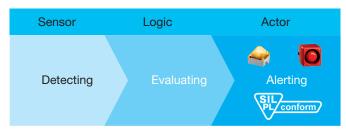
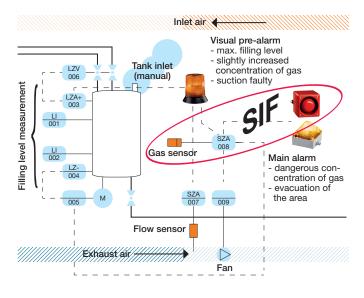
# Functional safety IEC 61508 / IEC 61511 (SIL)

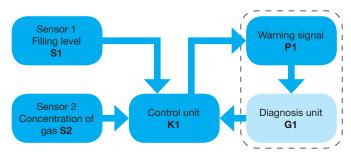
## Safety Instrumented System SIS (Safety Loop)



## Process safety e.g. gas alarm



## Safety block diagram filling level / gas

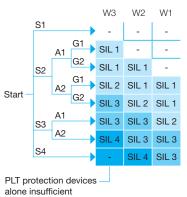


- S1 Sensor 1 (filling level in the tank)
- S2 Sensor 1 (concentration of gas in plant room)
- K1 Control unit
- P1 Visual and audible warning signal
- G1 Diagnosis unit for signaling devices

Safety integrity (type B) according to IEC 61508				SIL/PL (ISO 13849)	
	HFT				
SFF	0	1	2	SIL	PL
< 60%	-	SIL 1	SIL 2	1	b, c
60% up to < 90%	SIL 1	SIL 2	SIL 3	2	d
90% up to < 99%	SIL 2	SIL 3	SIL 4	3	е
99% up to > 99%	SIL 3	SIL 4	SIL 4	4	-

Requirement according to IEC 61508, type B (partially unknown failure conduct) Compare SIL/PL (IEC 61508 / DIN EN ISO 13849)

#### Hazard graph according to IEC 61508



- S = Extent of damage S1 minor injury of a person
- S2 serious, irreversible injury of one or more people or
- death of one person death of several people S3 <u>S</u>4 disastrous effects with several dead
- A = Likelihood of people being
- in the area rarely to slightly more often frequently to continuously A1 A2
- G = Danger prevention G1 possible under certain
- conditions
- G2 barely possible
- W = Likelihood of occurrence W1 very small W2 small
- W3 relatively high

#### **Evaluation of the safety function**

Required safety related parameters					
IEC	IEC 61508 Device type				
PFH/PFD SIL T1	-	Units with internal diagnosis		safety control safety switch gears	
$\begin{array}{c} MTTF_{d} \\ \lambda_{d} \\ \lambda_{s} \end{array}$	DC, CCF, subsystem type	Units without internal	Without omponents that are subject to wear and tear	sensors, signaling devices	
B10 <sub>d</sub> λ <sub>d</sub> λ <sub>s</sub>	DC, CCF, subsystem type, n <sub>op</sub>	diagnosis	With omponents that are subject to wear and tear	emergency shut- down, relay, switch	
CCF: failure due to common cause					

DC: Diagnostic coverage

## Calculation of an SIS with a SIL 2-actor

#### Given values:

PFD Sensor A	1.5 * 10-3	(suitable for SIL 2)
PFD Control	1.3 * 10-4	(suitable for SIL 3)
PFD Actor	1.1 * 10 <sup>-3</sup>	(suitable for SIL 2)

#### Example for a 1001 Actor

(1 unit required for the functioning of 1 available unit)

Sensor A SIL 2		•	Control SIL 3	(e.g.	SPS)	٠	Actor SIL 3
PFD <sub>Sys</sub>	=	PFD	) <sub>s</sub>	+	PFD	+	PFD <sub>A</sub>
PFD <sub>Sys</sub>	=	1.5	* 10 <sup>-3</sup>	+	1.3 * 10-4	+	1.1 * 10-3
$PFD_{Sys}$	=	2.73	3 * 10 <sup>-3</sup> (S	SIL 2)			

By using this component, the SIS reaches the PFD for SIL 2.

#### **Failure probability**

SIL	Operating mode with low requirement rate – PFD (average failure probability of the function in case of demand)	Operating mode with continual requirement rate – PFH (probability of a failure that brings dangerous risk per hour)	PL
SIL 4	$\geq 10^{-5} \text{ up to} < 10^{-4}$	$\ge 10^{-9}$ up to < $10^{-8}$	-
SIL 3	$\geq 10^{-4}$ up to < $10^{-3}$	$\geq 10^{-8}$ up to < $10^{-7}$	е
SIL 2	$\geq 10^{-3}$ up to < $10^{-2}$	$\geq 10^{-7}$ up to < $10^{-6}$	d
SIL 1	> 10 <sup>2</sup> up to 1 101	$\geq 10^{-6}$ up to 3 x 10 <sup>-6</sup>	С
	$\geq 10^{-2}$ up to < $10^{-1}$	$\ge 3 \times 10^{-6} \text{ up to} < 10^{-5}$	b

