

 <b>PNEUMAX</b>	<b>SAFETY MANUAL</b> <b>FOR STEEL LINE SERIES QUICK EXHAUST VALVES</b>	N.	TF231011-QEV-MA
		Rev	01
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# **SAFETY MANUAL** **QUICK EXHAUST VALVES** **STEEL LINE SERIES**

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## 1. INTRODUCTION

### 1.1. Scope

The purpose of this Safety Manual is to document all the information specifically related to the safety aspect of the following products:

#### **STEEL LINE SERIES QUICK EXHAUST VALVES 1/4-NPT, 1/2 NPT, 3/4-NPT & 1-NPT SIZES**

These products are certified for use as components in Safety Instrumented Systems (SIS). This Safety Manual is required to enable the integration of the quick exhaust valves into a Safety Instrumented System with the objective of being in compliance with the requirements of IEC 61508-2, Annex D.

The information contained in this Safety Manual is valid for the models/series indicated in section 2.1 of this Safety Manual.

This Safety Manual defines:

- Environmental conditions in which quick exhaust valves can operate,
- Parameters related to Functional Safety,
- Tests, checks, and periodic maintenance.

For the purpose of its correct use, this Safety Manual shall be consulted in conjunction with:

- TF231011-IST (Installation, use and maintenance instructions for valves and solenoid valves)
- CAT16 (Process Automation Technology Catalogue)

**CAUTION:** A copy of this Safety Manual must be stored by the User and used in conjunction with the product for all useful life of the product itself.

### 1.2. Disclaimer and warning

By using these quick exhaust valves, it hereby signifies that the User has read this disclaimer and warning carefully, and that understands and agrees to abide by the terms and conditions herein.

Integrating these quick exhaust valves into a Safety Instrumented System (SIS), the User agrees that is solely responsible for their own conduct while using these quick exhaust valves, and for any consequences thereof.

The User agrees to use these quick exhaust valves only for purposes that are proper and in accordance with all applicable laws, rules, and regulations, and all terms, safety prescriptions and precautions, practices, policies and all additional revisions or guidelines that PNEUMAX has made and may make available.

**IMPORTANT:** PNEUMAX won't be held liable for severe personal injuries, damage to property or environment caused by any of the followings:

- Unqualified personnel working on the quick exhaust valves,
- Override or bypassing of the Safety Function,
- Non-compliance with the instructions detailed in this Safety Manual.

### 1.3. Skill level required

This manual is addressed to qualified personnel authorized for installation, operation, and maintenance of quick exhaust valves series Steel Line. As required by IEC 61508-1 standard, an appropriate level of competence shall be taken into account considering all relevant factors including safety engineering knowledge appropriate to the technology, knowledge of safety regulatory framework and previous experience.

### 1.4. Product Support and Service

Please refer to Pneumax Quality, Technical and Customer Claim Offices.

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### 1.5. Related Documents

Id.	Code	Title
[D1]	TF231011-IST	Installation, use and maintenance instructions for valves and solenoid valves series SS11, SS12, SS14, SS18, SS34 and SS38
[D2]	CAT16	Process Automation Technology Catalogue

Related document D1 is available only for products compliant to Directive 2014/34/EU.

### 1.6. Reference Standards

Id.	Code	Title
[S1]	IEC 61508:2010 Parts 1-2 and 4-7	Functional safety of electrical/electronic/programmable electronic safety-related systems
[S2]	IEC 654-1:1993	Industrial-process measurements and control equipment – Operating conditions - Part 1: Climatic conditions
[S3]	IEC 61511:2016 Part 1–3 + Part 1-A1:2017	Functional Safety – Safety Instrumented Systems for the process industry sector

### 1.7. Terms and abbreviations

For terms and definitions, reference is made to IEC 61508-4.

### 1.8. Acronyms

<b>BPCS</b>	Basic Process Control System
<b>CCF</b>	Common Cause Failure
<b>DC</b>	Diagnostic Coverage
<b>DETT</b>	De-energise to trip
<b>EMC</b>	Electromagnetic Compatibility
<b>ETT</b>	Energise to trip
<b>FMEDA</b>	Failure Modes, Effects and Diagnostics Analysis
<b>FST</b>	Full Stroke Test
<b>HFT</b>	Hardware Fault Tolerance
<b>IOM</b>	Installation, Operation, and Maintenance
<b>MOC</b>	Management Of Change
<b>MRT</b>	Mean Repair Time
<b>PFD<sub>AVG</sub></b>	Average Probability of dangerous Failure on Demand
<b>PST</b>	Partial Stroke Test
<b>PTC</b>	Proof Test Coverage
<b>PVST</b>	Partial Valve Stroke Test
<b>QEV</b>	Quick Exhaust Valves
<b>SAT</b>	Site Acceptance Test
<b>SC</b>	Systematic Capability
<b>SFF</b>	Safe Failure Fraction
<b>SIF</b>	Safety Instrumented Function
<b>SIL</b>	Safety Integrity Level
<b>SIS</b>	Safety Instrumented System
<b>SRS</b>	Safety Requirements Specification
<b>STR</b>	Spurious Trip Rate

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## 2. PRODUCT DESCRIPTION

### 2.1. Detailed models

Product Code	Description
#SS1402SR##	Quick Exhaust Valves
#SS1202SR##	
#SS3402SR##	
#SS1102SR##	

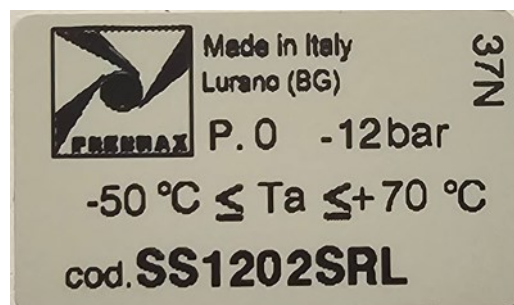
### 2.2. Main Technical Data

Feature	Description
Size	1/4" NPT – 1/2" NPT – 3/4" NPT – 1" NPT
Body Material	AISI 316L
Lip Seal	FPM for high temperatures Poliurethane for low temperatures

### 2.3. Service condition limitations (Environmental limits)

Please refer to the information indicated on the product label and product documentation regarding pressure, temperature and other conditions of use. It is important to not use the product outside the indicated operating limits.

Check the following image for an example of a product label:



**IMPORTANT:** The designer of the SIF must check that the product is rated for use within the expected environmental limits, maximum working pressure and temperature.

**IMPORTANT:** The materials of construction of the devices are specified on the dedicated products catalogue (document [D2]). It is especially important that the designer of the SIF check for material compatibility considering on-site chemical contaminants and air (as appropriate) supply conditions. If the QEV is used outside the application limits or with incompatible materials, the reliability data and predicted SIL capability becomes invalid.

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### 3. RELIABILITY AND SAFETY CHARACTERISTICS

#### 3.1. Safety Function(s)

The reliability parameters have been obtained with reference to the following Safety Function(s).

Id.	Safety Function	Safety Function Description
[SF1]	de-energised to trip (DETT)	The quick exhaust valve exhausts the cylinder of a pneumatic actuator within a specified safety time

#### 3.2. Demand mode

Low Demand mode, as per IEC 61508 [S1], part 4, subclause 3.5.16 (i.e., the Safety Function is only performed on demand, with a frequency of demands no greater than once per year).

#### 3.3. Product Classification

Quick Exhaust Valves Steel Line series are classified as Type A equipment, as per IEC 61508 [S1], part 2.

#### 3.4. Useful Time

Based on general field failure data and a low demand mode of operation, for standard service conditions the expected useful life of the quick exhaust valves can be considered 5 years to 10 years.

**WARNING:** The above value is valid only if prescriptions of this Safety Manual are fully respected.

#### 3.5. Mean Repair Time (MRT)

The Mean Repair Time (MRT) is 30 min.

This is an estimation for the quick exhaust valves replacement considering skilled personnel for maintenance, availability of spare parts and adequate tools on site. Contact the manufacturer for maintenance and repair of internal parts. Pneumax may not be hold accountable for any malfunctions related to reparations done by the end-user.

#### 3.6. Failure Rates

With reference to the Safety Function(s) previously specified, a FMEDA has been carried out. The following failure rates have been obtained.

Models	$\lambda_s$	$\lambda_{DU}$	$\lambda_{DD}$
#SS1402SR##	254.8	34.8	-
#SS1202SR##			
#SS3402SR##			
#SS1102SR##			

All failure rates are in FIT (Failure In Time 1 FIT = 1 failure/10<sup>9</sup> hours).

The dangerous undetected failure rate  $\lambda_{DU}$  is due to faults that cause the failure of the Safety Function(s) and that are not detected by the diagnostic tests.

The dangerous detected failure rate  $\lambda_{DD}$  is due to faults causing the failure of the Safety Function(s) but that are detected by diagnostic tests.

The safe failure rate  $\lambda_s$  is due to faults that result in the spurious operation of the Safety Function or in the increase of the probability of spurious operation of the Safety Function.

The failure rates shall be used for PFD<sub>AVG</sub> estimation, taking into consideration parameters such as redundancy, diagnostic capability (provided by external devices such as Partial Stroke Test devices, if any, or introduced by the whole Safety Instrumented System), Proof Test and its effectiveness, Mean Repair Time (MRT), up to the maintenance capability and its minimum characteristics.

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The assumptions associated with these failure rates are as follows:

- Failure rates are constant over the expected lifetime specified in section 3.4 of this Safety Manual,
- Wear-out or infant mortality contributions are not included.

The above failure rates are valid:

- For the service conditions listed in section 2.3 of this Safety Manual,
- If periodic test and maintenance are properly carried out.

### 3.7. Hardware safety integrity (Architectural constraints)

In compliance with Route 1<sub>H</sub> (see IEC 61508 [S1], part 2, subclause 7.4.4.2), the quick exhaust valve can be used in a single channel configuration (i.e., HFT = 0) up to SIL 2.

In compliance with Route 2<sub>H</sub> (see IEC 61508 [S1], part 2, subclause 7.4.4.3), the quick exhaust valve can be used in a single channel configuration (i.e., HFT = 0) up to SIL 2.

Faults detectable through a Partial Stroke Test (PST) can be considered substantially equivalent to those identified by a Full Stroke Test. Therefore, it can be assumed that the diagnostic coverage of the PST is close to the Proof Test Coverage (PTC) and, in any case, not less than 90%. It is a responsibility of the integrator or end user, for each specific project, to ensure that the PST has suitable characteristics in terms of automation and frequency, allowing it to be classified as a diagnostic test for the evaluation of Safe Failure Fraction (SFF) and for the use of this device with HFT=0 in SIL 3 systems, in accordance with Route 1<sub>H</sub> of IEC 61508-2.

Therefore, if the Integrator / End User has verified under their own responsibility the fulfilment of the conditions for considering PST as diagnostic test, the quick exhaust valves can be used up to:

- SIL 2 without external diagnostic tests (HFT=0),
- SIL 3 with external diagnostic tests (HFT=0) and
- SIL 3 with HFT=1.

Check the systematic capability SC=3 of section 3.8 of this safety manual.

### 3.8. Systematic safety integrity (Systematic Capability)

The quick exhaust valves have met manufacturer design process requirements of SIL 3 (evaluated according to Route 1<sub>s</sub> of IEC 61508-2 [S1]).

This Systematic Capability is guaranteed only if the User:

- Uses the product according to its instructions for use [D1] or [D2] and to this Safety Manual,
- Uses the product in the appropriate environment, as per section 2.3 of this Safety Manual.

**WARNING:** A Safety Instrumented Function (SIF) designed with this product must not be used at a SIL higher than that stated, unless diverse technology in the design of the SIF is used (see IEC 61508 [S1], part 2, subclause 7.4.3).

### 3.9. Common Cause Failures

The quick exhaust valve has a single channel configuration, i.e., HFT = 0.

When carrying out PFD<sub>AVG</sub> calculations for redundant architectures, the following Common Cause factors should be used:

- $\beta = \beta_D = 10\%$

The above values are referred to 1oo2 architecture.

The values for other architectures shall be calculated according to IEC 61508 [S1], part 6, table D.5.

The above values are calculated in the hypothesis of redundancy without diversity.



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## 4. INSTALLATION & COMMISSIONING

### 4.1. Installation

The quick exhaust valves must be installed per the standard practices outlined in the manual [D1] and product documentation [D2].

The environment must be checked to verify that environmental conditions do not exceed the ratings (see also section 2.3 of this Safety Manual).

The quick exhaust valve must be accessible for physical inspection.

### 4.2. Physical location and placement

The quick exhaust valves shall be accessible with sufficient room for pneumatic connections.

The valves shall be mounted in a low vibration environment. If excessive vibration can be expected, then special precautions shall be taken to ensure the integrity of pneumatic connectors, or the vibration should be reduced using appropriate damping mounts.

**IMPORTANT:** Every form of tampering or unauthorized intervention on the product is strictly forbidden. Such actions will void the warranty and the product conformity.

## 5. OPERATION & MAINTENANCE

### 5.1. Proof test

#### 5.1.1. General

Purpose of the Proof Test is to reveal (all, or as close as possible to all) the failures not detected by the diagnostic tests (if any).

#### 5.1.2. Disclaimer

The content of this chapter is relevant for reliability tests only.

Functional test must be executed before using the device.

Refer to manual [D1] or product catalogue [D2] for further information about the product maintenance, handling and storage. In case of any doubt, contact Pneumax SpA offices.

#### 5.1.3. Suggested Proof Test Interval

The suggested Proof Test interval is 1 year. The choice of the Proof Test interval, anyway, is under User's responsibility and should take in account (at least) the followings:

- PFD<sub>AVG</sub> target,
- Safety Function,
- Service conditions.

The following parameters can be verified through a Full Stroke test:

- Correct performance (open – close)
- Internal leakage

#### 5.1.4. Execution of the test

During a FST, the outlet port of the QEV can be connected to a cylinder of a pneumatic actuator and the inlet port is connected to a solenoid valve from which the QEV receives air supply. Changing the position of the valve, the cylinder is pneumatically exhausted through the QEV.

The test is considered passed if the following condition is satisfied:

Safety Function	Description
[SF1]	The actuator reaches safety position within a preset time determined during a SAT.

If the actuator does not reach the safety position, the QEV may be blocked. If the safety position is reached in a time superior to the preset, test failure is not clearly attributable to the QEV but maybe caused by other components.

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#### 5.1.5. Test set-up and test facilities

The test shall be carried out on the quick exhaust valve as installed.

The test can be automated, if carried out by using a Logic Solver or a Partial Stroke Test device.

The procedure carried out without automated means might lead to a lower test coverage.

#### 5.1.6. Proof Test Coverage

In case of Proof Test:

- automated, and
- supervised by trained and skilled operators, and
- carried out with calibrated measuring instruments,

the Proof Test Coverage (PTC) could be estimated in a value close to 100%.

Otherwise, the Proof Test Coverage (PTC) should be estimated by the User considering measurement inaccuracies as well as the reliability/competence of the operator.

#### 5.1.7. Further Inspections

Proper inspection should be carried out on the quick exhaust valve to ensure that (as minimum):

- there are no external leakages,
- dust and dirt are removed from surfaces,
- the valve is exempted from damages, even accidental.

Furthermore, for quick exhaust valves compliant to Directive 2014/34/EU, check the indications reported on document [D1] TF231011-IST.

#### 5.2. Notification of failures

In case of detection of a failure, it is under User's responsibility to take action according to IEC 61508 [S1] and IEC 61511 [S3], if applicable.

PNEUMAX must be informed when the quick exhaust valves are required to be replaced due to failure. The occurred failure shall be documented and reported to PNEUMAX Quality & Technical representatives.

### 6. DISPOSAL

The product must be disposed of in accordance with current regulations. It must not be dispersed into the environment.