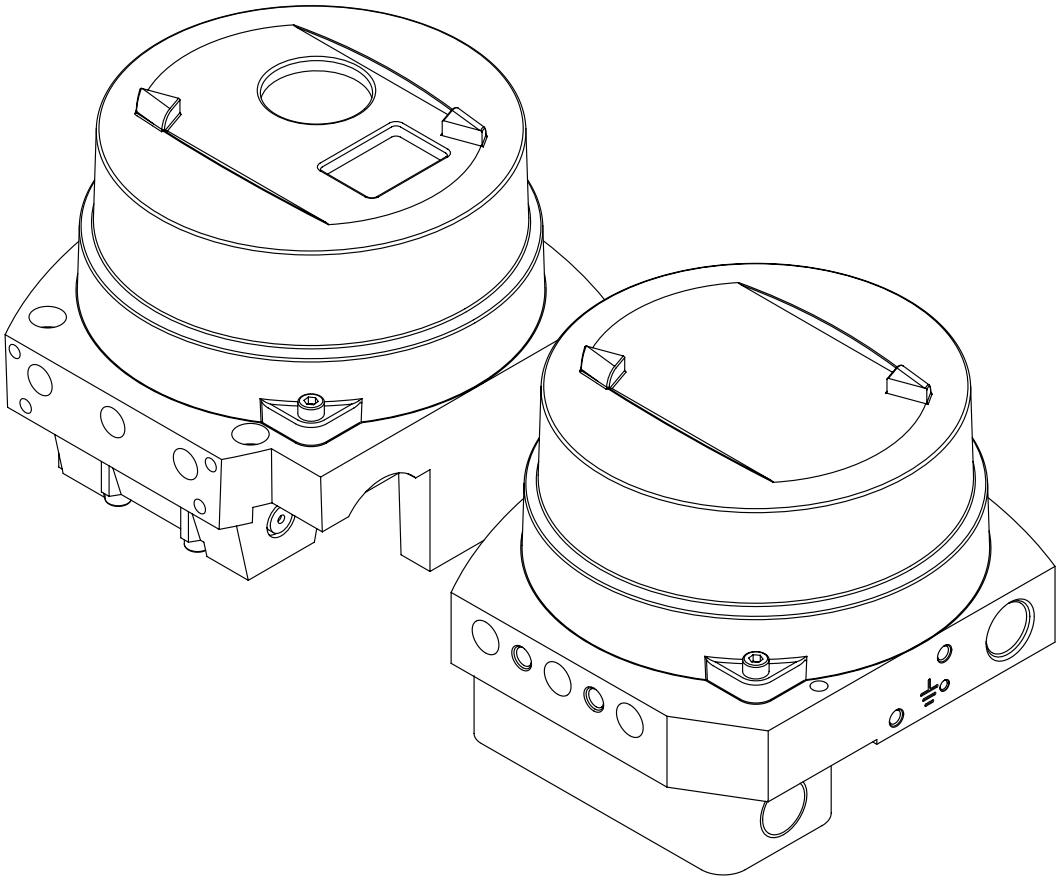
Neles™ ValvGuard™
VG9000H
Rev 2.0
Safety manual



Functional Safety
Type Approved
TÜVRheinland®
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1. General information

1.1 Purpose of the document

This safety manual provides necessary information to design, install, verify and maintain safety instrumented function (SIF) using the Neles ValvGuard Intelligent Safety Solenoid and/or the integrated position transmitter.

The document must be used as part of the safety lifecycle. Information provided in this manual is necessary for meeting the IEC 61508 or IEC 61511 functional safety standards.

1.2 Description of the device

Neles ValvGuard VG9000H is loop (mA) powered SIL 3 certified intelligent safety solenoid and thus a safety related product. VG9000H can be used with or without Local Control Panel (LCP). LCP has different product options; externally powered (24 VDC) version (LCP9H_) or the loop powered (mA) version (LCP9H_L). LCP9H_L is powered via the input signal of VG9000H. Optional integrated position transmitter (T01) is loop powered SIL 2 certified device and provides 4-20 mA output signal related to valve position.

Extra attention is required to make sure they are used in a way they are intended to be used and in a safe manner.

NOTE:
HART communication can be used for informational purposes, but is not safety certified for diagnostic annunciation.

2. Structure of safety valve controller

2.1 System components and description of use

See the IMO for the detailed technical description of the device and the system architecture.

2.2 Permitted device types

The information in this manual pertaining to functional safety applies to all device variants mentioned in the device type coding in the IMO.

2.3 Supplementary device documentation

This manual is not intended to be used as a stand-alone document. It must be used together with the document 7VG9H70EN; Installation, Maintenance and Operating Instructions for Neles ValvGuard VG9000H (later referred as IMO). It is available from your local Valmet office or for download from www.neles.com/VG9000

3. Description of safety requirements

3.1 Safety function

3.1.1 Intelligent safety solenoid

Intelligent safety solenoid part of the Neles ValvGuard consists of the spool valve (SV), the prestage unit (PR) and the safety electronics. They are the components, which takes part of the safety action. Prestage unit is coil operated flapper valve, which is open when de-energized. De-energized is the safe state of the device prestage unit coil. Prestage unit is controlling the spool valve, which is operated by spring force to fail safe position and by pneumatic force to the normal position. See figure 1 for the principle of operation. Prestage will be de-energized when input signal (loop current) to the device (VG9000H) is below 6.0 mA (nominal 4.0 mA). If using VG9000H_L3 product option, then the prestage will be de-energized when input signal is below 10.0 mA (nominal 8.0 mA). That will cause the spool valve to release the air from C2 port via spool valve exhaust and drive the emergency shutdown valve to close or open position depending on the application type.

Safety function is to release the air from C2 port via the spool valve exhaust. Reaction time of safety function is <200 milliseconds. The closing (or opening) time of the valve depends on the size of the spool valve, size and type of the pneumatic actuator and the valve, the supply pressure etc.

Micro controller and firmware are not part or cannot prevent the safety action. Measurements from the pressure sensors (Px) and position sensor (α) are used for controlling the Partial Stroke and other tests and used for the device diagnostics only.

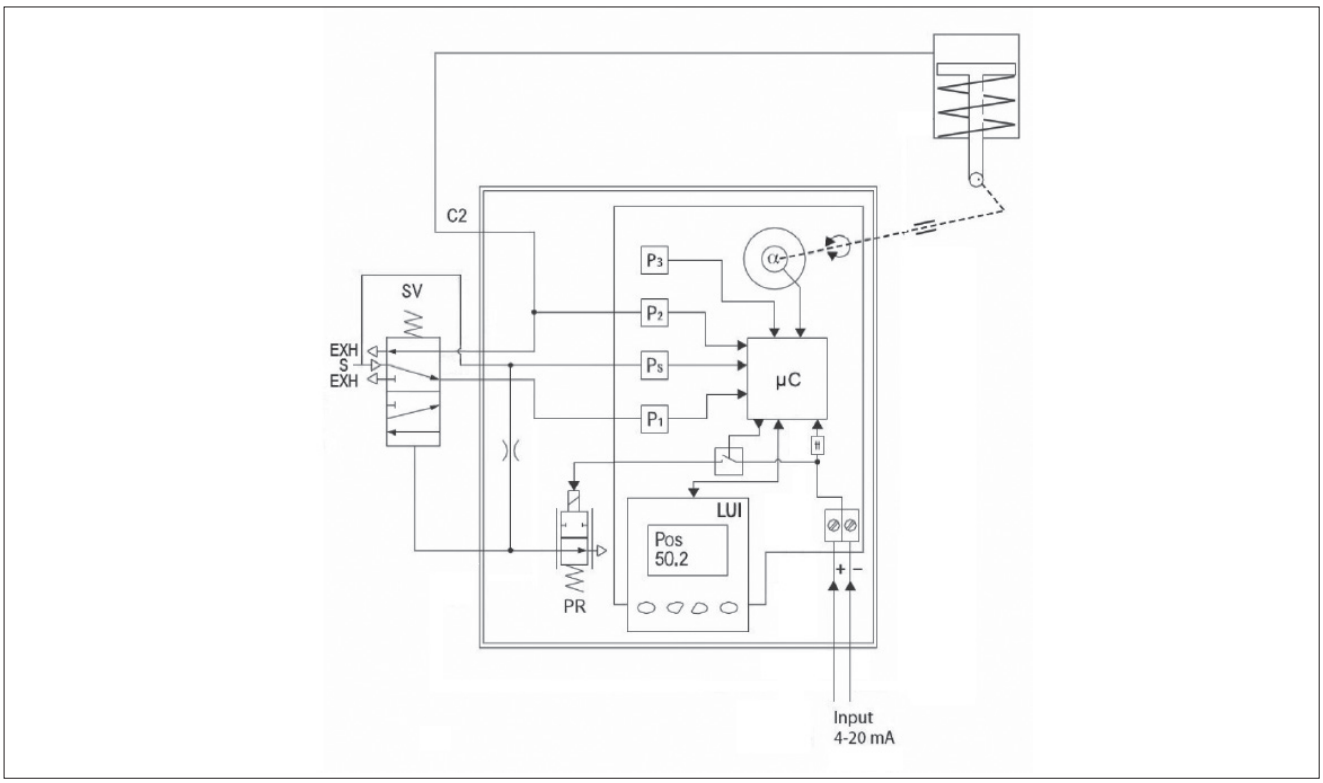

Fig. 1. Principle of operation. Spool valve and prestage are shown in de-energized position.

Figures 2 and 3 show the thresholds of VG9000H and VG9000H_L3 product option respectively. Thresholds for the de-energized states are the main safety related information, but the figures show also all other loop current thresholds of the intelligent safety solenoids.

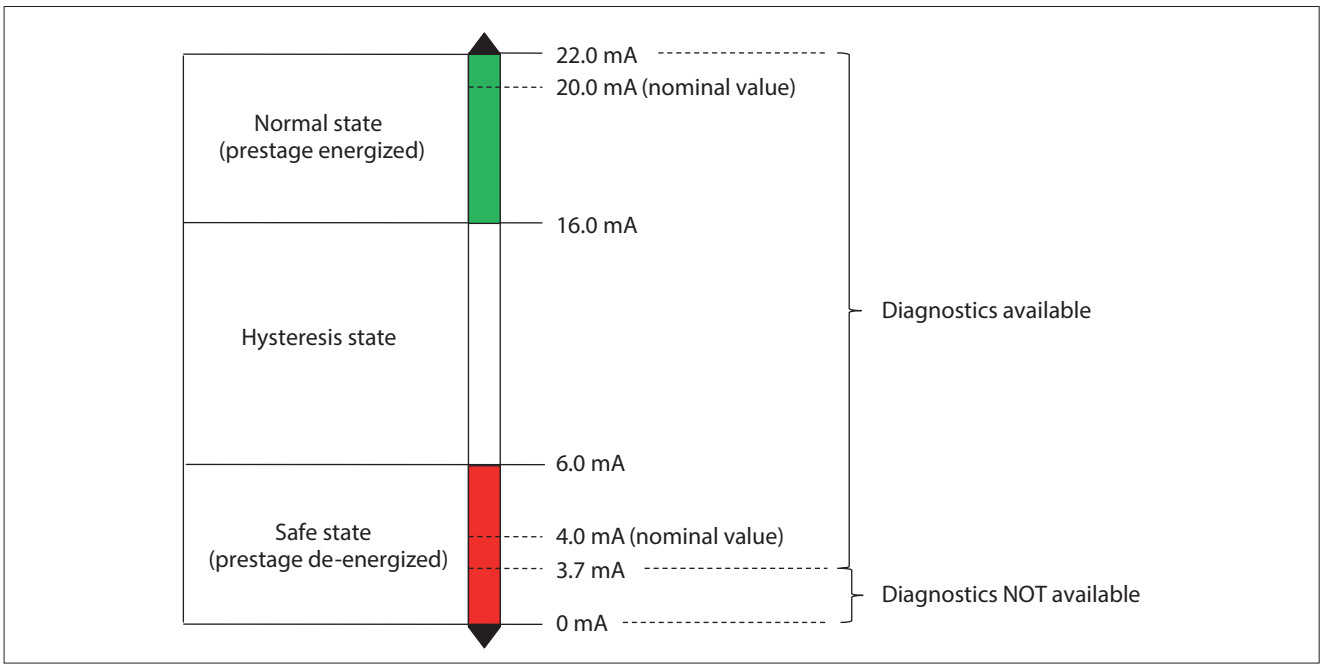

Fig. 2. Loop current thresholds of the intelligent safety solenoid input signal (VG9000H product option)

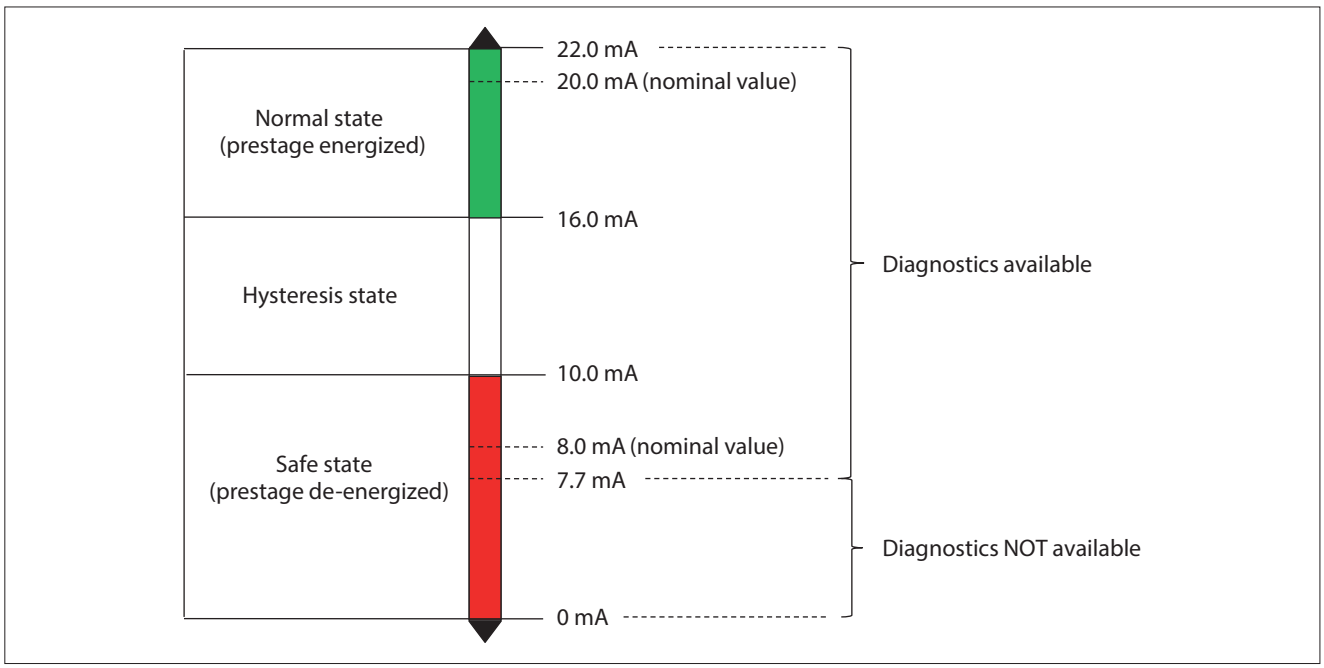

Fig. 3. Loop current thresholds of the intelligent safety solenoid input signal (VG9000H_L3 product option)

3.1.2 Position transmitter

In the position transmitter part of the Neles ValvGuard the feedback sensor (T01), located in the extension housing, measures the valve position and the transmitter electronics convert the position into a 4-20 mA signal. This signal is used by the safety control system. Safety function of the position transmitter is sensing the position of the valve or actuator and translating it into a 4-20 mA value. If the position transmitter produces feedback out of range (<3 mA or >21 mA), that is considered dangerous detected failure, and the safety system must perform the safety action.

3.2 Restrictions for use in safety-related applications

Please ensure that both, the intelligent safety solenoid and the position transmitter, are used correctly for the application in question and that the ambient conditions and air supply quality are taken into account. The instructions for installation conditions, as detailed in the IMO, shall be observed. The specifications in the IMO shall not be exceeded.

3.3 Functional safety indicators

The tables below show the functional safety indicators for VG9000 intelligent safety solenoid and partial stroke test devices.

3.3.1 Data for intelligent safety solenoid and partial stroke test device

Results of assessment

Route of Assessment		2_H / 1_S
Type of Sub-system		Type A
Mode of Operation		Low Demand Mode
Hardware Fault Tolerance	HFT	0
Systematic Capability		SC 3

Without diagnostics testing (DC = 0%)

Dangerous Undetected Failure Rate	λ_D	2.76 E-07 / h	**276 FIT**
Safe Failure Rate	λ_S	4.10 E-07 / h	**410 FIT**
Average Probability of Failure on Demand 1oo1	$PFD_{avg}(T_1)$	1.21 E-03	
Average Probability of Failure on Demand 1oo2	$PFD_{avg}(T_1)$	1.23 E-04	

Assumptions for the calculations above: T_1 = 1 year, DC = 0

With diagnostics testing, i.e. PST or internal pneumatics test (DC = 79%)

Dangerous Undetected Failure Rate	λ_{DU}	5.80 E-08 / h	**58 FIT**
Dangerous Detected Failure Rate	λ_{DD}	2.18 E-07 / h	**218 FIT**
Safe Failure Rate	λ_S	4.10 E-07 / h	**410 FIT**
Average Probability of Failure on Demand 1oo1	$PFD_{avg}(T_1)$	2.54 E-04	
Average Probability of Failure on Demand 1oo2	$PFD_{avg}(T_1)$	2.55 E-05	

Assumptions for the calculations above: T_1 = 1 year, DC = 79%, β_{1002} = 10%

3.3.2 Data for position transmitter T01

Functional safety indicators for position transmitter part of VG9000/T01

Safety function: Sensing of the position of valves or actuators and sending the position using a 4 to 20 mA signal.
Diagnostic measures: In case the current is <3 mA or >21 mA the sensor has an internal failure and the process has to be controlled in a way to lower the risk.

Dangerous Failure Rate (Current deviates more than 5 % from the “real” value (valve position)	λ_D	1.07 E-07 / h	**107 FIT**
Safe Failure Rate (Current deviates less than 5 % from the “real” value (valve position=	λ_S	2.84 E-08 / h	**28 FIT**
Dangerous Detected Failure Rate (Current is < 3 mA or > 21 mA)	λ_{DD}	7.03 E-08 / h	**70 FIT**
Dangerous Undetected Failure Rate (Current deviates more than 5 % from “real” value (valve position), but is still within 3 to 21 mA)	λ_{DU}	3.69 E-07 / h	**369 FIT**
Average Probability of Failure on Demand 1oo1	$PFD_{avg}(T_1)$	8.1 E-04	
Safe Failure Fracition	SFF	73 %	

Assumptions for the calculations above: T1 = 5 yers, Low Demand Mode, Diagnostic Measures: In case the current is < 3 mA or > 21 mA the sensor has an internal failure and the process has to be controlled in a way to lower the risk

3.3.3 Useful lifetime

A useful lifetime of approximately 12 years is expected for Neles ValvGuard. Published failure rates increase after this period. Operating conditions according to the device manual shall be observed

3.4 Behavior of device

3.4.1 During power-up

It may take up to 9 seconds for device diagnostics to power up and the intelligent safety solenoid to be fully operational in the diagnostics point of view. This is valid when the loop current is switched on and goes to 3.7 mA (7.7 mA for VG9000H_L3 product option) or above. This does not effect to the safety function of the device.

3.4.2 During operation

Once the loop current goes to 16.0 mA or above the prestage will be energized and the supply air will be fed to the pneumatic actuator by spool valve. That will eventually cause the valve to go to its normal operating position, which is open or close depending on the application type. Valve will remain in its normal operating position if the loop current is above 16.0 mA (nominal 20.0 mA). See all the loop current thresholds in section 3.1.

3.4.3 During emergency trip

See section 3.1.

3.4.4 In the event of alarms and warnings

Device alarms or warnings do not cause the intelligent safety solenoid to go to fail safe.

See the ‘behavior of device during operation’ above.

4. Installation

4.1 Hardware fault tolerance

The required hardware fault tolerance of the installation is zero (HFT = 0). If hardware fault tolerance of one (HFT =1) is required, then a dual redundant configuration of the valve installation shall be used.
The overall safety integrity depends mainly on the actuator and the valve (ESD or ESV). Therefore a hardware fault tolerance (HFT) of 1 in SIL 3 applications is strongly recommended.

4.2 Installation and commissioning

The installation of the device needs to be done according to the IMO. Every parameter related to the device type in question and mentioned in the IMO needs to be checked and compared against the device settings. If any deviations exist the safety of the installation cannot be guaranteed.

The VG9000H shall be configured before commissioning. The parameters configured to the VG9000H shall be read back and verified before commissioning using the HART Device Description (DD) or Neles Valve Manager (DTM) for VG9000H.

4.3 Orientation

Orientation of the device is described in the IMO.

4.4 Diagnostics coverage

To obtain the best possible diagnostic coverage, the automatic test intervals and the various alarm limits in the VG9000 solenoid shall be set, see Section 4 in the IMO.

The pneumatic test shall be enabled in case a safety integrity level of 3 (SIL 3) is required by the overall application.

The general value of diagnostic coverage factor for an ESD-valve (a fail to close valve) can be assumed to be around 75 % (valve + actuator), depending on the valve and actuator types. The general value of diagnostic coverage factor for an ESV-valve (fail to open valve) can be assumed to be around 90 % (valve + actuator), depending on the valve and actuator types. For more accurate estimates contact Valmet.

4.5 Parameters write protection

The parameters programmed in the VG9000H shall be write protected. If the organizational procedures are established, this can be done using the user access levels in the configuration software. See section 4.8.5 in the IMO.

4.6 Operation

See the IMO for the operation of the device.

4.7 Maintenance

See the IMO for maintenance instructions.
During maintenance work on the device, alternative safety function methods shall be taken to ensure process safety.

5. Testing

5.1 Internal tests of intelligent safety solenoid

Internal tests can be separated to two different parts, internal safety diagnostics and pneumatics test. They are described below.

5.1.1 Internal safety diagnostics

Device performs internal testing for its safety related electronics with the predefined interval of 10 minutes. User does not need to perform any electronics related tests manually. Problems in the internal safety related electronics test will be shown by diagnostics.

5.1.2 Pneumatics test

Device can perform internal pneumatics test for its pneumatics function. The test can be manual or automatic. Minimum automatic test interval is 10 minutes. The operation of the prestage and spool valve will be checked during the test. For procedure and details see the IMO.

This test does not affect the operation of the safety shutdown valve.

5.2 Position transmitter

If the device is equipped with the position transmitter, it can be tested by measuring the output signal. It shall be 4 mA when the valve is closed and 20 mA when the valve is open.

5.3 Partial stroke test (PST)

Device can perform valve partial stroke test, where the safety shutdown valve will be stroked certain amount from it's normal operating position. Typically this stroke size is about 10-20% depending on the process. The stroke size shall be defined by the user and should be defined so that the upset for the process is kept as minimum. The partial stroke test can be manual or automatic. Minimum automatic test interval is 10 minutes. PST interval is related to the SIL level of the application. PFD calculations should define this interval. For PST procedure and details see the IMO.

5.4 Valve proof-test

Safety shutdown valve proof-test is related to the required SIL level of the application. PFD calculations should define this safety shutdown valve proof test interval.

The valve proof test can be performed by using VG9000H's Emergency Trip Test (ETT) and it is available via HART. ETT can only check the valve closing/opening time, but not the the tightness. See the valve safety manual for further info regarding the proof testing.

The whole safety loop shall be tested via the safety system / logic solver.

6. Repair and maintenance

Any repair and maintenance to the device shall be carried out only by the manufacturer or the person certified by the manufacturer. Device failures must be reported to the manufacturer. The user shall provide a detailed report to the manufacturer describing the failure and any possible effects.

7. SIL certificate

Certificate

SIL/PL Capability

TÜVRheinland CERTIFIED

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ID 0600000000

No.: 968/V 1146.05/22

Product tested	Intelligent Safety Solenoids and Partial Stroke Test Device	**Certificate holder**	Valmet Flow Control Oy Vanha Porvoontie 229 FI-01380 Vantaa Finland
Type designation	VG9000F, VG9000H (Intelligent Safety Solenoids) and VG9000H_P (Partial Stroke Test Device) (Versions see current "Version Release List")		
Codes and standards	IEC 61508 Parts 1-2 and 4-7:2010		
Intended application	Safety Function: Prestage valve open by springforce when current below 6 mA (VG9000H) or below 9 VDC (VG9000F) and contemporaneous failsafe position of spool valve. The VG9000F and VG9000H are of Type A and have a Safety Capability of SC 3 acc. to IEC 61508. Accordingly they can be used in applications up to SIL 3 acc. to IEC 61508 and IEC 61511-1. The valves are suitable for use in a safety instrumented system up to SIL 2 (low demand mode). Under consideration of the minimum required hardware fault tolerance of HFT = 1 of the complete final element the test items may be used in a redundant architecture up to SIL 3. The VG9000H_P does not adversely affect the safety function of a connected ESD solenoid valve. It can therefore be used in safety related systems to enable partial stroke testing to improve the diagnostic coverage (DC).		
Specific requirements	The instructions of the associated Installation, Operating and Safety Manual shall be considered.		

Summary of test results see back side of this certificate.

The issue of this certificate is based upon an evaluation in accordance with the Certification Programs CERT FSP1 V1.0:2017, CERT FSP1 V1.0:2017 in their actual version, whose results are documented in Report No. 968/V 1146.05/22 dated 2022-10-19. This certificate is valid only for products, which are identical with the product tested. Issued by the certification body accredited by DAkkS according to DIN EN ISO/IEC 17065. The accreditation is only valid for the scope listed in the annex to the accreditation certificate D-ZE-11052-02-01.

TÜV Rheinland Industrie Service GmbH
Bereich Automation
Funktionale Sicherheit

Köln, 2022-12-15 — Certification Body Safety & Security for Automation & Grid — Dipl.-Ing. (FH) Wolf Rückwart

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