ACTREG

POWER IN AUTOMATION

SY01K SERIES
PNEUMATIC SCOTCH YOKE ACTUATOR

INSTALLATION AND OPERATING INSTRUCTION MANUAL

Manufacturing program:

CE Ex II 2 G D

Quality Management:

ISO 9001
BUREAU VERITAS Certification

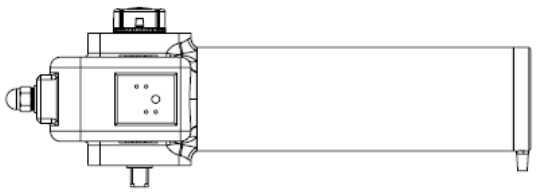
Safety Inregrity Level
SIL 3
IEC61508/IEC61511

INDEX

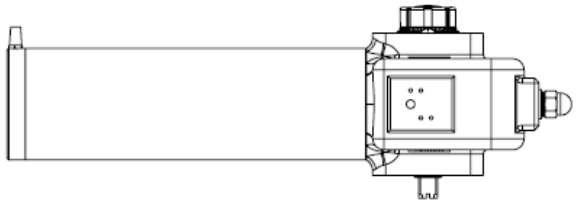
1. Summary

This manual provides the users all the necessary information for the correct manipulation and operation the actuator. The SY01K series of ACTREG actuators, are pneumatic actuators for operate quarter turn (90º) valves, with a compact design and three different sizes: SY01K10, SY01K12 and SY01K15. Each size has the double acting and the spring return model, and the same actuator with safety position can be mounted as a "fail close" position or "fail open" position.

Spring return "fail close":



Spring return "fail open":



2. Working conditions

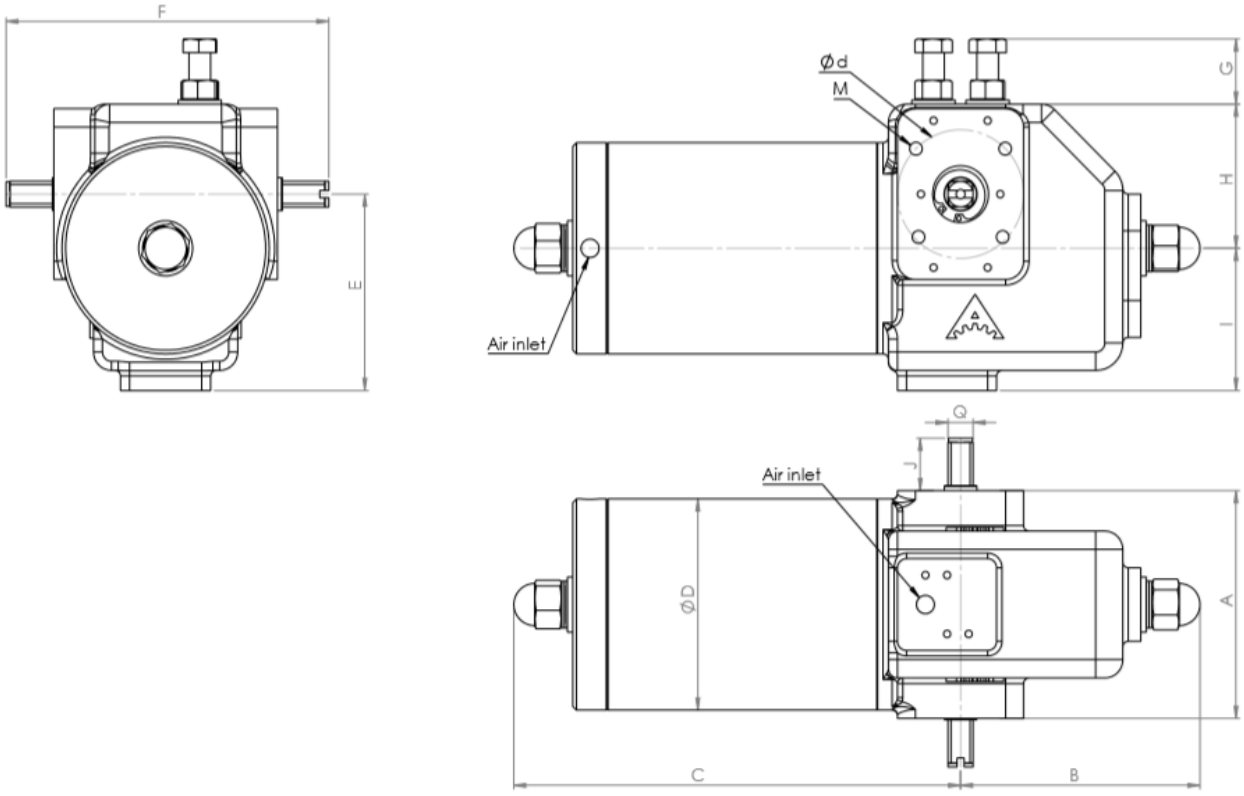
The operating pressure is the range of pressure where the actuator can operate and ensure the lifetime of the actuator. The design pressure is the maximum pressure that can resist the actuator without danger.

- Operating pressure: 0 ~ 8 bar.
- Testing pressure: 12 bar.

The operating fluid of the actuator is dry and clean air and the range of operating ambient temperature guaranteed is -30°C to 100°C for the standard actuators.

3. Technical data

3.1 Dimensions



	A	B	C	Ø D	E	F	G	H	I	Ø d	M	Q	J	AIR INLET
SY01K10 DA	120	135	250	115	107	179	33	78,5	77,5	70	M8	14	29,50	G1/4”
SY01K10 SR			305											
SY01K12 DA	160	164	346	130	128.25	220	33	107	86	125	M12	22	30	G1/4”
SY01K12 SR			492											
SY01K14 DA	176	191	395	165	161	235,51	45	141	109	125	M12	27	29,75	G1/4”
SY01K14 SR			561											

	Weight (kg)	Volume 1 (L)	Volume 2 (L)		Weight (kg)	Volume 1 (L)
SY01K07 DA	10	0.73	0.36	**SY01K07 SR**	13	0.36
SY01K10 DA	15	1.55	0,81	**SY01K10 SR**	18	1.55
SY01K12 DA	32	3.30	1.58	**SY01K12 SR**	38	3.30
SY01K14 DA	51	5.30	2,90	**SY01K14 SR**	64	5.30

3.2 Torque

Torque is measured in Nm.

	DOUBLE ACTING																	
	3 Bar			4 Bar			5 Bar			6 Bar			7 Bar			8 Bar		
	Start	Running	End	Start	Running	End	Start	Running	End	Start	Running	End	Start	Running	End	Start	Running	End
SY01K07DA	85	54	86	113	73	116	141	91	145	169	109	174	198	127	203	226	145	231
SY01K10DA	168	106	167	224	141	222	281	177	277	337	212	333	392	247	389	449	283	444
SY01K12DA	341	213	338	455	284	451	568	355	563	682	426	677	796	497	789	909	568	902
SY01K14DA	640	407	659	853	542	878	1067	678	1098	1280	814	1317	1493	949	1536	1706	1085	1756

For 4.5 & 5 bar torques refer to other chart.

	SINGLE ACTING (4 Bar)																	
	4 Bar			5 Bar			6 Bar			7 Bar			8 Bar			SPRING RETURN (4 Bar)		
	Start	Running	End	Start	Running	End	Start	Running	End	Start	Running	End	Start	Running	Start	End Cl.	Running	Start Cl.
SY01K07SR4	78	34	43	107	51	73	138	68	104	167	86	134	198	104	164	42	34	80
SY01K10SR	166	69	75	226	103	134	285	136	193	344	170	251	404	203	310	70	65	159
SY01K12SR	343	136	137	463	203	256	583	271	375	703	338	49	823	406	613	137	134	339
SY01K14SR	623	253	279	848	382	511	1074	511	743	1299	639	975	1524	769	1207	277	262	647

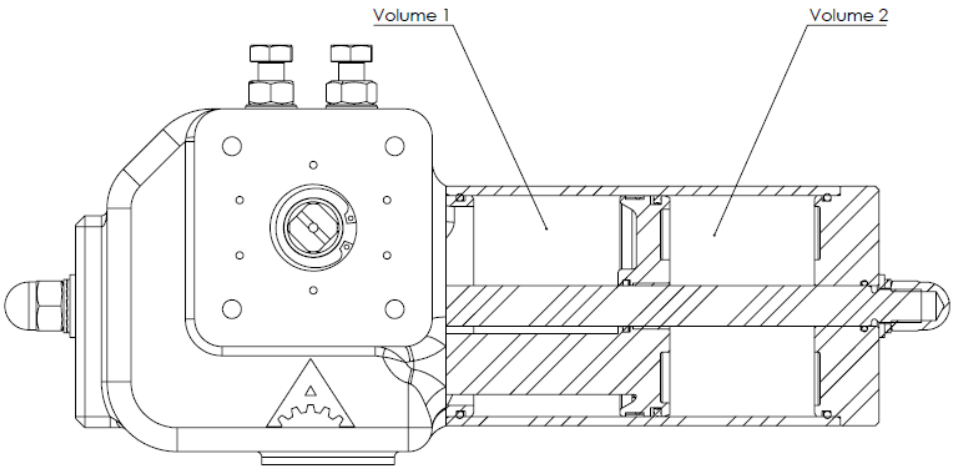
For 4.5 & 5 bar torques refer to other chart.

	SINGLE ACTING (6 Bar)														
	5 Bar			6 Bar			7 Bar			8 Bar			SPRING RETURN (6 Bar)		
	Start	Running	End	Start	Running	End	Start	Running	End	Start	Running	End	End Cl.	Running	Start Cl.
SY01K07SR6	168	69	75	227	103	142	287	137	192	346	170	251	128	98	218
SY01K10SR	168	69	75	227	103	142	287	137	192	346	170	251	128	98	218
SY01K12SR	346	139	143	466	206	263	586	274	382	706	341	501	254	199	451
SY01K14SR	662	257	258	887	387	490	1112	516	722	1338	644	954	463	386	900

For 4.5 & 5 bar torques refer to other chart.

4. Installation and Commissioning

The ACTREG actuator must be installed according to the instructions listed in this manual, and to ensure the



safety of the installation and commissioning please follow the instructions and pay attention to the warnings.

These are some tips for the correct and save installation:

- Check the packaging is fully secure in the event that it is to be moved.
- Always use endorsed chains and mooring straps of sufficient strength for moving the Actuator or the crates. Make sure they are in good condition. The weight of the crates is specified on them, and the weight of the actuators is indicated on the corresponding drawings.
- Hold the boxes by the marked mooring points.
- Never pass an actuator or a crate through the air over a person.
- Storing actuators must be carried out according to operation and maintenance paragraphs of this manual.
- When opening the crates, be careful with packing nails. Never leave the point of a nail sticking out, remove the nail completely from the crate if necessary. Do not handle crates with bare hands are there could be splinters.
- When the actuator is to be installed at a height above the ground, follow local safety regulations on working at heights.
- The installation should be avoided in high temperature, low temperature, high moisture and corrosive enviroments.

After installing the actuator will proceed to its connection. In the drawing included in this manual you will find where to plug the air connections. First, visually check the threads to make sure they

are free of dirt and particles before start using the actuator. Also prevent the dust from entering the exhaust ports installing some silencers or redirecting the air.

Pneumatic piping to the ACTREG actuator shall be kept as short and straight as possible to minimize airflow restrictions and potential clogging. Long or kinked tubes may also increase valve closure time. The pipes mounted on the actuator must not suffer vibrations while it is transported or in the place installed, otherwise the fittings could loose and create leaking points causing malfunction of the actuator.

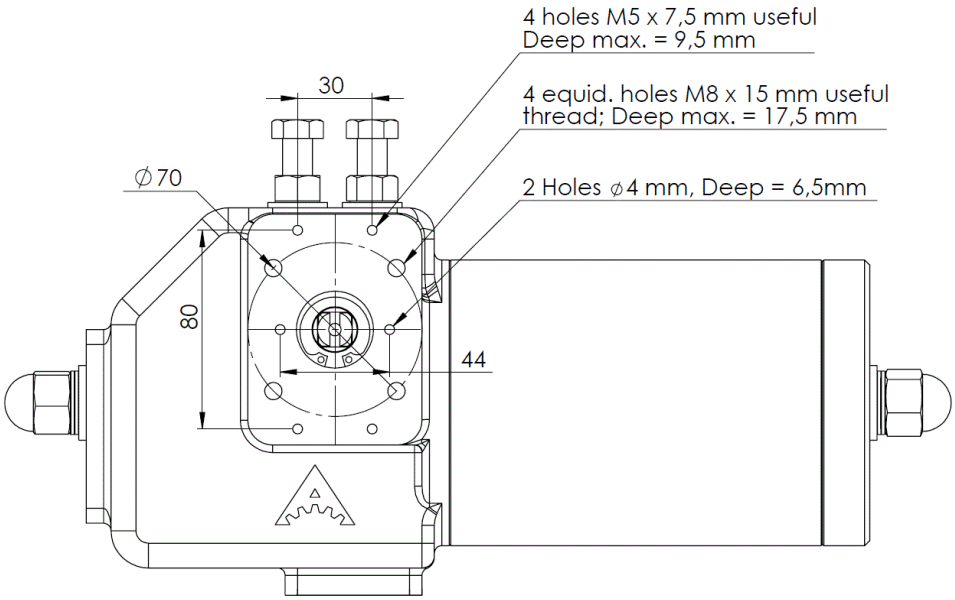
It is recommended to filter the air used to operate the actuator with a minimum of 40 µm filter to prevent the dust enters inside. Also, the air has to be dry, otherwise the condensation accumulates water inside the actuator and mixed with the grease, reduces the lifetime of the actuator and produces corrosion.

5. Accessories

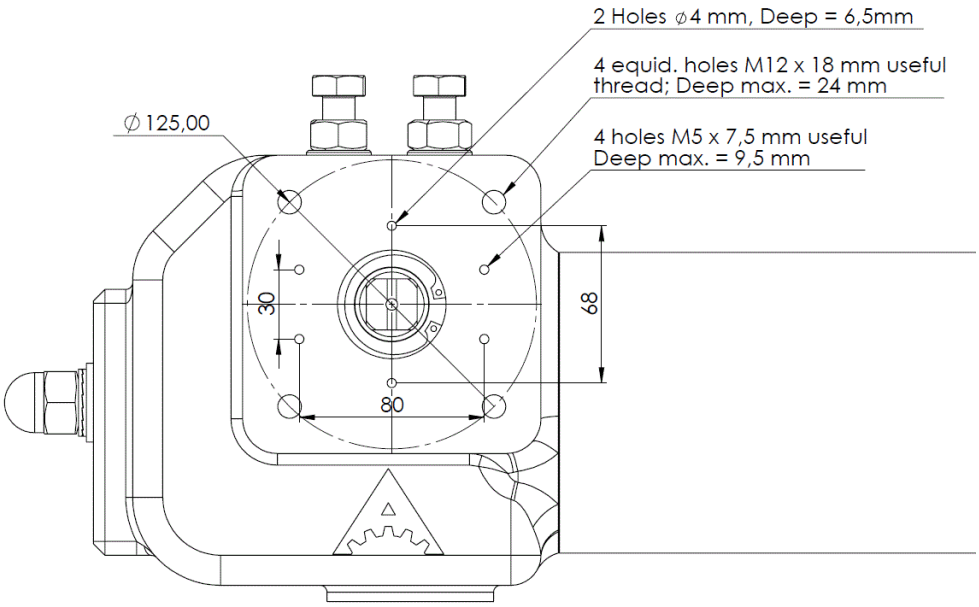
5.1 Device connections

The actuator has a flange connection according to ISO 5211 / DIN 3337 to fit valves or other devices. Also, the actuator has normalized connection according to EN 15714-4 for accessories and auxiliar monitoring devices.

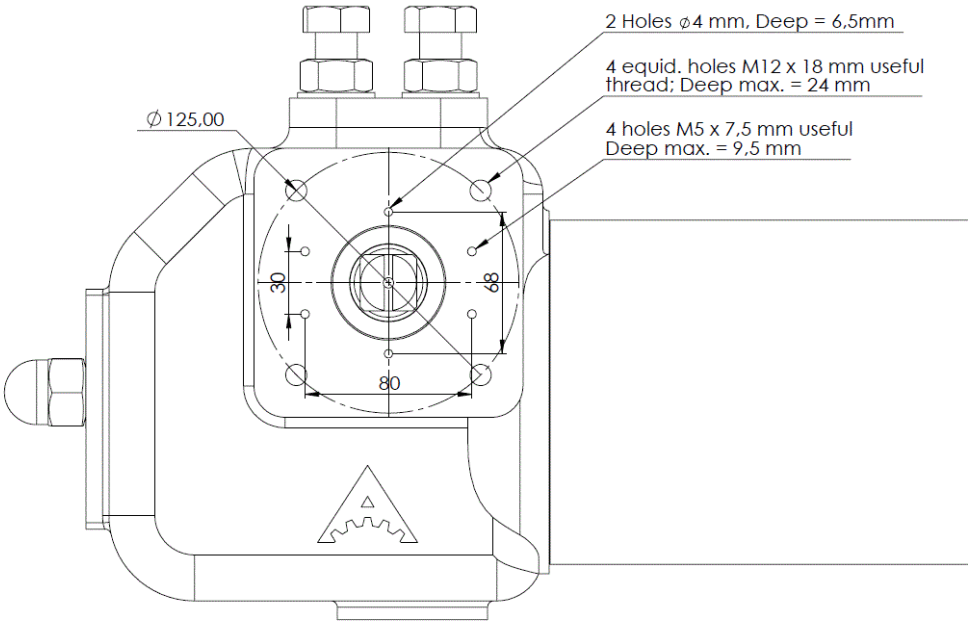
SY01K10



SY01K12

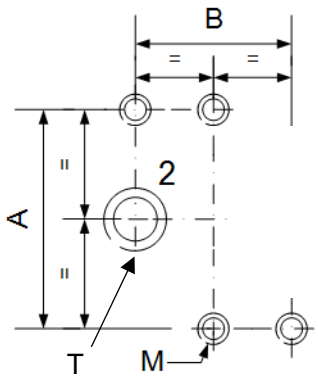


SY01K15

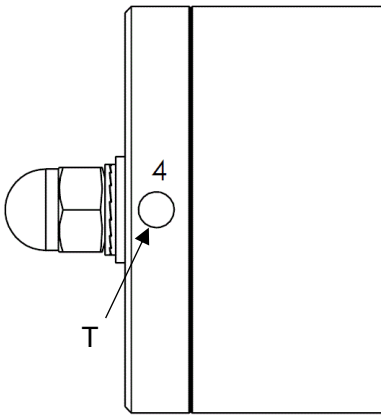


5.2 Air connection

For pneumatic devices, for example solenoid valves, the connection is the standard NAMUR VDI / NAMUR VDE 3845 Standard, only 3/2-way valves because the connection only have inlet number 2. The inlet number 4 is at the end cap cylinder.



T	A	B	M
G1/4"	32	24	M5



6. Operation

The actuator has to sides, for the spring return actuators, one side is for mounting the actuator in *"fail close"* position and the other side is for mounting *"fail open"* position. In *"fail close"* position the inlet number 2 is for open the valve, and the inlet number 4 it is not used. For the *"fail open"* position the inlet number 2 is for closing the valve.

The standard for the double acting actuators is to open the valve supplying air at the inlet number 2 and close the valve with the inlet number 4.

6.1 Auto-Operation

To control the actuator with other devices like positioners or solenoid valves, first choose the safety function of the actuator.

On/Off Control Pneumatic Actuated Valve: (example of the sequence of operations with a 3/2-way solenoid valve connected at the NAMUR interface)

The valve open when solenoid valve energized (Fail Close Actuator Type).
The valve close when solenoid valve de-energized (Fail Close Actuator Type).

The valve close when solenoid valve energized (Fail Open Actuator Type).

The valve opens when solenoid valve de-energized (Fail Open Actuator Type).

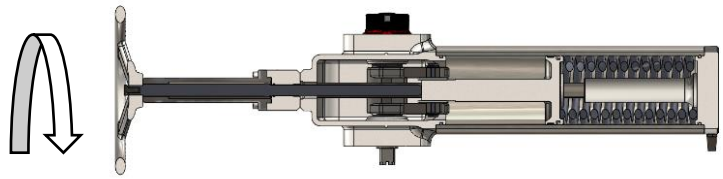
Modulating Control Pneumatic Actuated Valve:

To give 4-20mADC signal to Electro-Pneumatic positioner or 0.02 ~ 0.1Mpa to Pneumatic–Pneumatic positioner, the valve position can be proportionally controlled by the input signal.

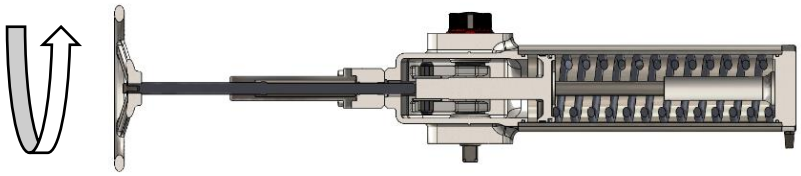
6.2.- Manual operating way

The manual operating runs by a jackscrew operator, turning the hand wheel or the lever to control the valve position by screwing in & out the trapezoid screw in spring case. After manual operation, screw out the trapezoid screw when it changes to auto-operation way, to ensure the auto-operation smoothly realized. Avoid to screw out integral trapezoid screw, the valve open & close position will be influenced if the screwing is not in place.

Operation with manual override - Spring return



If the actuator is Fail Close, manually open the valve turning clockwise. If the actuator is Fail Open, manually close the valve turning clockwise.



If the actuator is Fail Close, manually close the valve turning counterclockwise. If the actuator is Fail Open, manually close the valve turning counterclockwise.

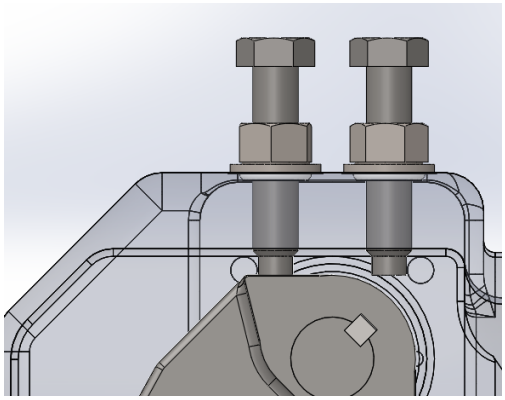
	Length with HW Open (mm)	Length with HW Closed (mm)	HW shaft distance travel (mm)
SY01K10-HW	729	627,5	101,5
SY01K12-HW	1036	894	142
SY01K15-HW	1168	993	175

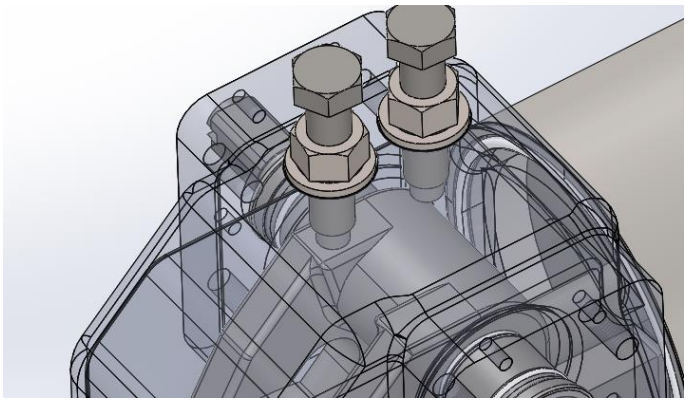
⚠ The most important thing before operating the actuator manually is to release the air pressure from the actuator. Trying to turn the jackscrew with air pressure inside the actuator could damage the actuator and it is very dangerous for the operator.

7. Stroke Adjustment

ACTREG pneumatic actuators are provided with bi-directional pinion travel stops. Top located stops allow a full ±5° travel adjustment between 85° and 95°. Adjustment of the counter clockwise and clockwise rotation limits is accomplished by unscrewing the locking nuts. 1/3 turn of those locking nuts means 1º of the stroke.

The way of stroke adjustment is loosening the stroke nut firstly, then regulate the stroke by screwing in or out the two adjusting screws.





⚠ Please note to tighten the bolt nut after adjusting the appropriate on/off position.

Do not adjust more than 5° each side, designed by the manufacturer. Internal parts could be damaged.

8. Maintenance

PREVENTIVE MAINTENANCE

This basically consists in a periodic inspection to check the actuator function. Actuators must be operated at least once every six months. However, depending on the application of the actuator, this may be done within shorter periods. It is the end user's responsibility to establish these operation plans depending on the working conditions.

It is recommended to replace the critical parts of the actuator when an in-depth revision of the installation is made.

MAINTENANCE OPERATIONS

First of all, disassemble the actuator from the valve or the system. Then follow these steps:

- Check visually the exterior of the actuator to see any damage or corrosion that can affect the functionality of the actuator.
- Check the functionality operating the actuator a few times.
- Disassemble the actuator and check all the internal parts, if they are worn out replace the parts that has been affected. The soft parts like the O-rings will be the ones that wear out the fastest.

Parts of the actuator will have to be repaired or replaced as soon as there is leakage. As soon as this happens, proceed with the disassembly of the actuator and replacement of all the parts affected.

Always check that the actuator is not pressurized before manipulating it.
Never leave the actuators opened or closed during a long period of time.
It is advisable to isolate the equipment from vibration sources to avoid possible stress relief of the fasteners
Never overcome the service pressure fixed in 8 bars.
Never fill the pneumatic cylinder with another fluid different than clean and dry air. To fill with another fluid first ask to manufacturer.
Never transport the equipment with an internal pressure different than the atmospheric.
Never install this equipment in nuclear plants.
Never manipulate the bolting of the equipment during the operation of the equipment.
Always wear adequate protective clothing (Follow the safety guidelines established by your company!
Any parts replacement should be done with the original ACTREG spare parts!!
The manufacturer will not be responsible of the wrong functioning of the actuator if original ACTREG parts have not been used.
After the maintenance check or a repairing disassemble, re-grease the internal parts of the actuator for the correct function of the actuator and to prevent the worn out of the internal parts.

To avoid these kinds of problems please follow the next requirements for the correct functionality of the actuator:

Air quality required:

For best possible service life and trouble-free operation, ISO 8573-1 quality class 5.4.4 should be used. This means 40µm filter, dew point +3ºC for indoor operation (a lower dew point should be selected for outdoor operation, Quality class 3) and oil concentration 5.0 mg oil/m^3.

Quality Class	Solid particles		Moisture		Oil
	Max. particle size (µm)	Max. concentration (mg/m³)	Max. press. dew point (ºC)	Max. concentration (g/m³)	Max. concentration (mg/m³)
1	0.1	0.1	-70	0.003	0.01
2	1	1	-40	0.12	0.1
3	5	5	-20	0.88	1.0
4	15	8	**+3**	**6**	**5.0**
5	**40**	**10**	+7	7.8	25
6	-	-	+10	9.4	-

Lubrication:

Actuators are factory lubricated for the lifetime in normal working conditions and do not require any further lubrication. If the actuator is manipulated by the costumer the manufacturer cannot guarantee this statement.

9. Functional Safety relevant Specifications

Safety Function

The ACTREG pneumatic actuators are typically used with another interface components (valve positioner or solenoid valve) and a valve to provide a final element subassembly for a safety Instrumented Function (SIF).

The safety position must be reached using the mechanical elements of the actuator or other external devices if the actuator does not have one. When the air or electricity supply fails, this safety elements take the valve to the safe position.

Application Limits

The material constructions of an ACTREG pneumatic actuators are specified in the ACTREG data sheets and in the main literature. It is especially important that the designer of the SIF checks for material compatibility considering on-site chemical contaminants and air supply conditions. If the ACTREG pneumatic actuators are used outside the application limits or with incompatible materials or environment, the reliability data and predicted SIL capability becomes invalid.

Design Verification

A detailed Failure Modes, Effects and Diagnostics Analysis (FMEDA) report is available from ACTREG for this product. This report details all failure rates and failure modes as well as expected lifetime of the product. The achieved Safety Integrity Level (SIL) of an entire Safety Instrumented Function (SIF) design must be verified by

the designer via a calculation of PFDAVG considering the architecture, proof test interval, proof test effectiveness, any automatic diagnostics, average repair time and the specific failures rates of all equipment included in the SIF. Each subsystem must be checked to assure compliance with minimum Hardware Fault Tolerance (HFT) requirements.

When using the ACTREG Pneumatic Actuator in a redundant configuration, a common cause factor of at least 5% should be included in the safety integrity calculations.

The failure rate data listed in the FMEDA report is only valid for the useful lifetime of the ACTREG Pneumatic Actuator. The failure rates will increase after this useful lifetime period has expired. Reliability calculations based on the data listed in the FMEDA report for mission times beyond the lifetime may yield results that are too optimistic, i.e., the calculated SIL will not be achieved.

SIL Capability

ACTREG Pneumatic actuators are suitable for use in a safety instrumented system up to SIL 2. Under consideration of the minimum required hardware fault tolerance HFT=1 the devices may be used in a redundant structure up to SIL 3.

ACTREG pneumatic actuator should be actuated four times per year in order to accomplish with the safety requirements.

Systematic Integrity

The Actreg pneumatic actuator has met manufacturer design process requirements of safety integrity level (SIL) 3. There are intended to achieve sufficient integrity against systematic errors of design by the manufacturer.

General Requirements

The system and function response time shall be less than the process safety time. The ACTREG Pneumatic Actuator will move to its defined safe state in less than this time with relation to the specific hazard scenario. All SIS components including the ACTREG Pneumatic Actuator must be operational before process start-up. The User shall verify that the ACTREG Pneumatic Actuator is suitable for use in safety applications by confirming the ACTREG Pneumatic Actuator nameplate and model number is properly marked. Personnel performing maintenance and testing on the ACTREG Pneumatic Actuator shall first be assessed as being competent to do so. Results from periodic proof tests and partial valve stroke tests (if any) shall be recorded and periodically reviewed.

Safety Related Values

Find below the Safety Related Values from the SIL Certificate N° 968/V 1029.01/22:

Results of Assessment

Route of Assessment		2_H / 1_s
Type of Sub-system		Type A
Mode of Operation		Low Demand Mode
Hardware Fault Tolerance	HFT	0
Systematic Capability		**SC3**

Spring Return

To move on direction of force Spring

Dangerous Failure Rate	λ_D	5.68 E-07 / h	**568 FIT**
Average Probability of Failure on Demand 1oo1	$PFD_{avg}(T_1)$	2.49 E-03	
Average Probability of Failure on Demand 1oo2	$PFD_{avg}(T_1)$	2.56 E-04	

To move on reverse direction of force Spring

Dangerous Failure Rate	λ_D	9.65 E-07 / h	**965 FIT**
Average Probability of Failure on Demand 1oo1	$PFD_{avg}(T_1)$	4.23 E-03	
Average Probability of Failure on Demand 1oo2	$PFD_{avg}(T_1)$	4.44 E-04	

Double Acting

Acting (to move) on demand

Dangerous Failure Rate	λ_D	6.42 E-07 / h	**642 FIT**
Average Probability of Failure on Demand 1oo1	$PFD_{avg}(T_1)$	2.81 E-03	
Average Probability of Failure on Demand 1oo2	$PFD_{avg}(T_1)$	2.91 E-04	

Assumptions for the calculations above: DC = 0 %, T_1 = 1 year; β_{1oo2} = 10 %

10. Handling and Storage

HANDLING AND STORAGE

All actuators must be examined upon delivery to ensure that they have not suffered any damage during transport. Inform the supplier immediately if there is any damage. As standard, actuators will leave the factory in closed position. Open position configuration must be specially requested.

Actuators must be stored under cover and protected from inclement weather conditions and dampness with air conducts properly covered and should not be unpacked until their definitive installation, except for inspection purposes.

The handling and transportation of actuators must be carried out with extreme precaution and using the necessary and adequate means depending on their size and weight in order to avoid risks to the operators handling them.

Actuators should be installed in such a way that they are easy to access in order to do the periodic inspections and corresponding maintenance operations necessary to guarantee the performance qualities that they have been designed for. Actuators must not support unexpected stress. It is important to do the assemble with a correct alignment and parallelism to guarantee that it is not submitted to unexpected stress.

After the installation carry out a final operational check of the actuator by making some opening and closing operations to ensure that it works properly. The use of dry air increases the lifetime of the actuators, as well as the lifetime of their accessories, solenoids and other pneumatic accessories.

During operation, a low demand mode SIF must be proof tested. The objective of proof testing is to detect failures within the equipment in the SIF that are not detected by any automatic diagnostics of the system. Of main concern are undetected failures that prevent the SIF from performing its function.

Periodic proof tests shall take place at the frequency (or interval) defined by a SIL verification calculation. The proof tests must be performed more frequently than (or as frequently as) specified in the SIL verification calculation in order to maintain the required safety integrity of the overall SIF. Results from periodic proof tests (a test per year four demand per test) and partial valve stroke tests (if any) shall be recorded and periodically reviewed. For detailed Proof Test information refer to the FMEDA report for the ACTREG Pneumatic Actuator.

Repair and replacement repair procedures outlined in the maintenance and installation instructions must be followed.

11. Remarks

- The equipment has been designed, manufactured and inspected according to the codes: ASME VIII div. I Ed 2010.
- Other directives that apply to this product: ATEX 2014/34/EC.
- Relevant union harmonization legislation: N/A.

Terms and Abbreviations

Describe Basic Terms of Functional safety: What is functional safety, safety function, safe state, fail safe, fail safe, fail dangerous, low demand mode etc.

Typical abbreviations:

- FMEDA: Failure Modes, Effects and Diagnostic Analysis
- HFT: Hardware Fault Tolerance
- PFD_{AVG}: Average Probability of Failure on Demand
- SFF: Safe Failure Fraction, the fraction of the overall failure rate of a device that results in either a safe fault or a diagnosed unsafe fault.
- SIF: Safety Instrumented Function, a set of equipment intended to reduce the risk due to a specific hazard (a safety loop), Safety instrumented control/protection function
- SIL: Safety Integrity Level, discrete level (one out of a possible four) for specifying the safety integrity requirements of the safety functions to be allocated to the E/E/PE safety-related systems where Safety Integrity Level 4 has the highest level of safety integrity and Safety Integrity Level 1 has the lowest.
- SIS: Safety Instrumented System — Implementation system of one or more Safety Instrumented Functions. A SIS is composed of any combination of sensor(s), logic solver(s), and final element(s).
- DC: Diagnostic Coverage Factor (if diagnostic measures exist)
- PTC: Proof Test Coverage Factor
- PFH: Probability of dangerous failure per hour
- PFD: Probability of dangerous failure per demand
- PVST: Partial valve stroke test
- BASIC SAFETY: Freedom from unacceptable risk of harm
- FAIL-SAFE STATE: State where solenoid valve is de-energized and spring is extended.
- FAIL ANNUNCIATION DETECTED: Failure that does not cause a false trip or prevent the safety function but does cause loss of an automatic and is not detected by another diagnostic

- FAIL ANNUNCIATION UNDETECTED: Failure that does not cause a false trip or prevent the safety function but does cause loss of an automatic or false diagnostic indication
- FUNCTIONAL SAFETY: Part of the overall safety relating to the process and the BPCS which depends on the correct functioning of the SIS and other protection layers.
- BPCS: Basic process control system – a system which responds to input signals from the process, its associated equipment, other programmable systems and/or and operator and generates output signals causing the process and its associated equipment to operate in the desired manner but which does not perform any safety instrumented functions with a claimed SIL $\geq$ 1

Reference Documents

- Special operating Instructions:

Actuators manufactured by Actreg can be equipped with a variety of Operating mechanisms, such as hand wheel, switch boxes, solenoid valves, relief valves, flow regulators, declutch able gear. This manual just covers the actuator stand alone.

- ACTREG Pneumatic actuator data sheet
- ACTREG actuator maintenance and installation instructions

Related Standards

- IEC 61508-2:2010 Functional safety of electrical/electronic/ programmable electronic safety-related systems
- IEC 60654-1:1993-02, second edition, industrial-process measurement and control equipment – Operation conditions.

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