stem ?	
Fluid leaks out of gasket	Has bonnet nut been properly tightened	
	Faulty gasket (Scar, deformation)	
Regardless of valve	Air Leakage in actuator	
leaks out to downstream of valve	Apply supply air or atmospheric pressure to actuator. (Check air source and positioner)	
	Is valve opening at true zero ? (Check lift)	
	Corrosion or erosion on plug or seat ring	
	Jamming on guide	
1		

Replace parts as required.

# Chapter 9: Recommended Spare parts

#### 9-1 : Major replacement parts

Although control valve parts have been designed and manufactured for prolonged usage, the following parts will have to be replaced as a part of maintenance work:

#### Body

* Gland packing	To be replaced with each disassembly
-----------------	--------------------------------------

\* Gasket To be replaced with each disassembly

#### Actuator

* Bushing	Once every five years	
* Seal Washer	"	(or when disassembled)
* Dust Seal	"	(or when disassembled)
* Rod Seal	"	(or when disassembled)
* O- ring	"	(or when disassembled)

### **Terms and Conditions**

We would like to express our appreciation for your purchase and use of Azbil Corporation's products. You are required to acknowledge and agree upon the following terms and conditions for your purchase of Azbil Corporation's products (system products, field instruments, control valves, and control products), unless otherwise stated in any separate document, including, without limitation, estimation sheets, written agreements, catalogs, specifications and instruction manuals.

#### 1. Warranty period and warranty scope

#### 1.1 Warranty period

Azbil Corporation's products shall be warranted for one (1) year from the date of your purchase of the said products or the delivery of the said products to a place designated by you.

#### 1.2 Warranty scope

In the event that Azbil Corporation's product has any failure attributable to azbil during the aforementioned warranty period, Azbil Corporation shall, without charge, deliver a replacement for the said product to the place where you purchased, or repair the said product and deliver it to the aforementioned place. Notwithstanding the foregoing, any failure falling under one of the following shall not be covered under this warranty:

- (1) Failure caused by your improper use of azbil product
  - (noncompliance with conditions, environment of use, precautions, etc. set forth in catalogs, specifications, instruction manuals, etc.);
- (2) Failure caused for other reasons than Azbil Corporation's product;
- (3) Failure caused by any modification or repair made by any person other than Azbil Corporation or Azbil Corporation's subcontractors;
- (4) Failure caused by your use of Azbil Corporation's product in a manner not conforming to the intended usage of that product;
- (5) Failure that the state-of-the-art at the time of Azbil Corporation's shipment did not allow Azbil Corporation to predict; or
- (6) Failure that arose from any reason not attributable to Azbil Corporation, including, without limitation, acts of God, disasters, and actions taken by a third party.

Please note that the term "warranty" as used herein refers to equipment-only-warranty, and Azbil Corporation shall not be liable for any damages, including direct, indirect, special, incidental or consequential damages in connection with or arising out of Azbil Corporation's products.

#### 2. Ascertainment of suitability

You are required to ascertain the suitability of Azbil Corporation's product in case of your use of the same with your machinery, equipment, etc. (hereinafter referred to as "Equipment") on your own responsibility, taking the following matters into consideration:

- (1) Regulations and standards or laws that your Equipment is to comply with.
- (2) Examples of application described in any documents provided by Azbil Corporation are for your reference purpose only, and you are required to check the functions and safety of your Equipment prior to your use.
- (3) Measures to be taken to secure the required level of the reliability and safety of your Equipment in your use Although azbil is constantly making efforts to improve the quality and reliability of Azbil Corporation's products, there exists a possibility that parts and machinery may break down.

You are required to provide your Equipment with safety design such as fool-proof design, \*1 and fail-safe design\*2 (anti-flame propagation design, etc.), whereby preventing any occurrence of physical injuries, fires, significant damage, and so forth. Furthermore, fault avoidance, \*3 fault tolerance,\*4 or the like should be incorporated so that the said Equipment can satisfy the level of reliability and safety required for your use.

- \*1. A design that is safe even if the user makes an error.
- \*2. A design that is safe even if the device fails.
- \*3. Avoidance of device failure by using highly reliable components, etc.
- \*4. The use of redundancy.

#### 3. Precautions and restrictions on application

Azbil Corporation's products other than those explicitly specified as applicable (e.g. azbil Limit Switch For Nuclear Energy) shall not be used in a nuclear energy controlled area (radiation controlled area).

Any Azbil Corporation's products shall not be used for/with medical equipment.

The products are for industrial use. Do not allow general consumers to install or use any Azbil Corporation's product. However, azbil products can be incorporated into products used by general consumers. If you intend to use a product for that purpose, please contact one of our sales representatives.

In addition,

you are required to conduct a consultation with our sales representative and understand detail specifications, cautions for operation, and so forth by reference to catalogs, specifications, instruction manual, etc. in case that you intend to use azbil product for any purposes specified in (1) through (6) below.

Moreover, you are required to provide your Equipment with fool-proof design, fail-safe design, anti-flame propagation design, fault avoidance, fault tolerance, and other kinds of protection/safety circuit design on your own responsibility to ensure reliability and safety, whereby preventing problems caused by failure or nonconformity.

(1) For use under such conditions or in such environments as not stated in technical documents, including catalogs, specification, and instruction manuals

- (2) For use of specific purposes, such as:
  - \* Nuclear energy/radiation related facilities
  - [For use outside nuclear energy controlled areas] [For use of Azbil Corporation's Limit Switch For Nuclear Energy]
  - \* Machinery or equipment for space/sea bottom
  - \* Transportation equipment
    - [Railway, aircraft, vessels, vehicle equipment, etc.]
  - \* Antidisaster/crime-prevention equipment
  - \* Burning appliances
  - \* Electrothermal equipment
  - \* Amusement facilities
  - \* Facilities/applications associated directly with billing
- (3) Supply systems such as electricity/gas/water supply systems, large-scale communication systems, and traffic/air traffic control systems requiring high reliability
- (4) Facilities that are to comply with regulations of governmental/public agencies or specific industries
- (5) Machinery or equipment that may affect human lives, human bodies or properties
- (6) Other machinery or equipment equivalent to those set forth in items (1) to (5) above which require high reliability and safety

#### 4. Precautions against long-term use

Use of Azbil Corporation's products, including switches, which contain electronic components, over a prolonged period may degrade insulation or increase contact-resistance and may result in heat generation or any other similar problem causing such product or switch to develop safety hazards such as smoking, ignition, and electrification.

Although acceleration of the above situation varies depending on the conditions or environment of use of the products, you are required not to use any Azbil Corporation's products for a period exceeding ten (10) years unless otherwise stated in specifications or instruction manuals.

#### 5. Recommendation for renewal

Mechanical components, such as relays and switches, used for Azbil Corporation's products will reach the end of their life due to wear by repetitious open/close operations.

In addition, electronic components such as electrolytic capacitors will reach the end of their life due to aged deterioration based on the conditions or environment in which such electronic components are used.

Although acceleration of the above situation varies depending on the conditions or environment of use, the number of open/close operations of relays, etc.

as prescribed in specifications or instruction manuals, or depending on the design margin of your machine or equipment, you are required to renew any Azbil Corporation's products every 5 to 10 years unless otherwise specified in specifications or instruction manuals.

System products, field instruments (sensors such as pressure/flow/level sensors, regulating valves, etc.) will reach the end of their life due to aged deterioration of parts.

For those parts that will reach the end of their life due to aged deterioration, recommended replacement cycles are prescribed. You are required to replace parts based on such recommended replacement cycles.

#### 6. Other precautions

Prior to your use of Azbil Corporation's products, you are required to understand and comply with specifications (e.g., conditions and environment of use), precautions, warnings/cautions/notices as set forth in the technical documents prepared for individual Azbil Corporation's products, such as catalogs, specifications, and instruction manuals to ensure the quality, reliability, and safety of those products.

#### 7. Changes to specifications

Please note that the descriptions contained in any documents provided by azbil are subject to change without notice for improvement or for any other reason.

For inquires or information on specifications as you may need to check, please contact our branch offices or sales offices, or your local sales agents.

#### 8. Discontinuance of the supply of products/parts

Please note that the production of any Azbil Corporation's product may be discontinued without notice. For repairable products, we will, in principle, undertake repairs for five (5) years after the discontinuance of those products. In some cases, however, we cannot undertake such repairs for reasons, such as the absence of repair parts. For system products, field instruments, we may not be able to undertake parts replacement for similar reasons.

#### 9. Scope of services

Prices of Azbil Corporation's products do not include any charges for services such as engineer dispatch service. Accordingly, a separate fee will be charged in any of the following cases:

- (1) Installation, adjustment, guidance, and attendance at a test run
- (2) Maintenance, inspection, adjustment, and repair
- (3) Technical guidance and technical education
- (4) Special test or special inspection of a product under the conditions specified by you

Please note that we cannot provide any services as set forth above in a nuclear energy controlled area (radiation controlled area) or at a place where the level of exposure to radiation is equivalent to that in a nuclear energy controlled area.

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