Safety Function Average Probability of Failure on Demand

Average probability of failure on demand for 1oo1, 1oo2 and 2oo3 voting from failure rate, proof-test interval and common cause, with the SIL band.

Method: Simplified PFDavg equations (1oo1: λT/2; 1oo2: ((1 − β)λT)²/3 + βλT/2; 2oo3: ((1 − β)λT)² + βλT/2); as in IEC 61508-6 and ISA-TR84.00.02

Input parameters

Unit system: SI

Parameter	Value	Unit
Dangerous undetected failure rate (per hour)	2.0000e-06	
Proof-test interval	8,760.0	h
Architecture	1oo1	
Common-cause factor	5.0000	%

Calculated results

Parameter	Value	Unit
Average probability of failure on demand	0.008760	
Risk reduction factor	114.16	
SIL band met by this element (0 = below SIL 1)	2.0000	

Notes for this case

- SIL band from PFDavg only: architectural constraints (hardware fault tolerance, safe failure fraction) and systematic capability are not checked.
- Simplified equations for low-demand mode (IEC 61508-6 / ISA-TR84 forms) neglecting repair time and diagnostics. A full SIL verification adds all elements, architectural constraints and systematic capability.

Formula and method

$$PFD_{1oo1} = \frac{\lambda_{DU} T_I}{2}, \quad PFD_{1oo2} = \frac{[(1-\beta)\lambda_{DU} T_I]^2}{3} + \beta\frac{\lambda_{DU} T_I}{2}, \quad PFD_{2oo3} = [(1-\beta)\lambda_{DU} T_I]^2 + \beta\frac{\lambda_{DU} T_I}{2}, \quad RRF = \frac{1}{PFD_{avg}}$$

Variables

λ_{DU}	Dangerous undetected failure rate (per hour)	-
T_I	Proof-test interval	s
voting	Architecture	-
β	Common-cause factor	-
PFD_{avg}	Average probability of failure on demand	-
RRF	Risk reduction factor	-
SIL	SIL band met by this element (0 = below SIL 1)	-

Method and standards

Simplified low-demand equations.

Assumptions and limits

- Low demand; perfect proof tests; no repair time.
- λT must be small: rejected at 1 or more, warned above 0.1.
- SIL band from PFDavg alone; architectural constraints (HFT, SFF) and systematic capability are not considered.

References

• Simplified PFDavg equations (1oo1: λT/2; 1oo2: ((1 − β)λT)²/3 + βλT/2; 2oo3: ((1 − β)λT)² + βλT/2)
• as in IEC 61508-6 and ISA-TR84.00.02

Report details

Report reference	FCC-SDPX-4PE7 (the same inputs always give the same reference)
Generated	17 November 2026, 19:45 UTC
Calculator	Safety Function Average Probability of Failure on Demand
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/instrumentation/signals-calibration/pfd-safety-function

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Reopens the calculator with the inputs of this report.