Logo 1

SILcet
SIL Verification

Logo 2

PROJECT

PROJECT NAME

PROJECT REFERENCE (CLIENT)	XXXXX
PROJECT REFERENCE (SUPPLIER)	E-XXXXX
LOCATION	Huelva (Spain)
SITE	YYYYYY
PLANT	AROMÁTICOS
UNIT	UNIFINING / PLATFORMING

VSIL - 1000 - XXXXX

SIL VERIFICATION REPORT

Rev.	Date	Description	Created	Checked	Approved
0	21/05/2025	**For comments**	JS	PR	JB

1. OBJETIVE & STANDARDS

The purpose of this report is the verification study of the Safety Instrumented Functions defined in the Process Hazardous Analysis (PHA).

The recommendations of the following Standards have been taken into account:

-IEC 61508:2010
-IEC 61511:2016
-ISA-S84

2. CALCULATIONS & VERIFICATION

As calculation tool "SILcet 8.0" has been used

The following three requirements of the IEC 61511/61508 has been checked:

-Systematic Capability (SIL certification or proven in use/prior use justification).
-Architectural Constraints (minimum redundancy) based on the routes of the Standards.
-Compliance of the PFDavg/PFH according with the Standards.

3. PROJECT INFORMATION

Project name:
Project description:

Safety Requirement Specification reference: SRS-1200-01

4. GENERAL DATA

The following general parameters have been used.

Parameter	Sensor subsystem	Logic Solver	Actuator subsystem
Operation mode	Low demand in all SIFs		
Life Time (LT)	15 years	15 years	15 years
MTTRDD	8 hours	8 hours	8 hours
Beta factor	5%	2%	10%
Proof test coverage (Cpt)	90%	95%	70%
Test interval (TI)	1 year	20 years	1 year
Start-up time	24 hours	24 hours	24 hours
PDC (high demand mode)	100%	100%	100%

MTTRDD: Mean Time To Restore (applicable to DD failures).
Beta Factor: for Common Cause Factor in redundant architectures (1oo2, 2oo3,...)
Cpt: Generic values if manufacturer data is not available.
TI: Test Interval showing the required frequency of proof tests.
Start-up time: used to calculate STR (Safe Trip Rate) and MTTFS (Mean Time To Fail Spuriously)
PDC (only for PFH): Partial Diagnostic Credit given to diagnostics of dangerous failures (depends on speed of automatic diagnostics versus demand frequency of the SIF). It considers DD failures that likely will not be converted to safe failures should be counted as DU failures.

5. VOTING DEGRADATION OF TRANSMITTERS

The most common voting scenarios utilized in the SIS are: One out of One (1oo1), One out of Two (1oo2), Two out of Two (2oo2), and Two out of Three (2oo3).

The following tables shows the configuration of the transmitters and the behaviour of the PLC on a Dangerous Detected Failure (DD). In this project the philosophy shown in Table 1 has been considered.

Table 1

			PLC software			
Logic	**Process Trip**	**Transmitter setting**	**Out of range diagnostic**	**Channel Trip**	**Architecture degradation**	
					1st failure	**2nd failure**
1oo1	Low	Over Range	Yes	No	Alarm	--
1oo1	High	Under Range	Yes	No	Alarm	--
1oo2	Low	Over Range	Yes	No	1oo1	Process Trip
1oo2	High	Under Range	Yes	No	1oo1	Process Trip
2oo2	Low	Under Range	Yes	Yes	1oo1	Process Trip
2oo2	High	Over Range	Yes	Yes	1oo1	Process Trip
2oo3	Low	Under Range	Yes	Yes	1oo2	Process Trip
2oo3	High	Over Range	Yes	Yes	1oo2	Process Trip

Table 2

			PLC software			
Logic	**Process Trip**	**Transmitter setting**	**Out of range diagnostic**	**Channel Trip**	**Architecture degradation**	
					1st failure	**2nd failure**
1oo1	Low	Under Range	Yes	Yes	Process Trip	--
1oo1	High	Over Range	Yes	Yes	Process Trip	--
1oo2	Low	Under Range	Yes	Yes	Process Trip	--
1oo2	High	Over Range	Yes	Yes	Process Trip	--
2oo2	Low	Under Range	Yes	Yes	1oo1	Process Trip
2oo2	High	Over Range	Yes	Yes	1oo1	Process Trip
2oo3	Low	Under Range	Yes	Yes	1oo2	Process Trip
2oo3	High	Over Range	Yes	Yes	1oo2	Process Trip

SIFs with unique voting schemes not defined by 1oo1, 1oo2, 2oo2, or 2oo3 are to be considered on a case-by-case basis.

SILcet	PROJECT NAME	Rev.1	20/08/2025	Logo 2
	SIF LIST & SUMMARY	Site:		
		Doc:		

No.	SIF Tag	TARGET			ACHIEVED					Achieved SIL			Arch. C.	Lowest value for SENSOR		Lowest value for ACTUATOR	
		SIL	RRF	MTTFS	SIL	RRF	PFDavg/PFH	MTTFS		Pr.	AC	SC	Route	SFF (1H)	DC	SFF (1H)	DC
1	M4-LT-1111-01	SIL-1	20	10	SIL-1	56	1,79E-02	67		1	1	2	1H	87,0%		52,5%	
2	M4-LT-1112-01	SIL-1	20	10	SIL-1	370	2,70E-03	45		2	1	2	1H	87,0%		52,5%	
3	M4-LT-1212-01	SIL-2	200	10	SIL-2	464	2,15E-03	43		2	2	2	1H	87,0%		52,5%	
6	M4-PT-2312-06	SIL-2	200	10	SIL-2	459	2,18E-03	47		2	2	3	1H	81,1%		52,5%	
7	M4-PT-2312-06B	SIL-2	200	10	SIL-2	458	2,18E-03	47		2	2	3	1H	82,1%		52,5%	
8	M4-PT-2312-06SS	SIL-2	200	10	SIL-2	231	4,32E-03	47		2	2	3	1H	76,1%		43,4%	
10	M4-PS-1112-10	SIL-2	200	10	SIL-1	238	4,20E-03	45		2	1	3	1H	38,7%		52,5%	
11	M4-PT-1112-10	SIL-2	200	10	SIL-2	392	2,55E-03	45		2	2	3	1H	90,1%		52,5%	
13	M4-PTTT-1212-13	SIL-2	200	10	SIL-2	469	2,13E-03	29		2	2	3	1H	85,0%		52,5%	
16	M4-PT-1112-16	SIL-1	20	10	SIL-0	146	6,87E-03	46		2	0	2	1H	54,1%		52,5%	
17	M4-PT-1112-16-CMP	SIL-1	20	10	SIL-0	55	1,81E-02	45		1	0	2	1H	58,7%		52,5%	
19	M4-PT-1111-19	SIL-1	20	10	SIL-1	48	2,08E-02	68		1	1	3	1H	81,1%		52,5%	
20	SIF-20	SIL-2	200	10	SIL-2	459	2,18E-03	47		2	2	3	1H	81,1%		52,5%	
30	M5-FT-2312-30	SIL-2	200	10	SIL-2	243	4,11E-03	27		2	2	3	1H	91,4%		52,5%	

Notes:

Pr: Probability of failure
AC: Architectural Constraints
SC: Systematic Capability
SFF: Safe Failure Fraction
DC: Diagnostic Coverage=DD/(DD+DU)
MTTFS in years: Mean Time To Fail Spuriously
RRF: Risk Reduction Factor

SIL, RRF, MTTFS are achieved
SIL & RRF targets are not achieved
MTTFS target is not achieved

SILcet	PROJECT NAME	Rev.1 20/08/2025	Logo 2
	EXTENDED SUMMARY OF SIL VERIFICATION	Site:	
		Doc:	

No.	SIF Tag / Description	TARGET		ACHIEVED			SIL achieved				Main Parameters									
							SIF			Arch. C.		Sensors			Final Elements					
		SIL	RRF	SIL	RRF	PFDavg/PFH	Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
1	M4-LT-1111-01	SIL-1	20	SIL-1	56	1,79E-02	1	1	2	1H	Voting	1oo1			1oo1				
		MTTFS	10	MTTFS	67						Cpt	95%			73%				
	On High High Level (LT-1) [1oo1] in Tank 100-1111 close valve XV-1 [1oo1]						Per subsystem				TI(y)	1,0			1,0				
							SE	LS	FE		Beta								
							1	3	1		SFF	87%			52%				
											DC	83%			0%				
2	M4-LT-1112-01	SIL-1	20	SIL-1	370	2,70E-03	Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
		MTTFS	10	MTTFS	45		2	1	2	1H	Voting	1oo1			1oo2				
	On High High Level (LT-1) [1oo1] in Tank 100-1111 close valve XV-1A/B [1oo2]						Per subsystem				Cpt	95%			73%				
							SE	LS	FE		TI(y)	1,0			1,0				
							1	3	2		Beta				10%				
											SFF	87%			52%				
											DC	83%			0%				
3	M4-LT-1212-01	SIL-2	200	SIL-2	464	2,15E-03	Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
		MTTFS	10	MTTFS	43		2	2	2	1H	Voting	1oo2			1oo2				
	On High High Level (LT-1A/B) [1oo2] in Tank 100-1111 close valve XV-1A/B [1oo2]						Per subsystem				Cpt	95%			73%				
							SE	LS	FE		TI(y)	1,0			1,0				
							2	3	2		Beta	5%			10%				
											SFF	87%			52%				
											DC	83%			0%				
6	M4-PT-2312-06	SIL-2	200	SIL-2	459	2,18E-03	Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
		MTTFS	10	MTTFS	47		2	2	3	1H	Voting	2oo3			1oo2				
	On High High Pressure (PT-6A/B/C) [2oo3] in Vessel 100-2312 close valves XV-6A/B [1oo2]						Per subsystem				Cpt	94%			73%				
							SE	LS	FE		TI(y)	1,0			1,0				
							2	3	2		Beta	5%			10%				
											SFF	81%			52%				
											DC	0%			0%				

Pr: Probability of failure
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SC: Systematic Capability

SFF: Safe Failure Fraction
DC: Diagnostic Coverage=DD/(DD+DU)
RRF: Risk Reduction Factor
MTTFS in years: Mean Time To Fail Spuriously

SIL, RRF, MTTFS are achieved | SIL & RRF targets are not achieved | MTTFS target is not achieved

SILcet	PROJECT NAME	Rev.1 20/08/2025	Logo 2
	EXTENDED SUMMARY OF SIL VERIFICATION	Site:	
		Doc:	

No.	SIF Tag / Description	TARGET		ACHIEVED			SIL achieved				Main Parameters									
							SIF			Arch. C.		Sensors			Final Elements					
		SIL	RRF	SIL	RRF	PFDavg/PFH	Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
7	M4-PT-2312-06B	SIL-2	200	SIL-2	458	2,18E-03	2	2	3	1H	Voting	2oo3			1oo2				
		MTTFS	10	MTTFS	47						Cpt	94%			73%				
	On High High Pressure (PT-6A/B/C) [2oo3] in Vessel 100-2312 close valves XV-6A/B [1oo2].						Per subsystem				TI(y)	1,0			1,0				
							SE	LS	FE		Beta	5%			10%				
							2	3	2		SFF	82%			52%				
											DC	0%			0%				
8	M4-PT-2312-06SS	SIL-2	200	SIL-2	231	4,32E-03	Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
		MTTFS	10	MTTFS	47		2	2	3	1H	Voting	2oo3			1oo2				
	[Severe Service Case] On High High Pressure (PT-6A/B/C) [2oo3] in Vessel 100-2312 close valves XV-6A/B [1oo2]										Cpt	95%			63%				
							Per subsystem				TI(y)	1,0			1,0				
							SE	LS	FE		Beta	5%			10%				
							2	3	2		SFF	76%			43%				
											DC	0%			0%				
10	M4-PS-1112-10	SIL-2	200	SIL-1	238	4,20E-03	Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
		MTTFS	10	MTTFS	45		2	1	3	1H	Voting	1oo1			1oo2				
	On High High Pressure [1oo1] in Vessel close valves XV-6A/B [1oo2]										Cpt	90%			73%				
							Per subsystem				TI(y)	1,0			1,0				
							SE	LS	FE		Beta				10%				
							1	3	2		SFF	39%			52%				
											DC	0%			0%				
11	M4-PT-1112-10	SIL-2	200	SIL-2	392	2,55E-03	Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
		MTTFS	10	MTTFS	45		2	2	3	1H	Voting	1oo1			1oo2				
	On High High Pressure [1oo1] in Vessel close valves XV-6A/B [1oo2]										Cpt	90%			73%				
							Per subsystem				TI(y)	1,0			1,0				
							SE	LS	FE		Beta				10%				
							2	3	2		SFF	90%			52%				
											DC	86%			0%				

Pr: Probability of failure
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MTTFS in years: Mean Time To Fail Spuriously

SIL, RRF, MTTFS are achieved
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SILcet	PROJECT NAME	Rev.1 20/08/2025	Logo 2
	EXTENDED SUMMARY OF SIL VERIFICATION	Site:	
		Doc:	

No.	SIF Tag / Description	TARGET		ACHIEVED			SIL achieved				Main Parameters									
							SIF			Arch. C.		Sensors			Final Elements					
		SIL	RRF	SIL	RRF	PFDavg/PFH	Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
13	M4-PTTT-1212-13	SIL-2	200	SIL-2	469	2,13E-03	2	2	3	1H	Voting	1oo1	1oo1		1oo2				
		MTTFS	10	MTTFS	29						Cpt	90%	98%		73%				
	On High Pressure PT-10 [OR] High Temperature TT-10 [1oo2] in Vessel close valves XV-6A/B [1oo2]						Per subsystem				TI(y)	1,0	1,0		1,0				
							SE	LS	FE		Beta				10%				
							3	3	2		SFF	90%	84%		52%				
											DC	86%	79%		0%				
16	M4-PT-1112-16	SIL-1	20	SIL-0	146	6,87E-03	Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
		MTTFS	10	MTTFS	46		2	0	2	1H	Voting	1oo1			1oo2				
	On High High Pressure (PT-1) [1oo1] in Vessel close valves XV-16A/B [1oo2]						Per subsystem				Cpt	90%			73%				
							SE	LS	FE		TI(y)	1,0			1,0				
							0	3	2		Beta				10%				
											SFF	54%			52%				
											DC	48%			0%				
17	M4-PT-1112-16-CMP	SIL-1	20	SIL-0	55	1,81E-02	Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
		MTTFS	10	MTTFS	45		1	0	2	1H	Voting	1oo1			1oo2				
	On High High Pressure (PT-1) [1oo1] in Vessel close valves XV-16A/B [1oo2] (90% credit by comparison used for PT-1 by comparing with PT-2 of BPCS)						Per subsystem				Cpt	54%			73%				
							SE	LS	FE		TI(y)	1,0			1,0				
							0	3	2		Beta				10%				
											SFF	59%			52%				
											DC	53%			0%				
19	M4-PT-1111-19	SIL-1	20	SIL-1	48	2,08E-02	Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
		MTTFS	10	MTTFS	68		1	1	3	1H	Voting	1oo1			1oo1	--			
	High High Pressure on PT closes feed valve. Calculation of Bypass impact						Per subsystem				Cpt	94%			73%				
							SE	LS	FE		TI(y)	1,0			1,0				
							1	3	1		Beta	5%			10%				
											SFF	81%			52%				
											DC	74%			0%				

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SIL, RRF, MTTFS are achieved
SIL & RRF targets are not achieved
MTTFS target is not achieved

SILcet	PROJECT NAME	Rev.1 20/08/2025	Logo 2
	EXTENDED SUMMARY OF SIL VERIFICATION	Site:	
		Doc:	

No.	SIF Tag / Description	TARGET		ACHIEVED			SIL achieved				Main Parameters									
		SIL	RRF	SIL	RRF	PFDavg/PFH	SIF			Arch. C.		Sensors			Final Elements					
							Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
20	SIF-20	SIL-2	200	SIL-2	459	2,18E-03	2	2	3	1H	Voting	2oo3			1oo2	--			
		MTTFS	10	MTTFS	47						Cpt	94%			73%				
	On High High Pressure (PT-6A/B/C) [2oo3] in Vessel 100-2312 close valves XV-6A/B [1oo2]. Calculation of Bypass impact						Per subsystem				TI(y)	1,0			1,0				
							SE	LS	FE		Beta	5%			10%				
							2	3	2		SFF	81%			52%				
											DC	0%			0%				
30	M5-FT-2312-30	SIL-2	200	SIL-2	243	4,11E-03	Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
		MTTFS	10	MTTFS	27		2	2	3	1H	Voting	2oo3			1oo2	1oo2			
	On Low Low Air Combustion Flow (FT-30A/B/C) [2oo3] in Incinerator 100-2312 closes Fuel Gas Valves (1oo2 XV-30/31) & Natural Gas Valves (1oo2 XV-32/33) [2oo2 of FG & NG]						Per subsystem				Cpt	90%			73%	73%			
							SE	LS	FE		TI(y)	1,0			1,0	1,0			
							3	3	2		Beta	5%			10%	10%			
											SFF	91%			52%	52%			
											DC	0%			0%	0%			
							Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
											Voting								
											Cpt								
							Per subsystem				TI(y)								
							SE	LS	FE		Beta								
											SFF								
											DC								
							Pr	AC	SC	Route		SE1	SE2	SE3	FE1	FE2	FE3	FE4	FE5
											Voting								
											Cpt								
							Per subsystem				TI(y)								
							SE	LS	FE		Beta								
											SFF								
											DC								

Pr: Probability of failure
AC: Architectural Constraints
SC: Systematic Capability
SE: Sensor FE: Final Element

SFF: Safe Failure Fraction
DC: Diagnostic Coverage=DD/(DD+DU)
RRF: Risk Reduction Factor
MTTFS in years: Mean Time To Fail Spuriously

SIL, RRF, MTTFS are achieved
SIL & RRF targets are not achieved
MTTFS target is not achieved

DETAILED SIL VERIFICATION	Rev.1	20/08/2025
PROJECT NAME	Doc:	

SIF: M4-LT-1111-01

Required		Achieved
SIL-1	SIL	**SIL-1**
20	RRF	**56**
	PFDavg	**1,79E-02**
10	MTTFS (y)	**67**

	Achieved
PFDavg	SIL-1
Arch. C.	SIL-1
SC	SIL-2

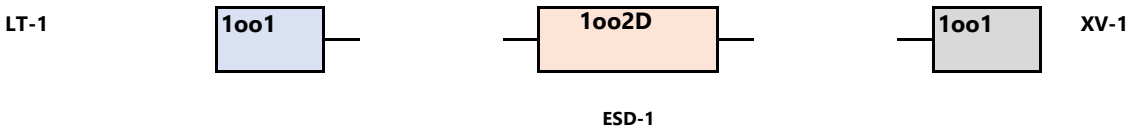
AC= Route 1H

	Achieved	PFDavg	MTTFS (years)
sensor	SIL-1	5,77E-04	836
logic solver	SIL-3	1,65E-04	178
actuator	SIL-1	1,72E-02	125

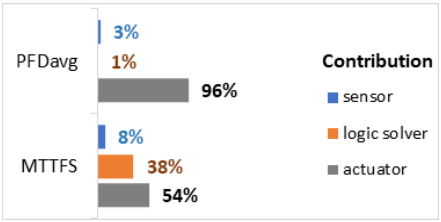
On High High Level (LT-1) [1oo1] in Tank 100-1111 close valve XV-1 [1oo1]

SIL Verification according to IEC61508/61511 & ISA TR84.00.02:2022.

Out of range diagnostic: ON Sensor Fault: U.R. Channel Trip: No



Generic PLC
SIL-3



HAZOP still open for this scenario. If IPL considered has not credit then SIL-2 is needed in this SIF.
To achieve SIL-2:
-Sensor: Route 2H or 1oo2.
-Actuator: 1oo2

Devices used in this SIF:

3051 Pressure Transmitter (Coplanar Differential)
Generic clean process connection
IS Isolator AI/AI
PLC: 1 AI. 1 DO
Floating Ball Valve, C series, Full Stroke, Clean Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1

SIF: M4-LT-1111-01

Subsystem	Description	Logic	PFDavg	SIL (PF)	SC	SIL (AC)	MTTFS (y)
sensor	LT-1	1oo1	5,77E-04	3	2	1	836
sen_part	transmitter	--			3	--	--
sen_part	process	--				--	--
sen_part	interface	--			2	--	--
logicsolver	ESD-1	1oo2D	1,65E-04	3	3	3	178
actuator	XV-1	1oo1	1,72E-02	1	3	1	125
act_part	valve	--			3	--	--
act_part	actuator	--			3	--	--
act_part	solenoid	--			3	--	--
act_part	isolator	--			3	--	--

Subsystem	Logic	Cpt	TI (y)	LT (y)	Beta	MTTRdd	Startup(h)	HFT	Type	Route
sensor		95%	1,00	15		48	24	0	B	Route 1H
sen_part								0	B	
sen_part								0	A	
sen_part								0	A	
logicsolver		99%	4,00	15	2%	48	24	1	B	Route 1H
actuator		73%	1,00	15		0	24	0	A	Route 1H
act_part								0	A	
act_part								0	A	
act_part								0	A	
act_part								0	A	

Subsystem	Description	Logic	SD	SU	DD	DU	SFF	DC
sensor	LT-1	1oo1	53	84	377	77	87%	
sen_part	transmitter	--	24	84	234	32		
sen_part	process	--	0	0	0	0		
sen_part	interface	--	29	0	143	45		
logicsolver	ESD-1	1oo2D	11617	129	3815	241	98%	
actuator	XV-1	1oo1	0	916	0	829	52%	
act_part	valve	--	0	0	0	442		
act_part	actuator	--	0	286	0	199		
act_part	solenoid	--	0	516	0	188		
act_part	isolator	--	0	114	0	0		

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

DETAILED SIL VERIFICATION	Rev.1	20/08/2025
PROJECT NAME	Doc:	

SIF: M4-LT-1112-01

Required		Achieved
SIL-1	SIL	**SIL-1**
20	RRF	**370**
	PFDavg	**2,70E-03**
10	MTTFS (y)	**45**

	Achieved
PFDavg	SIL-2
Arch. C.	SIL-1
SC	SIL-2

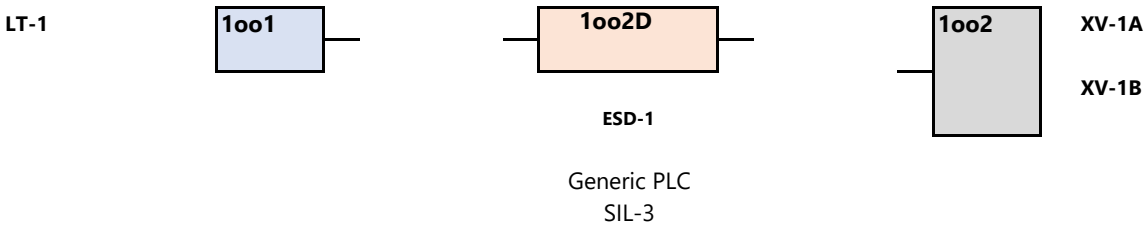
AC= Route 1H

	Achieved	PFDavg	MTTFS (years)
sensor	SIL-1	5,77E-04	836
logic solver	SIL-3	1,67E-04	176
actuator	SIL-2	1,95E-03	66

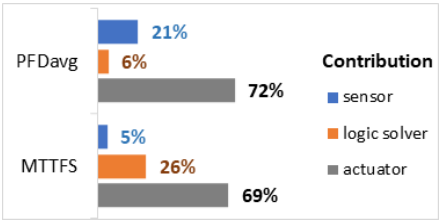
On High High Level (LT-1) [1oo1] in Tank 100-1111 close valve XV-1A/B [1oo2]

SIL Verification according to IEC61508/61511 & ISA TR84.00.02:2022.

Out of range diagnostic: ON Sensor Fault: U.R. Channel Trip: No



Generic PLC
SIL-3



HAZOP still open for this scenario. If IPL considered has not credit then SIL-2 is needed in this SIF.
To achieve SIL-2:
-Sensor: Route 2H or 1oo2.

Devices used in this SIF:

3051 Pressure Transmitter (Coplanar Differential)
Generic clean process connection
IS Isolator AI/AI
PLC: 1 AI, 2 DO same module
Floating Ball Valve, C series, Full Stroke, Clean Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1

SIF: M4-LT-1112-01

Subsystem	Description	Logic	PFDavg	SIL (PF)	SC	SIL (AC)	MTTFS (y)
sensor	LT-1	1oo1	5,77E-04	3	2	1	836
sen_part	transmitter	--			3	--	--
sen_part	process	--				--	--
sen_part	interface	--			2	--	--
logicsolver	ESD-1	1oo2D	1,67E-04	3	3	3	176
actuator	XV-1	1oo2	1,95E-03	2	3	2	66
act_part	valve	--			3	--	--
act_part	actuator	--			3	--	--
act_part	solenoid	--			3	--	--
act_part	isolator	--			3	--	--

Subsystem	Logic	Cpt	TI (y)	LT (y)	Beta	MTTRdd	Startup(h)	HFT	Type	Route
sensor		95%	1,00	15		48	24	0	B	Route 1H
sen_part								0	B	
sen_part								0	A	
sen_part								0	A	
logicsolver		99%	4,00	15	2%	48	24	1	B	Route 1H
actuator		73%	1,00	15	10%	0	24	1	A	Route 1H
act_part								1	A	
act_part								1	A	
act_part								1	A	
act_part								1	A	

Subsystem	Description	Logic	SD	SU	DD	DU	SFF	DC
sensor	LT-1	1oo1	53	84	377	77	87%	
sen_part	transmitter	--	24	84	234	32		
sen_part	process	--	0	0	0	0		
sen_part	interface	--	29	0	143	45		
logicsolver	ESD-1	1oo2D	11756	130	3872	244	98%	
actuator	XV-1	1oo2	0	916	0	829	52%	
act_part	valve	--	0	0	0	442		
act_part	actuator	--	0	286	0	199		
act_part	solenoid	--	0	516	0	188		
act_part	isolator	--	0	114	0	0		

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

DETAILED SIL VERIFICATION	Rev.1	20/08/2025
PROJECT NAME	Doc:	

SIF: M4-LT-1212-01

Required		Achieved
SIL-2	SIL	**SIL-2**
200	RRF	**464**
	PFDavg	**2,15E-03**
10	MTTFS (y)	**43**

	Achieved
PFDavg	SIL-2
Arch. C.	SIL-2
SC	SIL-2

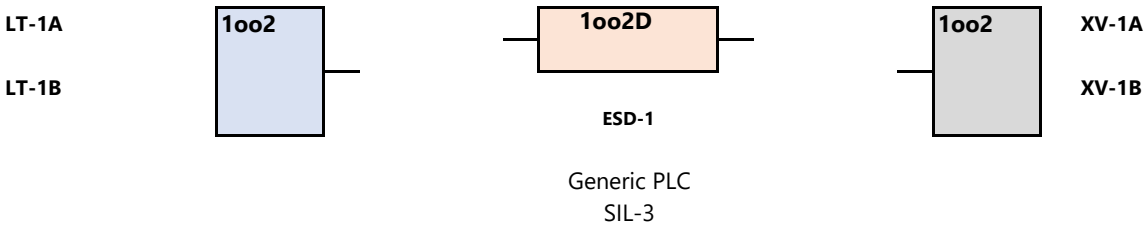
AC= Route 1H

	Achieved	PFDavg	MTTFS (years)
sensor	SIL-2	2,91E-05	429
logic solver	SIL-3	1,70E-04	173
actuator	SIL-2	1,95E-03	66

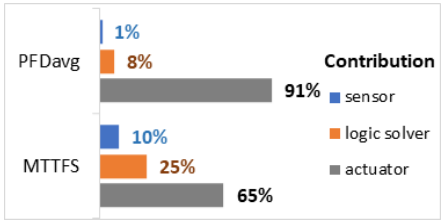
On High High Level (LT-1A/B) [1oo2] in Tank 100-1111 close valve XV-1A/B [1oo2]

SIL Verification according to IEC61508/61511 & ISA TR84.00.02:2022.

Out of range diagnostic: ON Sensor Fault: U.R. Channel Trip: No



Generic PLC
SIL-3



Devices used in this SIF:

3051 Pressure Transmitter (Coplanar Differential)
Generic clean process connection
IS Isolator AI/AI
PLC: 2 AI, 2 DO same module
Floating Ball Valve, C series, Full Stroke, Clean Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1

SIF: M4-LT-1212-01

Subsystem	Description	Logic	PFDavg	SIL (PF)	SC	SIL (AC)	MTTFS (y)
sensor	LT-1	1oo2	2,91E-05	4	2	2	429
sen_part	transmitter	--			3	--	--
sen_part	process	--				--	--
sen_part	interface	--			2	--	--
logicsolver	ESD-1	1oo2D	1,70E-04	3	3	3	173
actuator	XV-1	1oo2	1,95E-03	2	3	2	66
act_part	valve	--			3	--	--
act_part	actuator	--			3	--	--
act_part	solenoid	--			3	--	--
act_part	isolator	--			3	--	--

Subsystem	Logic	Cpt	TI (y)	LT (y)	Beta	MTTRdd	Startup(h)	HFT	Type	Route
sensor		95%	1,00	15	5%	48	24	1	B	Route 1H
sen_part								1	B	
sen_part								1	A	
sen_part								1	A	
logicsolver		99%	4,00	15	2%	48	24	1	B	Route 1H
actuator		73%	1,00	15	10%	48	24	1	A	Route 1H
act_part								1	A	
act_part								1	A	
act_part								1	A	
act_part								1	A	

Subsystem	Description	Logic	SD	SU	DD	DU	SFF	DC
sensor	LT-1	1oo2	53	84	377	77	87%	
sen_part	transmitter	--	24	84	234	32		
sen_part	process	--	0	0	0	0		
sen_part	interface	--	29	0	143	45		
logicsolver	ESD-1	1oo2D	11804	133	3920	247	98%	
actuator	XV-1	1oo2	0	916	0	829	52%	
act_part	valve	--	0	0	0	442		
act_part	actuator	--	0	286	0	199		
act_part	solenoid	--	0	516	0	188		
act_part	isolator	--	0	114	0	0		

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

DETAILED SIL VERIFICATION	Rev.1	20/08/2025
PROJECT NAME	Doc:	

SIF: M4-PT-2312-06

Required		Achieved
SIL-2	SIL	**SIL-2**
200	RRF	**459**
	PFDavg	**2,18E-03**
10	MTTFS (y)	**47**

	Achieved
PFDavg	SIL-2
Arch. C.	SIL-2
SC	SIL-3

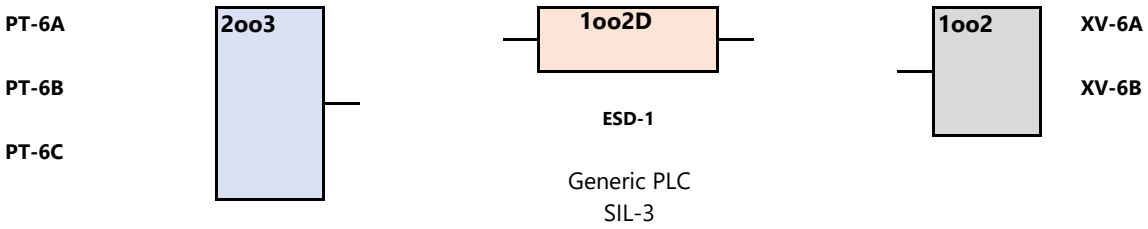
AC= Route 1H

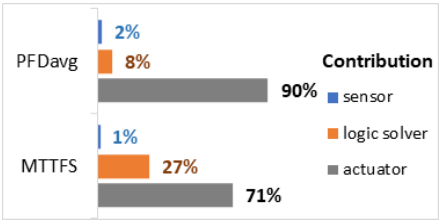
	Achieved	PFDavg	MTTFS (years)
sensor	SIL-2	5,29E-05	3417
logic solver	SIL-3	1,73E-04	171
actuator	SIL-2	1,95E-03	66

On High High Pressure (PT-6A/B/C) [2oo3] in Vessel 100-2312 close valves XV-6A/B [1oo2]

SIL Verification according to IEC61508/61511 & ISA TR84.00.02:2022.

Out of range diagnostic: ON Sensor Fault: -- Channel Trip: Yes





Devices used in this SIF:

3051 Pressure Transmitter (Coplanar Absolute)
1199 Remote Seal, High Trip, normal service
PLC: 3 AI, 2 DO same module
Floating Ball Valve, C series, Full Stroke, Clean Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1

SIF: M4-PT-2312-06

Subsystem	Description	Logic	PFDavg	SIL (PF)	SC	SIL (AC)	MTTFS (y)
sensor	PT-6	2oo3	5,29E-05	4	3	2	3.417
sen_part	transmitter	--			3	--	--
sen_part	seal	--			3	--	--
logicsolver	ESD-1	1oo2D	1,73E-04	3	3	3	171
actuator	XV-6	1oo2	1,95E-03	2	3	2	66
act_part	valve	--			3	--	--
act_part	actuator	--			3	--	--
act_part	solenoid	--			3	--	--
act_part	isolator	--			3	--	--

Subsystem	Logic	Cpt	TI (y)	LT (y)	Beta	MTTRdd	Startup(h)	HFT	Type	Route
sensor		94%	1,00	15	5%	48	24	1	B	Route 1H
sen_part								1	B	
sen_part								1	A	
logicsolver		99%	4,00	15	2%	48	24	1	B	Route 1H
actuator		73%	1,00	15	10%	48	24	1	A	Route 1H
act_part								1	A	
act_part								1	A	
act_part								1	A	
act_part								1	A	

Subsystem	Description	Logic	SD	SU	DD	DU	SFF	DC
sensor	PT-6	2oo3	279	94	0	87	81%	
sen_part	transmitter	--	279	94	0	41		
sen_part	seal	--	0	0	0	46		
logicsolver	ESD-1	1oo2D	11852	136	3968	250	98%	
actuator	XV-6	1oo2	0	916	0	829	52%	
act_part	valve	--	0	0	0	442		
act_part	actuator	--	0	286	0	199		
act_part	solenoid	--	0	516	0	188		
act_part	isolator	--	0	114	0	0		

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

DETAILED SIL VERIFICATION	Rev.1	20/08/2025
PROJECT NAME	Doc:	

SIF: M4-PT-2312-06B

Required		Achieved
SIL-2	SIL	**SIL-2**
200	RRF	**458**
	PFDavg	**2,18E-03**
10	MTTFS (y)	**47**

	Achieved
PFDavg	SIL-2
Arch. C.	SIL-2
SC	SIL-3

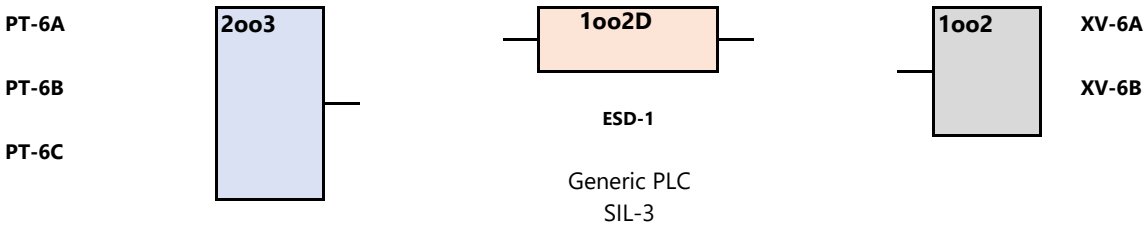
AC= Route 1H

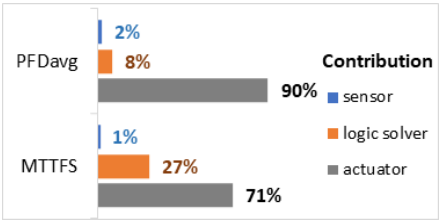
	Achieved	PFDavg	MTTFS (years)
sensor	SIL-2	5,37E-05	3144
logic solver	SIL-3	1,73E-04	171
actuator	SIL-2	1,95E-03	66

On High High Pressure (PT-6A/B/C) [2oo3] in Vessel 100-2312 close valves XV-6A/B [1oo2].

SIL Verification according to IEC61508/61511 & ISA TR84.00.02:2022.

Out of range diagnostic: ON Sensor Fault: -- Channel Trip: Yes





Devices used in this SIF:

PT700 Pressure Transmitter
1199 Remote Seal, High Trip, normal service
PLC: 3 AI, 2 DO same module
Floating Ball Valve, C series, Full Stroke, Clean Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1

SIF: M4-PT-2312-06B

Subsystem	Description	Logic	PFDavg	SIL (PF)	SC	SIL (AC)	MTTFS (y)
sensor	PT-6	2oo3	5,37E-05	4	3	2	3.144
sen_part	transmitter	--			3	--	--
sen_part	seal	--			3	--	--
logicsolver	ESD-1	1oo2D	1,73E-04	3	3	3	171
actuator	XV-6	1oo2	1,95E-03	2	3	2	66
act_part	valve	--			3	--	--
act_part	actuator	--			3	--	--
act_part	solenoid	--			3	--	--
act_part	isolator	--			3	--	--

Subsystem	Logic	Cpt	TI (y)	LT (y)	Beta	MTTRdd	Startup(h)	HFT	Type	Route
sensor		94%	1,00	15	5%	48	24	1	B	Route 1H
sen_part								1	B	
sen_part								1	A	
logicsolver		99%	4,00	15	2%	48	24	1	B	Route 1H
actuator		73%	1,00	15	10%	48	24	1	A	Route 1H
act_part								1	A	
act_part								1	A	
act_part								1	A	
act_part								1	A	

Subsystem	Description	Logic	SD	SU	DD	DU	SFF	DC
sensor	PT-6	2oo3	364	40	0	88	82%	
sen_part	transmitter	--	364	40	0	42		
sen_part	seal	--	0	0	0	46		
logicsolver	ESD-1	1oo2D	11852	136	3968	250	98%	
actuator	XV-6	1oo2	0	916	0	829	52%	
act_part	valve	--	0	0	0	442		
act_part	actuator	--	0	286	0	199		
act_part	solenoid	--	0	516	0	188		
act_part	isolator	--	0	114	0	0		

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

DETAILED SIL VERIFICATION	Rev.1	20/08/2025
PROJECT NAME	Doc:	

SIF: M4-PT-2312-06SS

Required		Achieved
SIL-2	SIL	**SIL-2**
200	RRF	**231**
	PFDavg	**4,32E-03**
10	MTTFS (y)	**47**

	Achieved
PFDavg	SIL-2
Arch. C.	SIL-2
SC	SIL-3

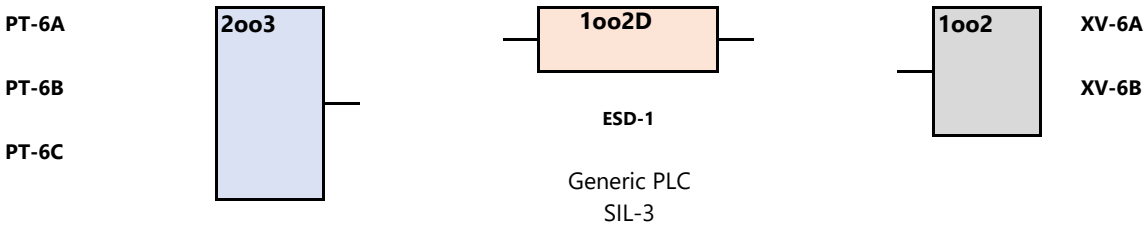
AC= Route 1H

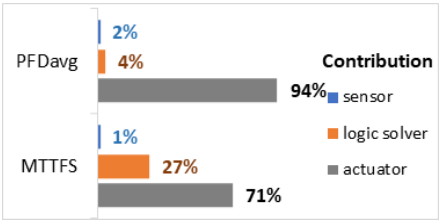
	Achieved	PFDavg	MTTFS (years)
sensor	SIL-2	6,62E-05	3406
logic solver	SIL-3	1,73E-04	171
actuator	SIL-2	4,09E-03	66

[Severe Service Case] On High High Pressure (PT-6A/B/C) [2oo3] in Vessel 100-2312 close valves XV-6A/B [1oo2]

SIL Verification according to IEC61508/61511 & ISA TR84.00.02:2022.

Out of range diagnostic: ON Sensor Fault: -- Channel Trip: Yes





Devices used in this SIF:

3051 Pressure Transmitter (Coplanar Absolute)
1199 Remote Seal, High Trip, severe service
PLC: 3 AI, 2 DO same module
Floating Ball Valve, C series, Full Stroke, Severe Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1

SIF: M4-PT-2312-06SS

Subsystem	Description	Logic	PFDavg	SIL (PF)	SC	SIL (AC)	MTTFS (y)
sensor	PT-6	2oo3	6,62E-05	4	3	2	3.406
sen_part	transmitter	--			3	--	--
sen_part	seal	--			3	--	--
logicsolver	ESD-1	1oo2D	1,73E-04	3	3	3	171
actuator	XV-6	1oo2	4,09E-03	2	3	2	66
act_part	valve	--			3	--	--
act_part	actuator	--			3	--	--
act_part	solenoid	--			3	--	--
act_part	isolator	--			3	--	--

Subsystem	Logic	Cpt	TI (y)	LT (y)	Beta	MTTRdd	Startup(h)	HFT	Type	Route
sensor		95%	1,00	15	5%	48	24	1	B	Route 1H
sen_part								1	B	
sen_part								1	A	
logicsolver		99%	4,00	15	2%	48	24	1	B	Route 1H
actuator		63%	1,00	15	10%	48	24	1	A	Route 1H
act_part								1	A	
act_part								1	A	
act_part								1	A	
act_part								1	A	

Subsystem	Description	Logic	SD	SU	DD	DU	SFF	DC
sensor	PT-6	2oo3	279	94	0	117	76%	
sen_part	transmitter	--	279	94	0	41		
sen_part	seal	--	0	0	0	76		
logicsolver	ESD-1	1oo2D	11852	136	3968	250	98%	
actuator	XV-6	1oo2	0	916	0	1196	43%	
act_part	valve	--	0	0	0	809		
act_part	actuator	--	0	286	0	199		
act_part	solenoid	--	0	516	0	188		
act_part	isolator	--	0	114	0	0		

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

DETAILED SIL VERIFICATION	Rev.1	20/08/2025
PROJECT NAME	Doc:	

SIF: M4-PS-1112-10

Required		Achieved
SIL-2	SIL	**SIL-1**
200	RRF	**238**
	PFDavg	**4,20E-03**
10	MTTFS (y)	**45**

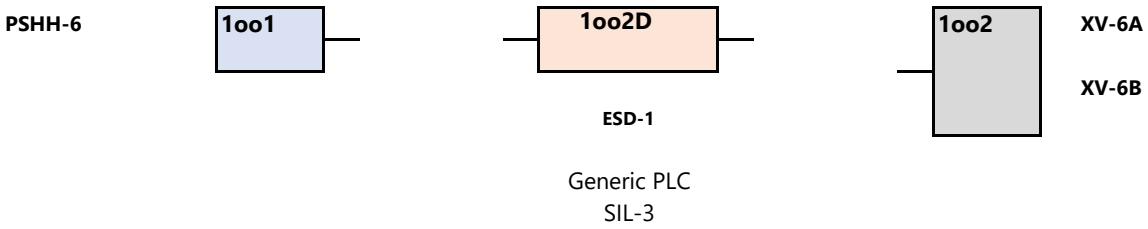
	Achieved
PFDavg	SIL-2
Arch. C.	SIL-1
SC	SIL-3

AC= Route 1H

	Achieved	PFDavg	MTTFS (years)
sensor	SIL-1	2,13E-03	892
logic solver	SIL-3	1,07E-04	166
actuator	SIL-2	1,95E-03	66

On High High Pressure [1oo1] in Vessel close valves XV-6A/B [1oo2]

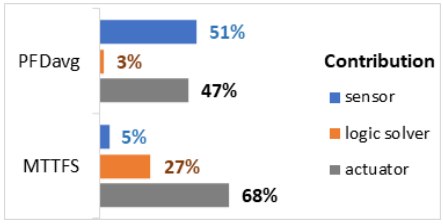
SIL Verification according to IEC61508/61511 & ISA TR84.00.02:2022.



Generic PLC
SIL-3

This SIF doesn't meet AC requirement in the sensor.

Recommendation: replace switch by transmitter.



Devices used in this SIF:

Absolute Pressure Switch series M, B, A, D, PC, PX
Generic clean process connection
PLC: 1 DI, 2 DO same module
Floating Ball Valve, C series, Full Stroke, Clean Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1

SIF: M4-PS-1112-10

Subsystem	Description	Logic	PFDavg	SIL (PF)	SC	SIL (AC)	MTTFS (y)
sensor	PSHH-6	1oo1	2,13E-03	2	3	1	892
sen_part	switch	--			3	--	--
sen_part	process	--				--	--
logicsolver	ESD-1	1oo2D	1,07E-04	3	3	3	166
actuator	XV-6	1oo2	1,95E-03	2	3	2	66
act_part	valve	--			3	--	--
act_part	actuator	--			3	--	--
act_part	solenoid	--			3	--	--
act_part	isolator	--			3	--	--

Subsystem	Logic	Cpt	TI (y)	LT (y)	Beta	MTTRdd	Startup(h)	HFT	Type	Route
sensor		90%	1,00	15			24	0	A	Route 1H
sen_part								0	A	
sen_part								0	A	
logicsolver		99%	4,00	15	2%	48	24	1	B	Route 1H
actuator		73%	1,00	15	10%		24	1	A	Route 1H
act_part								1	A	
act_part								1	A	
act_part								1	A	
act_part								1	A	

Subsystem	Description	Logic	SD	SU	DD	DU	SFF	DC
sensor	PSHH-6	1oo1	0	128	0	203	39%	
sen_part	switch	--	0	128	0	203		
sen_part	process	--	0	0	0	0		
logicsolver	ESD-1	1oo2D	11412	154	3371	165	99%	
actuator	XV-6	1oo2	0	916	0	829	52%	
act_part	valve	--	0	0	0	442		
act_part	actuator	--	0	286	0	199		
act_part	solenoid	--	0	516	0	188		
act_part	isolator	--	0	114	0	0		

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

DETAILED SIL VERIFICATION	Rev.1	20/08/2025
PROJECT NAME	Doc:	

SIF: M4-PT-1112-10

Required		Achieved
SIL-2	SIL	**SIL-2**
200	RRF	**392**
	PFDavg	**2,55E-03**
10	MTTFS (y)	**45**

	Achieved
PFDavg	SIL-2
Arch. C.	SIL-2
SC	SIL-3

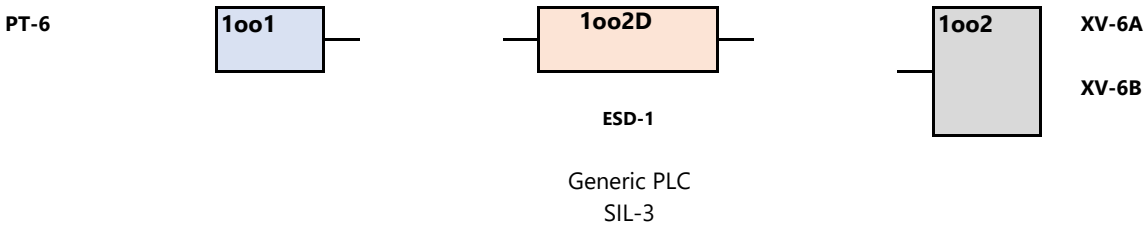
AC= Route 1H

	Achieved	PFDavg	MTTFS (years)
sensor	SIL-2	4,31E-04	928
logic solver	SIL-3	1,67E-04	176
actuator	SIL-2	1,95E-03	66

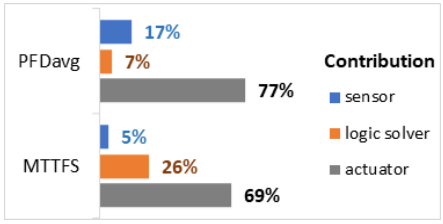
On High High Pressure [1oo1] in Vessel close valves XV-6A/B [1oo2]

SIL Verification according to IEC61508/61511 & ISA TR84.00.02:2022.

Out of range diagnostic: ON Sensor Fault: U.R. Channel Trip: No



Generic PLC
SIL-3



Devices used in this SIF:

3051 Pressure Transmitter (Coplanar Absolute)
Generic clean process connection
PLC: 1 AI, 2 DO same module
Floating Ball Valve, C series, Full Stroke, Clean Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1

SIF: M4-PT-1112-10

Subsystem	Description	Logic	PFDavg	SIL (PF)	SC	SIL (AC)	MTTFS (y)
sensor	PT-6	1oo1	4,31E-04	3	3	2	928
sen_part	transmitter	--			3	--	--
sen_part	process	--				--	--
logicsolver	ESD-1	1oo2D	1,67E-04	3	3	3	176
actuator	XV-6	1oo2	1,95E-03	2	3	2	66
act_part	valve	--			3	--	--
act_part	actuator	--			3	--	--
act_part	solenoid	--			3	--	--
act_part	isolator	--			3	--	--

Subsystem	Logic	Cpt	TI (y)	LT (y)	Beta	MTTRdd	Startup(h)	HFT	Type	Route
sensor		90%	1,00	15			24	0	B	Route 1H
sen_part								0	B	
sen_part								0	A	
logicsolver		99%	4,00	15	2%	48	24	1	B	Route 1H
actuator		73%	1,00	15	10%		24	1	A	Route 1H
act_part								1	A	
act_part								1	A	
act_part								1	A	
act_part								1	A	

Subsystem	Description	Logic	SD	SU	DD	DU	SFF	DC
sensor	PT-6	1oo1	29	94	250	41	90%	
sen_part	transmitter	--	29	94	250	41		
sen_part	process	--	0	0	0	0		
logicsolver	ESD-1	1oo2D	11756	130	3872	244	98%	
actuator	XV-6	1oo2	0	916	0	829	52%	
act_part	valve	--	0	0	0	442		
act_part	actuator	--	0	286	0	199		
act_part	solenoid	--	0	516	0	188		
act_part	isolator	--	0	114	0	0		

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

DETAILED SIL VERIFICATION	Rev.1	20/08/2025
PROJECT NAME	Doc:	

SIF: M4-PTTT-1212-13

Required		Achieved
SIL-2	SIL	**SIL-2**
200	RRF	**469**
	PFDavg	**2,13E-03**
10	MTTFS (y)	**29**

	Achieved
PFDavg	SIL-2
Arch. C.	SIL-2
SC	SIL-3

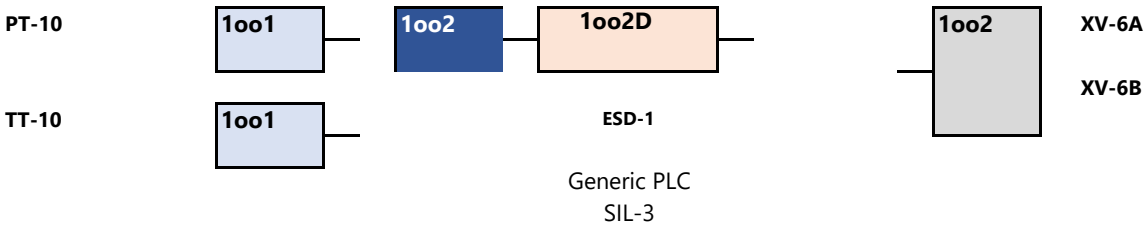
AC= Route 1H

	Achieved	PFDavg	MTTFS (years)
sensor	SIL-3	5,63E-06	138
logic solver	SIL-3	1,70E-04	173
actuator	SIL-2	1,95E-03	66

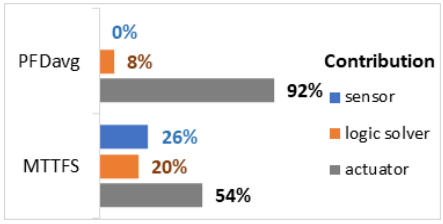
On High Pressure PT-10 [OR] High Temperature TT-10 [1oo2] in Vessel close valves XV-6A/B [1oo2]

SIL Verification according to IEC61508/61511 & ISA TR84.00.02:2022.

Out of range diagnostic: ON Sensor Fault: U.R. Channel Trip: No



Generic PLC
SIL-3



Devices used in this SIF:

3051 Pressure Transmitter (Coplanar Absolute)
YTA710 Temperature Transmitter
Generic RTD 2/3 wires
PLC: 2 AI, 2 DO same module
Floating Ball Valve, C series, Full Stroke, Clean Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1

SIF: M4-PTTT-1212-13

Subsystem	Description	Logic	PFDavg	SIL (PF)	SC	SIL (AC)	MTTFS (y)
SEN_VOTING		1oo2	5,63E-06	4	3	2	138
sensor	PT-10	1oo1			3	--	--
sen_part	transmitter	--			3	--	--
sensor	TT-10	1oo1			3	--	--
sen_part	transmitter	--			3	--	173
sen_part	process	--			3	--	--
logicsolver	ESD-1	1oo2D	1,70E-04	3	3	3	173
actuator	XV-6	1oo2	1,95E-03	2	3	2	66
act_part	valve	--			3	--	--
act_part	actuator	--			3	--	--
act_part	solenoid	--			3	--	--
act_part	isolator	--			3	--	--

Subsystem	Logic	Cpt	TI (y)	LT (y)	Beta	MTTRdd	Startup(h)	HFT	Type	Route
SEN_VOTING					1%			1	B	Route 1H
sensor		90%	1,00	15		48	24	0	B	
sen_part								0	B	
sensor		98%	1,00	15		48	24	0	B	
sen_part								0	B	
sen_part								0	A	
logicsolver		99%	4,00	15	2%	48	24	1	B	Route 1H
actuator		73%	1,00	15	10%		24	1	A	Route 1H
act_part								1	A	
act_part								1	A	
act_part								1	A	
act_part								1	A	

Subsystem	Description	Logic	SD	SU	DD	DU	SFF	DC
SEN_VOTING		1oo2	347	64	971	245	85%	
sensor	PT-10	1oo1	29	94	250	41		
sen_part	transmitter	--	29	94	250	41		
sensor	TT-10	1oo1	665	34	1691	448		
sen_part	transmitter	--	65	34	691	48		
sen_part	process	--	600	0	1000	400		
logicsolver	ESD-1	1oo2D	11804	133	3920	247	98%	
actuator	XV-6	1oo2	0	916	0	829	52%	
act_part	valve	--	0	0	0	442		
act_part	actuator	--	0	286	0	199		
act_part	solenoid	--	0	516	0	188		
act_part	isolator	--	0	114	0	0		

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

DETAILED SIL VERIFICATION	Rev.1	20/08/2025
PROJECT NAME	Doc:	

SIF: M4-PT-1112-16

Required		Achieved
SIL-1	SIL	**SIL-0**
20	RRF	**146**
	PFDavg	**6,87E-03**
10	MTTFS (y)	**46**

	Achieved
PFDavg	SIL-2
Arch. C.	SIL-0
SC	SIL-2

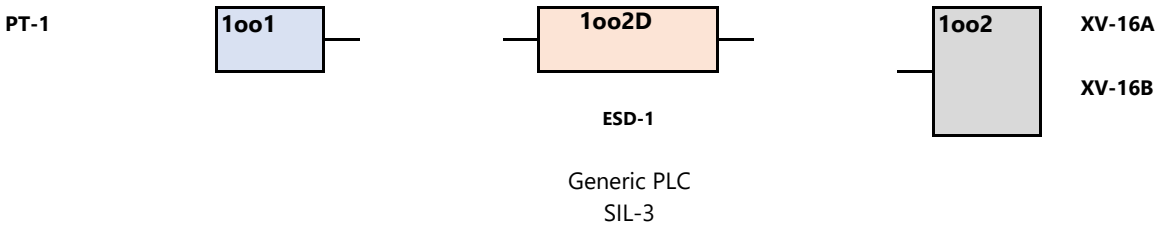
AC= Route 1H

	Achieved	PFDavg	MTTFS (years)
sensor	SIL-0	4,75E-03	993
logic solver	SIL-3	1,67E-04	176
actuator	SIL-2	1,95E-03	66

On High High Pressure (PT-1) [1oo1] in Vessel close valves XV-16A/B [1oo2]

SIL Verification according to IEC61508/61511 & ISA TR84.00.02:2022.

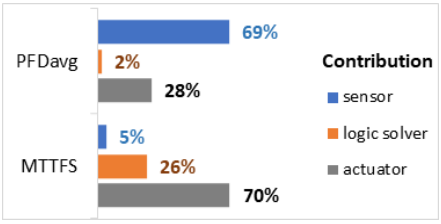
Out of range diagnostic: ON Sensor Fault: U.R. Channel Trip: No



Generic PLC
SIL-3

This SIF doesn't meet AC requirement in the sensor.
We have used failure rates of generic PT which conservative.

Recommendation: use a certificated transmitter with better failure rate values.



Devices used in this SIF:

Generic Pressure Transmitter
Generic clean process connection
PLC: 1 AI, 2 DO same module
Floating Ball Valve, C series, Full Stroke, Clean Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1

SIF: M4-PT-1112-16

Subsystem	Description	Logic	PFDavg	SIL (PF)	SC	SIL (AC)	MTTFS (y)
sensor	PT-1	1oo1	4,75E-03	2	2	0	993
sen_part	transmitter	--			2	--	--
sen_part	process connection	--				--	--
logicsolver	ESD-1	1oo2D	1,67E-04	3	3	3	176
actuator	XV-16	1oo2	1,95E-03	2	3	2	66
act_part	valve	--			3	--	--
act_part	actuator	--			3	--	--
act_part	solenoid	--			3	--	--
act_part	isolator	--			3	--	--

Subsystem	Logic	Cpt	TI (y)	LT (y)	Beta	MTTRdd	Startup(h)	HFT	Type	Route
sensor		90%	1,00	15		48	24	0	B	Route 1H
sen_part								0	B	
sen_part								0	A	
logicsolver		99%	4,00	15	2%	48	24	1	B	Route 1H
actuator		73%	1,00	15	10%	48	24	1	A	Route 1H
act_part								1	A	
act_part								1	A	
act_part								1	A	
act_part								1	A	

Subsystem	Description	Logic	SD	SU	DD	DU	SFF	DC
sensor	PT-1	1oo1	115	0	415	450	54%	
sen_part	transmitter	--	115	0	415	450		
sen_part	process connection	--	0	0	0	0		
logicsolver	ESD-1	1oo2D	11756	130	3872	244	98%	
actuator	XV-16	1oo2	0	916	0	829	52%	
act_part	valve	--	0	0	0	442		
act_part	actuator	--	0	286	0	199		
act_part	solenoid	--	0	516	0	188		
act_part	isolator	--	0	114	0	0		

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

DETAILED SIL VERIFICATION	Rev.1	20/08/2025
PROJECT NAME	Doc:	

SIF: M4-PT-1112-16-CMP

Required		Achieved
SIL-1	SIL	**SIL-0**
20	RRF	**55**
	PFDavg	**1,81E-02**
10	MTTFS (y)	**45**

	Achieved
PFDavg	SIL-1
Arch. C.	SIL-0
SC	SIL-2

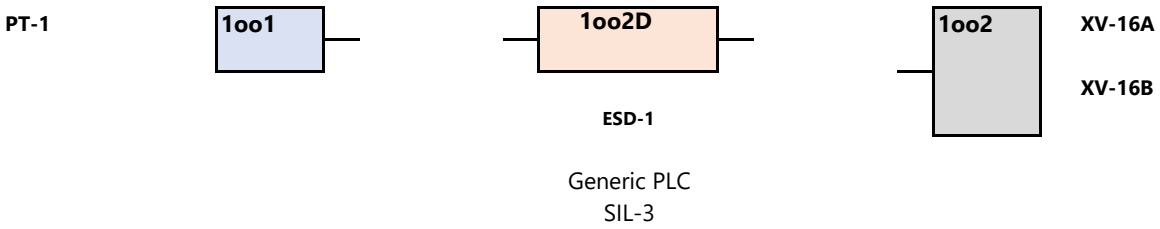
AC= Route 1H

	Achieved	PFDavg	MTTFS (years)
sensor	SIL-0	1,60E-02	796
logic solver	SIL-3	1,70E-04	173
actuator	SIL-2	1,95E-03	66

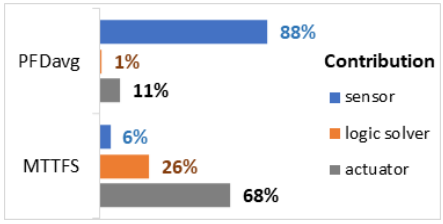
On High High Pressure (PT-1) [1oo1] in Vessel close valves XV-16A/B [1oo2] (90% credit by comparison used for PT-1 by comparing with PT-2 of BPCS)

SIL Verification according to IEC61508/61511 & ISA TR84.00.02:2022.

Out of range diagnostic: ON Sensor Fault: U.R. Channel Trip: No



Generic PLC
SIL-3



Devices used in this SIF:

Generic PT with credit by comparison
Generic clean process connection
IS Isolator AI/AI
PLC: 2 AI, 2 DO same module
Floating Ball Valve, C series, Full Stroke, Clean Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1

SIF: M4-PT-1112-16-CMP

Subsystem	Description	Logic	PFDavg	SIL (PF)	SC	SIL (AC)	MTTFS (y)
sensor	PT-1	1oo1	1,60E-02	1	2	0	796
sen_part	transmitter	--			2	--	--
sen_part	process connection	--				--	--
sen_part	splitter	--			2	--	--
logicsolver	ESD-1	1oo2D	1,70E-04	3	3	3	173
actuator	XV-16	1oo2	1,95E-03	2	3	2	66
act_part	valve	--			3	--	--
act_part	actuator	--			3	--	--
act_part	solenoid	--			3	--	--
act_part	isolator	--			3	--	--

Subsystem	Logic	Cpt	TI (y)	LT (y)	Beta	MTTRdd	Startup(h)	HFT	Type	Route
sensor		54%	1,00	15		48	24	0	B	Route 1H
sen_part								0	B	
sen_part								0	A	
sen_part								0	A	
logicsolver		99%	4,00	15	2%	48	24	1	B	Route 1H
actuator		73%	1,00	15	10%	48	24	1	A	Route 1H
act_part								1	A	
act_part								1	A	
act_part								1	A	
act_part								1	A	

Subsystem	Description	Logic	SD	SU	DD	DU	SFF	DC
sensor	PT-1	1oo1	144	0	558	495	59%	
sen_part	transmitter	--	115	0	415	450		
sen_part	process connection	--	0	0	0	0		
sen_part	splitter	--	29	0	143	45		
logicsolver	ESD-1	1oo2D	11804	133	3920	247	98%	
actuator	XV-16	1oo2	0	916	0	829	52%	
act_part	valve	--	0	0	0	442		
act_part	actuator	--	0	286	0	199		
act_part	solenoid	--	0	516	0	188		
act_part	isolator	--	0	114	0	0		

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

DETAILED SIL VERIFICATION	Rev.1	20/08/2025
PROJECT NAME	Doc:	

SIF: M4-PT-1111-19

Required		Achieved
SIL-1	SIL	**SIL-1**
20	RRF	**48**
	PFDavg	**2,08E-02**
10	MTTFS (y)	**68**

	Achieved
PFDavg	SIL-1
Arch. C.	SIL-1
SC	SIL-3

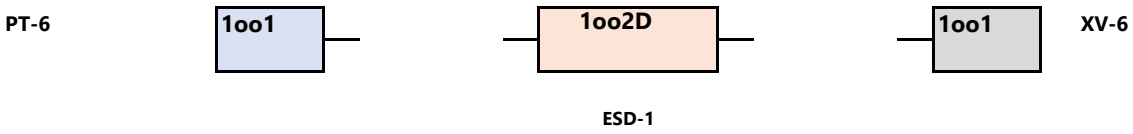
AC= Route 1H

	Achieved	PFDavg	MTTFS (years)
sensor	SIL-1	7,01E-04	928
logic solver	SIL-3	1,65E-04	178
actuator	SIL-1	1,99E-02	125

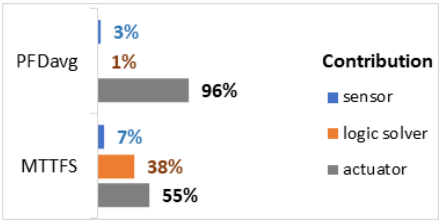
High High Pressure on PT closes feed valve. Calculation of Bypass impact

SIL Verification according to IEC61508/61511 & ISA TR84.00.02:2022.

Out of range diagnostic: ON Sensor Fault: U.R. Channel Trip: No



Generic PLC
SIL-3



Devices used in this SIF:

3051 Pressure Transmitter (Coplanar Absolute)
1199 Remote Seal, High Trip, normal service
PLC: 1 AI. 1 DO
Floating Ball Valve, C series, Full Stroke, Clean Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1

SIF: M4-PT-1111-19

Subsystem	Description	Logic	PFDavg	SIL (PF)	SC	SIL (AC)	MTTFS (y)
sensor	PT-6	1oo1	7,01E-04	3	3	1	928
sen_part	transmitter	--			3	--	--
sen_part	seal	--			3	--	--
logicsolver	ESD-1	1oo2D	1,65E-04	3	3	3	178
actuator	XV-6	1oo1	1,72E-02	1	3	1	125
act_part	valve	--			3	--	--
act_part	actuator	--			3	--	--
act_part	solenoid	--			3	--	--
act_part	isolator	--			3	--	--
actuator	BYPASS	--	2,74E-03	2		--	--

Subsystem	Logic	Cpt	TI (y)	LT (y)	Beta	MTTRdd	Startup(h)	HFT	Type	Route
sensor		94%	1,00	15	5%	48	24	0	B	Route 1H
sen_part								0	B	
sen_part								0	A	
logicsolver		99%	4,00	15	2%	48	24	1	B	Route 1H
actuator		73%	1,00	15	10%	48	24	0	A	Route 1H
act_part								0	A	
act_part								0	A	
act_part								0	A	
act_part								0	A	
actuator								--		

Subsystem	Description	Logic	SD	SU	DD	DU	SFF	DC
sensor	PT-6	1oo1	29	94	250	87	81%	
sen_part	transmitter	--	29	94	250	41		
sen_part	seal	--	0	0	0	46		
logicsolver	ESD-1	1oo2D	11617	129	3815	241	98%	
actuator	XV-6	1oo1	0	916	0	829	52%	
act_part	valve	--	0	0	0	442		
act_part	actuator	--	0	286	0	199		
act_part	solenoid	--	0	516	0	188		
act_part	isolator	--	0	114	0	0		
actuator	BYPASS	--						

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

DETAILED SIL VERIFICATION	Rev.1	20/08/2025
PROJECT NAME	Doc:	

SIF: SIF-20

Required		Achieved
SIL-2	SIL	**SIL-2**
200	RRF	**459**
	PFDavg	**2,18E-03**
10	MTTFS (y)	**47**

	Achieved
PFDavg	SIL-2
Arch. C.	SIL-2
SC	SIL-3

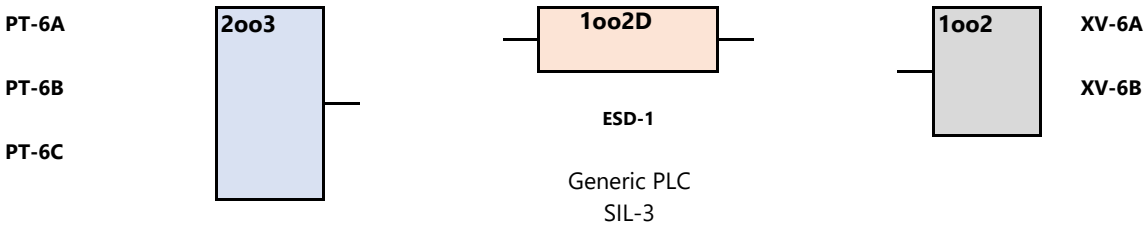
AC= Route 1H

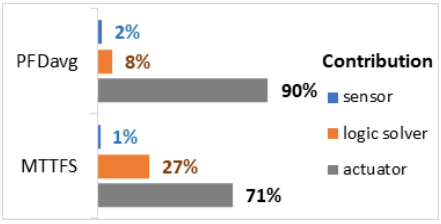
	Achieved	PFDavg	MTTFS (years)
sensor	SIL-2	5,29E-05	3433
logic solver	SIL-3	1,73E-04	171
actuator	SIL-2	1,95E-03	66

On High High Pressure (PT-6A/B/C) [2oo3] in Vessel 100-2312 close valves XV-6A/B [1oo2]. Calculation of Bypass impact

SIL Verification according to IEC61508/61511 & ISA TR84.00.02:2022.

Out of range diagnostic: ON Sensor Fault: -- Channel Trip: Yes





Devices used in this SIF:

3051 Pressure Transmitter (Coplanar Absolute)
1199 Remote Seal, High Trip, normal service
PLC: 3 AI, 2 DO same module
Floating Ball Valve, C series, Full Stroke, Clean Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1

SIF: SIF-20

Subsystem	Description	Logic	PFDavg	SIL (PF)	SC	SIL (AC)	MTTFS (y)
sensor	PT-6	2oo3	5,29E-05	4	3	2	3.433
sen_part	transmitter	--			3	--	--
sen_part	seal	--			3	--	--
logicsolver	ESD-1	1oo2D	1,73E-04	3	3	3	171
actuator	XV-6	1oo2	1,95E-03	2	3	2	66
act_part	valve	--			3	--	--
act_part	actuator	--			3	--	--
act_part	solenoid	--			3	--	--
act_part	isolator	--			3	--	--
actuator	BYPASS	--				--	--

Subsystem	Logic	Cpt	TI (y)	LT (y)	Beta	MTTRdd	Startup(h)	HFT	Type	Route
sensor		94%	1,00	15	5%	48	24	1	B	Route 1H
sen_part								1	B	
sen_part								1	A	
logicsolver		99%	4,00	15	2%	48	24	1	B	Route 1H
actuator		73%	1,00	15	10%	48	24	1	A	Route 1H
act_part								1	A	
act_part								1	A	
act_part								1	A	
act_part								1	A	
actuator								--		

Subsystem	Description	Logic	SD	SU	DD	DU	SFF	DC
sensor	PT-6	2oo3	279	94	0	87	81%	
sen_part	transmitter	--	279	94	0	41		
sen_part	seal	--	0	0	0	46		
logicsolver	ESD-1	1oo2D	11852	136	3968	250	98%	
actuator	XV-6	1oo2	0	916	0	829	52%	
act_part	valve	--	0	0	0	442		
act_part	actuator	--	0	286	0	199		
act_part	solenoid	--	0	516	0	188		
act_part	isolator	--	0	114	0	0		
actuator	BYPASS	--						

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

DETAILED SIL VERIFICATION	Rev.1	20/08/2025
PROJECT NAME	Doc:	

SIF: M5-FT-2312-30

Required		Achieved
SIL-2	SIL	**SIL-2**
200	RRF	**243**
	PFDavg	**4,11E-03**
10	MTTFS (y)	**27**

	Achieved
PFDavg	SIL-2
Arch. C.	SIL-2
SC	SIL-3

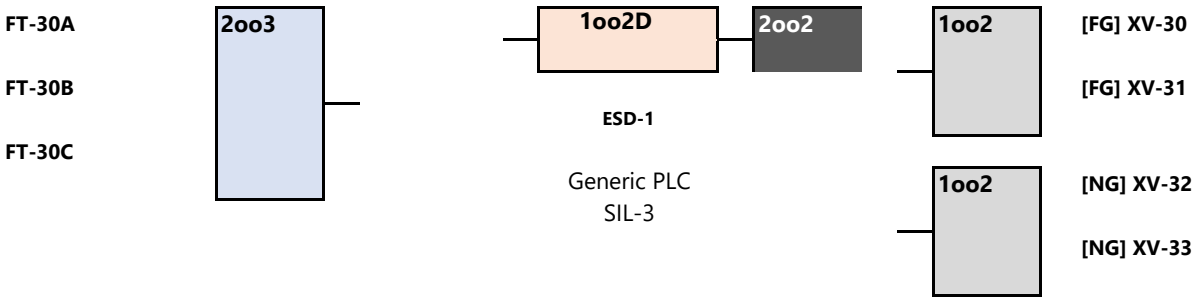
AC= Route 1H

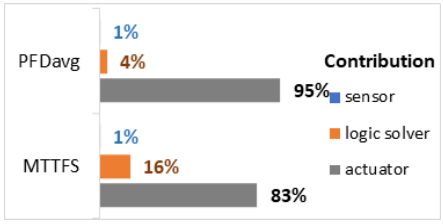
	Achieved	PFDavg	MTTFS (years)
sensor	SIL-3	2,55E-05	3714
logic solver	SIL-3	1,78E-04	167
actuator	SIL-2	3,91E-03	33

On Low Low Air Combustion Flow (FT-30A/B/C) [2oo3] in Incinerator 100-2312 closes Fuel Gas Valves (1oo2 XV-30/31) & Natural Gas Valves (1oo2 XV-32/33) [2oo2 of FG & NG]

SIL Verification according to IEC61508/61511 & ISA TR84.00.02:2022.

Out of range diagnostic: ON Sensor Fault: -- Channel Trip: Yes





Devices used in this SIF:

3051 Pressure Transmitter (Coplanar Differential)
Generic clean process connection
PLC: 3 AI, 4 DO same module

SIF: M5-FT-2312-30

Subsystem	Description	Logic	PFDavg	SIL (PF)	SC	SIL (AC)	MTTFS (y)
sensor	FT-30	2oo3	2,55E-05	4	3	3	3.714
sen_part	transmitter	--			3	--	--
sen_part	process	--				--	--
logicsolver	ESD-1	1oo2D	1,78E-04	3	3	3	167
actuator	[FG] XV-30/31	1oo2	1,95E-03	2	3	2	66
actuator	[NG] XV-32/33	1oo2	1,95E-03	2	3	2	66

Subsystem	Logic	Cpt	TI (y)	LT (y)	Beta	MTTRdd	Startup(h)	HFT	Type	Route
sensor		90%	1,00	15	5%	48	24	1	B	Route 1H
sen_part								1	B	
sen_part								1	A	
logicsolver		99%	4,00	15	2%	48	24	1	B	Route 1H
actuator		73%	1,00	15	10%	48	24	1	A	Route 1H
actuator		73%	1,00	15	10%	48	24	1	A	Route 1H

Subsystem	Description	Logic	SD	SU	DD	DU	SFF	DC
sensor	FT-30	2oo3	258	84	0	32	91%	
sen_part	transmitter	--	258	84	0	32		
sen_part	process	--	0	0	0	0		
logicsolver	ESD-1	1oo2D	12130	138	4082	256	98%	
actuator	[FG] XV-30/31	1oo2	0	916	0	829	52%	
actuator	[NG] XV-32/33	1oo2	0	916	0	829	52%	

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

Sub-SIF M5-FT-2312-30

sub-SIF: Groups of ACTUATOR SUBSYSTEM used in other SIFs

Subsystem	Description	SC	SD	SU	DD	DU	SFF	DC
actuator	[FG] XV-30/31	3	0	916	0	829	52%	
act_part	valve	3	0	0	0	442		
act_part	actuator	3	0	286	0	199		
act_part	solenoid	3	0	516	0	188		
act_part	driver	3	0	114	0	0		
actuator	[NG] XV-32/33	3	0	916	0	829	52%	
act_part	valve	3	0	0	0	442		
act_part	actuator	3	0	286	0	199		
act_part	solenoid	3	0	516	0	188		
act_part	driver	3	0	114	0	0		

Sensor DC calculation depends on sensor diagnostic set up.

SFF for Route 1H / DC for Routes 2H/IEC61511

Devices used in this SIF:

Floating Ball Valve, C series, Full Stroke, Clean Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1
Floating Ball Valve, C series, Full Stroke, Clean Service
Actuator VL series, spring cylinder, Air-to-Retract
Solenoid series 327, De-energize to trip
DO interface, Solenoid Driver KFD0-SD-Ex 1

PROJECT NAME	Rev.1	20/08/2025
SIL VERIFICATION - LIST OF PRODUCTS	Doc:	

		FAILURE RATES (FITS)								
Description	**Vendor**	**Fail-High**	**Fail-Low**	**Fail-Detected**	**SD**	**SU**	**DD**	**DU**	Type	SC
DEVICES OF SENSOR SUBSYSTEM										
3051 Pressure Transmitter (Coplanar Differential)	Emerson	24	27	207		84		32	B	3
IS Isolator AI/AI	P+F	28,50	143					44,50	A	2
1199 Remote Seal, High Trip, normal service	Rosemount							46	A	3
1199 Remote Seal, High Trip, severe service	Rosemount							76	A	3
Generic clean process connection	Generic								A	
3051 Pressure Transmitter (Coplanar Absolute)	Emerson	29	28	222		94		41	B	3
PT700 Pressure Transmitter	Honeywell	29	43	292		40		42	B	3
Absolute Pressure Switch series M, B, A, D, PC, PX	Ettore Cella					128		203	A	3
Generic Pressure Transmitter	Generic	115	300	115				450	B	PIU-2
Generic PT with credit by comparison	Generic				115		415	450	B	PIU-2
YTA710 Temperature Transmitter	Yokogawa	65	65	626		34		48	B	3
Generic RTD 2/3 wires	Generic	600	1000					400	A	3
DEVICES OF FINAL ELEMENTS										
Floating Ball Valve, C series, Full Stroke, Clean Service	Mogas							442	A	3
Floating Ball Valve, C series, Full Stroke, Severe Service	Mogas							809	A	3
Actuator VL series, spring cylinder, Air-to-Retract	Flowserve					286		199	A	3
Solenoid series 327, De-energize to trip	ASCO					516		188	A	3
DO interface, Solenoid Driver KFD0-SD-Ex 1	P+F					114			A	3
SAFETY PLC										
PLC: 1 AI. 1 DO	Generic				11617	129	3815	241	B	3
PLC: 1 AI, 2 DO same module	Generic				11756	130	3872	244	B	3
PLC: 2 AI, 2 DO same module	Generic				11804	133	3920	247	B	3
PLC: 3 AI, 2 DO same module	Generic				11852	136	3968	250	B	3
PLC: 3 AI, 4 DO same module	Generic				12130	138	4082	256	B	3
PLC: 1 DI, 2 DO same module	Generic				11412	154	3371	165	B	3