

Hytork XL Pneumatic Actuator

SIL Safety Manual



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Section 1: Introduction

Purpose of this Safety Manual, written in compliance with IEC 61508-2, Annex D, is to give all the necessary information to the system integrator for a correct use of the product in Safety Instrumented Systems for SIL classified applications.

Section 2: Functional Specification

The safety functions for Hytork XL pneumatic actuator are defined as follows:

Double-Acting Scenario

- a. When an unsafe condition is detected in a plant by a process sensor, the controller, via actuator control system, drives the Actuator to **close** the shut-down valve, depressurizing (if under pressure) the Opening side of the actuator and pressurizing the Closing side of the actuator.
- b. When an unsafe condition is detected in a plant by a process sensor, the controller, via actuator control system drives the Actuator to **open** the blow-down valve, depressurizing (if under pressure) the Closing side of the pneumatic actuator and pressurizing the Opening side of the pneumatic actuator.

Single-Acting Scenario

When an unsafe condition is detected in a plant by a process sensor, the controller, via actuator control system drives the Actuator to rotate with sufficient torque to move a valve to its fail-safe state when hold-position air pressure is released.

The Hytork XL brand Actuator Selection Procedure provides functional definition with specifics on input variables and performance.

In any case, the choice of the safety function to be implemented is responsibility of the system integrator.

Section 3: Configuration of the Product

The Hytork XL are pneumatically operated actuators designed to operate Ball/Plug/Butterfly valves, automation of louvers and dampers and automation of any quarter-turn mechanism. Both the double-acting and single-acting (spring-return) versions of the Hytork XL pneumatic actuators are designed in such a way that there are no moving parts on the outside (with the exception of the position indicator). This makes them safe, easy to install, and virtually maintenance free.

For further details about actuator configurations, please refer to the Hytork XL product Data Sheets, Safety Guide, and Installation, Operation and Maintenance Manual.

NOTE:

This product is only intended for use in large-scale fixed installations excluded from the scope of Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS 2).

Section 4: Service Condition Limitations (Limitation of Use)

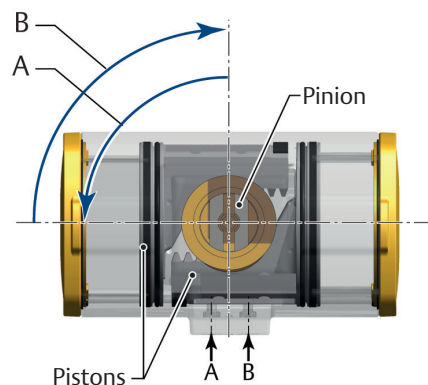
The operating capabilities are listed below:

- Maximum Operating Pressure:
 - Pneumatic Service
 - Up to 8 barg / 116 psig
- Ambient Temperature:
Temperature extremes require different solutions to maintain actuator operational integrity and reliability. Three different temperature executions are available for each Hytork XL actuator.
 - -20 to +100 °C / -4 to +212 °F Standard Temperature
 - -20 to +120 °C / -4 to +248 °F High Temperature
 - -40 to +100 °C / -40 to +212 °F Low Temperature
- Torque Output Range:
 - Double-Acting Hytork XL actuators, requiring pressure to rotate in either direction, are available with a torque range between 10 N•m / 83 lbf-in. and 4,702 N•m / 47,250 lbf-in.
 - The Hytork XL spring-return models require pressure in only one direction of travel and are suitable for air-fail close and air-fail to open applications without modification. These models are available with a spring end torque between 4 N•m / 32 lbf-in. and 1525 N•m / 13,494 lbf-in.
- Safety Function:
For spring-return models, the safety function is self-evident performed by the springs. The safety function of double-acting models shall be performed by the A-port. The failure rates in Section 6 are valid only for this configuration.

Figure 1 Use the A-Port for Safety Related Systems on Double-Acting Actuators

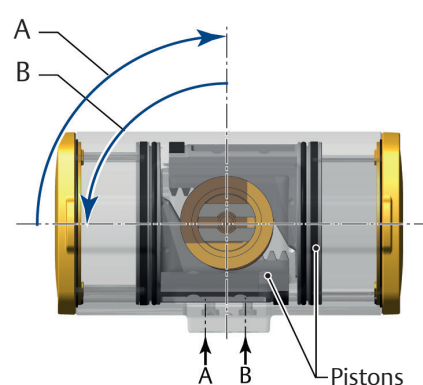
Assembly Code: CW

= Safety Function is
Counterclockwise Rotation



Assembly Code: CC

= Safety Function is
Clockwise Rotation



Section 5: Expected Lifetime

Actuator lifetime (for which failure rates indicated in Section 6 are ensured) strongly depends on operating conditions.

For normal service conditions, Hytork XL actuators can be in good conditions also after more than 10 years with planned minimum maintenance. Normal working life is the number of cycles as defined in Table 1 of EN 15714-3. Hytork XL carry a warranty period of:

- 18 months after delivery if properly stored in conditions that we declare, or
- 12 months after installation on site.

Section 6: Failure Modes and Estimated Failure Rates

Please refer to the values included in the latest valid version of SIL certificate(s) (available upon request sent to Emerson).

NOTE:

- No internal diagnostics is included in the product.
- The above failure rates are guaranteed:
 - For the service conditions listed in Section 4.
 - For the expected lifetime declared in Section 5.
 - Considering the periodic test and maintenance included in Section 8.

The failure rates are determined performing a FMEDA based on the failure rates of components taken from industrial databases (NPRD-2016/FMD97/2016, EXIDA E&MCRH and NSWG-2011), integrated with field feedback using the Bayesian statistical approach mentioned in IEC 61508-2 Section 7.4.4.3.3.

The system for reporting failures is based on field feedback from end users, with:

- Identification of the claim/failure
 - Root cause analysis to identify cause and responsibility of the failure
 - Identification of the possible effect of the failure on the Safety Function
 - Classification of the failure considering the failure categories of IEC 61508-2 (Safe, Dangerous, No Effect) Customer Service, Quality and Technical Department is responsible for the procedure according to the respective role
-

Section 7: Installation and Site Acceptance Procedure

Any necessary installation and site acceptance procedures are discussed in the Hytork XL actuators Installation, Operation and Maintenance manual. The IOM defines exercising of the actuator after installation and defines testing after maintenance.

Section 8: Periodic Test and Maintenance Requirements

8.1 General

NOTE:

Please consider that the information in this paragraph are relevant only in regards of Reliability Tests; please refer to IOM for detailed information about product maintenance, handling, and storage.

Diagnostic tests may be made to increase the system reliability (Full Stroke or Partial Stroke Test).

“On site” tests depend on Project/Plant facilities/requirements; however, a functional test must be executed on site, prior actuator operation.

8.2 Full Stroke Test

The “Full Stroke Test” (“On-line”) must be performed to satisfy the PFD_{AVG} (average probability of failure on demand) value.

The full test frequencies will be defined by the final integrator in relation to the defined SIL level to achieve.

- Procedures:
 - Operate the actuator/valve assembly for No. 2 open/close complete cycles with complete closing of the valve.
 - Verify the correct performing of open – close manoeuver (for example, check locally, or automatically via Logic solver, the correct movement of the actuator/valve).

Considering the application of the above described Full Stroke Test procedure, the “Test Coverage” can be considered 99%.

8.3 Partial Stroke Test

The “Partial Stroke Test” (“On-line”) can be performed to improve the PFD_{AVG} value.

A typical partial stroke value is 15% of the stroke.

The “Partial Stroke Test” (“On line”) can be performed to satisfy PFD_{AVG} (average probability of failure on demand) value.

- Recommended Test Interval = 1 to 3 months.
- Procedures:
 - Operate the actuator/valve assembly for No. 1 open/close cycles 15/20% of the stroke.
 - Verify the correct performing of partial stroke operation (for example, check locally, or automatically via Logic solver, or via the PST system the correct movement of the actuator/valve till 15/20% of the stroke).

The above parameters to check will depend from the partial stroke test system available. Considering the application of the above described Partial Stroke Test procedure, the “Diagnostic Coverage” is >90%.

8.4 Proof Test and Periodic Maintenance

We advise to perform the following checks upon each proof test interval complying with the rules and regulations of the country of final installation:

- Visually check the entire actuator as well as the control system (where foreseen).
- Ensure there are no leaks on the actuator parts under pressure.
- Check pneumatic connections for leaks. Tighten tube fittings as required.
- Check if manual override (where foreseen) is regular.
- Check if pneumatic filter cartridge (where foreseen) is sound and filter bowl (where foreseen) has been cleaned properly.
- Check the setting of the relief valves (where foreseen).
- Verify that the power fluid supply pressure value is within the required range.
- Remove built-up dust and dirt from all actuator surfaces.
- Inspect actuator paint work for damages to ensure continued corrosion protection. Touch-up as required in accordance with the applicable paint specification.
- Operate the actuator/valve assembly for No. 2 open/close complete cycles with complete closing of the valve.
- Verify the correct performing of open – close operations (for example, check locally, or automatically via Logic solver, the correct movement of the actuator).

The Installation, Operation and Maintenance Manual defines a minimum maintenance interval after 500,000 cycles for the Hytork XL actuators. This addresses components that may have age related degradation. When the maintenance interval has elapsed a complete overhaul of the actuator is required.

Section 9: Classification

The equipment is classified Type A according to IEC 61508-2.

Section 10: Architectural Constraints

For the evaluation of the conformity to the requirement of Hardware safety integrity architectural constraints of the standard IEC 61508, both Route 1_H and Route 2_H are used.

Route 1_H

- The product has a single channel configuration, HFT = 0
- According to IEC 61508 definitions (in particular definitions in 3.6.8 and 3.6.13 of IEC 61508-4), no safe failures are possible in a quarter-turn actuator: each failure mode of the actuator itself shall be classified as “Dangerous” or “No Effect” (failures which can generate the spurious operation of the safety function are only external to the actuator itself): hence $\lambda_s = 0$ for each type of quarter-turn actuator.

For this reason, according to definition 3.6.15 of IEC 61508-4, we have:

- SFF = 0 without external diagnostic tests;
- SFF > 0 with external diagnostic tests, carried out according to definition 3.8.7 of IEC 61508-4, and according to what written in Section 6 (see the same paragraph for the SFF/DC reachable).

NOTE:

The diagnostic test shall be performed considerably more often (at least 10 times) than the demand of the safety function.

Route 2_H

The application of Route 2_H (“field feedback”) is evaluated. Evidence is identified for each specific point.

As the product is classified as “Type A”, no requirements for SFF are given for Route 2_H.

In conclusion:

The product can be used in single channel configuration up to:

- SIL 2 without external diagnostic tests
- SIL 3 considering external diagnostic tests

Section 11: Mean Repair Time

The Mean Repair Time (MRT) of the device is 1 hour.

NOTICE

The MRT is estimated considering availability of skilled personnel for maintenance, spare parts, and adequate tools and materials on site (that is, it encompasses the effective time to repair and the time before the component is put back into operation).

Procedures to repair or replace the Hytork XL actuators are provided in the respective Installation, Operation and Maintenance Manual. Please refer to IOM for any tools required for repair and replacement and required competency of technicians. Maintenance and subsequent test procedures are also covered in the IOM. Any failures, identified by the end-user during maintenance, repair or proof testing that potentially impact the functional safety of the Hytork XL actuators should be reported back to Actuation Technologies Customer Service Coordinator.

Section 12: Common Cause Factors

The product has a single channel configuration, $HFT = 0$.

The β factors can be used when performing PFD_{AVG} calculations for redundant architectures.

The estimated values for the Common Cause factors are: $\beta = \beta_D = 0.05$

NOTE:

- The above value is the value for 1oo2 architecture. The values for other architectures shall be calculated according to IEC 61508 Part 6, Table D.5.
 - The above value is calculated in the hypothesis of redundancy without diversity.
-

Section 13: Systematic Capability

The systematic capability of the product is 3.

This systematic capability is guaranteed only if the user:

- Uses the product according to the instructions for use and to the present Manual.
- Uses the product in the appropriate environment (limitation of use).

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