SIL Safety Manual for VMR – VML – VMM Solenoid valve

DN8 … DN100

Introduction

This Safety Manual provides information necessary to design, install, verify and maintain a Safety Instrumented Function (SIF) using the type VMR-VML-VML solenoid valves.

This manual provides necessary requirements for meeting the IEC EN 61508:2010 functional safety standards.

Terms and abbreviations

Safety - Freedom from unacceptable risk of harm.

Safety Function - The ability of a system to carry out the actions necessary to achieve or to maintain a defined safe state for the equipment / machinery / plant / apparatus under control of the system.

Basic Safety- The equipment must be designed and manufactured such that it protects against risk of damage to persons by electrical shock and other hazards and against resulting fire and explosion. The protection must be effective under all conditions of the nominal operation and under single fault condition.

Safety Assessment -The investigation to arrive at a judgment - based on evidence - of the safety achieved by safety-related systems.

Fail-Safe State - State where the valve actuator is de-energized and (if applicable with a spring-returned actuator) the springs are extended.

Fail Safe - Failure that causes the valve to go to the defined fail-safe state without a demand from the process.

Fail Dangerous - Failure that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state).

Fail Dangerous Undetected - Failure that is dangerous and that is not being diagnosed by automatic stroke testing.

Fail Dangerous Detected - Failure that is dangerous but is detected by automatic stroke testing.

Fail No Effect - Failure of a component that is part of the safety function but that has no effect on the safety function.

Low Demand Mode - Mode, where the frequency of demands for operation made on a safety-related system is no greater than twice the proof test frequency.

High Demand Mode - Mode, where the frequency of demands for operation made on a safety-related system is greater than twice the proof test frequency.

Acronyms

FMEDA - Failure Modes, Effects and Diagnostic Analysis.

HFT - Hardware Fault Tolerance.

PFDavg - 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).

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 of one or more Safety Instrumented Functions. An SIS is composed of any combination of sensor(s), logic solver(s), and final element(s).

Product Support

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Related Literature

Hardware Documents: Product Datasheet: EE161, EE162, EE163.

Installation, Operation and Maintenance Instructions: VMR[i], VML[i], VMM[i].

Reference Standards: IEC EN 61508: 2010 Functional safety of electrical/ electronic/ programmable electronic safety-related systems

UNI EN 161: 2011 Automatic shut-off valves for gas burners and gas appliances

EN ISO 14224: 2006 Petroleum, petrochemical and natural gas industries - Collection and exchange of reliability and maintenance data for equipment.

Device description

The VMR-VML-VMM valves are automatic shut-off valves normally closed (open when energized) suitable for air or fuel gas blocking and releasing controls required in gas power burners, industrial kilns and other fuel gas consuming appliances.

A VMR valve is composed of a valve body, a plate shutter connected with a magnetic core, a spring and a coil. When the coil is energized, the magnetic core pulls the shutter so gas can flow (opening time <1s). When coil is de-energized, the spring pushes the shutter, so gas passage is closed (closing time <1s)..

In a VML valve there is an hydraulic brake of the magnetic core, so the valve opens slowly (opening time adjustable 5-30s). The closing function is always fast.

The VMM valve is a combination of VMR and VML valves in an only body.

Closed position indicator switch (type PCS) is an option available for all models.

These products conform with Regulation (EU) 2016/426 relating to appliances burning gaseous fuels – norm EN161 and the certification has been issued by the notified body KIWA NEDERLAND B.V. Wilmersdorf, 50, NL-7300 AC Apeldoorn, CE Reg.-Nr. 0063AQ1350.

Designing a SIF using VMR-VML-VMM valve

Safety Function

The safety function of valves type VMR-VML-VMM is: gas flow shut off further to coil de-energization and absence of internal and external leakages, in high demand mode of operation.

These items are intended to be part of final element subsystem as defined per IEC EN 61508 and the achieved SIL level of the designed function must be verified by the designer.

Environmental limits

The designer of a SIF must check that the product is rated for use within the expected environmental limits.

Refer to product datasheet, installation instruction and product label for environmental limits.

Application limits

The material of construction of VMR-VML-VMM valves are specified in product datasheet. These valves are suitable for air and fuel gas in accordance with EN437.

If valves are used with other gases, the designer has to check for material compatibility considering on–site conditions.

The gas has always to be dry and filtered (recommended filtering size <50µm).

If the VMR-VML-VMM valves are used outside of the environmental or application limits, the reliability data provided becomes invalid.

Design Verification

A detailed FMEDA report is available from Elettromeccanica Delta S.p.a. – Technical Department. This report details all failure rates and failure modes as well as the expected lifetime.

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 architecture, proof test interval, proof test effectiveness, any automatic diagnostics, average repair time and the specific failure rates of all products included in the SIF. Each subsystem must be checked to assure compliance with minimum hardware fault tolerance (HFT) requirements.

When using the VMR-VML-VMM valves, in a redundant configuration, a common cause factor of at least 10% should be included in safety integrity calculations.

The failure rate data listed the FMEDA report is only valid for the useful life time of VMR-VML-VMM valves.

The failure rates will increase sometime after this time period. 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 Safety Integrity Level will not be achieved.

SIL Capability

Systematic Integrity

The product has met manufacturer design process requirements of Safety Integrity Level (SIL) 2. These are intended to achieve sufficient integrity against systematic errors of design by the manufacturer. A Safety Instrumented Function (SIF) designed with this product must not be used at a SIL level higher than the statement without "prior use" justification by end user or diverse technology redundancy in the design.

Random Integrity

VMR-VML-VMM valves is classified as Type A devices according to IEC 61508, having a hardware fault tolerance of 0. They are just some of the many components that can be used in a final element assembly and the SIL must be verified for the entire assembly using failure rates from all components. This analysis must account for any hardware fault tolerance and architecture constraints.

Safety Parameters

For detailed failure rate information refer to the FMEDA Report.

General Requirements

The system response time shall be less than process safety time. The VMR-VML-VMM valves are only part of the final element of a SIS. All elements of the SIF must be chosen to meet the safety response time.

All SIS components, including VMR-VML-VMM valves must be operational before process start-up.

User shall verify that VMR-VML-VMM valve is suitable for use in safety applications.

Personnel performing maintenance and testing on those valves shall be competent to do so.

Results from the proof tests shall be recorded and reviewed periodically.

The useful life of the VMR-VML-VMM valves is discussed in Section "*Operation and maintenance*" below.

Installation and commissioning

Installation

The VMR-VML-VMM valves must be installed per standard practices outlined in the Installation, Operation and Maintenance Instructions.

The environment must be checked to verify that environmental conditions do not exceed the ratings.

The VMR-VML-VMM valves must be accessible for physical inspection.

Physical Location and Placement

The VMR-VML-VMM valves shall be accessible with sufficient room for coil and bonnet disassembly to allow internal inspection.

Valves and electrical cables shall be protected against mechanical danger (e.g. accidental impact).

Operation And Maintenance

Proof Test

The objective of proof testing is to detect failures within the valve that are not detected by any automatic diagnostics of the system. The main concern are undetected failures that prevent the safety instrumented function from performing its intended function.

The frequency of proof testing, or the proof test interval, is to be determined in reliability calculations for the safety instrumented functions for which a valve type VMR-VML-VMM is applied. The proof tests must be performed more frequently as specified in the calculation in order to maintain the required safety integrity of the safety function. A maximum inspection interval of 1 year is recommended (6 months in case of gas non-conforming EN437).

The following proof test is recommended. The results of proof test should be recorded and any failures that are detected and that compromise functional safety should be reported to Elettromeccanica Delta Spa.

The suggested proof test consists of:

1. External inspection
2. Internal inspection
3. Tightness test

Steps listed above are described in the Installation, Operation and Maintenance Instructions.

This proof test coverage for VMR-VML-VMM valves are listed in the FMEDA report.

The person(s) performing the proof test of VMR-VML-VMM valves should be trained in SIS operations, including bypass procedures, valve maintenance and company Management of Change procedures. No special tools are required.

Repair and replacement

Repair procedures are described in the VMR-VML-VMM valves Installation, Operation and Maintenance Instructions and must be strictly followed.

Useful Life

The normal useful life of the VMR-VML-VMM valves is 10 years from the date printed on the label (e.g. 1613 – week 16 of 2013) or the B10d value reported in the FMEDA report.

Manufacturer notification

Any failures that are detected and that compromise functional safety should be reported to Elettromeccanica Delta S.p.a.

Notes:

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