

OPERATING & MAINTENANCE MANUAL

PNL-Series Pneumatic Linear Actuators



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1. Introduction

This manual should be thoroughly reviewed and understood prior to installing, operating or performing maintenance on Paladon Systems pneumatic double-acting (DA) and spring-return (SRO or SRC) linear actuators. Throughout the manual, safety and/or caution notes will appear and must be strictly adhered to; otherwise serious injury or equipment malfunction could result.

Paladon Systems has highly skilled service engineers available for start-up, maintenance and repair of our actuators and component parts.

In addition, a scheduled training program can be conducted at Paladon Systems' workshops to train customer service and instrumentation personnel in the operation, maintenance and application of Paladon Systems actuators and instruments. Arrangements for these services can be made through your local Paladon Systems representative or sales office.

When performing maintenance, use only Paladon Systems Limited replacement parts. Parts are obtainable through your local Paladon Systems representative or sales office. When ordering parts, please include the product and contract information as detailed in section 9 of this manual.

Actuator Types

- DA - Double-acting actuator with no spring
- SRO - Spring-return actuator which retracts the actuator's stem when pneumatic pressure is removed from the actuator
- SRC - Spring-return actuator which extends the actuator's stem when pneumatic pressure is removed from the actuator

Double-acting actuators comprise of a pneumatic cylinder.

Spring-return actuators comprise of a pneumatic cylinder with an internal spring.

Pressurizing the cylinder's top cap port for SRO type actuators results in the spring being compressed; pressurizing the cylinder's bottom cap port for SRC type actuators results in the spring being compressed.

For actuators with a manual override, the manual handwheel shall be operated with absence of pneumatic supply only. After manual operation the device shall be reset in automatic position.

Caution: Failure to reset the manual override may result in damage to the cylinder parts

2. General

The following is a step by step procedure for the removal of the Models SRO and SRC linear actuators from mainline valves. The intent of this procedure is to provide all the specialized data necessary to properly assemble, disassemble and test these actuators. These instructions are written for use by a qualified person, and therefore proper use of lifting devices is assumed. Various parts of linear actuator are large, heavy and therefore potentially dangerous if not handled properly. Proper equipment and training of personnel is the responsibility of the user.

Throughout this manual the item numbers relating to the appropriate parts of the assembly are noted in () parenthesis after each part reference to facilitate layout examination and assembly. At this point, it is wise to visually examine each part for obvious defects.

- Models DA require a pneumatic supply to extend and retract the actuator stem.

- Models SRO require a pneumatic supply to extend the actuator stem, whereas the spring retracts it.
- Models SRC require a pneumatic supply to retract the actuator stem, whereas the spring extends it.

The cylinder should be disassembled once every 5 years at a minimum to re-lubricate the cylinder and replace all soft parts. For equipment with high cycle rates, the cylinder may require more frequent disassembly. Prior to disassembly, check the cylinder for leakage by pressurizing one side of the cylinder. Cylinder, rod and bushing should be inspected for wear or damage and replaced as necessary.

3. Actuator Removal

Before removal from the mainline valve and disassembly, the actuator must be isolated, with the pneumatic supply lines to the cylinder removed, and any pipeline pressure to the mainline valve isolated. Prior to disassembly, pneumatic volume tanks should be emptied so that no trapped air remains in the cylinder. All electrical connections to the actuator must also be disconnected.

Maintenance of this actuator series requires removal of the actuator from the mainline valve. The steps in removal of the actuator are different depending on whether the actuator requires a pneumatic supply to either extend (Model SRO) or retract the actuator's stem (Model SRC); or requires a pneumatic supply to both retract and extend the actuator's stem (Model DA).

Note: Instructions are general in nature. Check valve instructions for additional instructions.

Note: Actuator action may be checked by referring to the valve identification tag.

3.1 Air to Extend (Model SRO)

- A. Loosen locknuts (23).
- B. Apply required air pressure to top cap (6) to put valve plug on seat. **Caution: Do not exceed supply pressure indicated on the working pressure tag.**
- C. Remove cap screws (38) from top and bottom stem connectors (36 and 37).
- D. Shut off air supply to top cap (6).
- E. Bleed off all air pressure in cylinder.
- F. Disconnect air piping from top cap (6).
- G. Remove top stem connector (36), and nut (23) from piston stem (4).
- H. Loosen and remove cap screws between valve and actuator top mounting.
- I. Connecting to lifting eyes (18) lift actuator assembly from the valve.

3.2 Air to Retract (Model SRC)

- A. Loosen locknuts (23).
- B. Remove cap screws (38) from top and bottom stem connectors (36 and 37).
- C. Apply required air pressure to the bottom cap (5) to retract piston stem (4) to mid stroke. **Caution: Do not exceed supply pressure indicated on the working pressure tag.**
- D. Remove top stem connector (36), and nut (23) from piston stem (4).
- E. Shut off air supply to bottom cap (5).
- F. Bleed off all air pressure in cylinder.

- G. Disconnect air piping from bottom cap (5).
- H. Loosen and remove cap screws between valve and actuator top mounting.
- I. Connecting to lifting eyes (18) lift actuator assembly from the valve.

4. Actuator Disassembly and Reassembly

Caution: The actuator cylinder is a spring loaded device.

Caution: It is recommended that disassembly or assembly work on these actuators be done in an upright position.

Actuator disassembly and reassembly can be carried out referring to the sectional drawing and the parts list.

5. Maintenance

- 5.1 All Paladon Systems Ltd actuators have been designed to provide long service with minimum maintenance; however, a preventative maintenance program is recommended. Preventative maintenance programs not only help avoid unanticipated and costly down time, but also typically reduce the overall cost of ownership.
- 5.2 It is the user's responsibility to ensure that all applicable health and safety legislation is followed when undertaking any maintenance work.
- 5.3 **WARNING! Before commencing any maintenance work, the actuator's pneumatic supply line, actuator and associated controls must be fully depressurised. After system depressurisation, the actuator and controls must be isolated from the supply line, and from any remote control signals. Failure to follow any of these steps may result in unanticipated actuator and valve movement, possibly resulting in serious injury or death.**
- 5.4 Any unauthorised maintenance or modification to the actuator and, where applicable, the control system may invalidate the warranty.
- 5.5 Periodic inspection is recommended, specifically;
 - That smooth valve operation is maintained, and within the required stroking time.
 - That there is no external damage to any components.
 - The pneumatic supply pressure is kept within the specified range.
 - Pneumatic connections do not show any signs of leakage.
 - Paint system remains undamaged.
 - That any dirt or debris is removed from actuator surfaces.

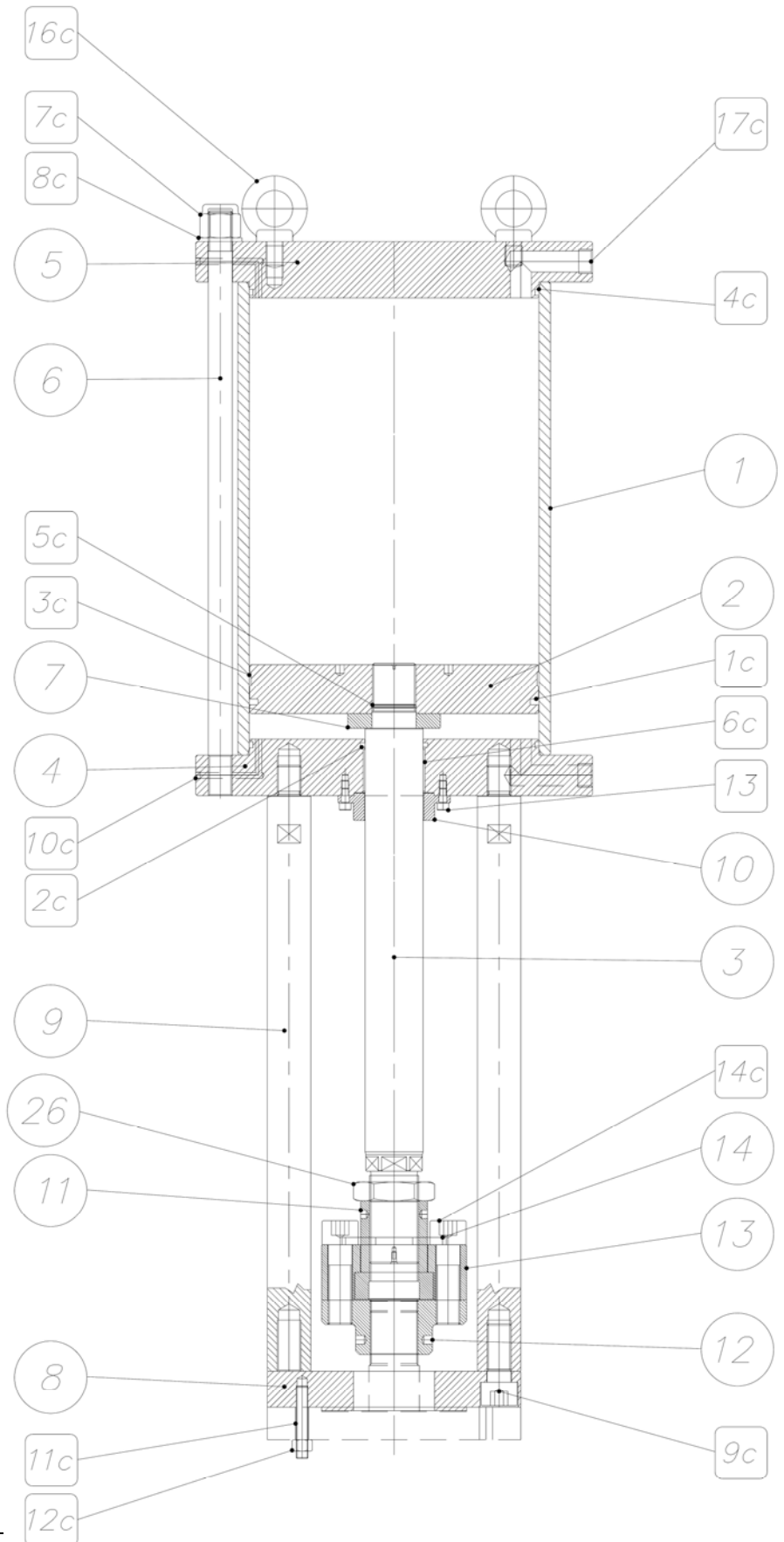
6. Testing

- 6.1 Case pressure integrity.
 - a. Pressurize the actuator cylinder with air to 8.25 bar (120 psi) and lock pressure in. Monitor any pressure change for 5 minutes.
 - b. Inspect for any sign of leakage with suitable leak detection solution.
- 6.2 Acceptable Criteria: Any observed loss in pressure is cause for rejection.

- 6.3 Operate the actuator through a minimum of five full travel cycles using 1/4" O.D. tubing direct input and a Cv = 0.3 exhaust valve (Nupro Model JN straight body is acceptable). Inspect for the following: (1) Smoothness of operation (2) Length of travel and (3) Travel time.
- 6.4 To disassemble actuator, refer to instructions on page 4.
- 6.5 All seals and guides in the actuator should be inspected once every 5 years minimum and replaced if necessary.

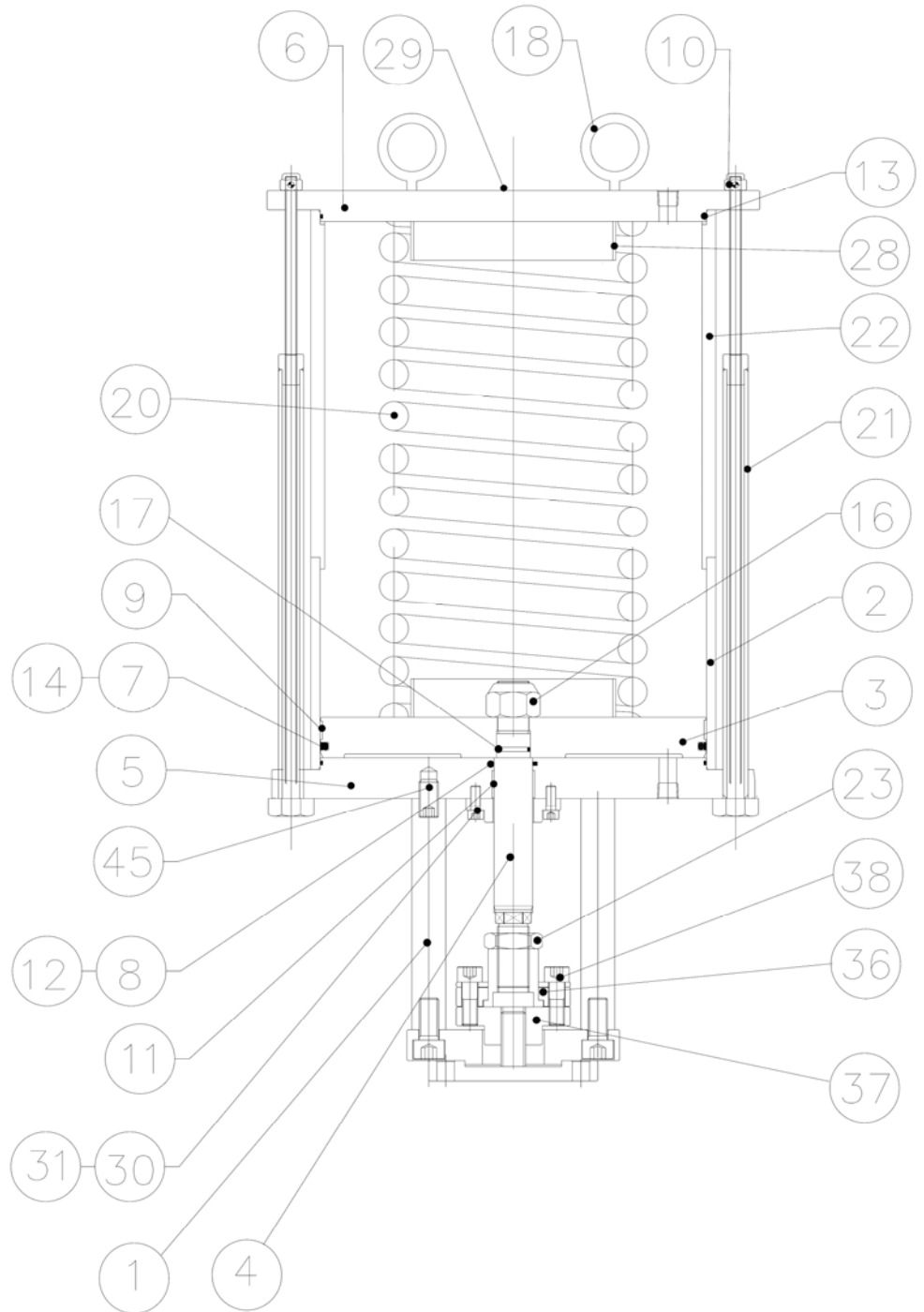
7. Model DA Actuator

Ref. No.	Description	Qty.
1	Cylinder	1
2	Piston	1
3	Piston Stem	1
4	Bottom Cap	1
5	Top Cap	1
6	Tie-rod	8
7	Piston washer	1
8	Actuator to Valve Connecting Flange	1
9	Column	4
10	Lock Plate	1
11	Stem Guide	1
12	Bottom Stem Connector	1
13	Top Stem Connector	1
14	Anti-Rotation Flange	1
26	Nut, Stem	1
1c*	Piston Glider with O-Ring	1
2c*	Stem Glider with O-Ring	1
3c*	Guide Slider, Piston	1
4c*	O-Ring, Caps	2
5c*	O-Ring, Stem	1
6c*	Du Bearing, Bottom Cap	1
7c	Tie-Rod Nut	8
8c	Tie-Rod Washer	8
9c	Cap Screw, Column	4
10c	Plug 1/4"NPT	2
11c	Stud	8
12c	Nut	8
13c	Cap Screw, Bottom Cap	4
14c	Cap Screw, Socket Head	2
16c	Lifting Eye	2
17c	Plug 1"NPT	2
*	Recommended Spare Parts	



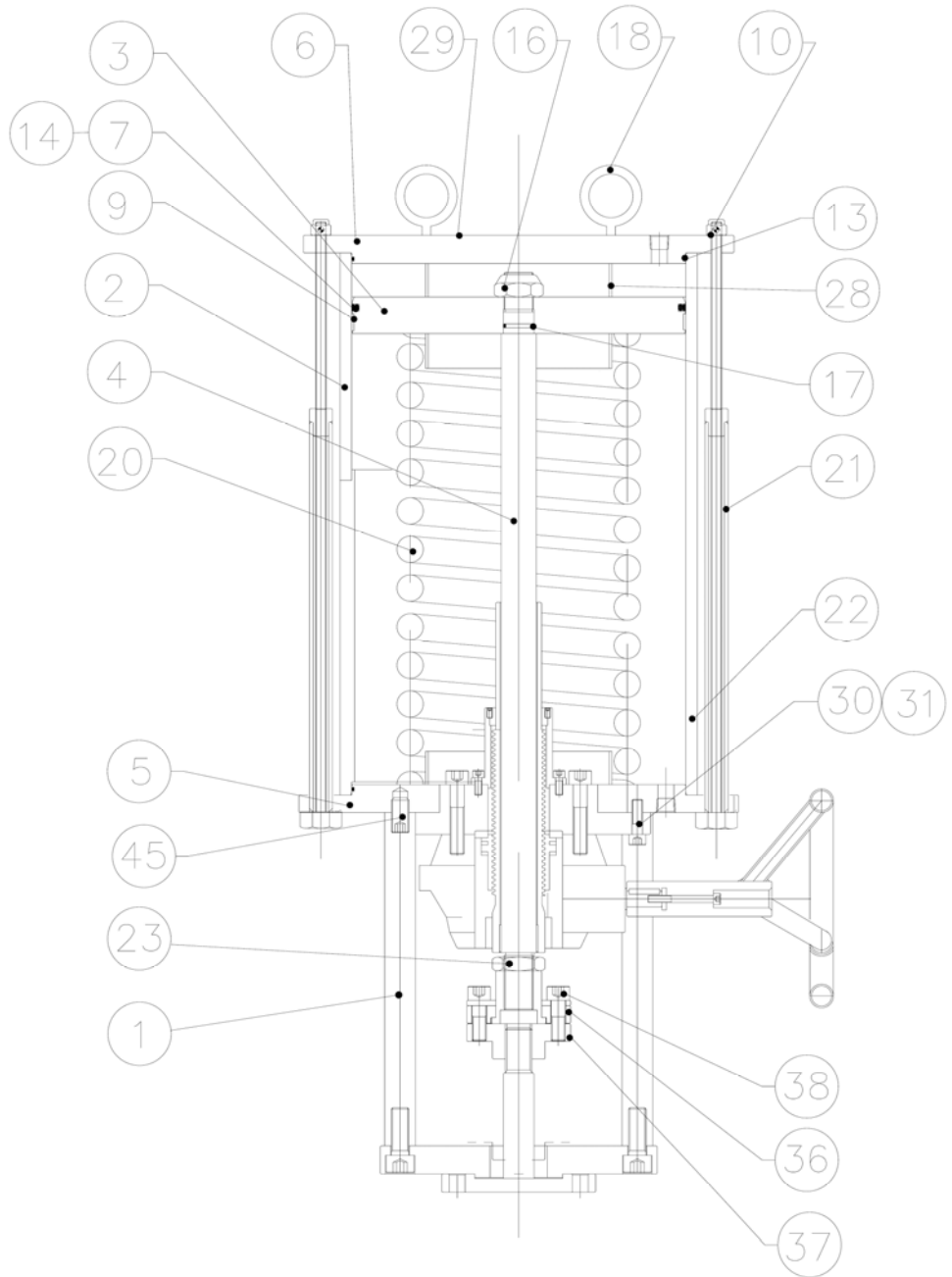
8. Model SRC Actuator

Ref. No.	Description	Qty.
1	Column	4
2	Cylinder	1
3	Piston	1
4	Piston Stem	1
5	Bottom Cap	1
6	Top Cap	1
7*	Piston Glider	1
8*	Stem Glider	1
9*	Guide Slider, Piston	1
10	Tie-rod Cap Screw	6
11*	Du Bearing, Bottom Cap	1
12*	O-Ring, Bottom Cap	1
13*	O-Ring, Caps	2
14*	O-Ring, Piston	1
16	Nut, Piston	1
17*	O-Ring, Stem	1
18	Lifting Eye	2
20	Spring	1
21	Tie-rod Extended Nut	6
22	Spring Container	1
23	Nut, Stem	1
28	Travel Stop	2
29	Nameplate	1
30	Lock Plate	1
31	Cap Screw, Bottom Cap	4
36	Top Stem Connector	1
37	Bottom Stem Connector	1
38	Cap Screw, Socket Head	2
45	Cap Screw, Column	4
*	Recommended Spare Parts	



9. Model SRO Actuator (with Handwheel Override)

Ref. No.	Description	Qty.
1	Column	4
2	Cylinder	1
3	Piston	1
4	Piston Stem	1
5	Bottom Cap	1
6	Top Cap	1
7*	Piston Glider	1
9*	Guide Slider, Piston	1
10	Tie-rod Cap Screw	6
13*	O-Ring, Caps	2
14*	O-Ring, Piston	1
16	Nut, Piston	1
17*	O-Ring, Stem	1
18	Lifting eye	2
20	Spring	1
21	Tie-rod Extended Nut	6
22	Spring Container	1
23	Nut, Stem	1
28	Travel Stop	3
29	Nameplate	1
30	Lock Plate	1
31	Cap Screw, Bottom Cap	4
36	Top Stem Connector	1
37	Bottom Stem Connector	1
38	Cap Screw, Socket Head	2
45	Cap Screw, Column	4
*	Recommended Spare Parts	



10. Spares Kit Ordering & Additional Service Support

When requesting service support or ordering spares kits, please provide the following contract details:

- Actuator Serial Number (6 or 7 digit number with a RFPL prefix)
- Paladon Contract Number (5 digit number with an ACCP, ACE, ACP, ACSP, CCP, CE, CGH, CP, CPC or CSP prefix)
- General Arrangement or Control Schematic Drawing Number
- Full Actuator Model Number(s) and Descriptions
- Tag Number(s)

Please contact your nearest Paladon representative as detailed below:

- **Paladon Systems Srl**
Loc. Ca' Verde (Strada 412/R), 29011 Borgonovo Val Tidone (PC), Italy
Tel: +39 0523 846611 Fax: +39 0523 846659
info.italia@paladonsystems.com
- **Paladon Systems Ltd**
Ferro Fields, Brixworth, Northampton, NN6 9UA, England
Tel: +44 (0)1604 880700 Fax: +44 (0)1604 882424
info@paladonsystems.com
- **Paladon Americas**
14514 Luthe Road, Houston, TX 77039, USA
Tel: +1 855 725 2366 Fax: +1 832 310 2370
info.usa@paladonsystems.com
- www.paladonsystems.com

11. Functional Safety Data

Parameter name	Symbol	Equation / source	PNL / HYL Actuator	HY/DG actuator	PN actuator
Proof Test Interval	T1		8760	8760	8760
Type A/B	type A		type A	type A	type A
Total failures:	λ	From FMEA	2.14E-06	1.30E-06	8.48E-07
Safe diagnosed failures:	λ_{SD}	From FMEA	0.00E+00	0.00E+00	0.00E+00
Safe undiagnosed failures:	λ_{SU}	From FMEA	1.65E-06	8.26E-07	5.37E-07
Dangerous diagnosed failures:	λ_{DD}	From FMEA	0.00E+00	0.00E+00	0.00E+00
Dangerous undiagnosed failures:	λ_{DU}	or High demand mode, PFH per (hour)	4.95E-07	4.75E-07	3.11E-07
Safe Failure Fraction:	SFF	$(\lambda_{SD} + \lambda_{SU} + \lambda_{DD}) / \lambda$	76.92%	63.48%	63.29%
PFD _{AVG} (using 61508-6 equation)	PFD _{AVG}	$(\lambda_{DU} + \lambda_{DD}) t_{CE}$	2.17E-03	2.09E-03	1.37E-03
SIL capability (High demand mode)		□	SIL 2	SIL 2	SIL 2

Parameter name	Symbol	Equation / source	PNL / HYL Actuator	HY/DG actuator	PN actuator
Proof Test Interval	T1	Given, for this example	8760	8760	8760
Hardware Fault Tolerance	HFT		1	1	1
Type A/B	type A	Given, for this example	type A	type A	type A
Total failures:	λ	$\lambda_{SD 1002} + \lambda_{SU 1002} + \lambda_{DD 1002} + \lambda_{DU 1002}$	2.40E-07	1.38E-07	8.82E-08
Safe diagnosed failures:	$\lambda_{SD 1002}$	$2\lambda_{SD}^2 MTTR + \beta \lambda_{SD}$	0.00E+00	0.00E+00	0.00E+00
Safe undiagnosed failures:	$\lambda_{SU 1002}$	$\lambda_{SU}^2 T + \beta \lambda_{SU}$	1.89E-07	8.86E-08	5.62E-08
Dangerous diagnosed failures:	$\lambda_{DD 1002}$	$2\lambda_{DD}^2 MTTR + \beta \lambda_{DD}$	0.00E+00	0.00E+00	0.00E+00
Dangerous undiagnosed failures:	$\lambda_{DU 1002}$	$\lambda_{DU}^2 T + \beta \lambda_{DU}$	5.16E-08	4.95E-08	3.20E-08
Safe Failure Fraction:	SFF ₁₀₀₂	$(\lambda_{SD 1002} + \lambda_{SU 1002} + \lambda_{DD 1002}) / \lambda_{1002}$	79%	64%	64%
PFD _{AVG} (using simplified equation)	PFD _{AVG 1002}	$\lambda_{DU 1002} (T / 2 + MTTR) + (\lambda_{DD 1002} * MTTR)$	2.26E-04	2.17E-04	1.40E-04
SIL capability (1002)		□	SIL 3	SIL 3	SIL 3

11.1 Operating limits and Conditions

The actuators must be operated within the pressure and temperature limits shown in the product test certificate and displayed on the actuator nameplate. **DO NOT EXCEED THESE LIMITS.**

The hardware fault tolerance is shown in the above table – HFT=0 is SIL2 capable, HFT=1 is SIL3 capable.

The Proof Test Interval is shown in the table above. Proof test can be carried out by full or partial stroking of the actuator.

11.2 Normal Operating condition:

When operating under a no fault condition, the PNL&HYL linear actuator will behave in the following way:

- a) Correct pressure is supplied to the input port; this forces the spring to compress. In this position the valve under actuation will be open.
- b) When the actuated valve needs to be closed, the actuator must move to the 'end' position. The pressure in the actuator cylinder will decrease, allowing the spring to fully expand. In this position the valve under actuation is fully closed.

11.3 Maintenance Requirement

The actuators are to be periodically inspected and maintained fully in accordance with Section 5 of this manual.