



SICK
Sensor Intelligence.

AUTONOMOUS MOBILE ROBOTS

ENSURING THE SAFE DETECTION OF PERSONS W/ 2D LIDAR

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■ Agenda

▶ Introduction - Approach to Mobile Robotics

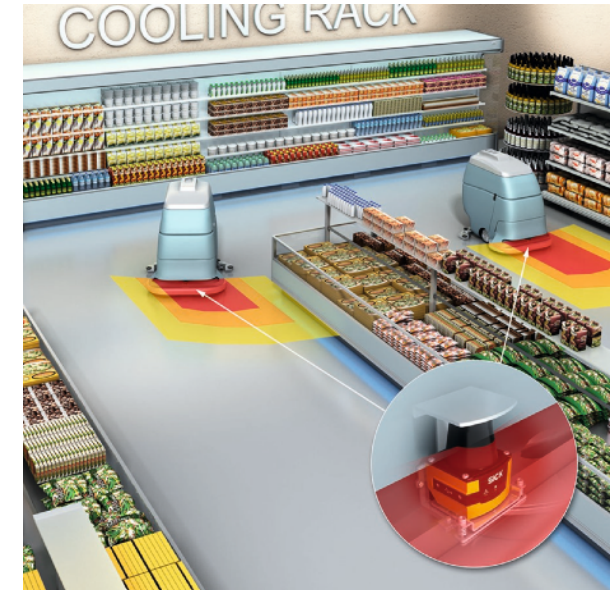
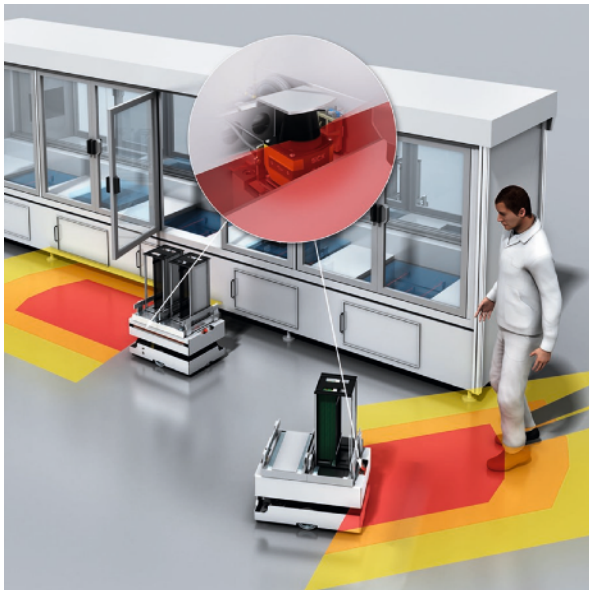
- Ensuring the Safe Detection of Persons

▶ New Sensors

- IEC 62998 (Safety Related Sensors)

▶ Safety Lidar

- IEC 61496-3



■ **Safety**

- ▶ Using products or systems for risk reduction by technical and organizational measures to achieve freedom from intolerable risk. Supporting services can additionally cover the machine/equipment design measures.
- ▶ **Protection of persons**
 - ▶ monitoring of persons or technical objects to achieve freedom from intolerable risk for persons
- ▶ **Protection of environment**
 - ▶ pollution monitoring or process parameter monitoring to achieve freedom from intolerable risk for the environmental.
- ▶ **Protection of objects**
 - ▶ monitoring of technical objects (e.g. defined targets) to achieve freedom from intolerable risk for technical objects (e.g. anti-collision).

■ Safety Components Bottom Up

- ▶ integrated into Machine

- ▶ Easy / Modular

- Application
- Performance
- certified



- ▶ Safety reserve

- ▶ Standards show design and application in a limited but adaptable way

- ▶ Availability of certified components

■ Safety System Top Down

- ▶ separated to component functions
- ▶ then integrated into appropriate Solution

- ▶ Scalable / Application Specific

- function oriented
- Varying sensors
- Adaptable for country or specific customer

- ▶ Appropriate Safety



- ▶ Use variety of safe and non-safe components

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■ Safety Components - Bottom Up

- ▶ The functional safety standard IEC 61496 contains the **design and performance requirements** for Electro-Sensitive Protective Equipment (ESPE) for the detection of people.
- ▶ It gives clear, but limited, guidelines for a variety of subjects including typical conditions representing indoor use in an industrial environment and the design, functional requirements and test to determine the ESPE's "Type" (2, 3 or 4).
- ▶ Safety Function - Safe Drive (STO) w/ Certified Devices
 - $PL \geq d$ CAT 3



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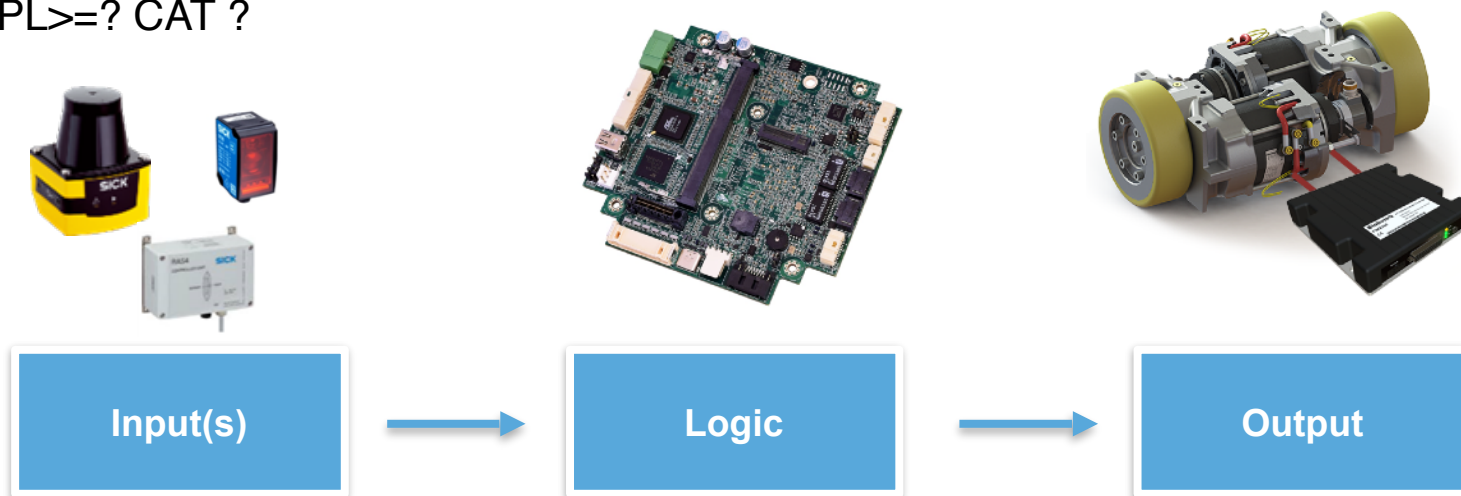
■ **Safety System - Top Down**

- ▶ Safety System Standards using “**safety related sensors**” as part of the control system the **design and performance requirements**

- IEC 62061
- ISO 13849
- IEC 61508
- **IEC 62998**

- ▶ Safety Function - Safe Drive System

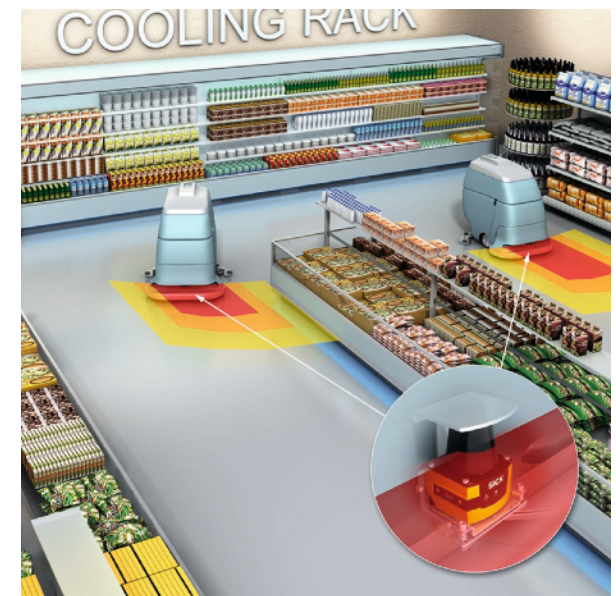
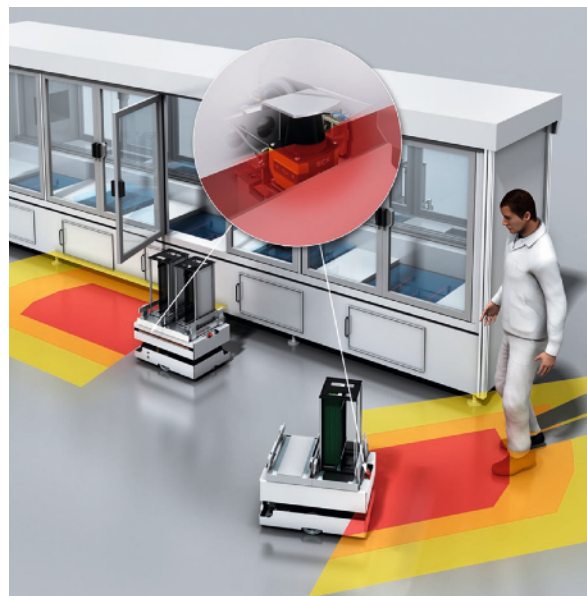
- $PL \geq ?$ CAT ?



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■ New Sensors

- ▶ IEC TS 62998-1
 - Safety Related Sensors - **SRS** & Safety related Sensor System - **SRSS**
- ▶ Content
- ▶ Implications



ENSURING THE SAFE DETECTION OF PERSONS W/ 2D LIDAR

■ **New Sensors**

▶ IEC TS 62998-1

- Safety Related Sensors - **SRS** & Safety related Sensor System - **SRSS**

▶ **1 Scope**

- This International Standard gives requirements for the development and integration of **safety related sensors and sensor systems** used for protection of persons with special attention to **systematics**.
- This generic standard only applies if:
 - protection of persons is to be performed by using sensors, and
 - standards for functional safety of electrical control systems address sensor(s) as subsystem or subsystem element, and
 - product specific sensor standards (e.g. IEC 61496 , IEC 60947-5-2) do not contain all necessary provisions, or product specific sensor standards are not developed.
- The approach of examination of systematic capabilities by using different safety related sensor standards has to be done in accordance to Annex A.

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■ **New Sensors**

▶ IEC TS 62998-1

- Safety Related Sensors - **SRS** & Safety related Sensor System - **SRSS**

▶ **3 Terms and definitions**

- 3.15 Definitions related to fusion

3.15.1 - alignment

- processing of SRS measurements to achieve a common time base and a common spatial reference

3.15.2 - diversity

- different means of performing a required function Note to entry: Diversity may be achieved by different physical methods or different design approaches. [SOURCE: IEC 61508-4:2010, 3.3.7]

3.15.3 - fusion

- the act or process of combining or associating data or information regarding one or more entities considered in an explicit or implicit knowledge framework to improve one's capability (or provide a new capability) for detection, identification, or characterization of that entity

3.15.4 – redundancy

- provision of more than one means for performing a function

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■ **New Sensors**

▶ IEC TS 62998-1

- Safety Related Sensors - **SRS** & Safety related Sensor System - **SRSS**

▶ **3 Terms and definitions**— **3.26 - Safety Related Sensor (SRS)**

- one or more sensing units combined to perform the safety related function
 - Note 1 to entry : An SRS can be regarded as a subsystem in a SRECS or as a subsystem element in an SRECS if the SRS is used as part of an SRSS.
 - Note 2 to entry: A sensing unit might contain one or more sensing elements.

— **3.27 - Safety Related Sensor System (SRSS)**

- combination of two or more safety related sensors performing the safety related function

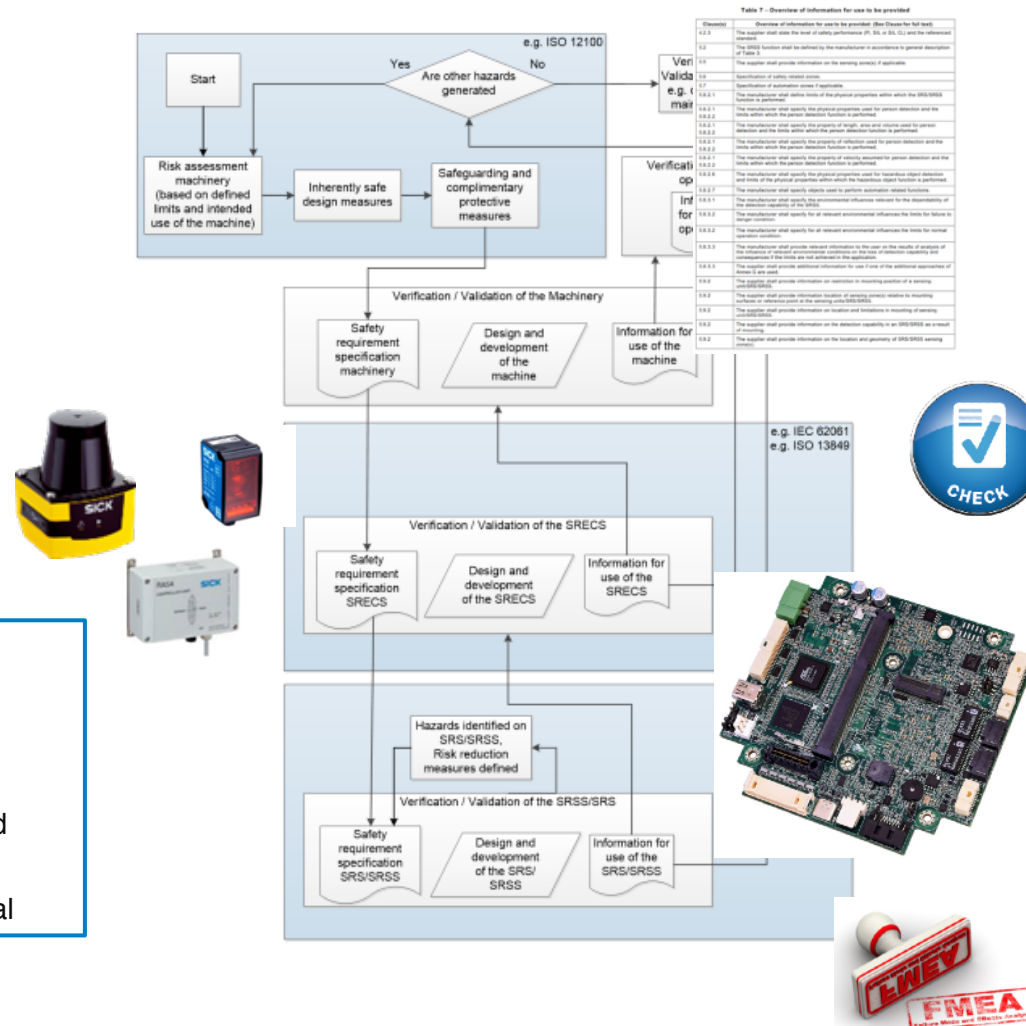
- Application & lifecycle oriented process in IEC TS 62998-1

1st – Perform a risk assessment for the application

2nd - Define Safety Requirements in specification of sensors used as part of control system

3rd – Design SRS

- Systematics of Sensor
- Detection capability
- safety and automation related sensor function
- achieved under environmental



8th - measures during maintenance

7th - provide information for use of sensor (system)

6th - validation of systematics

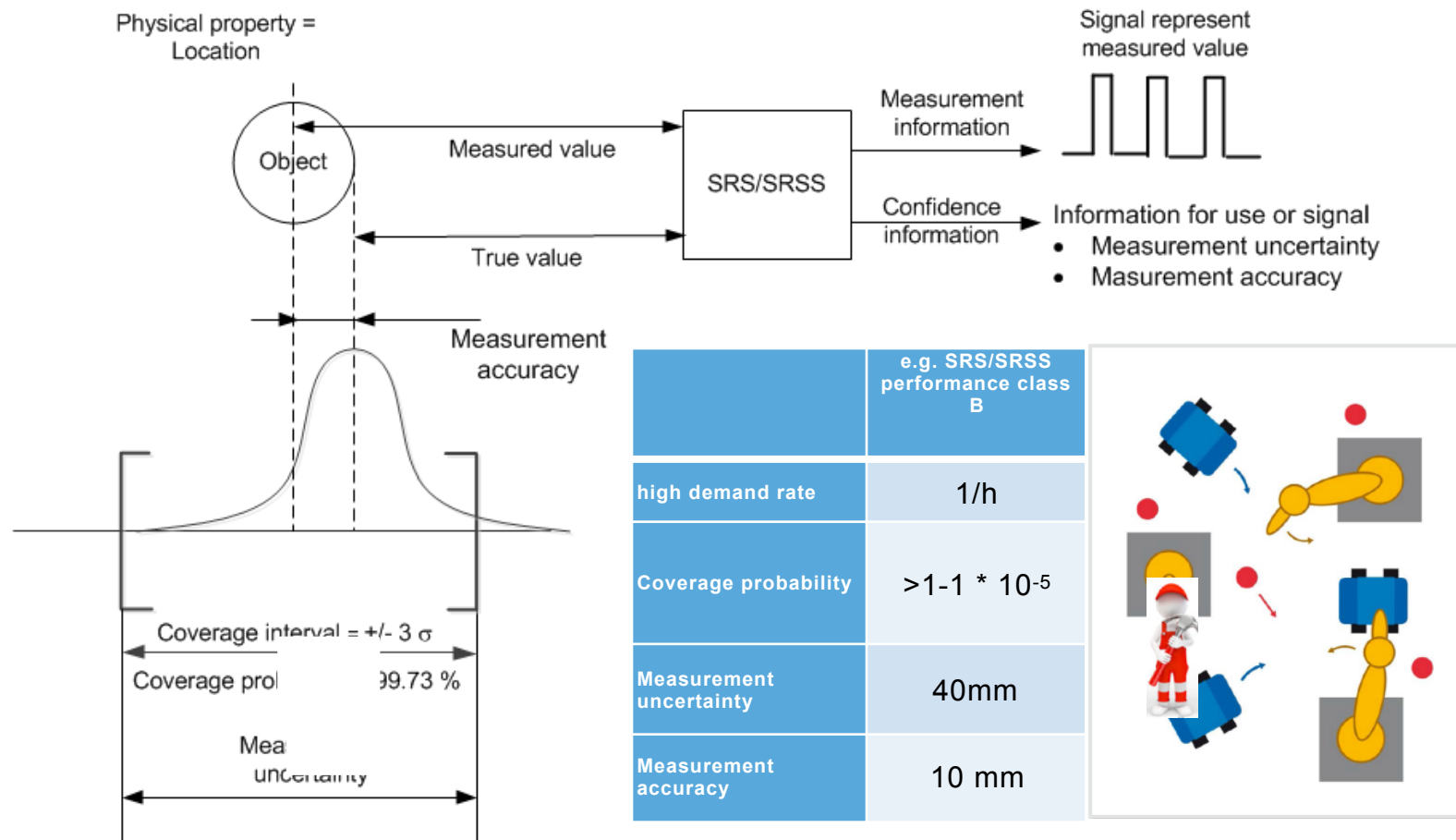
5th – further integration

4th - do verification of systematics

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■ Design SRS

- ▶ Appropriate confident measurement values (e.g. used for location) enable separation monitoring in human machine interaction and much more....



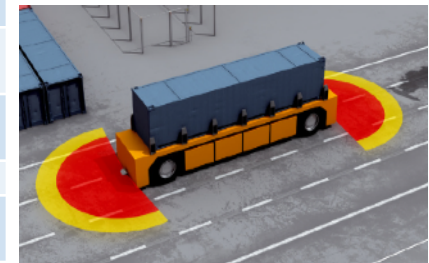
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■ Design SRS

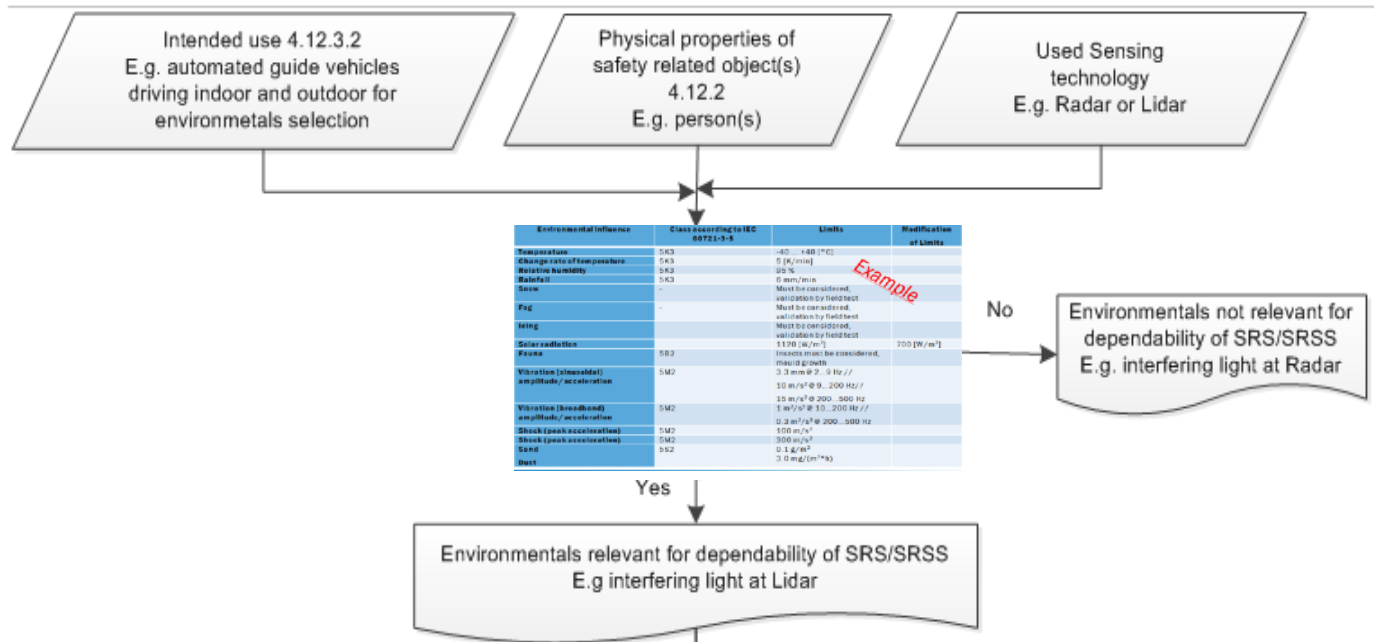
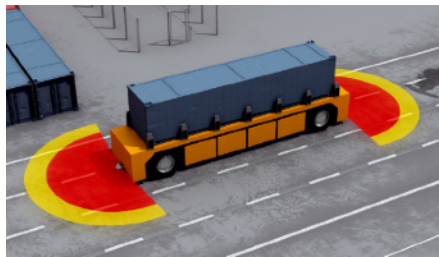
- ▶ The SRS/SRSS manufacturer or integrator of a SRSS shall:
 - ▶ specify environmental influences relevant for no failure to danger and normal operation
 - ▶ analyze and/or test to prove safety related functions under these limits

| Environmental influence | Class according to IEC 60721-3-5 | Limits | Modification of Limits |
|---|----------------------------------|--|-------------------------|
| Temperature | 5K3 | -40 ... +40 [°C] | |
| Change rate of temperature | 5K3 | 5 [K/min] | |
| Relative humidity | 5K3 | 95 % | |
| Rainfall | 5K3 | 6 mm/min | |
| Snow | - | Must be considered, validation by field test | |
| Fog | - | Must be considered, validation by field test | |
| Icing | - | Must be considered, validation by field test | |
| Solar radiation | | 1120 [W/m ²] | 700 [W/m ²] |
| Fauna | 5B2 | Insects must be considered, mould growth | |
| Vibration (sinusoidal) amplitude/acceleration | 5M2 | 3.3 mm @ 2...9 Hz // 10 m/s ² @ 9...200 Hz// 15 m/s ² @ 200...500 Hz | |
| Vibration (broadband) amplitude/acceleration | 5M2 | 1 m ² /s ³ @ 10...200 Hz // 0.3 m ² /s ³ @ 200...500 Hz | |
| Shock (peak acceleration) | 5M2 | 100 m/s ² | |
| Shock (peak acceleration) | 5M2 | 300 m/s ² | |
| Sand | 5S2 | 0.1 g/m ³ | |
| Dust | | 3.0 mg/(m ² *h) | |

Example



ENSURING THE SAFE DETECTION OF PERSONS W/ 2D LIDAR



- Verify of the Systematics by analysis (incl. simulation) and/or test for:
 - No failure to danger in general, or
 - fulfillment of required limit values for loss of detection at defined demand rate, or...

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■ **Provide information for use of sensor (system)**

- ▶ PL and/or SILcl and /or SIL shall be stated on the label and within Information for use
- ▶ SRS/SRSS performance class shall not be stated on the label

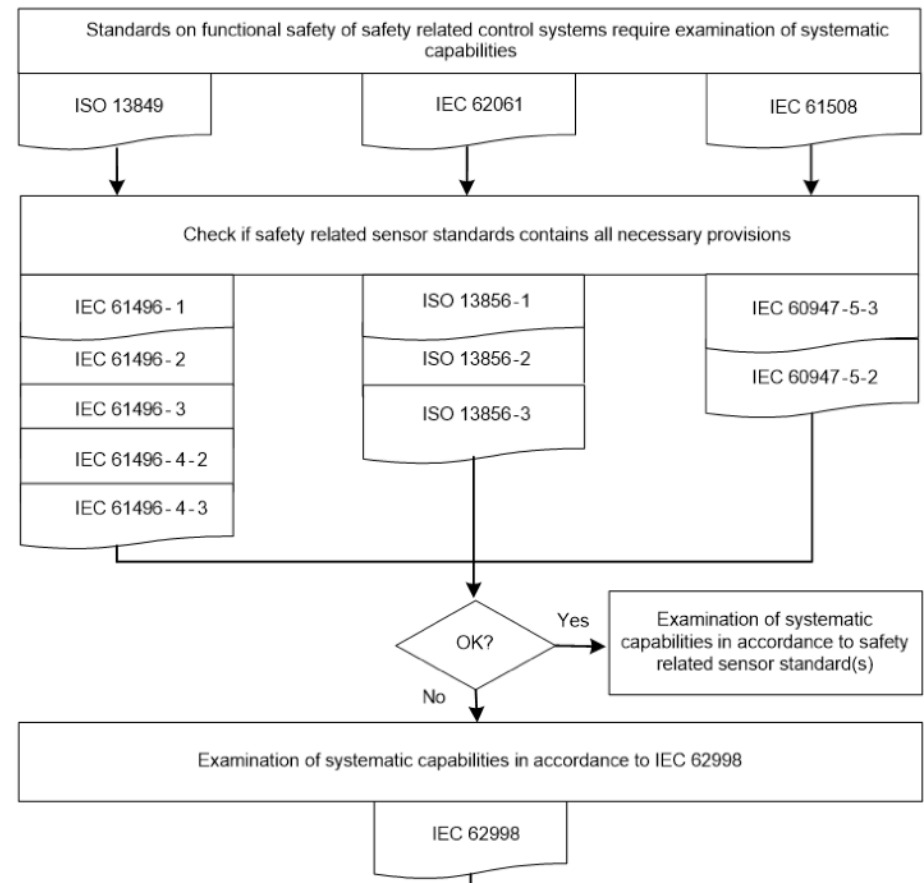
| | *SRS/SRSS performanc e class A | SRS/SRSS performanc e class B | SRS/SRSS performanc e class C | SRS/SRSS performanc e class D | SRS/SRSS performanc e class E | SRS/SRSS performanc e class F |
|------------|--------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| ISO 13849 | PL a | PL b | PL c | PL d | PL e | |
| IEC 62061 | | | SILcl 1 | SILcl 2 | SILcl 3 | |
| IEC 61508 | | | SIL 1 | SIL 2 | SIL 3 | SIL 4 |
| see NOTE 3 | | | | | | |

NOTE 3 Table 1 establishes a correspondence between the performance class of this standard and the level of safety performance of ISO 13849, IEC 62061 and IEC 61508. Nevertheless additional links can be established in future to other level of safety performance schemes as for example the Agriculture PL of ISO 25119 and the ASIL of ISO 26262.

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■ Examination of systematic capabilities

- ▶ The examination of systematic capabilities is required by functional safety standards for safety related control systems used for the protection of persons.
- ▶ It should be done in accordance to standards for functional safety.
- ▶ Different approaches by using safety related sensor standards are possible, see Fig. A 1 as example.
- ▶ The list of used standards should be stated and included in the instruction manual of a SRS/SRSS.



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■ Connect to more Sectors

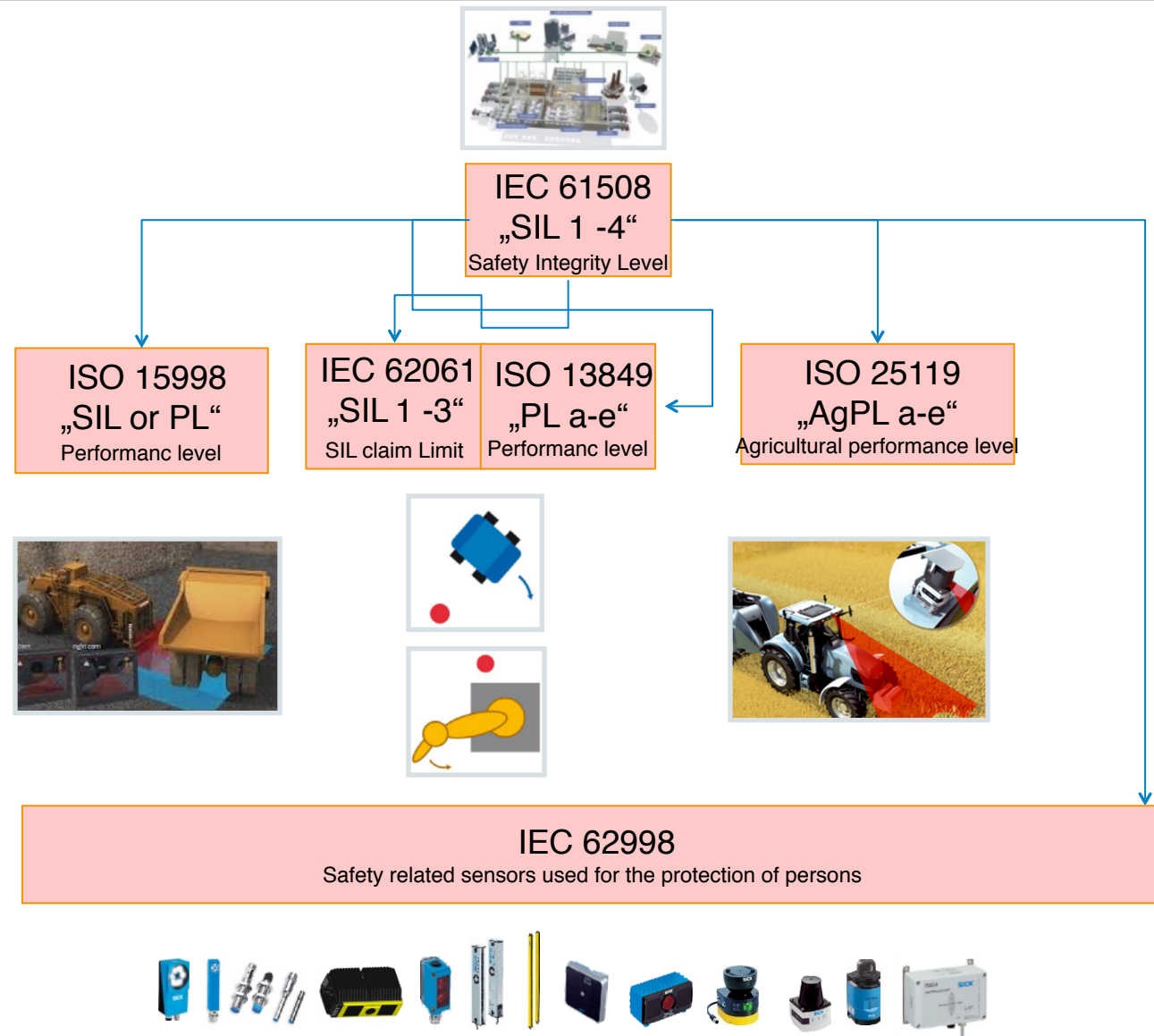
- ▶ Control system
- ▶ Hardware electronic design
- ▶ Software design
- ▶ Management of functional safety
- ▶ Assessment of functional safety

■ Address more Applications

- ▶ Intended use given by application
- ▶ Systematic capability for safety related object detection
- ▶ Persons to be detected and objects resulting in hazard for persons

■ Apply more Sensors

- ▶ Wide range of sensors will get into Safety related use





THANK YOU FOR YOUR ATTENTION

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