

# **Team Aware – Perception System using Stereo Vision and Radar**

**Standards and Regulations Presentation**

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# Standards and Regulations

1. ISO 26262 - Road Vehicles - Functional Safety

1. CA Autonomous Vehicle Testing Regulations

# ISO 26262: Road vehicles

- Functional safety

# ISO 26262 Introduction

- **ISO 26262** is an international standard for functional safety of electrical and/or electronic systems in production automobiles
- The objective of **functional safety** is freedom from unacceptable risk of physical injury or of damage to the health of people either directly or indirectly (through damage to property or to the environment).
- **ISO 26262** defines functional safety for automotive equipment applicable throughout the lifecycle of all automotive electronic and electrical safety-related systems

# ISO 26262 Introduction

- Published on November 2011
- Adaptation of the IEC 61508 for Automotive Electric/Electronic Systems
- Risk-based safety standard
- Aims to address possible hazards caused by the malfunctioning behavior of electronic and electrical systems.

# Goals

- Provides an automotive safety lifecycle and supports tailoring the necessary activities during the lifecycle;
- Provides an automotive specific risk-based approach to determine Automotive Safety Integrity Levels (ASILs);
- Uses ASILs for specifying the requirements for achieving an acceptable risk;
- Provides requirements for validation and confirmation measures to ensure a sufficient and acceptable level of safety.

10 Parts

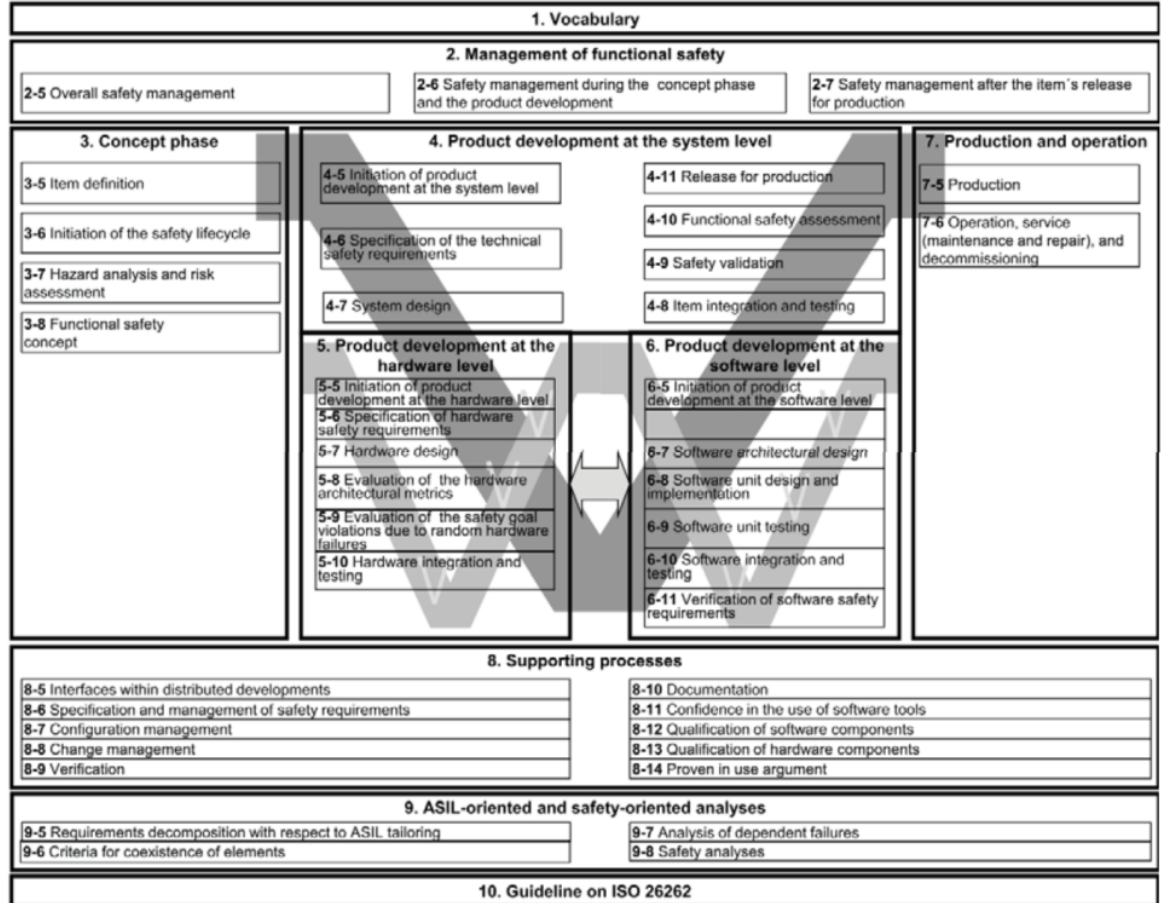
43 Chapters

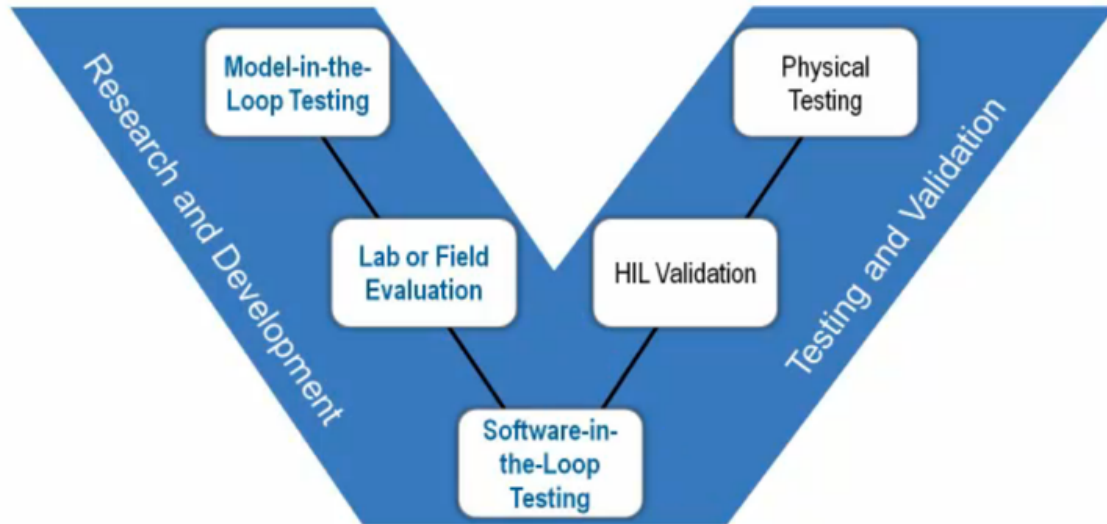
100 work products

180 engineering methods

500 pages

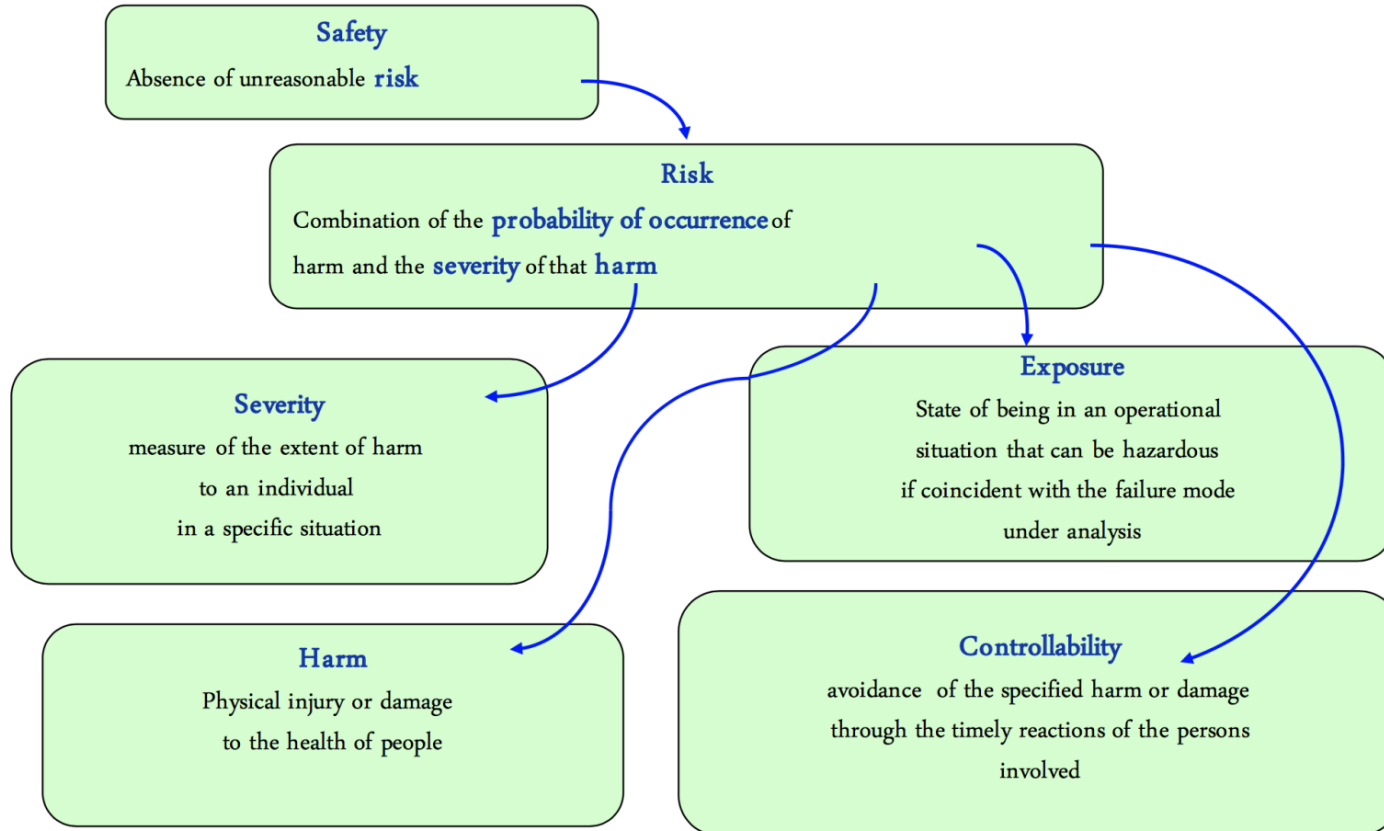
600 requirements





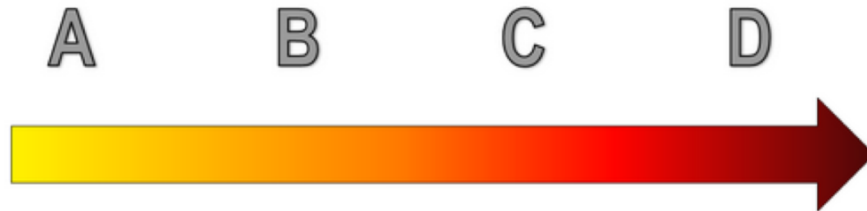


# Important definitions

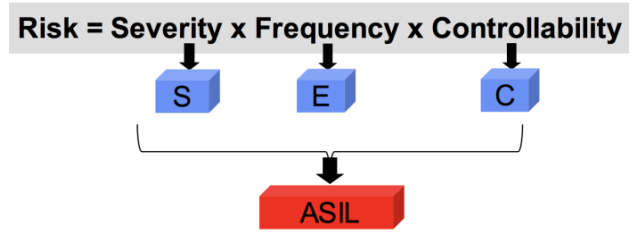


# ASIL

- The ASIL is a crucial component of ISO 26262. The ASIL should be determined at the beginning of the development process. To estimate a risk, a combination of the probability of exposure, the possible controllability, and the possible severity is used.
- ASIL D is defined as a combination of the highest probability of exposure (E4), the highest possible controllability (C3), and the highest severity (S3). Each single reduction in any one classification leads to a single level reduction in ASILs.



# ASIL



| S0          | S1                          | S2   | S3   |
|-------------|-----------------------------|--|--|
| No injuries | Light and moderate injuries | Severe and life-threatening injuries (survival probable) | Life-threatening injuries (survival uncertain), fatal injuries |

| E0         | E1                   | E2              | E3                 | E4               |
|------------|----------------------|-----------------|--------------------|------------------|
| Incredible | Very low probability | Low probability | Medium probability | High probability |

| C0                      | C1                  | C2                    | C3                                     |
|-------------------------|---------------------|-----------------------|--|
| Controllable in general | Simply controllable | Normally controllable | Difficult to control or uncontrollable |

# Calculating ASIL

|    |    | C1     | C2     | C3     |
|----|----|--------|--------|--------|
| S1 | E1 | QM     | QM     | QM     |
|    | E2 | QM     | QM     | QM     |
|    | E3 | QM     | QM     | ASIL A |
|    | E4 | QM     | ASIL A | ASIL B |
| S2 | E1 | QM     | QM     | QM     |
|    | E2 | QM     | QM     | ASIL A |
|    | E3 | QM     | ASIL A | ASIL B |
|    | E4 | ASIL A | ASIL B | ASIL C |
| S3 | E1 | QM     | QM     | ASIL A |
|    | E2 | QM     | ASIL A | ASIL B |
|    | E3 | ASIL A | ASIL B | ASIL C |
|    | E4 | ASIL B | ASIL C | ASIL D |

# Certifying Components

- Hardware
  - Simple parts standard qualification
  - Complex parts ASIL decomposition and testing
  - Test part in variety of environmental and operational conditions
- Software
  - Defining functional requirements
  - Resource usage
  - Predicting software behavior in failure and overload situations
  - Test under normal operating conditions and insert faults

# “Proven in-use”

- Safety has been proven
- Same release/version as tested
- Similar application

# Testing Tool Confidence

- Tools can affect the reliability of measurement
- Impacts verification and validation confidence
- Depends on what to measure
- Depends on circumstances

# Tool Confidence Level (TCL)

|     | Tool Impact |     |
|-----|-------------|-----|
|     | TI0         | TI1 |
| TD1 | 1           | 1   |
| TD2 | 1           | 2   |
| TD3 | 1           | 3   |
| TD4 | 1           | 4   |

- Tool Impact
  - TI 0 - Malfunction cannot violate safety requirements
  - TI 1 - Malfunction may lead to requirement violation
- Tool Error Detection
  - TD 1 - Error will be detected (High confidence)
  - TD 2 - Error should be detected (Medium confidence)
  - TD 3 - Error may/may not be detected (Low confidence)
  - TD 4 - Error is high to the point of randomization (Zero confidence)



# Application to our project

- *Requirements-based test*

- *Assertion*

- *Perception system work in real time (delay less than 100ms)*

- *User-defined targets*

- *Object detection accuracy > 60%*
    - *Stereo vision depth accuracy >80%*

- *Interface test*

- *Fault injection test*

- *Object tracking boxes' positions beyond the image*

# Application to our project

- *Failure detection test*
  - *As soon as hardware failure is detected, a safety method to minimize its impact should be initiated*
  - *Software should be able to address hardware failure*

# CA - Testing of Autonomous Vehicle

# The California Autonomous Vehicle Testing Regulations

- The regulations “**implement, interpret, and make specific**” Division 16.6 (commencing with section 38750) of the Vehicle Code.



A rulebook containing all traffic **laws**.

*The California Vehicle Code covers everything to do with the rules of the roads and driving, including:*

- **Registration and titling of vehicles.**
- Anti-theft laws.
- Driver's license procedures and processes.
- **Financial responsibility and car insurance.**
- Rules of the road.
- Towing and loading rules and regulations.
- Transporting hazardous materials.
- Off-highway/off-road vehicles.
- Bicycle laws and rules.
- **Safety regulations.**

# The California Autonomous Vehicle Testing Regulations

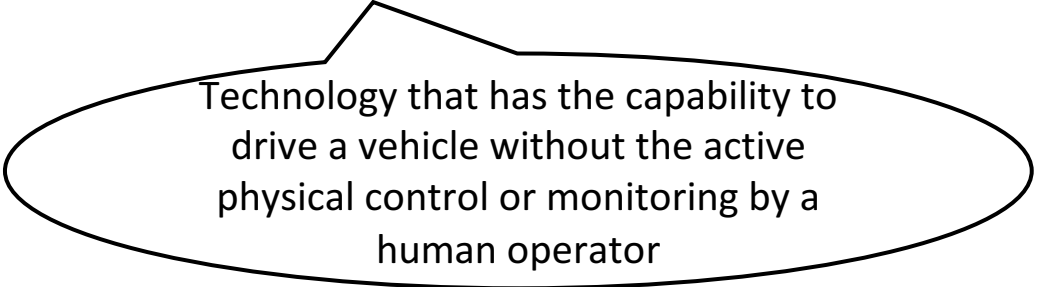
- Purpose:

To provide the regulation of **autonomous vehicles** operated on **public roads** in **California**.

# Definitions

- **Autonomous Vehicle:**

Any vehicle equipped with ***autonomous technology*** that has been integrated into that vehicle.



Technology that has the capability to drive a vehicle without the active physical control or monitoring by a human operator

- **Public Road:**

“**Highway**” as defined in Vehicle Code section 360

“**Offstreet public parking facility**” as defined in Vehicle Code section 4000

“**Street**” as defined in Vehicle Code section 590

# The Building Blocks of Autonomy

Prepared by  VISION SYSTEMS INTELLIGENCE

## AUTONOMOUS SOLUTIONS



Level of Integration

### PROCESSING



### SENSORS



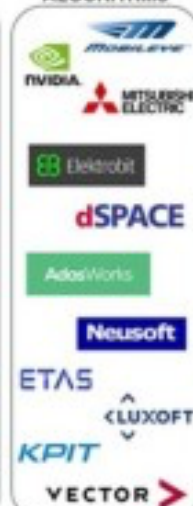
### CONNECTIVITY



### MAPPING



### ALGORITHMS



### SECURITY/SAFETY



### DEVELOPMENT TOOLS





# Applicable products / markets

- Autonomous Driving Industry in California
- Products by manufacturers:

1. Who **originally** manufactures a vehicle (from raw materials or new basic components) and **equips autonomous technology** on the originally completed vehicle



2. Who **modifies** any vehicle by installing autonomous technology

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## Before Receipt

## Upon Receipt

### Financial Responsibility

- Instrument of Insurance
- Surety Bond
- Self-insurance

### Drivers

- Qualifications
- Training Program

### Application

- Terms and procedures
- Employer Pull Notice (EPN)

Manufacturer's  
Testing Permit

### Reporting to DMV

- Accidents
- Disengagement of Auto mode

### Prohibitions

- Operations
- Vehicles

### Title / registration

### Refusal, Suspension, Revocation

# Relevant prescriptions:

- 1. Testing permit application**
- 2. Vehicle registration**
- 3. Self-driving performance review**
- 4. Financial responsibility**
- 5. Test-driver registration**



# Relevant prescriptions:

## 1. Test permit application:

- Fee of \$150
- Valid for one year
- Covers up to 10 vehicles and 20 test drivers
- Extra \$50 for each additional set of vehicles and drivers
- Takes 10 days processing time



# Relevant prescriptions:

## 2. Vehicle registration:



- Qualitative and quantitative description of vehicle autonomous capabilities
- Brake Light Adjustment Certificate
- Health & Safety Emissions Certificate
- Some vehicles not permitted for testing:
  - Motorcycles
  - Vehicles weighing over 10,000 lbs
  - Trailers and campers

# Relevant prescriptions:

## 3. Self-driving performance review:



- Must record and track every instance when the autonomous driving mode failed and a human driver had to take over
- Must submit annual report

# Relevant prescriptions:

## 4. Financial responsibility



- Submit proof of insurance of at least \$5,000,000 in the form of a surety bond, self-insurance, or another instrument of insurance
- Provide self-insurance and vehicle insurance (if applicable)
- Report accidents within 10 days of occurrence

# Relevant prescriptions:

## 5. Test-driver registration



- Driver must be in driver's seat actively monitoring vehicle
- Driver must be an employee/contractor/designee of the manufacturer
- Driver must have a standard license for at least 3 years and a clean driving record
- Driver must have completed manufacturer's training
- Driver must register with the Employee Pull Notice Program.



# Summary

- Manufacturer's Testing Permit:
  - Application/ Renewal Fee: **\$ 150**
  - Valid for one year
  - One permit for up to **10** vehicles and **20** test drivers (cost extra to add more)
- Evidence of Financial Responsibility  
(**\$ 5,000,000** in form of instrument of insurance/ surety bond/ self-insurance)
- Test driver training program required by Manufacturer
- Brake and Light Adjustment Certificate Required
- Annual testing report/ Accident report within 10 days to DMV



# Application to our project

- Delphi is licensed in CA
- Delphi already conducts testing in CA
- Project can be incorporated into future vehicle
- All relevant prescriptions will apply in future on-road testing



Questions?