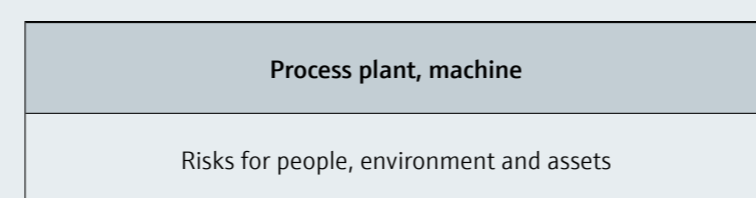


Functional Safety

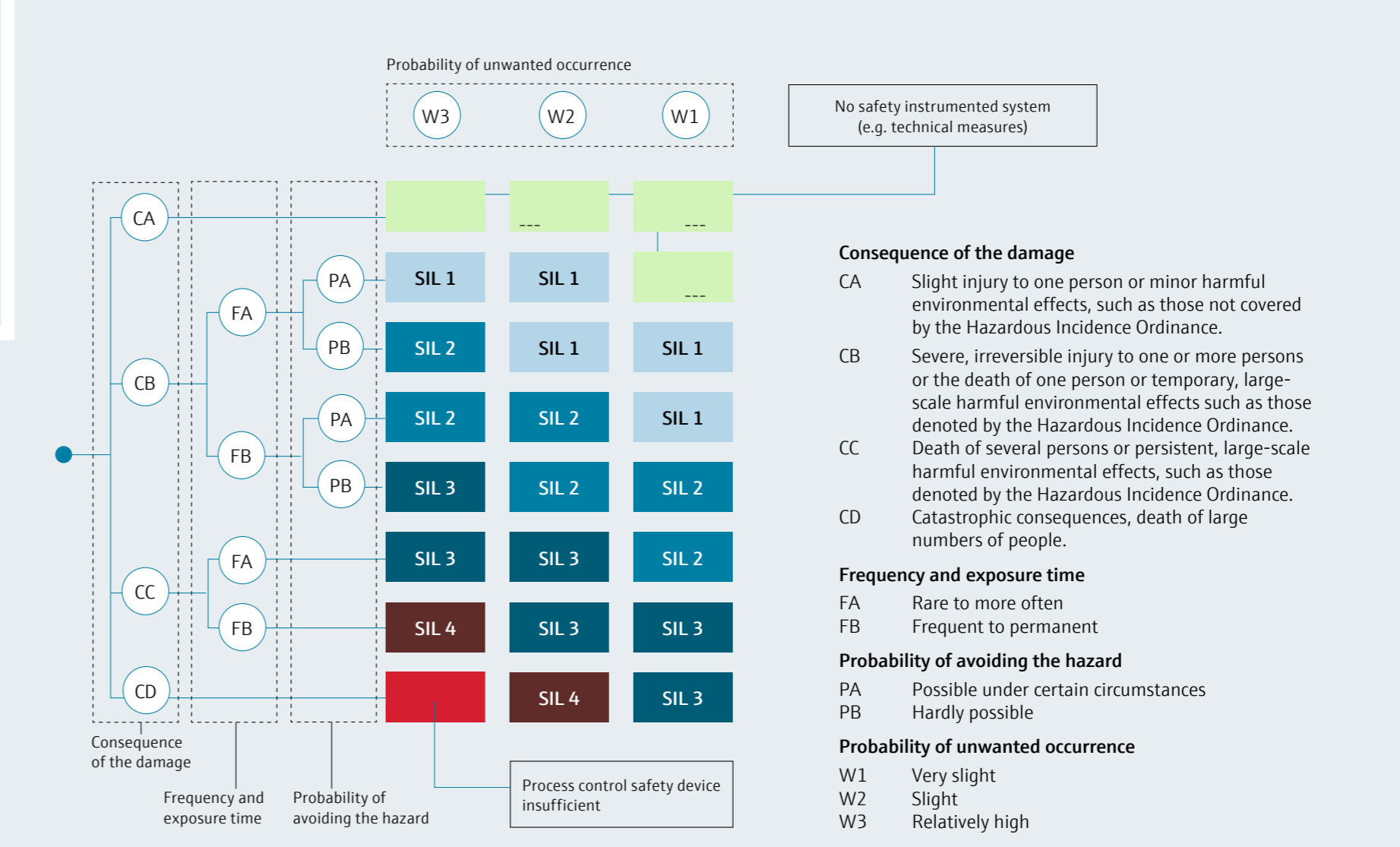
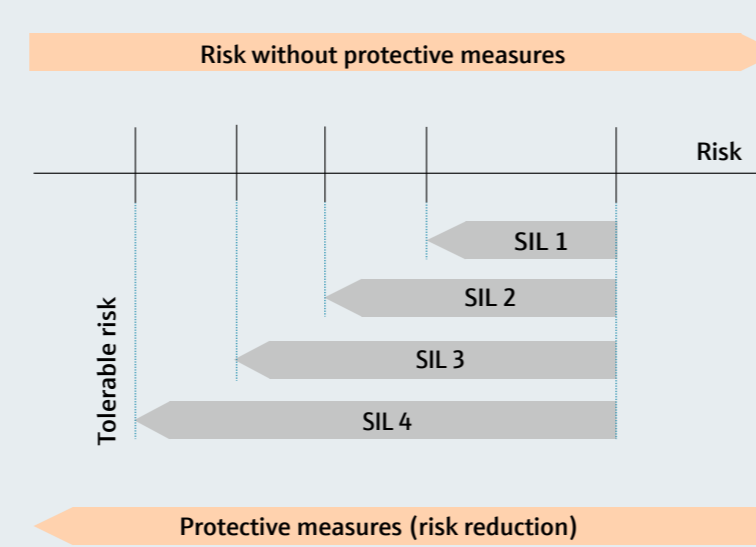
SIL (Safety Integrity Level)



Process risk



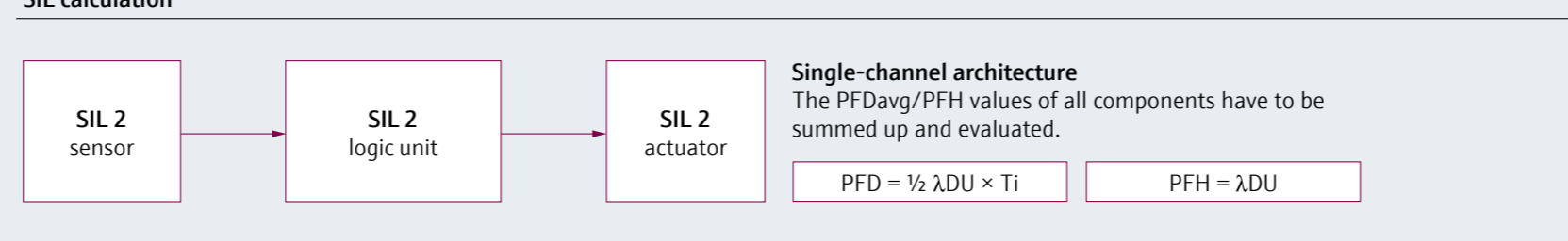
Risk reduction by implementation of SIL



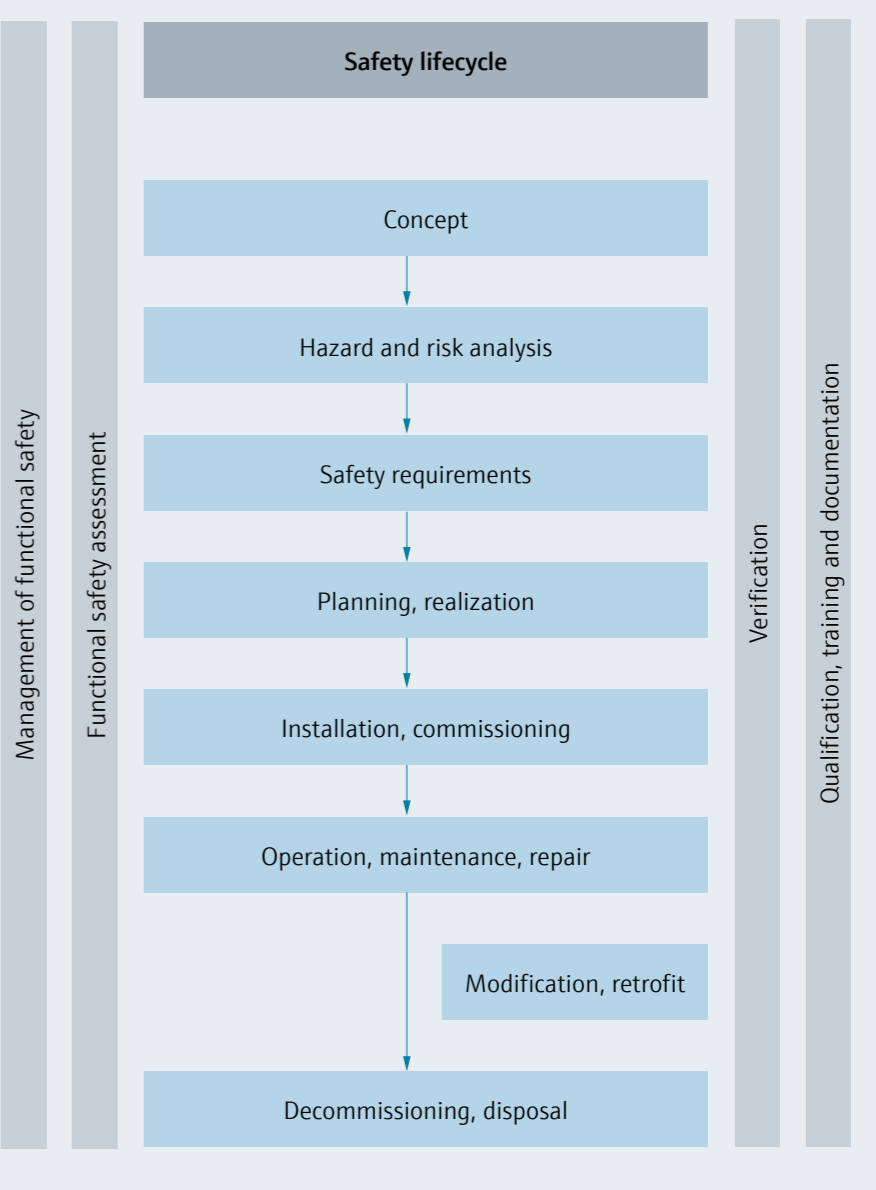
Technical requirements

Determination of safety parameters		SFF – HFT – SIL – type A, type B						
FMEDA		Safe failure fraction (SFF)			Hardware fault tolerance (Type A – simple equipment)		Hardware fault tolerance (Type B – complex equipment)	
Technical requirements		<60%	0	1	2	0	1 (0*)	2 (1*)
Failure types of safety functions and subsystems		SIL 1	SIL 2	SIL 3	Not permitted	SIL 1	SIL 2	SIL 3
Safe	Safe detected λSD	60% to <90%	SIL 2	SIL 3	SIL 4	SIL 1	SIL 2	SIL 3
Dangerous	Dangerous detected λDD	90% to <99%	SIL 3	SIL 4	SIL 4	SIL 2	SIL 3	SIL 4
	Dangerous undetected λDU	≥99%	SIL 3	SIL 4	SIL 4	SIL 3	SIL 4	SIL 4

* With proven-in-use demonstration acc. to IEC 61511 (for SIL <3 only)



Organizational requirements



Terminology

- Functional safety:** Part of the overall safety which depends on the correct functioning of safety-related systems for risk reduction. Functional safety is achieved when every safety function is performed as specified.
- Safety-related system:** System that implements the safety functions required to achieve or maintain a safe state for equipment under control (EUC).
- Safety function:** Function which is intended to achieve or maintain a safe state for equipment under control (EUC), in respect of a specific hazardous event.
- Safety lifecycle:** Describes all necessary activities involved in the implementation of safety-related systems, starting at the concept phase and ending at the decommissioning.
- Management of functional safety:** Necessary management and technical activities and responsibilities during the safety lifecycle for achievement of functional safety.
- Functional safety assessment:** Investigation, if functional safety was achieved by the safety-related systems.
- Safety Integrity Level (SIL):** Four discrete levels (SIL 1 to SIL 4). The higher the SIL of a safety-related system, the lower the probability that it will not perform the required safety functions.
- Average Probability of Failure on Demand (PFDavg):** Average probability of failure of a safety function working in low demand mode of operation.
- Probability of Failure per Hour (PFH):** For high or continuous demand, the numerical measure of PFH is used, which specifies the probability of a failure of the safety function per hour (dangerous failure rate).
- Safe Failure Fraction (SFF):** Percentage part of safe failures and dangerous detected failures of a safety function or a subsystem related to all failures.
- Hardware Fault Tolerance (HFT):** HFT = n means, that n+1 faults could cause a loss of the safety function.
- Low demand mode of operation:** Frequency of demands on a safety-related system no greater than one per year and no greater than twice the proof-test frequency.
- High demand or continuous mode of operation:** Frequency of demands on a safety-related system greater than one per year or greater than twice the proof-test frequency.
- Device type A (simple subsystem):** The failure modes of all constituent components are well defined and the behaviour under fault conditions can be completely determined.
- Device type B (complex subsystem):** The failure mode of at least one constituent component is not well defined (e.g. µC, ASIC) and the behaviour under fault conditions cannot be completely determined.

Standards

- Basic standard:** IEC 61508
- Application sector standards:** IEC 61511 (process industry), IEC 61513 (nuclear power plants), IEC 62061 (machinery), IEC 61800-5-2 (power drive systems)
- Failure rates:** ASD: Total failure rate for safe detected failures, ASU: Total failure rate for safe undetected failures, ADD: Total failure rate for dangerous detected failures, ADU: Total failure rate for dangerous undetected failures
- Mean Time Between Failures (MTBF):** Statistical measure of failure rates to determine how reliable a component is.
- Proof-test interval (T1):** Interval between periodic tests performed to detect failures in a safety-related system.

