

IVS 2019 - Industrial Valve Summit Conference Bergamo (Italy) - May 22/23, 2019

# Lifecycle of the ESD valve – Install-and-forget device?

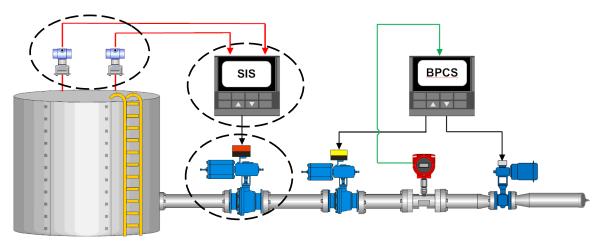
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**Metso Flow Control** 

#### Improving plant safety Safety Instrumented System - SIS

- A SIF protects against a single hazard, but a Safety Instrumented System (SIS) implements one of more SIFs
- SIS takes the process to a safe state in case of emergency
- SIS consist of three elements: sensor, logic solver, final element



SIS = Safety Instrumented System BPCS = Basic Process Control System





# Only ESD valve is considered in following examples even SIS has other components





### What is SIS final element ?

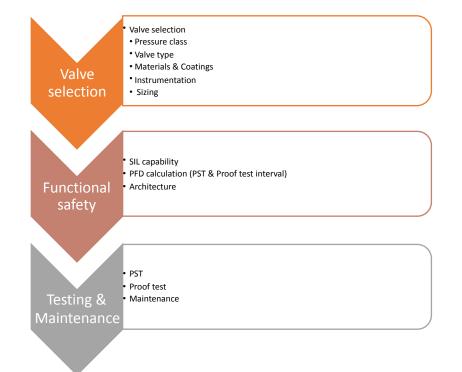
- SIS final element consist of
  - Valve body,
  - Actuator
  - Instrumentation
    - VG (PST device) or/and SOV
    - Additional accessories e.g. LS, QEV, VB, AOV
  - Linkages
- Commonly called just ESD valve
- Defense against process upset, environment and personnel which operates only in trip situation. → SIF
- Shutdown valves (SDV) or emergency shutdown valves (ESD) shutdown have safety position close.
- Blowdown (BDV) or emergency venting (ESV) or depressuring valves have safety position open.



SIS final element (SIS=Safety Instrumented System)



#### **ESD** valve selection









Perfectly selected valve for the process?



### What kind of failures valves have

- Systematic failure
  - Valve not suitable for the process (e.g. Temperature too high)
- Random
  - Dangerous Loss of protective function
  - Safe Sprurious trip



#### What kind of failures valves have

### Do Mechanical components have random failures?



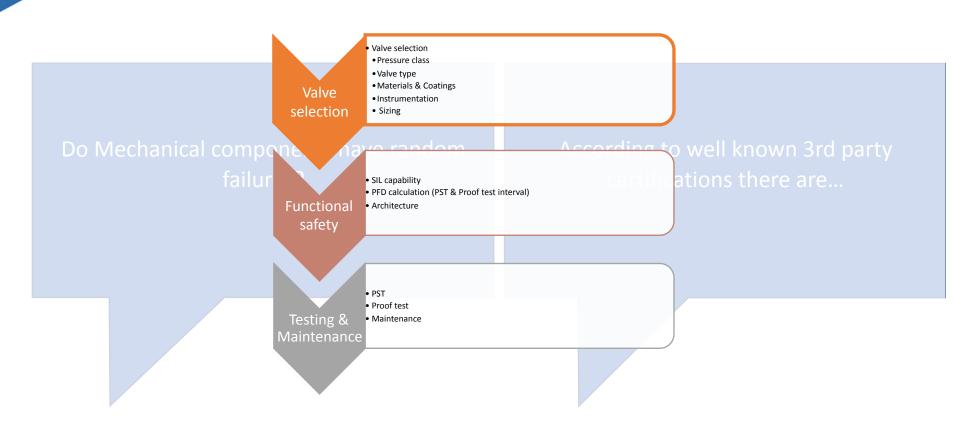
#### What kind of failures valves have

### Do Mechanical components have random failures?

### According to well known 3rd party certifications there are...



#### What kind of failures valves have





• Let's follow the current approach to include random errors for mechanical components



INTERNAL

#### **PFD** calculations

Final element setup								
Safety position		Close						
Architecture		1001D						
Diagnostic coverage		Valve+Actuator (clo	se)+VG				0.77	
-						1		
Test intervals								
Full stroke test		TIFST [months]			36			
Partial stroke test		TIPST [months]			3			
Pneumatic test		TIPNEUMATIC [day	/S]		7			
Valve and Actuator			λD[1/h]		MTT	[R[Hours]	PFD	
Valve	X/M-SEF	RIES (METAL SEAT)	1.42	27E-7		24	5.5	55E-4
Actuator	<b>B-SERIE</b>	S	8.63	35E-8		24	3.3	58E-4
Accessories			λD[1/h]		мтт	[R[Hours]	PED	
Intelligent PST	VG9000	н		93E-8		4		34E-4
Instru 1 (None)								
Instru 2 (None)								
Instru 3 (None)								
Instru 4 (None)								
Instru 5 (None)								
	Result:							
	PFD total							
	1.004E-3	}						
Calculate	Final eler	nent is suitable for u	se in safet	y syste	ems u	up to and in	cludin	g
	SIL 2							

Final element setup								
Safety position		Close						
Architecture		1001D						
Diagnostic coverage		Valve+Actuator (clo	se)+VG				0.77	
Test intervals								
Full stroke test		TIFST [months]			48			
Partial stroke test		TIPST [months]			3			
Pneumatic test		TIPNEUMATIC [day	/s]		7			
Valve and Actuator			λD[1/h]		МТТ	R[Hours]	PFD	
Valve	X/M-SEF	RIES (METAL SEAT)	1.4	27E-7		24	6.98	88E-4
Actuator	B-SERIE	S	8.6	35E-8		24	4.22	28E-4
Accessories			λD[1/h]		МТТ	R[Hours]	PFD	
Intelligent PST	VG9000	н	2.4	93E-8		4	1.40	)7E-4
Instru 1 (None)								
Instru 2 (None)								
Instru 3 (None)								
Instru 4 (None)								
Instru 5 (None)								
	Result:							
	PFD total							
	1.262E-3							
Calculate	Final elen	nent is suitable for u	se in safet	v svste	ms u	ip to and ir	ncluding	
	SIL 2							·
	Sic 2							





#### When to do maintenance for ESD valve?

- "Maintenance?"
- "Usefull lifetime"
- "Not possible to do maintenance in each shutdown"
- "When should we test the valve?"





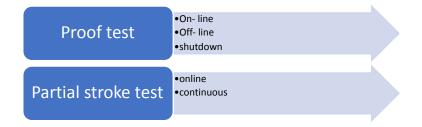
## Process conditions VS PFD calculation



#### ESD valve testing

ESD valve will spend majority of its life in operational phase

- Testing is an essential activity to prove the integrity of Safety Instrumented System
- Testing secures that target SIL can be maintained
- Testing secures that the system can respond to true demand





Final element setup								
Safety position		Close						
Architecture		1001						
Diagnostic coverage		No diagnostic test					0	
Test intervals								
Full stroke test		TIFST [months]			48			
Valve and Actuator			λD[1/h]		MTTR[Ho	ours]	PFD	
Valve	X/M-SER	RIES	2.	04E-7		24	3.57	9E-3
Actuator	B1J-SEF	RIES	2	2.4E-8		24	4.21	1E-4
Accessories			λD[1/h]		MTTR[Ho	oursl	PFD	
Instru 1 (1001)	SOV GE	NERIC 3-WAY		85E-7		4	1.02	5E-2
Instru 2 (None)						- 1		
Instru 3 (None)						- 1		
Instru 4 (None)						- 1		
Instru 5 (None)						- 1		
						-		
	Result: PFD total							
	1.425E-2							
Calculate		nent is suitable for u	se in safet	y syste	ems up to a	and inc	luding	
	SIL 1							

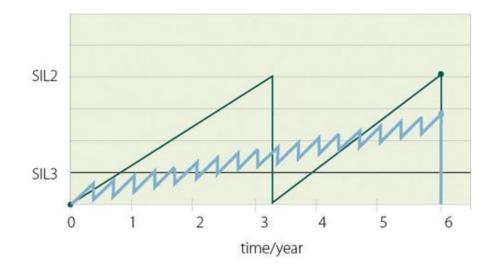
- Requirement SIL 2
- Shutdown period 48 months

Accessories         AD(1/h)         MTTR[Hours]         PFD           Actuator         XIM-SERIES         2.4E-8         24         1.792E-3           Actuator         B1J-SERIES         2.4E-8         24         2.108E-4           Accessories         AD(1/h)         MTTR[Hours]         PFD           Instru 1 (1001)         SOV GENERIC 3-WAY         5.85E-7         4         5.127E-3           Instru 4 (None)         Instru 4 (None)         4         5.127E-3         5	Architecture Diagnostic coverage	1001 No diagnostic tes	et .		0
Full stroke test     TIFST [months]     24       Valve and Actuator     AD[1/h]     MTTR[Hours]     PFD       Valve     X/M-SERIES     2.04E-7     2.4     1.792E-3       Actuator     B1J-SERIES     2.4E-8     2.4     2.108E-4       Accessories     AD[1/h]     MTTR[Hours]     PFD       Instru 2 (None)     SOV GENERIC 3-WAY     5.85E-7     4     5.127E-3       Instru 4 (None)     Instru 5 (None)     Instru 5 (None)     Instru 5 (None)     Instru 6 (None)       Cal c u l at e     Final element is suitable for use in safety systems up to and including     Final element is suitable for use in safety systems up to and including	Diagnostic coverage	No diagnostic tes			U
Valve     AD[1/h]     MTTR[Hours]     PFD       Valve     X/M-SERIES     2.04E-7     24     1.792E-3       Actuator     B1J-SERIES     2.4E-8     24     2.108E-4       Accessories     AD[1/h]     MTTR[Hours]     PFD       Instru 1 (1001)     SOV GENERIC 3-WAY     5.85E-7     4     5.127E-3       Instru 3 (None)     Instru 4 (None)     Instru 5 (None)     Instru 5 (None)     Instru 5 (None)       Result: PFD total       7.13E-3     Final element is suitable for use in safety systems up to and including	Test intervals				
Valve     X/M-SERIES     2.04E-7     24     1.792E-3       Actuator     B1J-SERIES     2.4E-8     24     2.108E-4       Accessories     ND[1/h]     MTTR[Hours]     PFD       Instru 1 (1001)     SOV GENERIC 3-WAY     5.85E-7     4     5.127E-3       Instru 2 (None)     Instru 4 (None)     Instru 4 (None)     Instru 5 (None)     Instru 5 (None)       Result:     PFD total     7.13E-3     Final element is suitable for use in safety systems up to and including	Full stroke test	TIFST [months]		24	
Actuator     B1J-SERIES     2.4E-8     24     2.108E-4       Accessories Instru 1 (1001)     SOV GENERIC 3-WAY     5.85E-7     4     5.127E-3       Instru 2 (None)     Instru 3 (None)     Instru 4 (None)     Instru 4 (None)     Instru 5 (None)       Result: PFD total     PED total     Instru 5 (None)     Instru 5 (None)       C a I c u I a t e     Final element is suitable for use in safety systems up to and including	Valve and Actuator		λD[1/h]	MTTR[Hours]	PFD
Accessories ACCESS	Valve	X/M-SERIES	2.04E-7	7 24	1.792E-3
Instru 1 (1001) SOV GENERIC 3-WAY 5.85E-7 4 5.127E-3 Instru 2 (None) Instru 3 (None) Instru 4 (None) Result: PED total 7.13E-3 Final element is suitable for use in safety systems up to and including	Actuator	B1J-SERIES	2.4E-8	3 24	2.108E-4
Instru 2 (None) Instru 3 (None) Instru 4 (None) Instru 5 (None) Result: PFD total 7.13E-3 Final element is suitable for use in safety systems up to and including	Accessories		λD[1/h]	MTTR[Hours]	PFD
Instru 3 (None) Instru 4 (None) Instru 5 (None) Result: PED total 7.13E-3 Final element is suitable for use in safety systems up to and including	Instru 1 (1oo1)	SOV GENERIC 3-WAY	5.85E-7	7 4	4 5.127E-3
Instru 4 (None) Instru 5 (None) Result: PFD total 7.13E-3 Final element is suitable for use in safety systems up to and including	Instru 2 (None)				
Result: PFD total C a I c u I a t e Final element is suitable for use in safety systems up to and including	Instru 3 (None)				
Result: PFD total 7.13E-3 Final element is suitable for use in safety systems up to and including	Instru 4 (None)				
PFD total 7.13E-3 C a I c u I a t e Final element is suitable for use in safety systems up to and including	Instru 5 (None)				
	Calculate	PFD total 7.13E-3 Final element is suitable for	use in safety syst	ems up to and i	ncluding

• Original calculation to fulfill SIL 2 with 24 months testing period



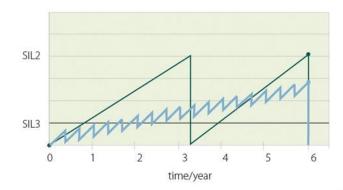
#### Turn around schedule Vs. Proof test interval





#### Turn around schedule Vs. Proof test interval

 To be able to use PFD avg calculations to determine proof test, partial stroke test and maintenance, valve selection must be done so that valve will be able to perform safety function

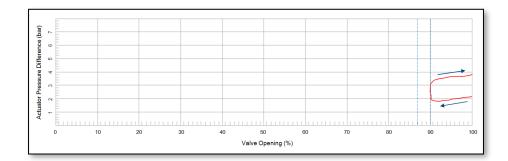






#### Partial stroke test

- By partial stroke test the proof test period can be extended
- But proof test cannot be avoided









#### Proof test, more than full stroke

- 1) The purpose of the proof testing is to detected failures of the complete final element subsystem. Metso recommends the following proof test procedure:
- 2) Visual inspection. Check that there are no unauthorized modifications in SIS final element. Check that the SIS final element is in the normal position and that verify all accessories are according the specification for the SIS valve normal operation. Verify that there are no observable deterioration in SIS valve, such as pneumatic leakages, visible damages or impurities on the SIS valve.
- 3) Bypass the SIS final element, if full stroke may cause an unnecessary process shutdown or other negative effects.
- 4) Perform the safety action (full stroke) preferably using the safety system. Verify that the SIS valve achieves the safe position within the required time specified by the application. Verify also the shutoff tightness for tightness critical applications. Note, that tightness measurements might require removing the valve from the pipeline. If the valve is removed from the pipeline repeat full stroke test after re-installation.
- 5) Restore the SIS valve into normal position.
- 6) Visual inspection. Check the SIS final element is in normal position and verify all accessories are according the specification for the SIS valve normal operation. Inspect visually there is no observable deterioration in SIS final element.
- 7) Record all results and observations into corresponding database with necessary audit trail information.
- 8) Remove the SIS final element bypassing.





#### Conclusion

- Never think that ESD valve is install and forget device
- PST and Proof testing
- Turn around vs. PFD calculations
- Valve selection and controlling systematic failures is the most important part of ensuring safety!!





Thank you!

#### Do you have questions?

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