

CERTIFICATE OF COMPLIANCE

Certificate Owner: **Guide Valve Limited**
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The assessment concluded that the overall Functional Safety Lifecycle frame work employed by Guide Valve Limited (GVS) for the provision of the scoped shut-off valves are in accordance with the requirements of IEC 61508:2010 and thus satisfy the requirement for use within a Safety Related System as a Safety Integrity Level (SIL) capable element.

Systematic Capability: SC 3 (SIL 3) **Architecture Capability: Type A Device, Route 2H**

Notes:

- Average Probability of Failure On Demand (PFD_{AVG}) and Hardware Fault Tolerance must be verified for each application.
- The Safety Function is specified as the ball valve shall move to the designated safe position as per application design.

This certification is supported by:

- IEC 61508:2010 Part 1 and Part 2 Functional Safety Assessment (Route 1s) which concludes Systematic Capability (SC) up to an including SIL 3 documented in FSES reports FSES_P180091_FS001 iss. 0 and FSES_P180091_FS002 iss. 0.
- Failure Mode, Effect & Criticality Analysis (FMECA) which demonstrates Random Hardware Reliability and Architectural Constraints suitability (Route 2H) for use in a SIL 2 application in a 1oo1 configuration and SIL 3 application in a 1oo2 configuration documented in FSES report FSES_P180091_FM001 iss. 0.

The scoped valves are as follows:

1. GVS Trunnion Mounted Soft Seated Ball Valves.
2. GVS Trunnion Mounted Metal to Metal Ball Valve.
3. GVS Special Trim Valves wet or dry.
4. GVS Triple Seated Ball Valves.
5. VCI Floating Type Valves.

Document No.: FSES_P180091_CE001.docx

Date of Issue: 8th of August 2019

Expiry date: 8th of August 2024

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Systematic Capability

The process associated with design, development and management of the manufacturing process for the scoped valves has met the requirements for SC 3 and thus has deemed the products suitable for use in a SIL 3 application. The intention of SC is to control and minimize systematic failures and to achieve sufficient integrity against such failures in design and manufacturing processes.

Random Hardware and Architectural Capabilities

Average Probability of Failure on Demand (PFD_{AVG}) and Hardware Fault Tolerance must be verified for each application. The information below shall be used to conduct the required calculations. The assessment of Random Hardware and Architectural capabilities determined suitable for use in a SIL 2 application in a 1oo1 configuration and SIL 3 application in a 1oo2 configuration.

Valve Types	λ_{DD} (/hr.)	λ_{DU} (/hr.)	λ_S (/hr.)
GVS Trunnion Mounted Soft Seated Ball Valve	0.00E+00	1.34E-07	9.25E-07
GVS Trunnion Mounted Metal to Metal (up to 240 deg C)	0.00E+00	1.63E-07	1.25E-06
GVS Trunnion Mounted Metal to Metal (350 deg C +)	0.00E+00	1.63E-07	1.25E-06
GVS Special Trim Valve Acid Gas	0.00E+00	1.59E-07	1.26E-06
GVS Special Trim Valve CO ₂ - ANSI 150-900 6"-24"	0.00E+00	1.44E-07	1.09E-06
GVS Special Trim Valve CO ₂ - ANSI 1500 6"-16"	0.00E+00	1.47E-07	1.09E-06
GVS Special Trim Valve CO ₂ - ANSI 2500 2"-4"	0.00E+00	1.50E-07	1.14E-06
GVS Special Trim Valve CO ₂ - ANSI 1500 18"-24"	0.00E+00	1.50E-07	1.14E-06
GVS Special Trim Valve CO ₂ - ANSI 2500 6"-12"	0.00E+00	1.50E-07	1.14E-06
GVS Trunnion Mounted Triple Seated Ball Valve	0.00E+00	1.51E-07	1.20E-06
VCI Floating Type Valve F200k	0.00E+00	2.16E-07	3.24E-07
VCI Floating Type Valve 2001F	0.00E+00	2.49E-07	4.06E-07
VCI Floating Type Valve F100	0.00E+00	2.16E-07	3.24E-07

Note:

1. λ_{DD} refers to Dangerous Detected (DD) failures of the safety critical system.
2. λ_{DU} refers to Dangerous Un-detected (DU) failures of the safety critical system.
3. λ_S refers to Safe (S) failures of the safety critical system.

The SIL for the complete Safety Instrumented Function (SIF) must be verified via calculation of PFD_{AVG} considering the voting configuration (i.e. redundancy), proof test interval, applicable diagnostics, repair times and other pertinent factors. based on the failure rate data provide above.

Valve Types	Voting Configuration	Calculated PFD	Assessed SIL Capability
GVS Trunnion Mounted Soft Seated Ball Valve	1oo1	2.82E-03	SIL 2
GVS Trunnion Mounted Soft Seated Ball Valve	1oo2	2.88E-04	SIL 3
GVS Trunnion Mounted Metal to Metal (up to 240 deg C)	1oo1	3.43E-03	SIL 2
GVS Trunnion Mounted Metal to Metal (up to 240 deg C)	1oo2	3.53E-04	SIL 3
GVS Trunnion Mounted Metal to Metal (350 deg C +)	1oo1	3.43E-03	SIL 2
GVS Trunnion Mounted Metal to Metal (350 deg C +)	1oo2	3.53E-04	SIL 3
GVS Special Trim Valve Acid Gas	1oo1	3.34E-03	SIL 2
GVS Special Trim Valve Acid Gas	1oo2	3.43E-04	SIL 3
GVS Special Trim Valve CO ₂ - ANSI 150-900 6"-24"	1oo1	3.02E-03	SIL 2
GVS Special Trim Valve CO ₂ - ANSI 150-900 6"-24"	1oo2	3.09E-04	SIL 3
GVS Special Trim Valve CO ₂ - ANSI 1500 6"-16"	1oo1	3.09E-03	SIL 2
GVS Special Trim Valve CO ₂ - ANSI 1500 6"-16"	1oo2	3.16E-04	SIL 3
GVS Special Trim Valve CO ₂ - ANSI 2500 2"-4"	1oo1	3.15E-03	SIL 2
GVS Special Trim Valve CO ₂ - ANSI 2500 2"-4"	1oo2	3.22E-04	SIL 3
GVS Special Trim Valve CO ₂ - ANSI 1500 18"-24"	1oo1	3.15E-03	SIL 2
GVS Special Trim Valve CO ₂ - ANSI 1500 18"-24"	1oo2	3.22E-04	SIL 3
GVS Special Trim Valve CO ₂ - ANSI 2500 6"-12"	1oo1	3.15E-03	SIL 2
GVS Special Trim Valve CO ₂ - ANSI 2500 6"-12"	1oo2	3.22E-04	SIL 3
GVS Trunnion Mounted Triple Seated Ball Valve	1oo1	3.18E-03	SIL 2
GVS Trunnion Mounted Triple Seated Ball Valve	1oo2	3.26E-04	SIL 3
VCI Floating Type Valve F200k	1oo1	4.55E-03	SIL 2
VCI Floating Type Valve F200k	1oo2	4.71E-04	SIL 3
VCI Floating Type Valve 2001F	1oo1	4.78E-03	SIL 2
VCI Floating Type Valve 2001F	1oo2	4.96E-04	SIL 3
VCI Floating Type Valve F100	1oo1	4.55E-03	SIL 2
VCI Floating Type Valve F100	1oo2	4.71E-04	SIL 3

Note:

1. Proof Test Interval (PTI) is the assumed interval for functional testing in hours and is assumed to be 8760 hrs. (i.e. yearly).
2. Proof Test Coverage (PTC) is the assumed portion dangerous failures revealed by proof test. The PTC has been assumed to be 80% effective. Note useful life time of the valves considered to be 20 years and thus all unrevealed failures are subject to this time period.
3. Mean Time To Repair (MTTR) is the repair time in hours, for which the SIF or equipment may not respond to a demand. It has been assumed that it takes 24 hrs for the equipment to be brought back into operation.
4. Voting Configuration represent the redundancy of the system or sub system.

5. PFD is the calculated average probability of failure on demand for the valve which is a final element to the Safety Instrumented Function (SIF).
6. SIL capability is based on calculated PFD and the minimum required hardware fault tolerance (route 2H).
7. All scoped valves are considered to be Type A.
8. The Random Hardware Assessment has been carried out in accordance with IEC 61508:2010 Part 2.
9. PFD is calculated in accordance with the guidance presented in IEC 61508:2010 Part 6.
10. The valves presented above are only applicable where the equipment has been used within the specified operation and environmental envelop and the specified conditions.
11. Average Probability of Failure On Demand (PFD_{AVG}) and Hardware Fault Tolerance must be verified for each application.

DISCLAIMER

The information and statements contained in this document are opinions only and reflect Functional Safety Engineering Services' best judgement based on the available information. Functional Safety Engineering Services shall not be responsible whatsoever for loss or damage (including, without limitation, loss of profits or any indirect loss), if any, suffered by any party as a result of decisions made or actions taken in reliance upon or in connection with the information contained in this report.

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CHANGE HISTORY

Issue	Date of Issue	No. of Pages	Reasons for Change
0	07/08/2019	4	Initial issue.

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