SAFETY MANUAL
FOR QUICK EXHAUST VALVES
VSR

STC-SM-VSR

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1	First Revision	16/09/2019	CM	GC	DMDC
0	First Issue	08/02/2016	CM	GC	DMDC
No.	DESCRIPTION	DATA	ISSUE Technical Dept.	VERIFIED Quality Dept.	APPROVED General Mngr.
REVISIONS					

SUMMARY

0 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.

1 SAFETY FUNCTION SPECIFICATION

The device is used in safety applications to discharge the cylinder chamber of single effect pneumatic actuator.
The Safety Function for QUICK EXHAUST Valves used in safety-related services duties is to quickly vent the air from the cylinder of the actuator, in order to reach the desired stroking time.
When pressure falls at the inlet of the Quick Exhaust Valve, the cylinder port is automatically opened to the exhaust and the actuator cylinder is rapidly depressurized.

The choice of the safety function to be implemented is responsibility of the system integrator.

2 CONFIGURATION OF THE PRODUCT

The product is named and coded as follow:

Denomination	Code
QUICK EXHAUST VALVE 1/8”	VSR02N
QUICK EXHAUST VALVE ¼”	VSR04N
QUICK EXHAUST VALVE ½”	VSR08N
QUICK EXHAUST VALVE 3/8”	VSR06N
QUICK EXHAUST VALVE ¾”	VSR12N
QUICK EXHAUST VALVE 1”	VSR16N

Body Material: AISI316L “SS”; Anticorodal Aluminum Alloy “AL”

The code of the products above mentioned is referring to standard temperature conditions - T(min)-20°C, T(max)+80°C

Special Material for Low Temperature (Special Compounds) T(min)-55°; Special Material for High Temperature (FKM) T(max)+90°C) have a special code :

Low Temperature: standard code + “AL” Aluminium Body + "LT” example: VSRXXN AL LT
High Temperature: standard code + “SS” AISI316L Body + “FK” example: VSRXXN SS FK

The reference document for the specific configuration of the product is the Data Sheet sent to the customer and/or the final user, which contains any technical information of the product.

3 SERVICE CONDITION LIMITATIONS (LIMITATION OF USE)

The service condition limitations (Operating Pressure 2÷12 bar), are included on valve label (see the sample below).

4 EXPECTED LIFETIME

Valves lifetime strongly depends on operating conditions and on materials of construction. As a general rule, the customer selects the main materials of construction.

For normal service conditions, the expected lifetime can be considered an average of 20 years.

The above value is valid only if prescriptions in paragraph 6 of this manual are respected.

5 FAILURE MODES AND ESTIMATED FAILURE RATES

Configuration	Safety function	λ_{DU} [1/h]	λ_{DD} [1/h]	λ_{S} [1/h]
VSR - No PST	De-Energise-To-Trip	4,52E-09	0,00E+00	4,80E-08
VSR - With PST	De-Energise-To-Trip	4,52E-11	4,47E-09	4,80E-08

Failure modes and estimated failure rates

NOTES:

1. No internal diagnostics is included in the device.
2. The failure rates are guaranteed:
    a. For the service conditions listed in par. 3
    b. For the expected lifetime declared in par. 4
    c. Considering the periodic test and maintenance included in par. 6

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 NSWC-2011), integrated with field feedback using the Bayesian statistical approach mentioned in IEC 61508-2 Par. 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 are responsible for the procedure, according to the respective role.

6 PERIODIC TEST AND MAINTENANCE REQUIREMENTS

6.1 General

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

Tests may be carried out to increase the system reliability.
"On site" tests depend on Project/Plant facilities/requirements; however, a functional test must be executed on site, before Valve usage.

6.2 Full Stroke

The Full Stroke ("On line") must be performed to satisfy the PFD_{AVG} (average probability of failure on demand) value.
The test frequencies will be defined from the final integrator in relation to the defined SIL level to achieve.

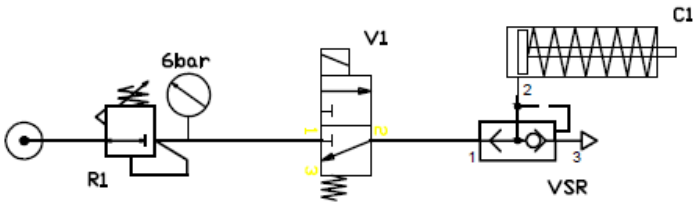
The following parameters can be verified:

- Correct performing of open – close;
- Internal Leakage.

Procedure for Full Stroke Test

- Port 2 is connected directly to the actuator cylinder C1

- Port 1 receives airflow from the Solenoid Valve V1 and Air flows past the lips of the seal to Quick Exhaust Valve and pressurize the actuator cylinder C1.



- When changing the position of the Solenoid Valve V1, the airflow inlet in the port 2 close the lips of the seal and discharge the airflow in the port 3

If the actuator does not reach the safety position, then failing the test may be due to the blocking of VSR
If the actuator reaches to the safety position, but in a time superior to that preset, the test is failed but is not due to the VSR but to other elements of ESD assembly.

The test is considered positive if the actuator reach the safety position in the pre-defined time (as verified during the SAT

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

6.3 Partial Stroke Test

- The Partial Stroke Test on the ESD assembly results in full stroke on the VSR. So a partial stroke test done with manual or automatic procedure with PST device, gives as a result on the VSR the same test coverage reached with the Full Stroke Test.

6.4 Periodic Maintenance

The periodic maintenance is described in section 8 of the IOM Manual.

7 CLASSIFICATION

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

8 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 device has a single channel configuration, HFT=0
- SFF (without external diagnostic tests): 91,40%
- SFF (with external diagnostic tests): 99%

Route 2_H

The application of Route 2_H ("proven in use approach") is evaluated according paragraphs 7.4.10.1÷7.4.10.7 of IEC 61508-2. Evidence was identified for each specific point.
As the device is classified as "Type A", no requirements for SFF are given for Route 2_H.

Conclusion

The device can be used in single channel configuration up to SIL 3.

9 MEAN REPAIR TIME

The Mean Repair Time (MRT) is: 30 min

Note: The MRT considered is the Technical Mean Repair Time, i.e., it takes in consideration availability of skilled personnel and adequate tools.
For these devices is considered as MRT the replacement time

10 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 Common Cause factors, relevant when the product is used in redundant configuration, are:

$\beta=\beta_D=0,05$

NOTES:

- 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

11 SYSTEMATIC CAPABILITY

The systematic capability of the device is 3.

This systematic capability is guaranteed only if the user:

1. Use the device according to the instructions for use and to the present Manual
2. Use the device in the appropriate environment (limitation of use)