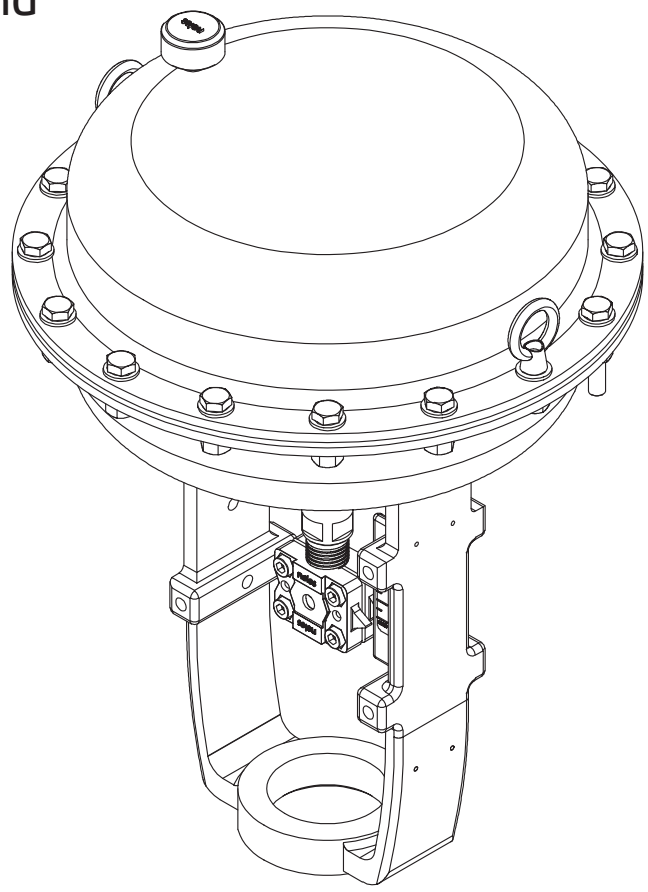
Pneumatic linear diaphragm actuator

Series VDD/VDR

Installation, maintenance and operating instructions



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This product meets the requirements set by the Customs Union of the Republic of Belarus, the Republic of Kazakhstan and the Russian Federation.

READ THESE INSTRUCTIONS FIRST!

These instructions provide information about safe handling and operation of the valve.

If you require additional assistance, please contact the manufacturer or manufacturer's representative.
See also www.valmet.com/flowcontrol for the latest documentation.

SAVE THESE INSTRUCTIONS!

Addresses and phone numbers are printed on the back cover.

1. GENERAL

1.1 Scope of the manual

This manual provides essential information on Neles series VD, Pneumatic Linear, Spring Diaphragm Actuators. Valve body and trims are only discussed briefly. Refer to the individual manuals for further information on their installation, operation and maintenance.

NOTE:
Selection and use of the actuator in a specific application requires close consideration of detailed aspects. Due to the nature of the product, this manual cannot cover all the individual situations that may occur when the actuator is used.
If you are uncertain about use of the actuator or its suitability for your intended purpose, please contact Valmet for more information.

1.2 Structure and operation

Neles series VD are Pneumatic Linear, Spring Diaphragm actuators. Excellent accuracy and reliability is achieved through the use of multiple springs and rolling diaphragm in the actuator.

The use of involute rolling diaphragm permits the long travel and excellent linearity without the need of expensive hardware normally associated with diaphragm actuators. The rugged one piece yoke, pressed steel diaphragm case and special nylon reinforced diaphragm provide dependable, high thrust performance.

This series are available to provide a optional handwheel for manual operation. The detailed structure is revealed by the type code shown on the valve identification plate. The type code is explained in Section 10.

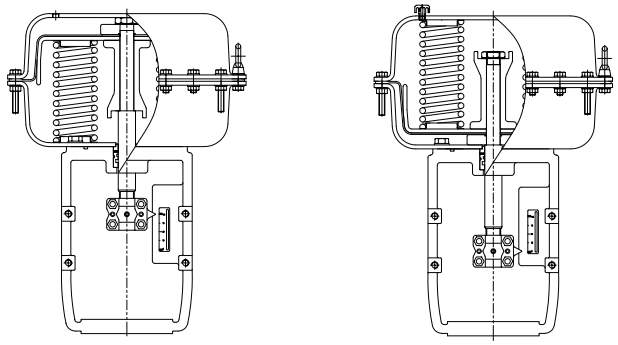


Fig. 1 VDD, Direct & VDR, Reverse

1.3 Actuator markings

The actuator is provided with an identification plate, see Fig. 2. Identification plate markings are:

1. Actuator code (model)
2. Manufacturing site, date, serial no.
3. Supply, air fail to
4. Range and travel
5. Max. operating pressure

Also, provided with an warning plate, see Fig. 3.

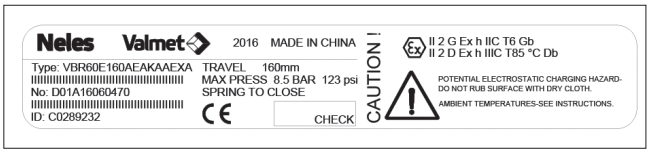


Fig. 2 Identification plate

Fig. 3 Warning plate

1.4 Specifications

Table 1 VD Actuators temperature ranges

Description	Standard VD	Low. Temp. VD	Arctic VD model
Temp. range	-20 °C to +85 °C	-40 °C to +70 °C	-55 °C to +70 °C
Type code ref. (sign 6-9)	AEAK	AELK	ASSK

Note:
1. Temperature: Ambient temperature
2. Type code reference: Please see in page 17 (materials).
3. Other low temperature ranges: Please contact Valmet Flow Control

Table 2 VD Actuators air supply connections

Stardard	1/4" NPT for all sizes
Optional	3/8", 1/2" NPT and others

1. Maximum operation pressure (MOP) for VDR/VDD: 4.2 bar / 60 psi
2. ATEX class: II 2 GD
3. Protection class: IP67M, NEMA 4X

Table 3 VD Actuators specifications

Actuator Size	Effective Area		Volume		Actuator Stem Size Ø		Maximum Stroke		Max. operating pressure	
	cm^2	$inch^2$	dm^3	$inch^3$	mm	inch	mm	inch	bar	psi
VD_25	270	42	0.9	54.9	24.0	0.95	20	0.8	4.2	60
VD_29	390	60	1.8	109.8	24.0	0.95	40	1.6		
VD_37	640	99	3.5	213.5	24.0	0.95	50	2.0		
VD_48	1130	175	10.2	622.4	35.0	1.38	70	2.8		
VD_55	1520	236	18.2	1110	35.0	1.38	80	3.2		

Table 4 VD Actuators spring ranges

Actuator Size	VDR (Signal Increrased to Open)						VDD (Signal Increrased to Close)					
	Spring Range		Recommended Supply Pressure		Max. Travel		Spring Range		Recommended Supply Pressure		Max. Travel	
	bar	psi	bar	psi	mm	inch	bar	psi	bar	psi	mm	inch
VD_25	0.8~2.6	11~37	3.2	44	20	0.8	0.8~2.6	11~37	3.2	44	20	0.8
	1.5~3.4	21~48	3.9	55			1.5~3.4	21~48	3.9	55		
VD_29	0.8~2.6	11~37	3.2	44	40	1.6	0.8~2.6	11~37	3.2	44	40	1.6
	1.5~3.4	21~48	3.9	55			1.5~3.4	21~48	3.9	55		
VD_37	0.8~2.6	11~37	3.5	44	50	2.0	0.8~2.6	11~37	3.5	44	50	2.0
	1.5~3.4	21~48	3.9	55			1.5~3.4	21~48	3.9	55		
VD_48	0.8~2.6	11~37	3.5	44	70	2.8	0.8~2.6	11~37	3.5	44	70	2.8
	1.5~3.4	21~48	3.9	55			1.5~3.4	21~48	3.9	55		
VD_55	0.8~2.6	11~37	3.5	44	80	3.2	0.8~2.6	11~37	3.5	44	80	3.2
	1.5~3.4	21~48	3.9	55			1.5~3.4	21~48	3.9	55		

Table 5 VD & VC stroking time table

Act'r Series	Stroke length	Controller Series	Stroking time (Sec.)		Act'r Series	Stroke length	Controller Series	Stroking time (Sec.)	
			Load	Vent				Load	Vent
VD_25	20mm	NDX	3	3	VD_25	20mm	ND9202	5	7
							ND9203	4	5
VD_29	20mm	NDX	3	3	VD_29	20mm	ND9203	5	7
	40mm		3	4		40mm		8	10
VD_37	20mm	NDX	3	3.5	VD_37	20mm	ND9203	9	11
	40mm		3.5	4		40mm		11	16
	50mm		4	5		50mm	ND9206	7	8
VD_48	20mm	NDX	3	4	VD_48	20mm	ND9203 ND9206	16	19
	40mm		3.5	5		40mm		9	11
	50mm		4	6		50mm		10	12
	60mm		5	6.5		60mm		11	13
	70mm		6	7.5		70mm		12	14
VD_55	20mm	NDX	3	6	VD_55	20mm	ND9206	9	11
	40mm		4	7		40mm		12	15
	50mm		5	8		50mm		14	17
	60mm		6	9		60mm		16	19
	70mm		7	10		70mm		18	21
	80mm		8	11		80mm		20	23

Note:
- Mounted with ND9 / NDX smart positioners and B72G-2AS-980 AFR only.
- VD model / spring range : VDR / 0.8 ~ 2.6 bar
- Stroking time accuracy: ± 10 %
- Supply pressure for VD_25/29/37 is 3.2 bar and VD_48&55 is 3.5 bar.

1.5 Recycling and disposal

Most actuator parts can be recycled if sorted according to material. Most parts have material marking. A material list is supplied with the actuator. In addition, separate recycling and disposal instructions are available from the manufacturer. An actuator can also be returned to the manufacturer for recycling and disposal against a fee.

1.6 Safety precautions

CAUTION:
Don't exceed the permitted values!
Exceeding the permitted pressure value marked on the actuator may cause damage and lead to uncontrolled pressure release in the worst case. Damage to the equipment and personal injury may result.

CAUTION:
Don't dismantle a pressurized actuator!
Dismantling a pressurized actuator leads to uncontrolled pressure release. Shut off the supply pressure and release pressure from the diaphragm case before dismantling the actuator.
Otherwise, personal injury and damage to equipment may result.

CAUTION:
Follow the instructions given on the actuator warning plates!

CAUTION:
Before opening the diaphragm case fastening screws, release spring tension directed on actuator warning plate and in these instructions!

CAUTION:
Take the weight of the actuator or valve combination into account when handling it!
Do not lift the valve combination from the actuator, positioner, limit switch or their piping. Lift the actuator as directed in Section 2, lifting ropes for a valve combination should be fastened around it. The weights are shown in Section 9. Dropping may result in personal injury or damage to the equipment.

ATEX/Ex Safety

CAUTION:
Potential electrostatic charging hazard, do not rub surface with dry cloth

CAUTION:
Ensure the general process and worker protection from static electricity in the facilities.

NOTIFICATION:
The actual surface temperature of actuator is depended on the process and ambient conditions. The protection from high or low temperature must be considered by the end user before put into service.

2. TRANSPORTATION, RECEPTION AND STORAGE

Make sure that the actuator and associated equipment have not been damaged during transportation. Store the actuator carefully before installation, preferably indoors in a dry place. Do not take it to the installation site or remove the protective caps of ports for piping until just before installation.

Lift the actuator as shown in Fig. 4. in an upright from an eye bolt screwed in the place of a stop screw. Refer to Section 9 for weights.

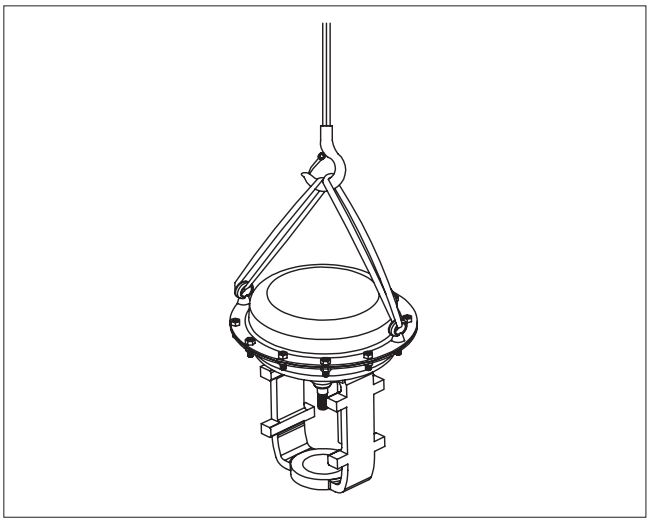


Fig. 4 Lifting the complete valve & actuator

3. MOUNTING AND REMOVAL

3.1 Actuator air supply

Dry compressed air or natural gas can be used in actuators in open-close operation, no oil spraying is needed. Clean, dry and oil-free instrument air must be used for diaphragm actuators with a positioner. The air supply connections are presented in the dimensional drawings in Section 9. The maximum operating pressure is 4.2 bar.

3.2 Mounting the actuator on the valve

CAUTION:
Take the weight of the actuator or valve combination into account when handling it!

CAUTION:
Beware of the cutting movement of the valve!

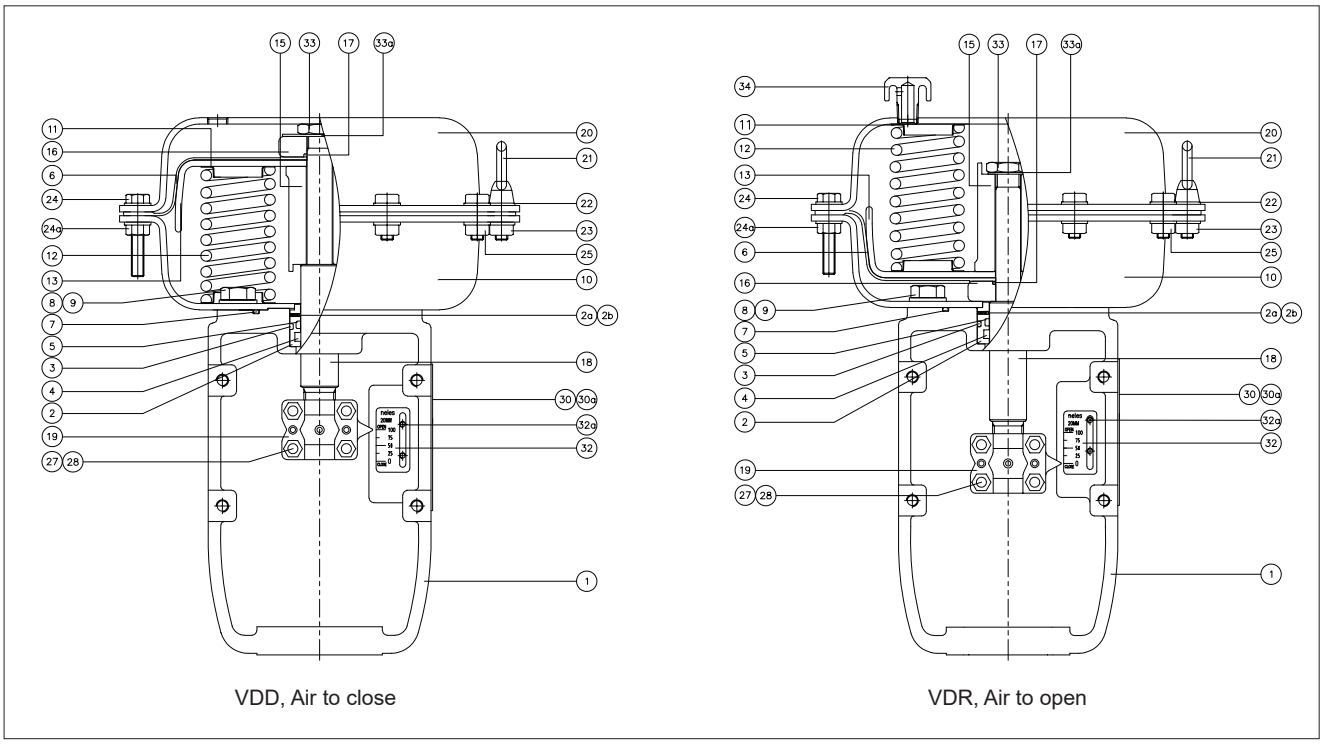
Several types of Neles valves can be used with suitable clamps. Refer to the selected valve model manuals for further information on their installation, maintenance and operation.

CAUTION:
Beware of the plug movement!
Do not use air pressure higher than what specified on the identification plate.

Actuator mounting for VDD, Direct <air to close, stem extend> actuator

See Fig. 5.

- Mount the new or repaired actuator on top of the bonnet, using a suitable lifting device.
- Insert the yoke nut and tightly fasten the yoke by turning the yoke nut clockwise using tightening tools.
- Connect air line and accessories.
- Down the top stem (18), using by specified air pressure.
- Adjustment stem length after clamping the clamp (19) according to rated travel (stroke) as ‘open’ and ‘close’ position as per pressurizing and depressurizing the upper diaphragm chamber (see 4.8 for stem adjustment).
- Tighten the 4 socket head screws (27) with hexagon nuts (28) and the lower stem locknut.



VDD, Air to close

VDR, Air to open

Fig. 5 VD Actuator Constructions without Handwheel

Actuator mounting for VDR, Reverse <air to open, stem retract> actuator

See Fig. 5.

- Mount the new or repaired actuator on top of the bonnet, using a suitable lifting device.
- Insert the yoke nut between the plug stem and actuator stem while lowering the actuator on to the bonnet. Secure the yoke by tightening the yoke nut clockwise.
- Connect air line and accessories.
- Lift the top stem (18), using by specified air pressure.
- Adjustment stem length after clamping the clamp (19) according to rated travel (stroke) as ‘open’ and ‘close’ position as per pressurizing and depressurizing the lower diaphragm chamber (see 4.8 for stem adjustment).
- Tighten the 4 socket head screws (27) with hexagon nuts (28) and the plug stem locknut.

CAUTION:
Avoid to turn the valve plug and stem when plug is on seat ring to prevent the seating line from being damaged.

The installation position can be selected freely, but Valmet recommends installation with the upright. The actuator is thus best protected against damage due to supply air impurities or water.

When necessary, lubricate the actuator stem and guide with Cortec VCI 369 or an equivalent anti-corrosive agent to prevent it from jamming due to rust.

The actuator must not be allowed to come in contact with the pipework, because the vibrations may damage it or cause unsatisfactory operation.

3.3 Removing the actuator from the valve

CAUTION:
Make sure the valve is not pressurized when removing the actuator.

Actuator removal for VDD, Direct <air to close, stem extend> actuator

See Fig. 5 and exploded view.

- Shut off and disconnect the air supply lines and accessories.
- Loosen the plug stem locknut and the 4 socket head screws (27) with hexagon nuts (28).
- Remove the clamp (19).
- Support the actuator with the suitable lifting device.
- Remove the yoke nut.
- Remove the actuator from the valve body assembly.

Actuator removal for VDR, Reverse <air to open, stem retract> actuator

See Fig. 5 and exploded view.

- Lift up to the valve plug 100 % from the seat ring, using by specified air pressure.
- Loosen the plug stem locknut and the 4 socket head screws (27) with hexagon nuts (28).
- Remove the stem clamp (19).
- Shut off and disconnect air supply line.
- Support the actuator with the suitable lifting device.
- Remove the yoke nut.
- Remove the actuator from the valve body assembly.

CAUTION:
Avoid to turn the valve plug and stem when plug is on seat ring to prevent the seating line from being damaged.

4. MAINTENANCE

CAUTION:
Observe the safety precautions listed in Section 1.6 before starting work!

CAUTION:
When handling the actuator or the control valve assembly, take its weight into account!

4.1 General

Although the Neles VD actuators require no regular maintenance.

However, check the vent port and the diaphragm with case and the guide bushing for leakage, proper preventative maintenance can significantly help to prevent unplanned downtime and in real terms reduce the total cost of ownership. Valmet recommends inspecting the valves at least every five (5) years. The inspection and maintenance interval depends on the actual application and process condition. The inspection and maintenance intervals can be specified together with your local Valmet experts. During this periodic inspection the parts detailed in the Spare Part Set should be replaced. Time in storage should be included in the inspection interval.

Maintenance can be performed as presented below. For maintenance assistance, please contact your local Valmet office. The part numbers in the text refer to the exploded view and to the parts list in Section 8, unless otherwise stated.

NOTE:
When sending goods to the manufacturer for repair, do not disassemble them. Clean the valve carefully and flush the valve internals. For safety reasons, inform the manufacturer of the type of medium used in the valve (include material safety datasheets (MSDS)).

NOTE:
In order to ensure safe and effective operation, always use original spare parts to make sure that the valve functions as intended.

NOTE:
For safety reasons, replace pressure retaining bolting if the threads are damaged, have been heated, stretched or corroded.

NOTE:
If you send the actuator to the manufacturer for repair, do not dismantle it. For safety reasons, please see the warning plate on the top side of actuator.

NOTE:
Always use original spare parts to make sure the valve functions as intended.

CAUTION:
Do not dismantle the actuator or remove it from the pipeline while the valve is pressurised!

CAUTION:
Make sure the valve is not pressurized when removing the actuator.

4.2 Replacement diaphragm for VDD, Air to close

See Fig. 5 and Exploded view.

We recommend that all seals be replaced when the actuator has been dismantled for servicing.

The actuator must be depressurized and the supply air pipes disconnected.

- Detach the actuator.
- Check that the actuator has been depressurized, and remove air tubing from the upper case (20).

NOTE:
If actuator is equipped with the handwheel, rotate handwheel to a neutral position.

- Remove the short hexagon screws (23, 24, diaphragm case bolts) and the hexagon nuts (25).

CAUTION:
Diaphragm case is under spring tension and is equipped with the long hexagon screws (24, tension bolts) which must be removal last.

- Loosen the long hexagon screws(24, tension bolts) and the hexagon nuts(25) facing each other to prevent the risk of case popping up by the spring tension.
- Remove the upper case (20).
- Loosen the stem nut (33) and remove the lock washer (33a) and the stem rod plate (16) with O-ring (17).
- Remove the diaphragm (6) and the diaphragm plate (13) with the stopper (15) from the top stem (18).
- Remove the spring seats (11) and springs (12).
- Replace the U-packing (4) and O-ring (5) in the stem guide (2).

CAUTION:
Checking whether scratched on the top stem (18) and dirty particles inside of the stem guide (2) and the diaphragm and O-rings before reassembling.

NOTE:
Lubricate seal space and new O-ring with Unisilikon L250L or equal silicone grease.

- Mount the spring seats (11) and springs (12).

NOTE:
Spring ends should point towards the stem to ensure the actuator performance.

- Mount the diaphragm plate (13) with the stopper (15) on the top stem (18).
- Mount the replaced diaphragm (6).
- Insert the replaced O-ring (17).
- Mount the stem rod plate (16) and lock washer (33a), stem nut (33) and tighten.
- Mount the upper case (20).
- Tighten the long hexagon screws(24, tension bolts) and hexagon nuts(25) facing each other slightingly at first, and, tighten them fully . Refer to the table 6.
- Replace the remaining the short hexagon screws and nuts.

CAUTION:
Refer to the table 6 for torque values. Over tightening may cause tearing of diaphragm.

4.3 Replacement diaphragm for VDR, Air to open

See Fig. 5 and Exploded view.

We recommend that all seals be replaced when the actuator has been dismantled for servicing.

The actuator must be depressurized and the supply air pipes disconnected.

- Detach the actuator.
- Check that the actuator has been depressurized, and remove air tubing from the lower case (10).

NOTE:
If actuator is equipped with the handwheel, rotate handwheel to a neutral position.

- Remove the short hexagon screws (23, 24, diaphragm case bolts) and the hexagon nuts (25).

CAUTION:
Diaphragm case is under spring tension and is equipped with the long hexagon screws (24, tension bolts) which must be removal last.

- Loosen the long hexagon screws(24, tension bolts) and the hexagon nuts(25) facing each other to prevent the risk of case popping up by the spring tension.
- Remove the upper case (20).
- Remove the spring seats (11) and springs (12).
- Remove the diaphragm (6) and the diaphragm plate (13) with the stopper (15) and O-ring (17) from the top stem (18).
- Replace the U-packing (4) and O-ring (5) in the stem guide (2).

CAUTION:
Checking whether scratched on the stem guide (18) and dirty particles inside of the stem guide (2) and the diaphragm and O-rings before reassembling.

- Mount the stem rod plate, the replaced O-ring (5), diaphragm (6), the diaphragm plate (13) with the stopper (15) and the top stem (18). Tighten them referring to the table 6 for torque values.
- Mount the spring seats (11) and springs (12).

NOTE:
Spring ends should point towards the stem to ensure the actuator performance.

NOTE:
Lubricate seal space and new O-ring with Unisilikon L250L or equal silicone grease.

- Mount the upper case (20).
- Tighten the long hexagon screws(24, tension bolts) and hexagon nuts(25) facing each other slightingly at first, and, tighten them fully referring to the table 6 for torque values. These long hexagon screw (tension bolts) must be equally spaced.
- Replace the remaining short hexagon screws and nuts.

CAUTION:
Refer to the table 6 for torque values. Over tightening may cause tearing of diaphragm.

4.4 Operation the handwheel

See Fig. 6 and 7.

- Check the current valve position should be ‘AUTO’ position (see the stroke indicator, which is open or close).
- Turn over the locking device to release the handwheel.

CAUTION:
Don`t operate the handwheel while the locking device engaged, it can cause damage.

- Operate the handwheel to be open or close position --- Manual mode.
- Return the stem position to be ‘AUTO’ position.
- Return the locking device to be locked with the ‘AUTO’ position --- Auto mode.

CAUTION:
Potential electrostatic charging hazard, do not rub surface with dry cloth.

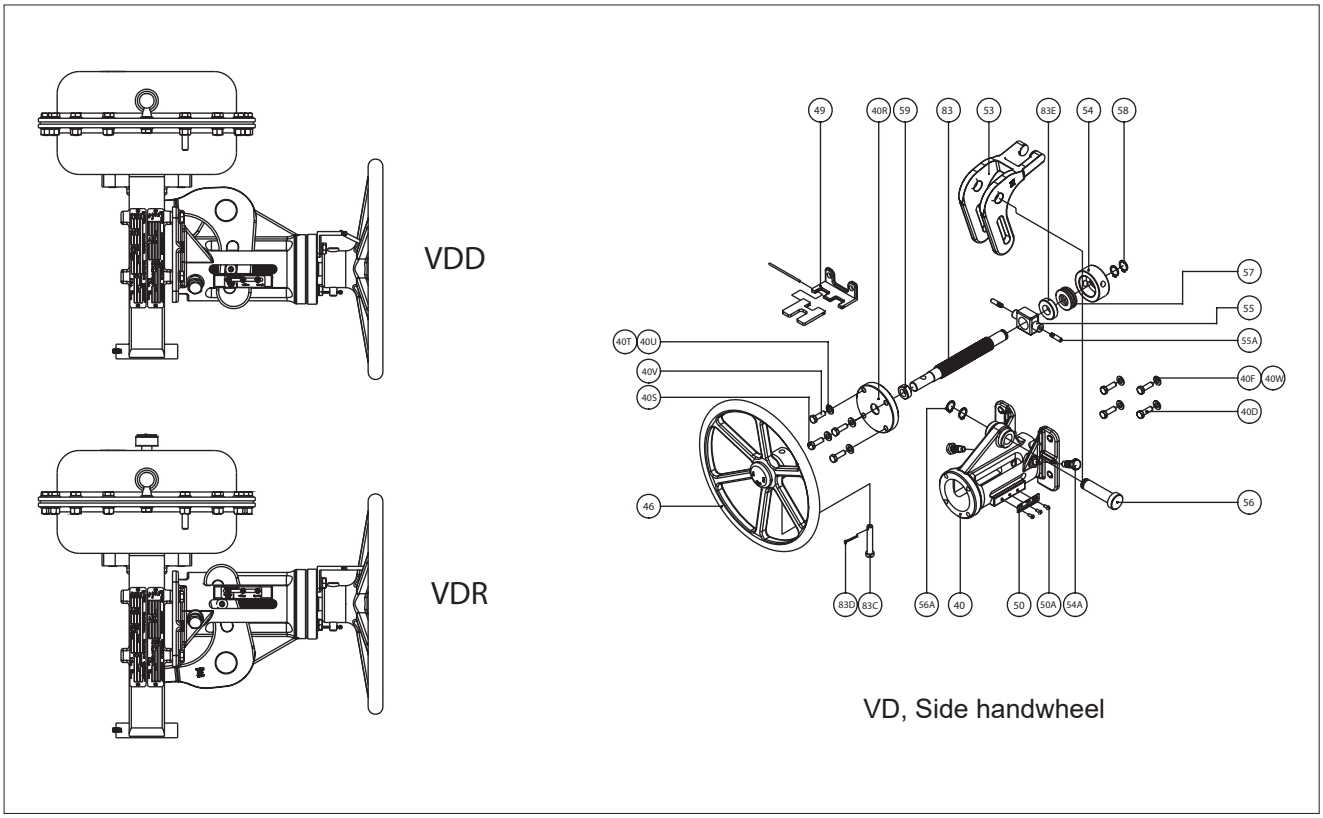
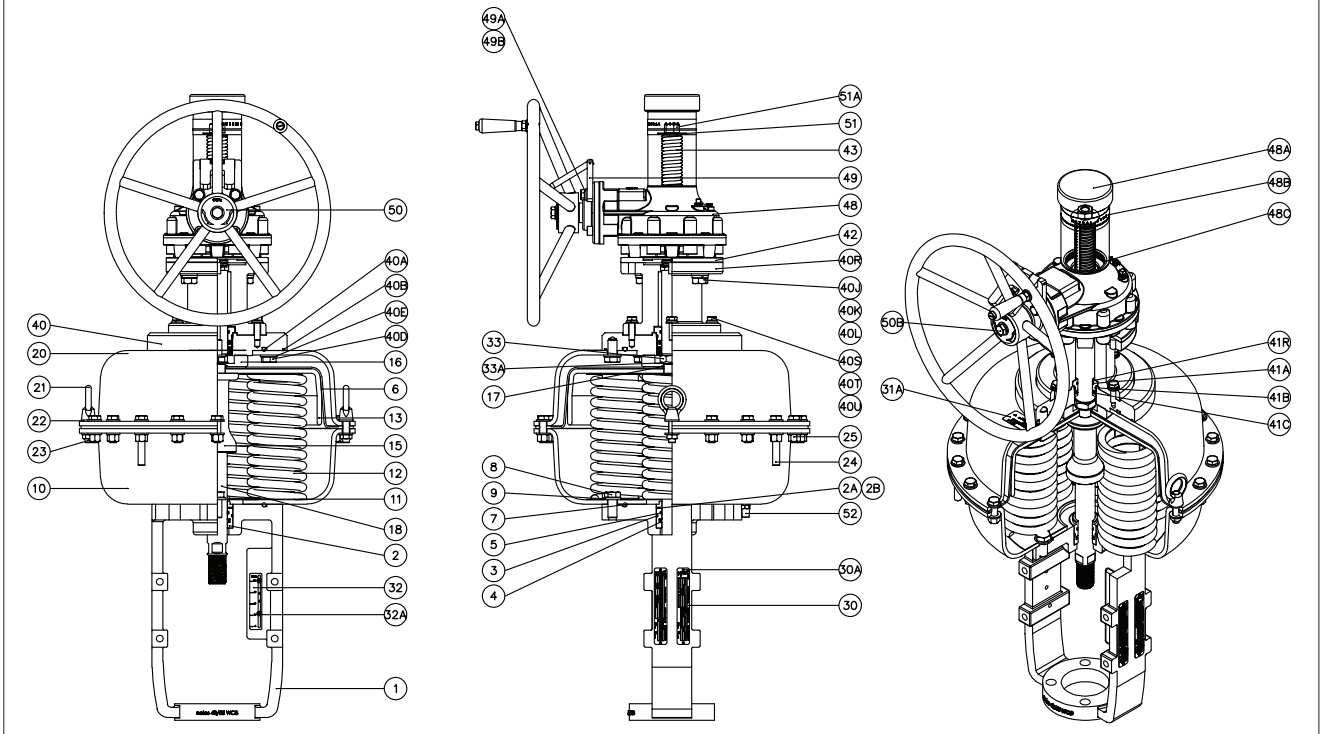
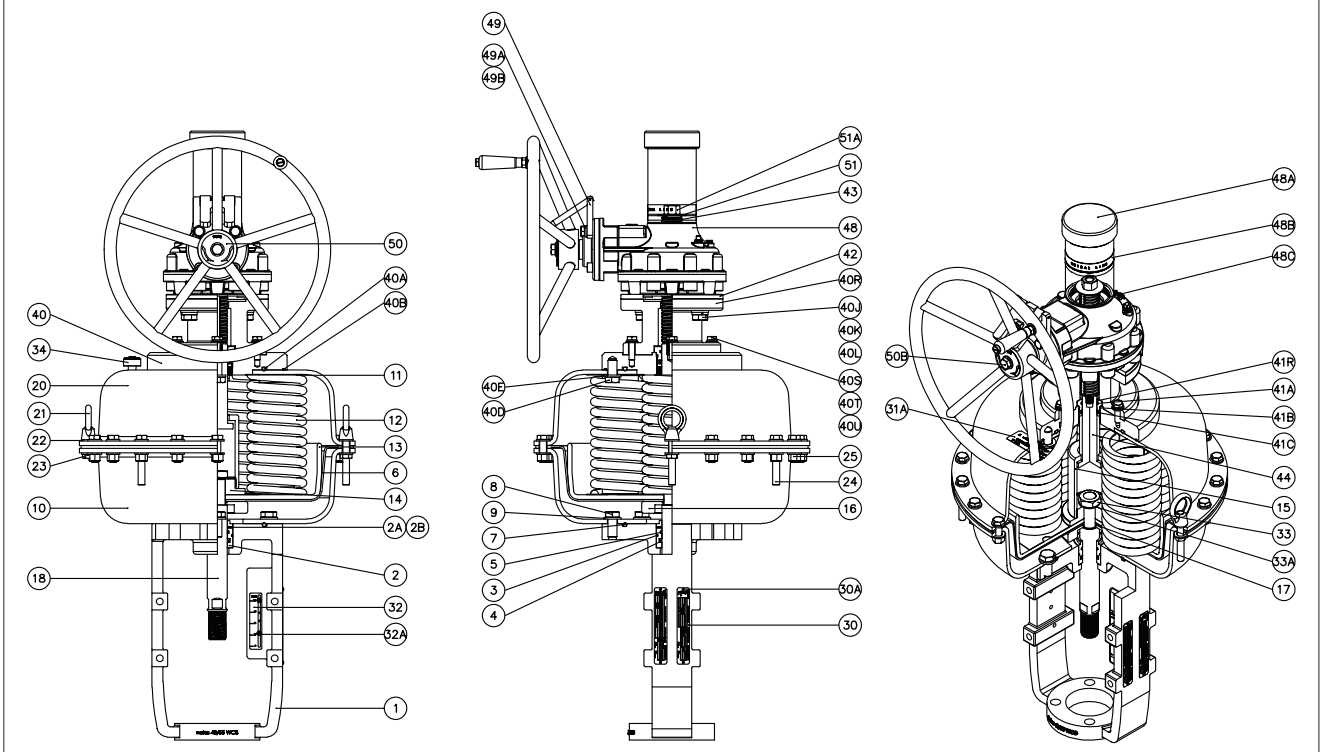


Fig. 6 VD_25/29/37, Actuator Constructions with Handwheel

Part No.	Description	Material
040	HANDLE BASE	ASTM A216 gr. WCB
040D	HEXAGON SCREW	ISO 3506 A2-70
040F	SPRING WASHER	AISI 304
040R	HANDLE BASE COVER	JIS G3101-SS400
040S	HEXAGON SCREW	ISO 3506 A2-70
040T	WASHER	AISI 304
040U	SPRING WASHER	AISI 304
040V	HEXAGON SCREW	ISO 3506 A2-70
040W	WASHER	AISI 304
046	HANDLE	ASTM B209 ALLOY 6061 T6
049	LOCKING HANDLE	AISI 304
050	HANDLE INDICATOR	ALUMINIUM
050A	ROUND HEAD SCREW	AISI 304
053	LEVER ARM	ASTM A747 gr. CB7Cu-1
054	BEARING FLANGE	AISI 304
054A	BEARING FLANGE SCREW	ISO 3506 A2-70
055	SHAFT FLANGE	JIS G4051-S45C
055A	SHAFT FLANGE SCREW	AISI 304
056	LEVER ARM SHAFT	AISI 304
056A	SNAP RING	AISI 304
057	THRUST BALL BEARING	JIS G3101-SS400
058	SNAP RING	AISI304
059	DU DRY BEARING	AISI 304+PTFE+Pb
083	HANDLE SHAFT	JIS G4051-S45C
083C	SHAFT PIN	AISI 304
083D	SPLIT PIN	CARBON STEEL +ZINC
083E	SHAFT GUIDE	AISI 304



VDD, Top side handwheel



VDR, Top side handwheel

Fig. 7 VD_ 48/55, Standard parts & materials with handwheel

Part No.	Description	Material
040	HAND WHEEL BASE	JIS G3101-SS400
040A	0-RING	NITRILE, NBR
0408	0-RING	NITRILE, NBR
040D	HEXAGON SCREW	ISO 3506 A2-70
040E	WASHER	BRONZE
040J	HEXAGON SCREW	ISO 3506 A2-70
040K	WASHER	AISI304
040L	SPRING WASHER	ISO 3506 A2-70
040R	HAND WHEEL COVER	JIS G3101-SS400
040S	HEXAGON SCREW	ISO 3506 A2-70
040T	WASHER	AISI304
040U	SPRING WASHER	AISI304
041A	0-RING	NITRILE, NBR
0418	0-RING	NITRILE, NBR
041C	U-PACKING	NITRILE, NBR
041R	HAND WHEEL GUIDE BUSH	BRASS
042	SCREW GUIDE PLATE	JIS G3101-SS400
043	HAND WHEEL SCREW	AISI304
044	HAND WHEEL STEM	JIS G3101-SS400+ Zn
048	GEAR BOX	DUCTILE IRON
048A	GEAR BOX CAP	PMMA
0488	STICKER	
048C	0-RING	NITRILE, NBR
049	LOCKING HAND WHEEL	JIS G3101-SS400
049A	HEXAGON SCREW	ISO 3506 A2-70
0498	SPRING WASHER	AISI304
050	HAND WHEEL INDICATOR	ALUMINIUM
0508	HEXAGON SCREW	ISO 3506 A2-70
051	INDICATOR PLATE	AISI304
051A	HEXAGON NUT	ISO 3506 A2-70

4.5 Removal & mounting of the handwheel bundle

See Fig. 6 and 7.

- Turn over the locking device to be released the handwheel.
- Check if valve is in 'AUTO' position. If not, operate the handwheel to 'AUTO' position.
- Operate the handwheel to be open or close position --- Manual mode.
- Hold the handwheel bundle by lifting device.
- Remove the hexagon screws (40d) and spring washers (40f) from the yoke side
- Lift up the handwheel bundle using by lifting devices from the yoke side.

CAUTION:
Lift the handwheel bundle using by lifting devices, don`t lift by only hand for the safety.

- Repair or replace the parts if necessary.

NOTE:
We recommend that to replace the bearing (57) with Mob no. 2 grease or equal when the annual shutdown.

- Remounting: follow reversed procedures from the last step through first step.
- Return the locking device to be locked with the 'AUTO' position --- Auto mode.

CAUTION:
Keep your fingers, tools or other items out of the housing while operating the actuator with the cover open!

Table 6 VD Tightening torques for screws

PN	Description	Screw Size	Q`ty	VD Required Torques for Each Size									
				#25		#29		#37		#48		#55	
				N.m	Lbf.ft	N.m	Lbf.ft	N.m	Lbf.ft	N.m	Lbf.ft	N.m	Lbf.ft
8	"Hexagon Screw (for #10, Lower Case)"	M12 x 1.75P	4	34	25	34	25	34	25				
		M16 x 2.0P	6							65	48	65	48
21	"Lifting Eye Nut (for #10 & 20, Cases)"	M8 x 1.25P	2	26	19	26	19	24	18				
		M12 x 1.75P	2							24	18	32	24
24a, 25	"Hexagon Nut (for #10 & 20, Cases)"	M8 x 1.25P	10	26	19								
		M8 x 1.25P	14			26	19						
		M8 x 1.25P	18					24	18				
		M12 x 1.75P	18							24	18		
		M12 x 1.75P	22									32	24
28	"Hexagon Nut (for #19, Clamp)"	M6 x 1.0P	4	22	16	22	16	22	16				
		M10 x 1.5P	4							26	19	26	19
33	"Stem Nut (for #18, Top Stem)"	M16X2.0P	1	65	48	65	48	65	48				
		M24X1.5P	1							180	133	180	133
for VD Handwheel Screws													
40D	Hexagon Screw	M8 x 1.25P	4	26	19	26	19	26	19				
		M14 x 2.0P	4							50	37	50	37
40S	Hexagon Screw	M8 x 1.25P	2	26	19	26	19	26	19				
		M10 x 1.5P	2							26	19	26	19
40V	Hexagon Screw	M8 x 1.25P	2	26	19	26	19	26	19				
		M10 x 1.5P	2							26	19	26	19
50A	Round Head Screw	M4 x 0.7P	6	8	6	8	6	8	6	8	6	8	6
54A	Bearing Flange Screw	M12 x 1.75P	2	34	25	34	25						
		M16 x 2.0P	2					65	48				
		M22 x 2.5P	2							120	88	120	88

Note :
1. Torque value tolerance : ± 10 %
2. Torques are norminal values.

4.6 Change of the spring range

Change of the spring range: VDD, Air to close

See Fig. 5,6 and Exploded view (Fig. 9)

We recommend that all seals be replaced when the actuator has been dismantled for servicing.

The actuator must be depressurized and the supply air pipes disconnected.

- Detach the actuator.
- Check that the actuator has been depressurized, and remove air tubing from the upper case (20).

NOTE:
If actuator is equipped with the handwheel, rotate handwheel to a 'AUTO' position.

- Loose and remove the short hexagon screws (23, 24, diaphragm case bolts) and the hexagon nuts (25).

CAUTION:
Diaphragm case is under spring tension and is equipped with the long hexagon screws (24, tension bolts) which must be removal last.

- Loose and remove the the long hexagon screws (24, tension bolts) and the hexagon nuts (25) in cross steps to release spring tension gradually.
- Remove the upper case (20).
- Loose the stem nut (33) and remove the lock washer (33a).
- Remove the stem rod plate (16) with inserted o-ring (17) from top stem (18).
- Remove the diaphragm (6) and diaphragm plate (13) and stopper (15) from the top stem (18).
- Remove the spring seats (11) and springs (12).
- Replace the spring(12), the stem(18), the stopper(15) and the bolts(23, 24) as per strong spring configuration. And, add the spacer(26) in between the upper case and the lower case.

CAUTION:
Checking whether scratched on the top stem (18) and dirty particles inside of the stem guide (2) and the diaphragm and o-rings before reassembling.

NOTE:
Lubricate seal space and new o-ring with Unisilikon L250L or equal silicone grease.

NOTE:
Set the springs so that the coil ends are located toward the actuator stem center, this will be assures best performance of the actuator.

- Replace the long hexagon screws (24, tension bolts) and the hexagon nuts (25).
- Reassembling: to follow reverse procedures from the last step through first step.

CAUTION:
Do not over tighten the hexagon screws as this could possibly warp the diaphragm and cases, see torque values on the table 6.

Change of the spring range: VDR, Air to open

See Fig. 5,6 and Exploded view (Fig. 10)

We recommend that all seals be replaced when the actuator has been dismantled for servicing.

The actuator must be depressurized and the supply air pipes disconnected.

- Detach the actuator.
- Check that the actuator has been depressurized, and remove air tubing from the lower case (10).

NOTE:
If actuator is equipped with the handwheel, rotate handwheel to a 'free position`.

- Loose and remove the short hexagon screws (23, 24, diaphragm case bolts) and the hexagon nuts (25).

CAUTION:
Diaphragm case is under spring tension and is equipped with the long hexagon screws (24, tension bolts) which must be removal last.

- Loose and remove the the long hexagon screws (24, tension bolts) and the hexagon nuts (25). in cross steps to release spring tension gradually.
- Remove the upper case (20).
- Remove the spring seats (11).
- Replace the spring(12), the stem(18), the stopper(15) and the bolts(23, 24) as per strong spring configuration. And, add the spacer(26) in between the upper case and the lower case.

NOTE:
Set the springs so that the coil ends are located toward the actuator stem center, this will be assures best performance of the actuator.

- Replace the long hexagon screws (24, tension bolts) and the hexagon nuts (25).
- Reassembling: follow reversed procedures from the last step through first step.

CAUTION:
Do not over tighten the hexagon screws as this could possibly warp the diaphragm and cases, see torque values on the table 6.

4.7 Change of the actuator action

Change of the actuator action: VDD, Air to close --> VDR, Air to open

See Fig. 5 and Exploded view.

We recommend that all seals be replaced when the actuator has been dismantled for servicing.

The actuator must be depressurized and the supply air pipes disconnected.

- Detach the actuator.
- Check that the actuator has been depressurized, and remove air tubing from the upper case (20).

NOTE:
If actuator is equipped with the handwheel, rotate handwheel to a 'AUTO' position.

- Loose and remove the short hexagon screws (23, 24, diaphragm case bolts) and the hexagon nuts (25).

CAUTION:
Diaphragm case is under spring tension and is equipped with the long hexagon screws (24, tension bolts) which must be removal last.

- Loose and remove the the long hexagon screws (24, tension bolts) and the hexagon nuts (25). in cross steps to release spring tension gradually.
- Remove the upper case (20).
- Loose the stem nut (33) and remove the lock washer (33a).
- Remove the stem rod plate (16) with inserted o-ring (17) from top stem (18).
- Remove the diaphragm (6) and diaphragm plate (13) and stopper (15) from the top stem (18).
- Remove the spring seats (11) and springs (12).

CAUTION:
Checking whether scratched on the top stem (18) and dirty particles inside of the case and the diaphragm and o-rings before reassembling.

- Mount the stem rod plate (16) with inserted o-ring (17) on the top stem (18).
- Mount the the diaphragm (6) and diaphragm plate (13).
- Mount the the stopper (15) on the top stem (18).
- Mount the lock washer (33a) and stem nut (33) and tighten.
- Mount the spring seats (11) and springs (12).

NOTE:
Set the springs so that the coil ends are located toward the actuator stem center, this will be assures best performance of the actuator.

- Mount the upper case (20).
- Replace the long hexagon screws(24, tension bolts) and hexagon nuts(25) facing each other. Tighten them slightingly at first, and then fully as per the table 6, torque values.

CAUTION:
Do not over tighten the hexagon screws as this could possibly warp the diaphragm and cases, see torque values on the table 6.

- Mount the vent cap (34) on the upper case (20) for prevent go water, dirty particles into the actuator.
- To connect the related instrument fitting and tubings on the bottom side of lower case (10).

Change of the actuator action: VDR, Air to open --> VDD, Air to close

- See Fig. 5 and Exploded view.
- We recommend that all seals be replaced when the actuator has been dismantled for servicing.
- The actuator must be depressurized and the supply air pipes disconnected.
- Detach the actuator.
- Check that the actuator has been depressurized, and remove air tubing from the lower case (10).

NOTE:
If actuator is equipped with the handwheel, rotate handwheel to a 'AUTO' position.

- Loose and remove the short hexagon screws (23, 24, diaphragm case bolts) and the hexagon nuts (25).

CAUTION:
Diaphragm case is under spring tension and is equipped with the long hexagon screws (24, tension bolts) which must be removal last.

- Loose and remove the the long hexagon screws (24, tension bolts) and the hexagon nuts (25). in cross steps to release spring tension gradually.
- Remove the upper case (20).
- Remove the spring seats (11) and springs (12).
- Loose the stem nut (33) and remove the lock washer (33a).
- Remove the stopper (15) and the diaphragm plate (13) and diaphragm (6) from the top stem (18).
- Remove the stem rod plate (16) with inserted o-ring (17) from top stem (18).

CAUTION:
Checking whether scratched on the top stem (18) and dirty particles inside of the case and the diaphragm and o-rings before reassembling.

- Mount the spring seats (11) and springs (12) on the lower case (10).

NOTE:
Set the springs so that the coil ends are located toward the actuator stem center, this will be assures best performance of the actuator.

- Mount the the stopper (15) on the top stem (18).
- Mount the diaphragm plate (13) and the diaphragm (6).
- Mount the stem rod plate (16) with inserted o-ring (17) on the top stem (18).
- Mount the lock washer (33a) and stem nut (33) and tighten.
- Mount the upper case (20).
- Replace and tighten the long hexagon screws (24, tension bolts) and hexagon nuts (25) in equal steps until the cases meet.
- Replace and tighten the remaining the short.

4.8 Adjustment for valve stem

Model VDD, Air to close

See Fig. 5, 6, 7, 8 and 9.

CAUTION:
Avoid to turn the valve plug and stem when plug is on seat ring to prevent the seating line from being damaged.

- With the handwheel or pneumatically, stroke the actuator to the rated range or stroke.
- Unscrew the socket head screws (27) and hexagon nut (28) by one turn.
- Using the stem lock nut, unscrew the stem until the plug touches the seat.
- Release the pressure in the actuator or returned the handwheel to raise the stem.
- Line up the stroke indicator (32) with the clamp arrow (19) and check actuator for operation.
- To adjust with rotating valve stem if the stroke is inconsistent with the rated stroke.
- Tighten the socket head screws (27) and hexagon nut (28) after adjusted the rated stroke.

Model VDR, Air to open

See Fig. 5, 6, 7,8 and 9.

CAUTION:
Avoid to turn the valve plug and stem when plug is on seat ring to prevent the seating line from being damaged.

- Keep the actuator stem is fully extended.
- Unscrew the socket head screws (27) and hexagon nut (28) by one turn.
- Using the stem lock nut, unscrew the stem until the plug touches the seat.
- With the handwheel or pneumatically, stroke the actuator to raised the plug off the seat.
- Line up the stroke indicator (32) with the clamp arrow (19) and check actuator for operation.
- To adjust with rotating valve stem if the stroke is inconsistent with the rated stroke.
- Tighten the socket head screws (27) and hexagon nut (28) after adjusted the rated stroke.

4.9 Maximum & minimum stopper

See Fig. 8.

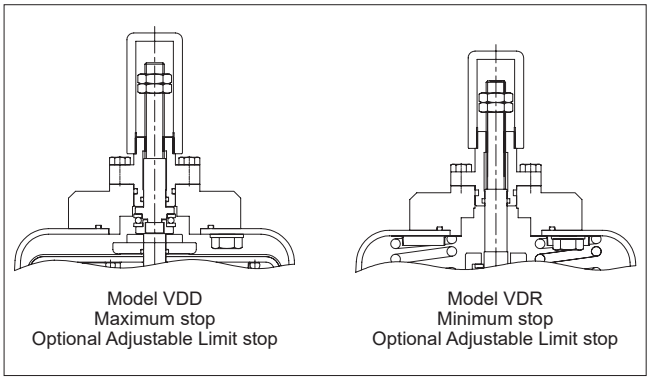


Fig. 8 Max./Min. stopper

5. MALFUNCTIONS

Table 7 Possible malfunctions

Symptom	Possible cause	Action
Irregular or slow operation	Low supply pressure	Make sure that supply pressure complies with minimum force required by valve. Check that supply air pipes are large enough.
	Positioner fault	Check positioner operation.
	Valve fault	Check that valve functions properly without actuator.
	Incorrect actuator rating	Contact manufacturer to check rating.
	Leak in diaphragm case or O-rings	Replace O-rings. See sect. 4.2 or 4.3, depending on actuator type.

6. TOOLS

Removal of the actuator

- wrench set (mm)
- hex socket wrench set
- chisel and hammer (10 pound)
- drivers

7. ORDERING SPARE PARTS

NOTE:
Always use original spare parts to make sure that the valve functions as intended.

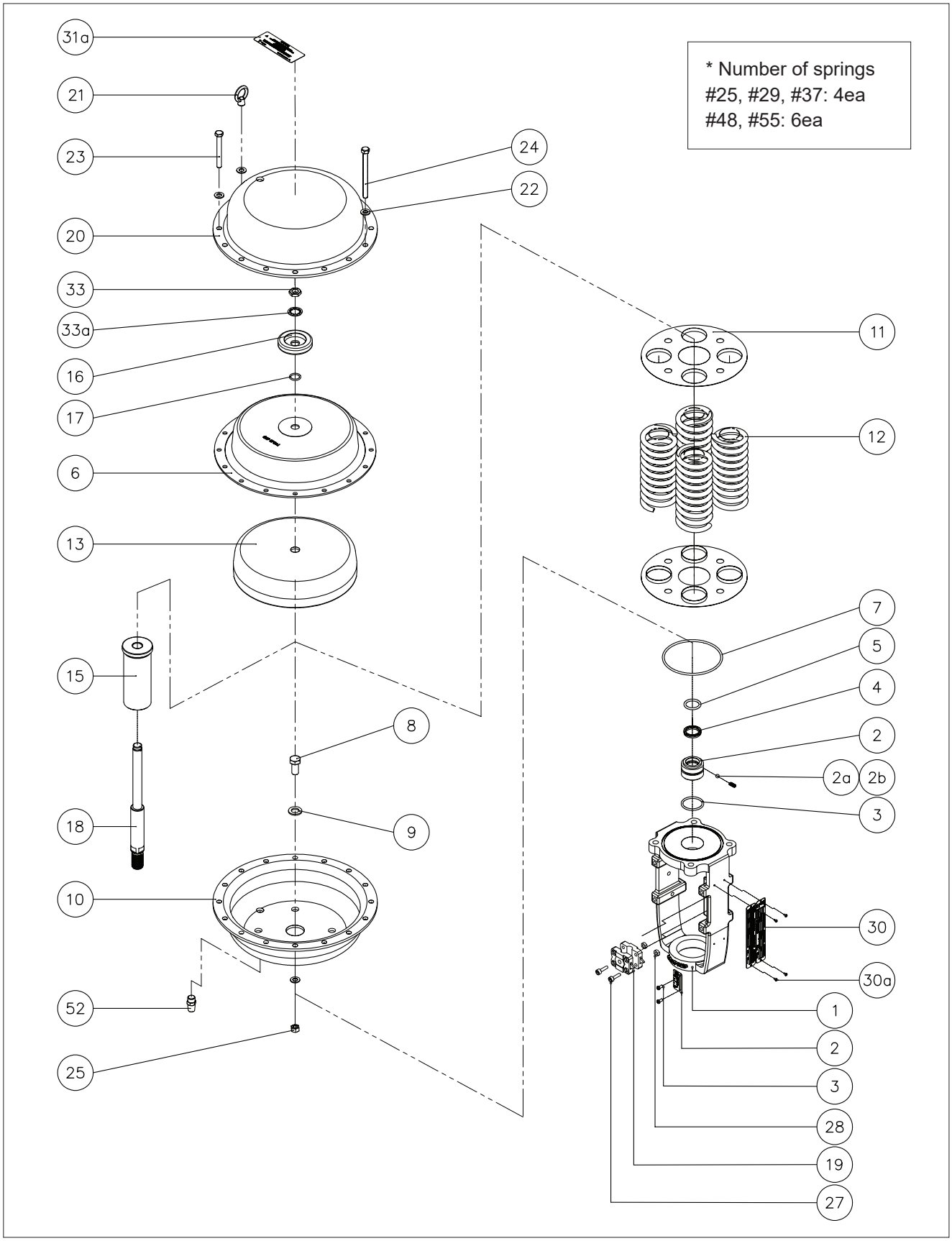
When ordering spare parts, always include the following information:

- type code, sales order number, serial number
- number of the parts list, part number, name of the part and quantity required

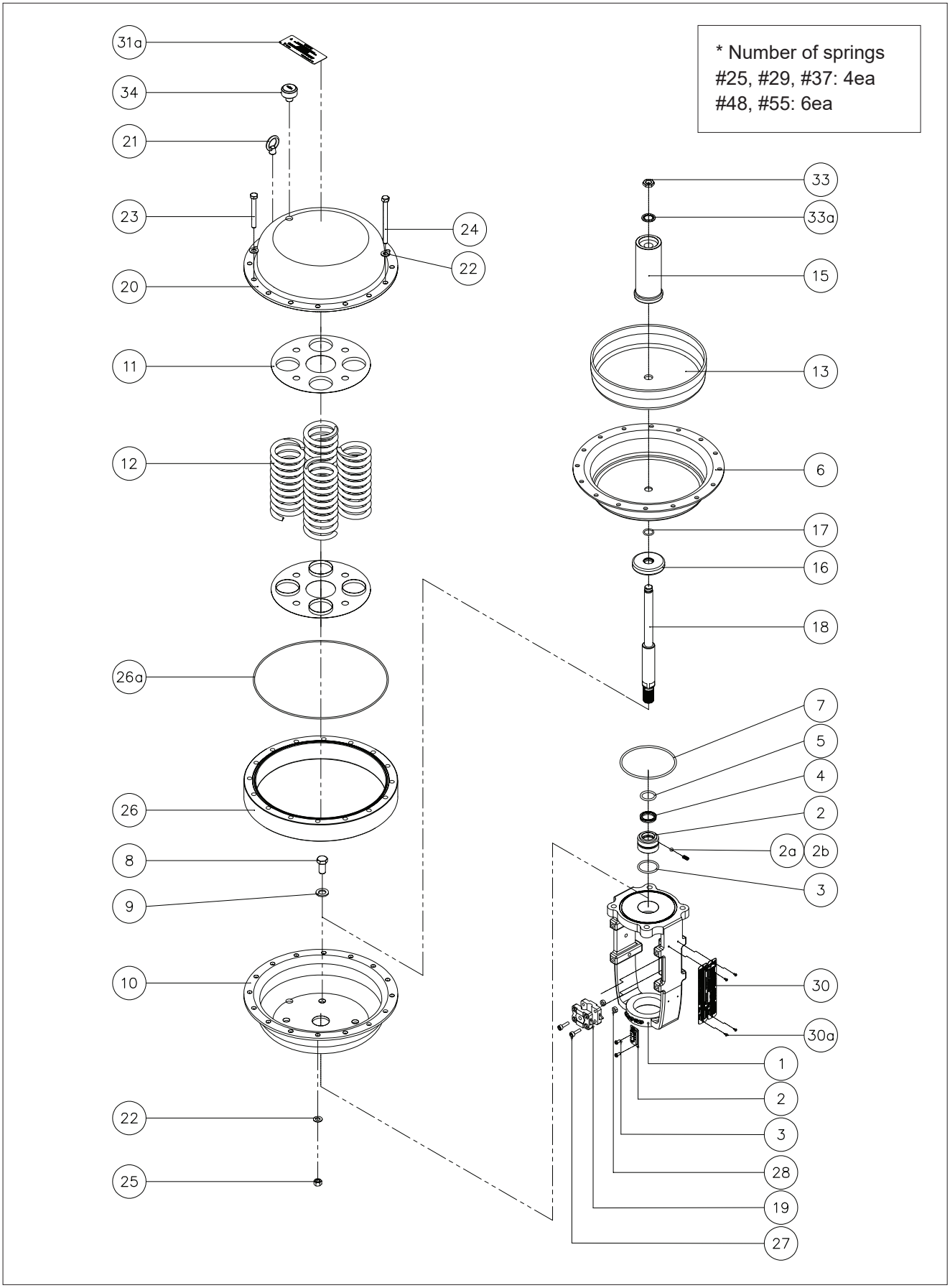
This information can be found from the identification plate or documents.

8. EXPLODED VIEWS AND PARTS LIST

VDD, Direct Acting, Air to Stem Extended



VDR, Reverse Acting, Air to Stem Retracted

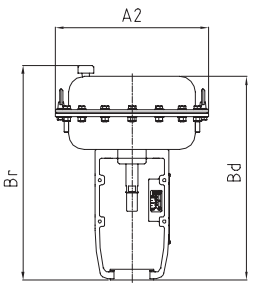


Series VD

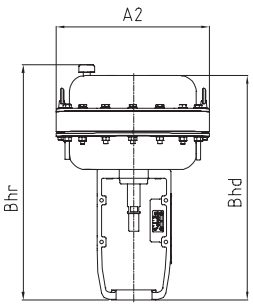
Item	Description	Recommended spare part
1	YOKE	
2	STEM GUIDE	
2a	COIL SPRING	
2b	BALL	
3	0-RING	X Cat 1
4	U-PACKING	X Cat 1
5	0-RING	X Cat 1
6	DIAPHRAGM	X Cat 1
7	0-RING	X Cat 1
8	HEXAGON SCREW	
9	WASHER	
10	LOWER CASE	
11	SPRING SEAT	
12	SPRING	
13	DIAPHRAGM PLATE	
15	STOPPER	
16	STEM ROD PLATE	
17	0-RING	X Cat 1
18	TOP STEM	
19	CLAMP	
20	UPPER CASE	
21	LIFTING EYE NUT	
22	WASHER	
23	HEXAGON SCREW	
24	HEXAGON SCREW	
24a	HEXAGON NUT	
25	HEXAGON NUT	
26	SPACER RING	
26a	O-RING	X Cat 1
27	SOCKET HEAD SCREW	
28	HEXAGON NUT	
30	IDENTIFICATION PLATE	
30a	RIVET	
31a	STICKER (WARNING)	
32	INDICATOR	
32a	ROUND HEAD SCREW	
33	STEM NUT	
33a	LOCK WASHER	
34	VENT CAP	

*) Delivered as a set
**) V-A Mounting Parts
***) Part no. 65A applicable only for 20” and 24”

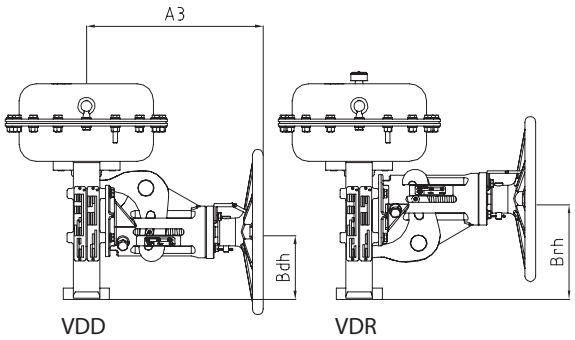
9. DIMENSIONS AND WEIGHTS



VDD/R E
Standard spring



VDD/RD
High spring

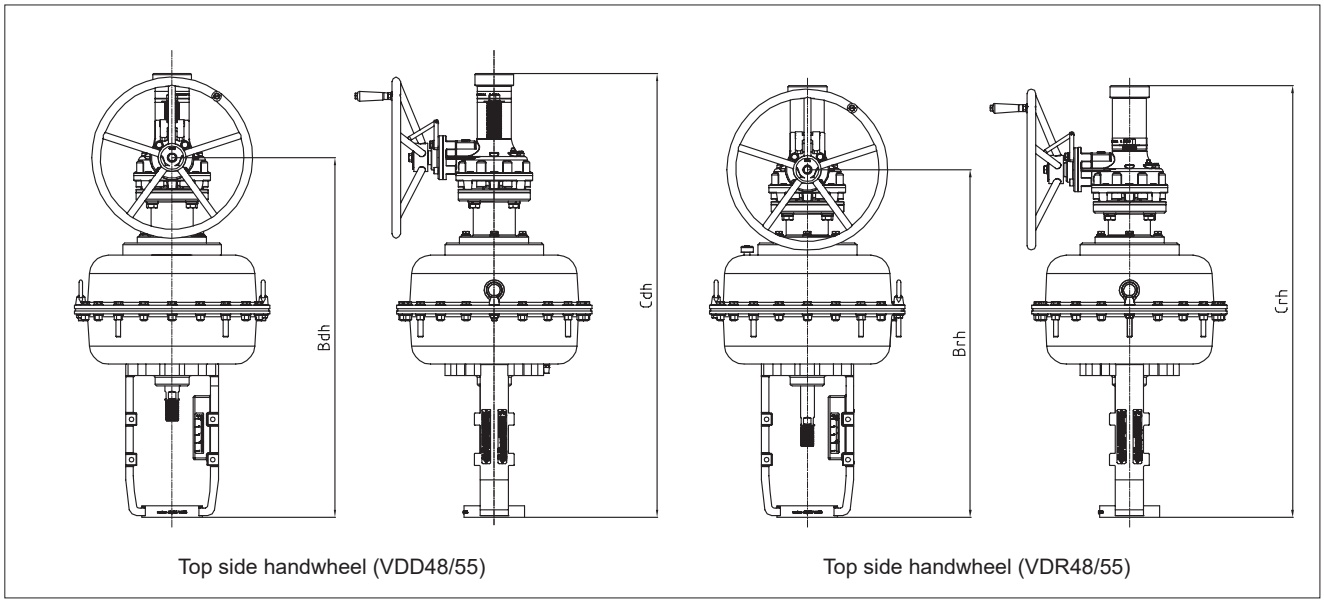


VDD VDR

Side handwheel (25/29/37)
Standard spring

Dimension (mm) / Size (mm)	Without handwheel				With handwheel				
	A2	Bd / Bhd	Br / Bhr	Weight (kg)	A2	A3	Bdh	Brh	Weight (kg)
VD_25 E	255	348	373	12	255	312	110	170	23
VD_25 D	255	373	395	17	255	312	110	170	28
VD_29 E	295	391	416	18	295	312	122	182	29
VD_29 D	295	431	453	26	295	312	122	182	32
VD_37 E	375	464	489	28	375	352	131	211	43
VD_37 D	375	514	535	46					

Dimension (inch) / Size (inch)	Without handwheel				With handwheel				
	A2	Bd / Bhd	Br / Bhr	Weight (kg)	A2	A3	Bdh	Brh	Weight (kg)
VD_25 E	10	14	15	26	10	12	4	7	51
VD_25 D	10	15	16	37	10	12	4	7	62
VD_29 E	12	15	16	40	12	12	5	7	64
VD_29 D	12	17	18	57	12	12	5	7	82
VD_37 E	15	18	19	62	15	14	5	8	95
VD_37 D	15	20	21	101					



Top side handwheel (VDD48/55)

Top side handwheel (VDR48/55)

Dimension (mm) / Size (mm)	Without handwheel				With handwheel				
	A2	Bd / Bhd	Br / Bhr	Weight (kg)	A2	A3	Bdh	Brh	Weight (kg)
VD_48 E	486	652	677	86	896	865	1102	1072	112
VD_48 D	486	702	724	118	946	915	1152	1122	144
VD_55 E	566	695	720	112	940	910	1145	1115	145
VD_55 D	566	745	767	152					

Dimension (inch) / Size (inch)	Without handwheel				With handwheel				
	A2	Bd / Bhd	Br / Bhr	Weight (kg)	A2	A3	Bdh	Brh	Weight (kg)
VD_48 E	19	26	27	190	35	34	43	42	247
VD_48 D	19	28	29	260	37	36	45	44	317
VD_55 E	22	27	28	247	37	36	45	44	320
VD_55 D	22	29	30	335					

NOTE
1. “E” refers to Spring range 0.8~2.6
2. “D” refers to Spring range 1.5~3.4
3. “Br / Bhr” refers to reverse acting actuator, VDR E / D
4. “Bd / Bhd” refers to direct acting actuator, VDD E / D
5. “Cdh / Crh” Top side handwheel actuator, VD_48/55

10. TYPE CODE

Pneumatic Diaphragm Actuator, Linear Type, Series VD													
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
VD	D	25	E	020	A	E	A	K	X	X	A	X	R

ACTUATOR CONSTRUCTIONS

1.	ACTUATOR SERIES
VD	Pneumatic Diaphragm actuator, Linear type

2.	FUNCTION CODE		
	Direction	Spring to	Air to Stem
D	Direct acting	Open	Extended
R	Reverse acting	Close	Retracted

3.	ACTUATOR SIZE
	Outline Dimension
25	Ø255 mm
29	Ø295 mm
37	Ø375 mm
48	Ø486 mm
55	Ø566 mm

4.	SPRING RANGE		
	bar	psi	Supply Air Press.
E	0.8 - 2.6	11 - 37	3.2 bar / 44 psi
Optional Spring Range			
D	1.5 - 3.4	21 - 48	3.9 bar / 55 psi
Y	Special	Special	Special

5.	STROKE					
	Desc.	VD_25	VD_29	VD_37	VD_48	VD_55
020	20 mm	STD	STD	STD	IQI	IQI
030	30 mm	N/A	STD	STD	IQI	IQI
040	40 mm	N/A	STD	STD	STD	STD
050	50 mm	N/A	N/A	STD	STD	STD
060	60 mm	N/A	N/A	N/A	STD	STD
070	60 mm	N/A	N/A	N/A	STD	STD
080	80 mm	N/A	N/A	N/A	N/A	STD
YYY	Special	Contact Valmet for special stroke				

MATERIALS

6.	ACTUATOR CASE MATERIAL
A	JIS G3101-SS400 (ASTM A-36)
Y	Special

7.	DIAPHRAGM MATERIAL	
	Material	Description
E	EPDM	General material for --40 to +85 °C
S	Low temp. Silicone	Low temperature material for -55 to +75 °C
Y	Special	Other special material

8.	SEAL MATERIAL	
	Material	Temperature
A	Nitrile Rubber	-20...+85 °C
L	Low temp. NBR	-40...+70 °C
S	Low temp. Silicone	-55...+70 °C
Y	Special	Other special material

9.	BOLTING MATERIAL
K	Stainless steel
Y	Special

OTHERS

10.	POSITION LIMITATION
X	Not applicable
Optional Application	
M	Mechanical Stopper
Y	Special

11.	EXTERNAL OVERRIDE OPTION
X	Not applicable
A	Side Handwheel mounted (applicable 25/29/37 sizes only)
T	Top-Side Handwheel mounted (applicable 48/55 sizes only)
Y	Special mounting side or Special H/W construction

- Handwheel is not applicable for 'D' spring option (sign 4).
- Field reversible function is not available with H/W construction.

12.	AIR SUPPLY CONNECTION	
	Connection Size	Actuator Size
A	1/4" NPT	VD_25/29/37/48/55
Y	Special	

13.	OPTIONS
X	Not applicable
Y	Special

14.	MODEL CODE
R	Model R

11. GENERAL SAFETY WARNINGS AND DISCLAIMERS

General safety warnings

Lifting

1. Always use a lifting plan created by a qualified person to lift this equipment. Lifting guidance is provided in this IMO (Installation, Maintenance and Operation manual) to assist in lifting plan development. Think about the point center of gravity (CG) of the equipment being lifted. Make sure the CG is always under the central lifting point.
2. Valves may be equipped with lifting threads on the body or on the flanges. These are which are intended for use with the lifting plan.
3. Use only correct and approved lifting devices. Ensure that lifting devices and straps are securely attached to the equipment prior to lifting.
4. Check, that lifting devices are not damaged and in good condition with a valid check stamp prior to use.
5. Workers must be trained for lifting and handling valves.
6. Never lift an assembly by the instrumentation (solenoid, positioner, limit switch, etc.) or by the instrumentation piping. Straps and lifting devices should be fitted to prevent damage to instrumentation and instrumentation piping. Failure to follow the lifting guidance provided may result in damage and personal injury from falling objects.

Work activities on the valve

1. Wear your personal safety equipment. Personal safety equipment includes but is not limited to protective shoes, protective clothing, safety glasses, helmet, hearing protection and working gloves.
2. Always follow the local safety instructions in addition to the Valmet instructions. If Valmet instructions conflict with local safety instructions, stop work and contact Valmet for more information.
3. Before beginning service on the equipment, make sure that the actuator is disconnected from any kind of power source (pneumatic, hydraulic, and/or electric), and no stored energy is applied on the actuator (compressed spring, compressed air volumes, etc.). Do not attempt to remove a spring return actuator unless the stop screw is carrying the spring force.
4. Make sure that there is a LOTOTO (Lock Out / Tag Out / Try Out) procedure in place for the system in which the valve is installed and strictly follow it.
5. Always make sure that the pipeline is depressurized and in ambient temperature condition before maintenance work is started.
6. Keep hands and other body parts out of the flow port when the valve is being serviced and the actuator is connected to the valve. There is a high risk of serious injury to hands and/or fingers due to malfunction if the valve suddenly starts to operate.

General disclaimers

Receive, handle and unpacking

1. Respect the safety warnings above!
2. Valves are critical components for pipelines to control high pressure fluids and must therefore be handled with care.
3. Store valves and equipment in a dry and protected area until the equipment is installed.
4. Keep the original packaging on the valve as long as possible to avoid environmental contamination by dust, water, dirt, etc.
5. Remove the valve endcaps just before mounting into the pipeline.
6. FOR YOUR SAFETY IT IS IMPORTANT THE FOLLOWING PRECAUTIONS BE TAKEN PRIOR TO REMOVAL OF THE VALVE FROM THE PIPELINE OR BEFORE ANY DISASSEMBLY:
   - Be sure you know what fluid is in the pipeline. If there is any doubt, confirm with the proper supervisor.
   - Wear any personal protective equipment (PPE) required for working with the fluid involved in addition to any other PPE normally required.
   - Depressurize the pipeline, bring to ambient temperature, and drain the pipeline fluid.
   - Cycle the valve to relieve any residual pressure in the body cavity.
   - After removal but before disassembly, cycle the valve again until no evidence of trapped pressure remains.
7. The identification plate (nameplate, or engraved markings) on the valve gives the information of max. process conditions to the valve.
8. Temperatures and pressures must never exceed values marked on the valve. Exceeding these values may cause uncontrolled release of pressure and process fluid. Damage or personal injury may result.
9. Valmet valves typically are designed to be used in atmospheric conditions. Do not use valves under external pressurized conditions unless specifically designed and explicitly marked for this service.
10. Avoid Pressure shocks or water hammer. Systems with high pressure valves should be equipped with a bypass to reduce the differential pressure before opening the valve to avoid pressure shock.
11. Avoid thermal shock. High temperature, Low temperature and cryogenic valves should be operated in a way that limits the rate of increase or decrease in temperature. The valve should be thermally stabilized before being pressurized.
12. Materials of the valve are carefully selected for the process conditions. Changes to the process media can have a major impact on function and safety of the valve. Always confirm the materials are suitable for the service prior to installation.
13. As the use of the valve is application specific, a number of factors should be taken into account when selecting a valve for a given application. Therefore, some situations in which the valves are used are outside the scope of this manual.
14. It is the end user’s responsibility to confirm compatibility of the valve materials with the intended service, however if you have questions concerning the use, application, or compatibility of the valve for the intended service, contact Valmet for more information.
15. Never use a valve with enriched or pure oxygen if the valve is not explicitly designed and cleaned for oxygen. Selected materials and design have a major impact on the safety to operate the valve with oxygen.
16. Valves intended for use in or with explosive atmospheres must be equipped with a grounding device and marked according ATEX (or equivalent international standards).

Maintenance

17. Respect the safety warnings above!
18. Plan service and maintenance actions, that spare parts, lifting devices and service personnel is available.

19. Maintain the valve within the recommended minimum maintenance intervals or within the recommended maximum operating cycles.
20. Always make sure that the valve and the pipeline is depressurized before starting any kind of maintenance work at a valve.
21. Always check the position of the valve before starting maintenance work. Follow the Lock out /tag out (LOTO) rules at the site before starting any maintenance activity.
    - See IMO for the correct stem position.
    - Consider that the positioner may give the wrong signals.
22. Sealing materials (soft sealing parts) should be changed when the valve is maintained. Always use original equipment manufacturers (OEM) spare parts to ensure proper performance of the repaired valve.
23. All pressure containing parts must be inspected visually for damage or corrosion. Damaged parts must be replaced.
24. Valve pressure bearing parts and all internals must be inspected for corrosion or erosion which may result in reduced wall thickness on pressure bearing parts. Damaged pressure bearing parts must be replaced with original equipment manufacturer's (OEM) replacement parts or repaired to factory specifications by an authorized Valmet service partner in order to maintain the warrantee.
25. Do not use sharp tools, grinding machines, or files to work on functional surfaces such as sealing, seating or bearing surfaces as this can damage these surfaces.
26. Do not weld on pressure bearing parts without an ASME and PED qualified procedure and personnel.
27. Pressure bearing parts of valves in high temperature applications must be carefully examined for the effects of material creep and fatigue.
28. Make sure that the valve is positioned in the correct flow direction into the pipeline.
29. If the valves are marked to be suitable for explosive atmospheres, the correct function of the discharging device must be tested before returning to service.
30. Always work in a clean environment. Avoid getting particles inside the valve due to machining, grinding, or welding nearby.
31. Never store a maintained valve without flow port protection.
32. When pressure testing valve seats, never exceed the maximum operating pressure of the system or the maximum shut-off pressure marked on the valve identification plate.
33. Actuator mounting and unmounting:
    - Before installing the actuator on to the valve, be sure the actuator is properly indicating the valve position. Failure to assemble these to indicate correct valve position may result in damage or personal injury.
    - When installing or removing a linkage kit, best practice is to remove the entire linkage assembly, including couplings which may fall off the valve during lifting or when position changes.
    - Mounting sets have been designed to support the weight of the Valmet actuator and recommended accessories. Use of the linkage to support additional equipment or additional weight such as people, ladders, etc. may result in equipment damage or personal injury.
34. The valve should be installed between flanges using appropriate gaskets and fasteners that are compatible with the application, and in compliance with applicable piping codes and standards. Center the gaskets carefully when fitting the valve between the flanges. Do not attempt to correct pipeline misalignment by means of the flange bolting.
35. Repairs on valves for special service like Oxygen, Chlorine, and Peroxide, have special requirements.
    - Parts must be cleaned appropriate to the service and protected from contamination prior to assembly.
    - Assembly areas and tools must be clean and dry to prevent contamination of the parts during assembly.
    - Test equipment must be clean and dry to prevent contamination during testing. This includes the test equipment internals that may allow particles or other contamination into the test fluid during the test.
    - Lubrication shall be used only if specifically required in the instructions. Where lubrication is required, the lubricant must be approved for the service by the end user.

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