

SIGMAHLR QUICK EXHAUST

**SAFETY MANUAL APPLICABLE FOR MODELS. 13QS38,
13QS39, 13QS40, 13QS41, 13QS44, & 13QS45**

Model	Pressure Rating (PSI)	Service
13QS38	6000 PSI	STANDARD (STD)
13QS39	6000 PSI	H2S
13QS40	6000 PSI	STD
13QS41	6000 PSI	H2S
13QS44	10, 000 PSI	STD
13QS45	10, 000 PSI	H2S

1 INTRODUCTION

This Safety Manual provides information necessary to design, install, verify and maintain a Safety Instrumented Function (SIF) utilizing the quick exhaust valves with model numbers 13QS38, 13QS39, 13QS40, 13QS41, 13QS44, & 13QS45. This manual provides necessary user information and requirements for meeting the IEC 61508 and/or IEC 61511 functional safety standards.

1.1 Terms and Abbreviations

Safety Freedom	Freedom from unacceptable risk of harm
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
Functional Safety	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
Safety Assessment	The investigation to arrive at a judgment - based on evidence - of the safety achieved by safety-related systems
Element	part of a subsystem comprising a single component or any group of components that performs one or more element safety functions
Fail-Safe State	state of the process when safety is achieved; A loss or significant decrease of inlet supply pressure establish high volume reverse flow exhaust.
Fail Safe	Failure that causes the quick exhaust valve to go to the defined fail-safe state without a demand from the process.

Fail Dangerous	Failure that does not permit the SIF to 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 testing.
Fail Dangerous Detected	Failure that is dangerous but is detected by automatic testing.
Fail Annunciation Undetected	Failure that does not cause a false trip or prevent the safety function but does cause loss of an automatic diagnostic and is not detected by another diagnostic.
Fail Annunciation Detected	Failure that does not cause a false trip or prevent the safety function but does cause loss of an automatic diagnostic or false diagnostic indication.
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 safety function is only performed on demand, to transfer the EUC into a specified safe state, and where the frequency of demands is no greater than one per year and no greater than twice the proof test frequency.
High demand mode	Mode where the safety function is only performed on demand, to transfer the EUC into a specified safe state, and where the frequency of demands is greater than one per year or greater than twice the proof test frequency.

Continuous Mode

Mode where the safety function maintains the EUC in a safe state as part of normal operation.

1.2 Acronyms

EUC	Equipment Under Control
FMEDA	Failure Modes, Effects and Diagnostic Analysis
HFT	Hardware Fault Tolerance
MOC	Management of Change. These are specific procedures to follow for any work activities in compliance with government regulatory authorities or requirements of a standard.
PFDavg	Average Probability of Failure on Demand
PFH	Probability of Failure per Hour
SFF	Safe Failure Fraction, the fraction of the overall failure rate of an element that results in either a safe fault or a diagnosed dangerous 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 is the highest level and Safety Integrity Level 1 is the lowest.
SIS	Safety Instrumented System – Implementation of one or more Safety Instrumented Functions. A SIS is composed of any combination of sensor(s), logic solver(s), and final element(s).

1.3 Product Support

Product support can be obtained from:

SigmaHLR

sales@sigmahlr.com

www.sigmahlr.com

Phone:+1 972-355-3453

1.4 Related Literature

Hardware Documents:

Installation, Operation & Maintenance Instructions. This information can be obtained on www.sigmahlr.com or contact sales@sigmahlr.com

Guidelines/References:

- • Practical SIL Target Selection – Risk Analysis per the IEC 61511 Safety Lifecycle, ISBN 978-1-934977-03-3, Exida
- • Control System Safety Evaluation and Reliability, 3rd Edition, ISBN 978-1-934394-80-9, ISA
- • Safety Instrumented Systems Verification, Practical Probabilistic Calculations, ISBN 1-55617-909-9, ISA

1.5 Reference Standards

Functional Safety

- • IEC 61508: 2010 Functional safety of electrical/electronic/programmable electronic safety-related systems
- • IEC 61511:2003 Functional Safety – Safety Instrumented Systems for the Process Industry Sector (or ISA 84.00.01 if it is more appropriate)

2 PRODUCT DESCRIPTION

The **13QS38,13Q39, 13QS40, & 13QS41** is a two position, poppet operated control valve assembly. This hydraulic Quick Exhaust valve has a maximum working pressure of 6,000 PSI (413 bar) with high flow exhaust capacity. It establishes flow from supply to valve (inlet to outlet) connections to open a Surface Safety Valve (SSV) or Surface Controlled Subsurface Safety Valve (SCSSV) actuator automatically with each application of operating pressure. The **13QS44 & 13QS45** is a two position, poppet operated control valve assembly for 10,000 PSI hydraulic service. This high flow exhaust valve establishes flow from the Supply to Valve connections (inlet to outlet) to open a Surface Safety Valve (SSV or hydraulic Actuator) automatically with each application of operating pressure. See Installation and Maintenance Manual for additional setup and configuration details.

2.1 Hardware and Software Versions

Not applicable.

3 DESIGNING A SIF USING A MANUFACTURER PRODUCT

3.1 Safety Function

A loss or significant decrease of inlet supply pressure will unseat the Poppet to quickly establish high volume reverse flow exhaust. Rapid closure of a hydraulic actuator is assured with the use of a Sigma Quick Exhaust Valve. The 13SQ38 utilizes a small internal orifice that bypasses the Poppet assembly to provide thermal expansion capability. It also minimizes the effects of pump cycling or small volume fluid leaks, to maintain proper operating volume or pressure. When internal dangerous faults are detected, all QEV's output moves to its fail-safe state. For other detected faults, the product will shut the hydraulic actuator system. When de-energized, listed QEVs will *move* to its fail-safe position.

The listed QEV models are intended to be part of a SIF subsystem as defined per IEC 61508 and the achieved SIL level of the designed function must be verified by the designer.

3.2 Environmental limits

The designer of a SIF must check that the product is rated for use within the expected environmental limits. Refer our listed QEV models spec sheets for environmental limits.

3.3 Application limits & restrictions

The listed QEV models are intended for use in the Oil & Gas Industry to control the Subsurface Safety Valve (SCSSV) actuator. Please refer our product spec sheets for its intended applications & usage requirements.

The materials of construction of listed QEV models are specified in the individual model product spec sheets. It is especially important that the designer check for material compatibility considering on-site chemical contaminants and air supply conditions. If the listed QEV models are used outside of the application limits or with incompatible materials, the reliability data provided becomes invalid. Decommissioning and disposal considerations for the product due to materials of construction are listed in installation manual.

3.4 Design Verification

A detailed Failure Mode, Effects, and Diagnostics Analysis (FMEDA) report is available from **SigmaHLR**. This report details all failure rates and failure modes as well as the expected lifetime. Assumptions made during the FMEDA are listed in the FMEDA report.

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 or PFH, considering safety architecture, proof test interval, proof test effectiveness, any automatic diagnostics and worst-case fault detection interval, 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. The Exida exSILentia® tool is recommended for this purpose as it contains accurate models for the listed QEV models and its failure rates. The failure rate data listed the FMEDA report are only valid for the useful life time of listed QEV models. 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 required Safety Integrity Level will not be achieved.

An appropriate MTTR shall be selected based on SigmaHLR and/or plant operation and maintenance procedures.

3.5 SIL Capability

3.5.1 Systematic Integrity

The product has met manufacturer design process requirements of Safety Integrity Level (SIL) 3. 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 the end user or diverse technology redundancy in the design.

3.5.2 Random Integrity

The Quick Exhaust valve models in this document are Type A Element. Therefore, the quick exhaust valve can be classified as a 2H device when the listed failure rates are used. When 2H data is used for all of the devices in an element, then the element meets the hardware architectural constraints up to SIL 2 at HFT=0 (or SIL 3 @ HFT=1) per Route 2H. If Route 2H is not applicable for the entire final element, the architectural constraints will need to be evaluated per Route 1H.

3.5.3 Safety Parameters

For detailed failure rate information refer to the Failure Modes, Effects and Diagnostic Analysis Report for the listed QEV models in this document.

4 OPERATION AND MAINTENANCE

For a routine maintenance or any safety recommendations use the listed QEV model spec. sheets for its rated pressures & specified operating temperatures. Contact SigmaHLR (sales@sigmahlr.com) for all or any other technical information & product limitations.

4.1 Proof test without automatic testing

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

The frequency of proof testing, or proof test interval, is to be determined in reliability calculations for the safety instrumented functions for which listed QEV models *are* applied. The proof tests must be performed at least as frequently as specified in the calculation to maintain the required safety integrity of the safety instrumented function.

The following proof test is recommended. The results of the proof test should be recorded and any failures that are detected and that compromise functional safety should be reported to SigmaHLR. The suggested proof test consists of << brief description if applicable >>.

Table1: Recommended proof Test

Step	Action
1	Bypass the safety function and take appropriate action to avoid a false trip.
2	Interrupt or change the supply pressure to Quick exhaust valve to force the QEV to perform the exhaust function & confirm the safety state for the final element was achieved & within correct time.
3	Inspect the QEV for any visible damage or contamination.

4	Restore the supply pressure to QEV and inspect the QEV valve for any leaks, visible damage or contamination & confirm the final operating stage was achieved.
5	Remove the bypass and otherwise restore normal operation.

The tests to be effective the movement of the valve must be confirmed. To confirm the effectiveness of the test both travel of the valve & slew rate must be monitored & compared to expected results to validate the testing.

Proof Test Coverage:

The proof test coverage for various device configurations is given Table 2

Table 2 Proof test Results- Quick Exhaust Valve

DEVICE	λ_{DUPT^5} (FIT)	PROOF TEST COVERAGE
Quick Exhaust Valve	2	0.94

The person(s) performing the proof test of a Quick Exhaust valve should be trained in SIS operations, including bypass procedures, valve maintenance and company Management of Change procedures. It is recommended that a physical inspection (Step 3 from Table 1) be performed on a periodic basis with the time interval determined by plant conditions. A maximum inspection interval of 2 years is recommended.

4.2 Repair and replacement

Repair procedures as listed in product of the QEV models listed in this document Installation, Operation and Maintenance manual must be followed.

4.3 Useful Life

The useful life of the Quick Exhaust Valve is 10 to 15 years, or 10,000 cycles

4.4 MANUFACTURER Notification

Any failures that are detected and that compromise functional safety should be reported to SigmaHLR. Please contact sales@sigmahlr.com or call us at +972-355-3453 for any notifications related Quick Exhaust Valve models listed in this document.