SIGMA HLR

SIGMAHLR hydraulic interface valve

SAFETY MANUAL APPLICABLE FOR MODELS HLR 7950A, HLR 7955A, HLR 7960A, & HLR 7965A

Model	Pilot Supply (PSI)	Pressure Rating (PSI)	Service
HLR 7950	80-150	10,000	Standard
HLR 7955A	80-150	10,000	With By-Pass
HLR 7960A	80-150	10,000	Std Service
HLR 7965A	80-150	10000	With By-Pass

1 INTRODUCTION

This Safety Manual provides information necessary to design, install, verify and maintain a Safety Instrumented Function (SIF) utilizing the Hydraulic Interface Valve with model numbers HLR 7950A, HLR 7955A, HLR 7960A, & HLR 7965A. 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 hydraulic interface 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

HLR 7950A is a two position, three way Normally Closed, pilot supply pressure operated, spring return, 10,000 PSI, flow control valve. A Pilot Supply pressure of 80 PSI is required for controlling hydraulic pressure of 10,000 PSI. These Hydraulic Valves are generally used to operate Surface Controlled Sub-Surface Safety Valves (SCSSV).

HLR 7955A is a two position, three way Normally Closed, pilot supply pressure operated, spring return, 10,000 PSI, flow control valve that has a manual operate (By-Pass) Handle. A Pilot Supply pressure of 80 PSI is required for controlling hydraulic pressure of 10,000 PSI.

HLR 7960A is a tow position, two way Normally Open, pilot supply pressure operated, spring return, hydraulic flow control valve. It is designed to bleed hydraulic fluid to a vented reservoir upon loss of the pilot supply. A pilot pressure of 80 PSI is required for controlling hydraulic pressure of 10,000 PSI.

HLR 7965A is a two (2) way, normally open, hydraulic valve. It is designed to bleed hydraulic supply to a hydraulic reservoir upon loss of pilot pressure. Hydraulic control of the Surface Controlled-Sub-Surface Safety Valve (SCSSV) is the most typical application for the HLR 7965A. A pilot pressure of 80 PSI is required for controlling hydraulic pressure of 10,000 PSI. To operate the valve without a pilot supply, turn the by-pass handle clockwise

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2.1 Hardware and Software Versions

Not applicable.

3 DESIGNING A SIF USING A MANUFACTURER PRODUCT

3.1 Safety Function

The safety function of Hydraulic interface valves listed in this document is to vent the outlet pressure to exhaust on the loss of pilot pressure
The listed hydraulic interface valve 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 hydraulic interface valve models spec. sheets for environmental limits.

3.3 Application limits & restrictions

The listed hydraulic interface valve 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 hydraulic interface valve 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 hydraulic interface valve 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 hydraulic interface valve models and its failure rates. The failure rate data listed the FMEDA report are only valid for the useful life time of listed hydraulic interface valve 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 hydraulic interface valve models in this document are Type A Element. Therefore, the hydraulic interface 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 hydraulic interface valve models in this document.

4 OPERATION AND MAINTENANCE

For a routine maintenance for any safety recommendations use the listed hydraulic interface valve models spec. sheets for its rated pressures & at specified operating temperatures only. Refer the spec. sheets for all necessary technical information & product limitations.

4.1 Proof test without automatic testing

The objective of proof testing is to detect failures within listed hydraulic interface valve 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 hydraulic interface valve
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.

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 pilot supply pressure to hydraulic interface valve to force the hydraulic interface valve to perform an exhaust function & confirm the safety sate for the final element was achieved & within correct time.
3	Inspect the hydraulic interface valve for any visible damage or contamination.
4	Restore the pilot supply pressure to hydraulic interface valve pressure sensor and inspect the interface valve for any leaks, visible damage or contamination & confirm the normal 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- hydraulic interface valve

DEVICE	$\lambda_{DU}PT^5$ (FIT)	PROOF TEST COVERAGE
hydraulic interface valve	6	94%

The person(s) performing the proof test of a hydraulic interface 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 recommended in the listed hydraulic interface valve models spec. sheets should be followed. Contact SigmaHLR (sales@sigmahlr.com) for any further assistance.

4.3 Useful Life

The useful life of the hydraulic interface 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 hydraulic interface valve sensor models listed in this document.