INTERNATIONAL STANDARD

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Road vehicles — Functional safety —

Part 6: **Product development at the software level**

Véhicules routiers — Sécurité fonctionnelle —

Partie 6: Développement du produit au niveau du logiciel

Reference number
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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 26262-6 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 3, *Electrical and electronic equipment*.

ISO 26262 consists of the following parts, under the general title *Road vehicles — Functional safety*:

- *Part 1: Vocabulary*
- *Part 2: Management of functional safety*
- *Part 3: Concept phase*
- *Part 4: Product development at the system level*
- *Part 5: Product development at the hardware level*
- *Part 6: Product development at the software level*
- *Part 7: Production and operation*
- *Part 8: Supporting processes*
- *Part 9: Automotive Safety Integrity Level (ASIL)-oriented and safety-oriented analyses*
- *Part 10: Guideline on ISO 26262*

Introduction

ISO 26262 is the adaptation of IEC 61508 to comply with needs specific to the application sector of electrical and/or electronic (E/E) systems within road vehicles.

This adaptation applies to all activities during the safety lifecycle of safety-related systems comprised of electrical, electronic and software components.

Safety is one of the key issues of future automobile development. New functionalities not only in areas such as driver assistance, propulsion, in vehicle dynamics control and active and passive safety systems increasingly touch the domain of system safety engineering. Development and integration of these functionalities will strengthen the need for safe system development processes and the need to provide evidence that all reasonable system safety objectives are satisfied.

With the trend of increasing technological complexity, software content and mechatronic implementation, there are increasing risks from systematic failures and random hardware failures. ISO 26262 includes guidance to avoid these risks by providing appropriate requirements and processes.

System safety is achieved through a number of safety measures, which are implemented in a variety of technologies (e.g. mechanical, hydraulic, pneumatic, electrical, electronic, programmable electronic) and applied at the various levels of the development process. Although ISO 26262 is concerned with functional safety of E/E systems, it provides a framework within which safety-related systems based on other technologies can be considered. ISO 26262:

a) provides an automotive safety lifecycle (management, development, production, operation, service, decommissioning) and supports tailoring the necessary activities during these lifecycle phases;

b) provides an automotive-specific risk-based approach to determine integrity levels [Automotive Safety Integrity Levels (ASIL)];

c) uses ASILs to specify applicable requirements of ISO 26262 so as to avoid unreasonable residual risk;

d) provides requirements for validation and confirmation measures to ensure a sufficient and acceptable level of safety being achieved;

e) provides requirements for relations with suppliers.

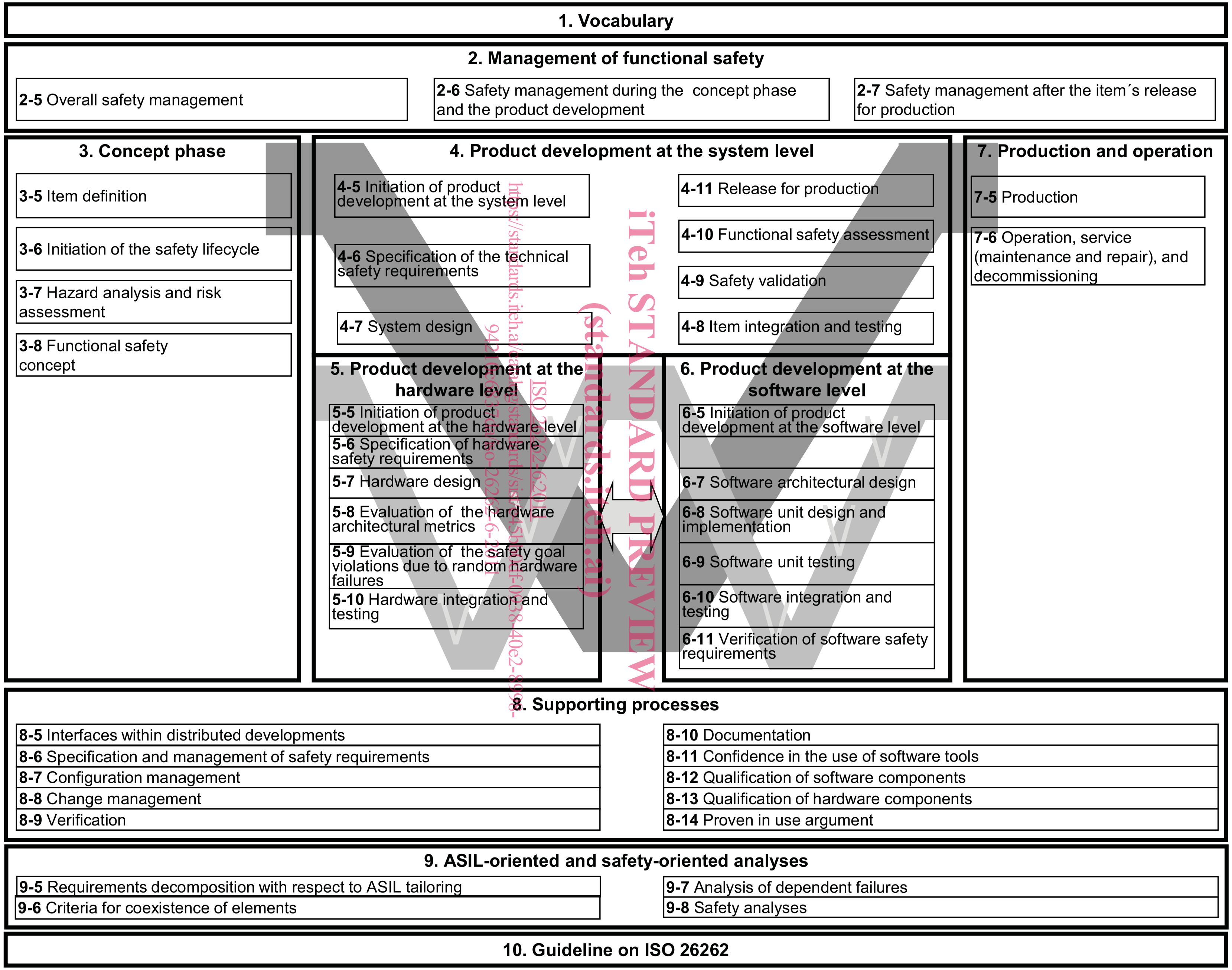
Functional safety is influenced by the development process (including such activities as requirements specification, design, implementation, integration, verification, validation and configuration), the production and service processes and by the management processes.

Safety issues are intertwined with common function-oriented and quality-oriented development activities and work products. ISO 26262 addresses the safety-related aspects of development activities and work products.

Figure 1 shows the overall structure of this edition of ISO 26262. ISO 26262 is based upon a V-model as a reference process model for the different phases of product development. Within the figure:

- the shaded “V”s represent the interconnection between ISO 26262-3, ISO 26262-4, ISO 26262-5, ISO 26262-6 and ISO 26262-7;
- the specific clauses are indicated in the following manner: “m-n”, where “m” represents the number of the particular part and “n” indicates the number of the clause within that part.

EXAMPLE “2-6” represents Clause 6 of ISO 26262-2.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2-6 Safety management during the concept phase and the product development
2-7 Safety management after the item´s release for production
3. Concept phase
3-5 Item definition
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4-9 Safety validation
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5-5 Initiation of product development at the hardware level
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8-6 Specification and management of safety requirements
8-7 Configuration management
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8-9 Verification
8-10 Documentation
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9. ASIL-oriented and safety-oriented analyses
9-5 Requirements decomposition with respect to ASIL tailoring
9-6 Criteria for coexistence of elements
9-7 Analysis of dependent failures
9-8 Safety analyses
10. Guideline on ISO 26262

Figure 1 — Overview of ISO 26262

Road vehicles — Functional safety —

Part 6: Product development at the software level

1 Scope

ISO 26262 is intended to be applied to safety-related systems that include one or more electrical and/or electronic (E/E) systems and that are installed in series production passenger cars with a maximum gross vehicle mass up to 3 500 kg. ISO 26262 does not address unique E/E systems in special purpose vehicles such as vehicles designed for drivers with disabilities.

Systems and their components released for production, or systems and their components already under development prior to the publication date of ISO 26262, are exempted from the scope. For further development or alterations based on systems and their components released for production prior to the publication of ISO 26262, only the modifications will be developed in accordance with ISO 26262.

ISO 26262 addresses possible hazards caused by malfunctioning behaviour of E/E safety-related systems, including interaction of these systems. It does not address hazards related to electric shock, fire, smoke, heat, radiation, toxicity, flammability, reactivity, corrosion, release of energy and similar hazards, unless directly caused by malfunctioning behaviour of E/E safety-related systems.

ISO 26262 does not address the nominal performance of E/E systems, even if dedicated functional performance standards exist for these systems (e.g. active and passive safety systems, brake systems, Adaptive Cruise Control).

This part of ISO 26262 specifies the requirements for product development at the software level for automotive applications, including the following:

- requirements for initiation of product development at the software level,
- specification of the software safety requirements,
- software architectural design,
- software unit design and implementation,
- software unit testing,
- software integration and testing, and
- verification of software safety requirements.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 26262-1:2011, *Road vehicles — Functional safety — Part 1: Vocabulary*

ISO 26262-2:2011, *Road vehicles — Functional safety — Part 2: Management of functional safety*

ISO 26262-4:2011, *Road vehicles — Functional safety — Part 4: Product development at the system level*

ISO 26262-5:2011, *Road vehicles — Functional safety — Part 5: Product development at the hardware level*

ISO 26262-8:2011, *Road vehicles — Functional safety — Part 8: Supporting processes*

ISO 26262-9:2011, *Road vehicles — Functional safety — Part 9: Automotive Safety Integrity Level (ASIL)-oriented and safety-oriented analyses*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms, definitions and abbreviated terms given in ISO 26262-1:2011 apply.

4 Requirements for compliance

4.1 General requirements

When claiming compliance with ISO 26262, each requirement shall be complied with, unless one of the following applies:

a) tailoring of the safety activities in accordance with ISO 26262-2 has been planned and shows that the requirement does not apply, or

b) a rationale is available that the non-compliance is acceptable and the rationale has been assessed in accordance with ISO 26262-2.

Information marked as a “NOTE” or “EXAMPLE” is only for guidance in understanding, or for clarification of the associated requirement, and shall not be interpreted as a requirement itself or as complete or exhaustive.

The results of safety activities are given as work products. “Prerequisites” are information which shall be available as work products of a previous phase. Given that certain requirements of a clause are ASIL-dependent or may be tailored, certain work products may not be needed as prerequisites.

“Further supporting information” is information that can be considered, but which in some cases is not required by ISO 26262 as a work product of a previous phase and which may be made available by external sources that are different from the persons or organizations responsible for the functional safety activities.

4.2 Interpretations of tables

Tables are normative or informative depending on their context. The different methods listed in a table contribute to the level of confidence in achieving compliance with the corresponding requirement. Each method in a table is either

a) a consecutive entry (marked by a sequence number in the leftmost column, e.g. 1, 2, 3), or

b) an alternative entry (marked by a number followed by a letter in the leftmost column, e.g. 2a, 2b, 2c).

For consecutive entries, all methods shall be applied as recommended in accordance with the ASIL. If methods other than those listed are to be applied, a rationale shall be given that these fulfil the corresponding requirement.

For alternative entries, an appropriate combination of methods shall be applied in accordance with the ASIL indicated, independent of whether they are listed in the table or not. If methods are listed with different degrees of recommendation for an ASIL, the methods with the higher recommendation should be preferred. A rationale shall be given that the selected combination of methods complies with the corresponding requirement.

NOTE A rationale based on the methods listed in the table is sufficient. However, this does not imply a bias for or against methods not listed in the table.

For each method, the degree of recommendation to use the corresponding method depends on the ASIL and is categorized as follows:

- "++" indicates that the method is highly recommended for the identified ASIL;
- "+" indicates that the method is recommended for the identified ASIL;
- "o" indicates that the method has no recommendation for or against its usage for the identified ASIL.

4.3 ASIL-dependent requirements and recommendations

The requirements or recommendations of each subclause shall be complied with for ASIL A, B, C and D, if not stated otherwise. These requirements and recommendations refer to the ASIL of the safety goal. If ASIL decomposition has been performed at an earlier stage of development, in accordance with ISO 26262-9:2011, Clause 5, the ASIL resulting from the decomposition shall be complied with.

If an ASIL is given in parentheses in ISO 26262, the corresponding subclause shall be considered as a recommendation rather than a requirement for this ASIL. This has no link with the parenthesis notation related to ASIL decomposition.

5 Initiation of product development at the software level

5.1 Objectives

The objective of this sub-phase is to plan and initiate the functional safety activities for the sub-phases of the software development.

5.2 General

The initiation of the software development is a planning activity, where software development sub-phases and their supporting processes (see ISO 26262-8 and ISO 26262-9) are determined and planned according to the extent and complexity of the item development. The software development sub-phases and supporting processes are initiated by determining the appropriate methods in order to comply with the requirements and their respective ASIL. The methods are supported by guidelines and tools, which are determined and planned for each sub-phase and supporting process.

NOTE Tools used for software development can include tools other than software tools.

EXAMPLE Tools used for testing phases.

The planning of the software development includes the coordination with the product development at the system level (see ISO 26262-4) and the hardware level (see ISO 26262-5).

5.3 Inputs to this clause

5.3.1 Prerequisites

The following information shall be available:

- project plan (refined) in accordance with ISO 26262-4:2011, 5.5.1;
- safety plan (refined) in accordance with ISO 26262-4:2011, 5.5.2;
- technical safety concept in accordance with ISO 26262-4:2011, 7.5.1;
- system design specification in accordance with ISO 26262-4:2011, 7.5.2; and
- item integration and testing plan (refined) in accordance with ISO 26262-4:2011, 8.5.1.

5.3.2 Further supporting information

The following information can be considered:

- qualified software tools available (see ISO 26262-8:2011, Clause 11);
- qualified software components available (see ISO 26262-8:2011, Clause 12);
- design and coding guidelines for modelling and programming languages (from external source);
- guidelines for the application of methods (from external source); and
- guidelines for the application of tools (from external source).

5.4 Requirements and recommendations

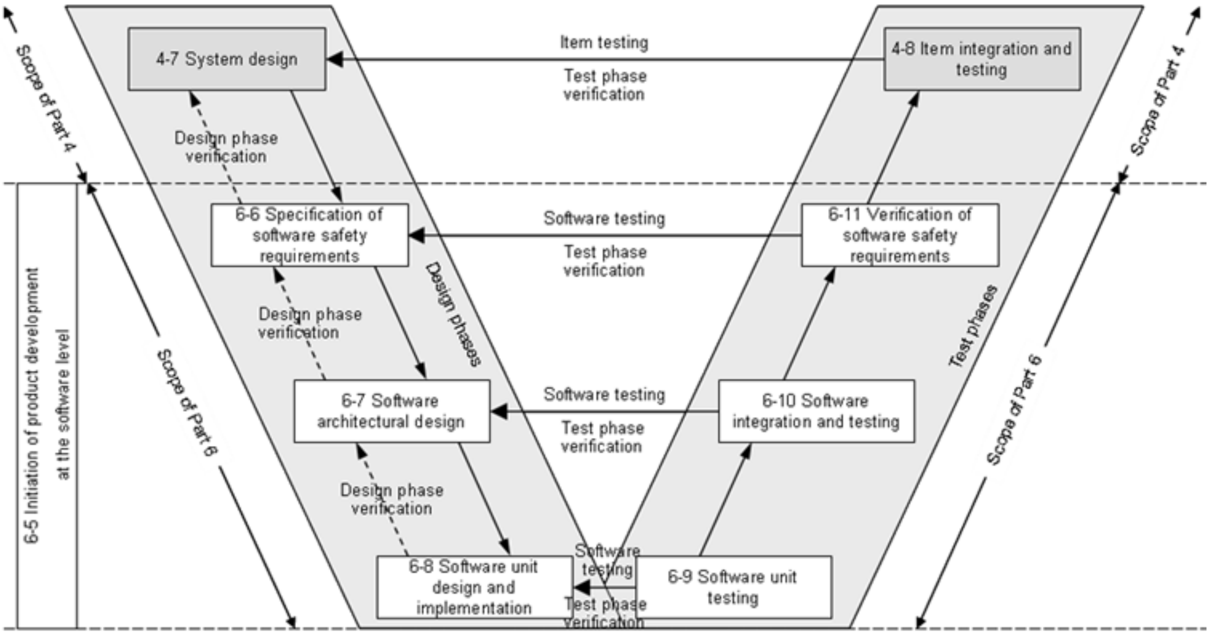
5.4.1 The activities and the determination of appropriate methods for the product development at the software level shall be planned.

5.4.2 The tailoring of the lifecycle for product development at the software level shall be performed in accordance with ISO 26262-2:2011, 6.4.5, and based on the reference phase model given in Figure 2.

5.4.3 If developing configurable software, Annex C shall be applied.

5.4.4 The software development process for the software of an item, including lifecycle phases, methods, languages and tools, shall be consistent across all the sub-phases of the software lifecycle and be compatible with the system and hardware development phases, such that the required data can be transformed correctly.

NOTE The sequencing of phases, tasks and activities, including iteration steps, for the software of an item is to ensure the consistency of the corresponding work products with the product development at the hardware level (see ISO 26262-5) and the product development at the system level (see ISO 26262-4).


Scope of Part 4
4-7 System design
Item testing
Test phase verification
4-8 Item integration and testing
Scope of Part 4
Design phase verification
6-6 Specification of software safety requirements
Software testing
Test phase verification
6-11 Verification of software safety requirements
6-5 Initiation of product development at the software level
Scope of Part 6
Design phases
Design phase verification
Test phases
6-7 Software architectural design
Software testing
Test phase verification
6-10 Software integration and testing
Scope of Part 6
Design phase verification
6-8 Software unit design and implementation
Software testing
Test phase verification
6-9 Software unit testing

NOTE Within the figure, the specific clauses of each part of ISO 26262 are indicated in the following manner: “m-n”, where “m” represents the number of the part and “n” indicates the number of the clause, e.g. “4.7” represents Clause 7 of ISO 26262-4.

Figure 2 — Reference phase model for the software development

5.4.5 For each sub-phase of software development, the selection of the following, including guidelines for their application, shall be carried out:

a) methods; and

b) corresponding tools.

5.4.6 The criteria that shall be considered when selecting a suitable modelling or programming language are:

a) an unambiguous definition;

EXAMPLE Syntax and semantics of the language.

b) the support for embedded real time software and runtime error handling; and

c) the support for modularity, abstraction and structured constructs.

Criteria that are not sufficiently addressed by the language itself shall be covered by the corresponding guidelines, or by the development environment.

NOTE 1 The selected programming language (such as ADA, C, C++, Java, Assembler or a graphical modelling language) supports the topics given in 5.4.7. Programming or modelling guidelines can be used to comply with these topics.

NOTE 2 Assembly languages can be used for those parts of the software where the use of high-level programming languages is not appropriate, such as low-level software with interfaces to the hardware, interrupt handlers, or time-critical algorithms.

5.4.7 To support the correctness of the design and implementation, the design and coding guidelines for the modelling, or programming languages, shall address the topics listed in Table 1.

NOTE 1 Coding guidelines are usually different for different programming languages.

NOTE 2 Coding guidelines can be different for model-based development.

NOTE 3 Existing coding guidelines can be modified for a specific item development.

EXAMPLE MISRA C[3] and MISRA AC AGC[4] are coding guidelines for the programming language C.

Table 1 — Topics to be covered by modelling and coding guidelines

Topics		ASIL			
		A	B	C	D
1a	Enforcement of low complexity[a]	++	++	++	++
1b	Use of language subsets[b]	++	++	++	++
1c	Enforcement of strong typing[c]	++	++	++	++
1d	Use of defensive implementation techniques	o	+	++	++
1e	Use of established design principles	+	+	+	++
1f	Use of unambiguous graphical representation	+	++	++	++
1g	Use of style guides	+	++	++	++
1h	Use of naming conventions	++	++	++	++

[a] An appropriate compromise of this topic with other methods in this part of ISO 26262 may be required.

[b] The objectives of method 1b are

- Exclusion of ambiguously defined language constructs which may be interpreted differently by different modellers, programmers, code generators or compilers.
- Exclusion of language constructs which from experience easily lead to mistakes, for example assignments in conditions or identical naming of local and global variables.
- Exclusion of language constructs which could result in unhandled run-time errors.

[c] The objective of method 1c is to impose principles of strong typing where these are not inherent in the language.

5.5 Work products

5.5.1 Safety plan (refined) resulting from requirements 5.4.1 to 5.4.7.

5.5.2 Software verification plan resulting from requirements 5.4.1 to 5.4.5 and 5.4.7.

5.5.3 Design and coding guidelines for modelling and programming languages resulting from requirements 5.4.6 and 5.4.7.

5.5.4 Tool application guidelines resulting from requirements 5.4.5 and 5.4.6.

6 Specification of software safety requirements

6.1 Objectives

The first objective of this sub-phase is to specify the software safety requirements. They are derived from the technical safety concept and the system design specification.

The second objective is to detail the hardware-software interface requirements initiated in ISO 26262-4:2011, Clause 7.

The third objective is to verify that the software safety requirements and the hardware-software interface requirements are consistent with the technical safety concept and the system design specification.

6.2 General

The technical safety requirements are refined and allocated to hardware and software during the system design phase given in ISO 26262-4:2011, Clause 7. The specification of the software safety requirements considers constraints of the hardware and the impact of these constraints on the software. This sub-phase includes the specification of software safety requirements to support the subsequent design phases.

6.3 Inputs to this clause

6.3.1 Prerequisites

The following information shall be available:

- technical safety concept in accordance with ISO 26262-4:2011, 7.5.1;
- system design specification in accordance with ISO 26262-4:2011, 7.5.2;
- hardware-software interface specification in accordance with ISO 26262-4:2011, 7.5.3;
- safety plan (refined) in accordance with 5.5.1;
- software verification plan in accordance with 5.5.2.

6.3.2 Further supporting information

The following information can be considered:

- hardware design specification (see ISO 26262-5:2011, 7.5.1);
- guidelines for the application of methods (from external source).

6.4 Requirements and recommendations

6.4.1 The software safety requirements shall address each software-based function whose failure could lead to a violation of a technical safety requirement allocated to software.

EXAMPLE Functions whose failure could lead to a violation of a safety requirement can be:

- functions that enable the system to achieve or maintain a safe state;
- functions related to the detection, indication and handling of faults of safety-related hardware elements;
- functions related to the detection, notification and mitigation of faults in the software itself;

  NOTE 1 These include both the self-monitoring of the software in the operating system and application-specific self-monitoring of the software to detect, indicate and handle systematic faults in the application software.

- functions related to on-board and off-board tests;

  NOTE 2 On-board tests can be carried out by the system itself or through other systems within the vehicle network during operation and during the pre-run and post-run phase of the vehicle.