

Maintenance recommendation for valves, actuators and intelligent safety solenoids in Safety Instrumented Systems (SIS)

	Three distinct types of events		
	Visual inspection	Proof Test	Workshop Inspection and Maintenance
Frequency	According to SRS	According to SRS	According to SRS, for example when a dangerous fault has been detected
Neles guideline	Periodically throughout the SIS operation and maintenance lifecycle phase	Determined by testing intervals used in PFDavg or PFHavg calculations	The interval typically cannot exceed 10 years or two major unit shutdowns for general ESD applications, and should be shorter for severe applications
Valve, actuator and pneumatic instrumentation	1. Check there are no unauthorized modification 2. Check the final element is in normal position 3. Check there is no observable deterioration (damage, process leakage, pneumatic leakage, etc) 4. Download and analyze ValvGuard diagnostics (ex: load factor trends) and look for warnings	1. Perform maintenance event Visual Inspection 2. Open bypass line around the final element or remove the final element from the pipeline during a planned shutdown 3. Perform full stroke test, preferably using the safety system 4. Verify that the valve reaches the safe position within the required time and verify shutoff tightness for tightness-critical applications 5. If the final element is removed from the pipeline, repeat full stroke test after re-installation 6. Return valve to normal position	1. Make sure you have spare parts needed 2. Perform visual inspection 3. Perform maintenance event Proof Test 4. Check there is no observable deterioration on internals and flanges 5. Replace soft parts 6. Replace other parts (ex: seat, trim, etc) if deteriorated 7. Perform maintenance event Proof Test 8. Return valve to normal position 9. Perform maintenance event Visual Inspection 10. Record all results and observations
Neles™ ValvGuard™ intelligent safety solenoid		7. Perform maintenance event Visual Inspection 8. Record all results and observations 9. If the final element is bypassed, remove the bypass	Have Neles inspect and maintain ValvGuard.
Safety Manual	“Repairs on Neles and Jamesbury valves or actuators in Safety Instrumented Systems must be carried out by Neles or by competent personnel. Repairs on ValvGuard intelligent safety solenoids can only be carried out by Neles.” All repair must be done according to Neles maintenance procedures given in the corresponding Instructions, Maintenance and Operation (IMO) manual. After maintenance, perform shell test and verify seat tightness if necessary according to relevant tightness standards. Verify the functionality of the valve including the assembly regarding the safety function in question. Note that all maintenance actions should be recorded. The need for parts replacement is directly comparable to the amount of operations done by the valve unit during its lifetime and the severity of service. Soft sealing materials especially are affected by aging and useful lifetime depends strongly on the application. Therefore the condition of those components should be checked carefully during proof testing.” For further guidance please refer to the Safety Manual.		

What are IEC 61511-1: 2016 requirements? How often should the SIS final element be inspected and tested? Why, when and how should the SIS final element be maintained?

IEC 61511-1:2016 **Functional safety - Safety instrumented systems for the process industry sector** is a widely accepted standard of good practice in the process sector which, among other objectives, sets out to ensure that “the required SIL of each SIF is maintained during operation and maintenance” and “the SIS is operated and maintained in a way that sustains the required safety integrity” (16.1).

Inspection and testing intervals and steps to be taken in case of, for instance, a failed proof test, diagnostic warning or spurious process trip should be defined in the SRS specific to each SIS.

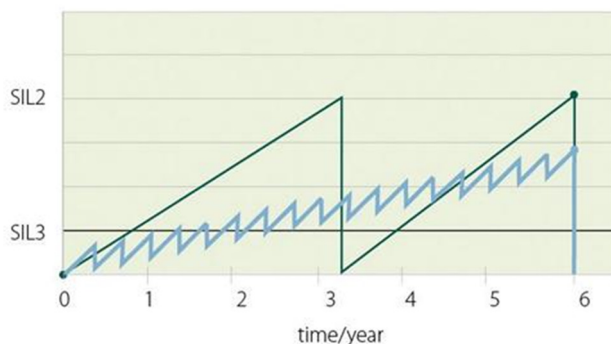
In addition, Neles can share the following comments with references to standard's requirements for SIS operation and maintenance. These only consider the SIS final element.

- “Each SIS shall be periodically visually inspected to ensure there are no unauthorized modifications and no observable deterioration” (16.3.2) - “Periodic proof tests shall be conducted using a written procedure to reveal undetected faults that prevent the SIS from operating in accordance with the Safety Requirement Specification (SRS)” (16.3.1.1)

Inspections conducted externally during operation and proof tests performed on a bypass do not allow the operator to detect all dangerous faults. Only periodic ‘bench type’ inspection and maintenance – such as examining valve seats, valve flanges and actuator seals – can return the final element to ‘like new’ condition.

- “The schedule for the proof tests shall be according to the SRS and the frequency of proof tests for a Safety Instrumented Function (SIF) shall be determined through Probability of Failure on Demand average (PFDavg) or Probability of Failure per Hour (PFH) calculation in accordance with 11.9 [quantification of random failure] for the SIS as installed in the operating environment.” (16.3.1.3)

Higher diagnostic coverage with partial stroke testing performed by the ValveGuard intelligent safety solenoid while the plant is in operation allows plants to prolong intervals between full stroke tests to align proof testing with shutdown intervals.



A good and easy-to-use tool to determine diagnostic and proof test intervals is Nelprof SIL.

Final element setup			
Safety position	Close		
Architecture	1oo1D		
Diagnostic coverage	Valve+Actuator (close)+VG		0.77

Test intervals			
Full stroke test	TIFST [months]		36
Partial stroke test	TIPST [months]		3
Pneumatic test	TIPNEUMATIC [days]		7

Valve and Actuator		AD[1/h]	MTTR[Hours]	PFD
Valve	X/M-SERIES (METAL SEAT)	1.427E-7	24	5.55E-4
Actuator	B-SERIES	8.635E-8	24	3.358E-4

Accessories		AD[1/h]	MTTR[Hours]	PFD
Intelligent PST	VG9000H	2.493E-8	4	1.134E-4
Instru 1 (None)				
Instru 2 (None)				
Instru 3 (None)				
Instru 4 (None)				
Instru 5 (None)				

Result:
PFD total

1.004E-3

Final element is suitable for use in safety systems up to and including
SIL 2

Calculate

ValveGuard diagnostics monitor certain dangerous failures and can reveal undetected failures. ValveGuard diagnostics also help rule out potential failures while planning maintenance.

- “Any deficiencies found during the proof testing shall be repaired in a safe and timely manner. A proof test shall be repeated after the repair is completed.” (16.3.1.4)

- “The user shall maintain records that certify that proof tests and inspections were completed as required” (16.3.3)

In case of a failed test or inspection, either corrective maintenance must be completed or the faulty product must be replaced with a new one before the final element is returned to service. Only final elements that have passed the test and inspection can be returned to service. A final element that has failed the test or inspection might not fulfill the original requirements or last until the next possible shutdown if returned to service.

Having the right spare parts at hand, particularly during a shutdown, is crucial to ensuring plant safety. A final element that has failed the test or inspection might not fulfill the original requirements or last until the next possible shutdown if returned to service.

If spare parts are no longer available, Neles can recommend a suitable replacement.

- Personnel performing each task “shall be competent to carry out the activities for which they are accountable” (5.2.2.2)

Competence of the person carrying out testing and inspection may also affect ability to bring the final element back to ‘like new’ condition. The final element might not fulfill the original requirements if the testing and inspection is not carried out by competent person.