S+ IEC 61508

Edition 2.0 2010-04

IEC STANDARDS+

COMMENTED VERSION

Functional safety of electrical/electronic/programmable electronic safety-related systems –

Part 1: General requirements
Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
Part 3: Software requirements
Part 4: Definitions and abbreviations
Part 5: Examples of methods for the determination of safety integrity levels
Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3
Part 7: Overview of techniques and measures



S+ IEC 61508:2010(E)



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/ PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –

Part 1: General requirements

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This second edition cancels and replaces the first edition published in 1998. This edition constitutes a technical revision.

This edition has been subject to a thorough review and incorporates many comments received at the various revision stages.

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65A/548/FDIS	65A/572/RVD

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INTRODUCTION

Systems comprised of electrical and/or electronic ~~components~~ elements (1) have been used for many years to perform safety functions in most application sectors. Computer-based systems (generically referred to as programmable electronic systems ~~(PESs)~~) are being used in all application sectors to perform non-safety functions and, increasingly, to perform safety functions. If computer system technology is to be effectively and safely exploited, it is essential that those responsible for making decisions have sufficient guidance on the safety aspects on which to make these decisions.

This International Standard sets out a generic approach for all safety lifecycle activities for systems comprised of electrical and/or electronic and/or programmable electronic ~~components (electrical/electronic/programmable electronic systems (E/E/PESs))~~ (E/E/PE) (2) elements (1) that are used to perform safety functions. This unified approach has been adopted in order that a rational and consistent technical policy be developed for all electrically-based safety-related systems. A major objective is to facilitate the development of product and application sector international standards based on the IEC 61508 series.

NOTE 1 Examples of product and application sector international standards based on the IEC 61508 series are given in the Bibliography (see references [1], [2] and [3]).

In most situations, safety is achieved by a number of ~~protective~~ systems which rely on many technologies (for example mechanical, hydraulic, pneumatic, electrical, electronic, programmable electronic). Any safety strategy must therefore consider not only all the elements (1) within an individual system (for example sensors, controlling devices and actuators) but also all the safety-related systems making up the total combination of safety-related systems. Therefore, while this International Standard is concerned with ~~electrical/electronic/programmable electronic~~ ~~(~~E/E/PE~~)~~ safety-related systems, it may also provide a framework within which safety-related systems based on other technologies may be considered.

It is recognized that there is a great variety of ~~E/E/PES~~ applications using E/E/PE safety-related systems in a variety of application sectors and covering a wide range of complexity, hazard and risk potentials. In any particular application, the required safety measures will be dependent on many factors specific to the application. This International Standard, by being generic, will enable such measures to be formulated in future product and (10) application sector international standards and in revisions of those that already exist.

This International Standard

– considers all relevant overall, E/E/PE~~S~~ system (2) and software safety lifecycle phases (for example, from initial concept, through design, implementation, operation and maintenance to decommissioning) when E/E/PE~~Ss~~ systems (2) are used to perform safety functions;

– has been conceived with a rapidly developing technology in mind; the framework is sufficiently robust and comprehensive to cater for future developments;

– enables product and application sector international standards, dealing with E/E/PE safety-related ~~E/E/PESs~~ systems (2), to be developed; the development of product and (10) application sector international standards, within the framework of this standard, should lead to a high level of consistency (for example, of underlying principles, terminology etc.) both within application sectors and across application sectors; this will have both safety and economic benefits;

– provides a method for the development of the safety requirements specification necessary to achieve the required functional safety for E/E/PE safety-related systems;

– adopts a risk-based approach ~~for the determination of~~ by which the safety integrity ~~level~~ requirements can be determined;

– ~~us~~ introduces safety integrity levels for specifying the target level of safety integrity for the safety functions to be implemented by the E/E/PE safety-related systems;

NOTE 2 The standard does not specify the safety integrity level requirements for any safety function, nor does it mandate how the safety integrity level is determined. Instead it provides a risk-based conceptual framework and example techniques.

– sets ~~numerical~~ (3) target failure measures for safety functions carried out by E/E/PE safety-related systems, which are linked to the safety integrity levels;

– sets a lower limit on the target failure measures~~, in a dangerous mode of failure, that can be claimed~~ for a safety function carried out by a single E/E/PE safety-related system (4). For E/E/PE safety-related systems operating in

  – a low demand mode of operation, the lower limit is set at an average probability of ~~failure~~ a dangerous failure on demand of 10^{-5} ~~to perform its design function on demand~~;(4)

  – a high demand or a continuous mode of operation, the lower limit is set at ~~a probability~~ an average frequency of a dangerous failure of 10^{-9} ~~per hour~~ [h^{-1}];(4)

NOTE 3 A single E/E/PE safety-related system does not necessarily mean a single-channel architecture.

NOTE 4 It may be possible to achieve designs of safety-related systems with lower values for the target safety integrity for non-complex systems, but these limits are considered to represent what can be achieved for relatively complex systems (for example programmable electronic safety-related systems) at the present time.(6)

– sets requirements for the avoidance and control of systematic faults, which are based on experience and judgement from practical experience gained in industry. Even though the probability of occurrence of systematic failures cannot in general be quantified the standard does, however, allow a claim to be made, for a specified safety function, that the target failure measure associated with the safety function can be considered to be achieved if all the requirements in the standard have been met;(7)

– introduces systematic capability which applies to an element (1) with respect to its confidence that the systematic safety integrity meets the requirements of the specified safety integrity level;(8)

– adopts a broad range of principles, techniques and measures to achieve functional safety for E/E/PE safety-related systems, but does not explicitly use the concept of fail safe ~~which may be of value when the failure modes are well defined and the level of complexity is relatively low. The concept of fail safe was considered inappropriate because of the full range of complexity of E/E/PE safety-related systems that are within the scope of the standard.~~(5) However, the concepts of “fail safe” and “inherently safe” principles may be applicable and adoption of such concepts is acceptable providing the requirements of the relevant clauses in the standard are met.(9)

FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/ PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –

Part 1: General requirements

1 Scope

1.1 This International Standard covers those aspects to be considered when electrical/electronic/programmable electronic (E/E/PE) systems ~~(E/E/PESs)~~ (2) are used to carry out safety functions. A major objective of this standard is to facilitate the development of product and application sector international standards by the technical committees responsible for the product or application sector. This will allow all the relevant factors, associated with the product or application, to be fully taken into account and thereby meet the specific needs of users of the product and the application sector. A ~~dual~~ second objective of this standard is to enable the development of ~~electrical/electronic/programmable electronic~~ ~~(~~E/E/PE~~)~~ safety-related systems where product or application sector international standards ~~may~~ do not exist.(10)

1.2 In particular, this standard

a) applies to safety-related systems when one or more of such systems incorporates electrical/electronic/programmable electronic ~~devices~~ elements;(1)

NOTE 1 In the context of low complexity E/E/PE safety-related systems, certain requirements specified in this standard may be unnecessary, and exemption from compliance with such requirements is possible (see 4.2, and the definition of a low complexity E/E/PE safety-related system in ~~3.4.4~~ 3.4.3 of IEC 61508-4).

NOTE 2 Although a person can form part of a safety-related system (see 3.4.1 of IEC 61508-4), human factor requirements related to the design of E/E/PE safety-related systems are not considered in detail in this standard.

b) is generically-based and applicable to all E/E/PE safety-related systems irrespective of the application; ~~1)~~

c) ~~covers possible hazards caused by failures of the safety functions to be performed by E/E/PE safety-related systems, as distinct from hazards arising from the E/E/PE equipment itself (for example electric shock etc);~~ covers the achievement of a tolerable risk through the application of E/E/PE safety-related systems, but does not cover hazards (52) arising from the E/E/PE equipment itself (for example electric shock);(11)

d) applies to all types of E/E/PE safety-related systems, including protection systems and control systems;(12)

~~d~~e) does not cover E/E/PE systems where

- a single E/E/PE system is capable ~~of providing the necessary risk reduction~~ on its own of meeting the tolerable risk, and
- the required safety integrity of the safety functions of the single E/E/PE system is less than that specified for safety integrity level 1 (the lowest safety integrity level in this standard).(4)

~~e~~f) is mainly concerned with the E/E/PE safety-related systems whose failure could have an impact on the safety of persons and/or the environment; however, it is recognized that the consequences of failure could also have serious economic implications and in such cases this standard could be used to specify any E/E/PE system used for the protection of equipment or product;

NOTE 3 See 3.1.1 of IEC 61508-4.

~~1)~~ ~~Applies to French text only.~~

~~f~~g) considers E/E/PE safety-related systems and other ~~technology safety-related systems and external~~ risk reduction ~~facilities~~ measures, in order that the safety requirements specification for the E/E/PE safety-related systems can be determined in a systematic, risk-based manner;(13)

~~g~~h) uses an overall safety lifecycle model as the technical framework for dealing systematically with the activities necessary for ensuring the functional safety of the E/E/PE safety-related systems;

~~NOTE 3 – The early phases of the overall safety lifecycle include, of necessity, consideration of other technology (as well as the E/E/PE safety-related systems) and external risk reduction facilities, in order that the safety requirements specification for the E/E/PE safety-related systems can be developed in a systematic, risk-based manner.~~

NOTE 4 Although the overall safety lifecycle is primarily concerned with E/E/PE safety-related systems, it could also provide a technical framework for ~~the consideration of~~ considering any safety-related system irrespective of the technology of that system (for example mechanical, hydraulic or pneumatic).

~~h~~i) does not specify the safety integrity levels required for sector applications (which must be based on detailed information and knowledge of the sector application). The technical committees responsible for the specific application sectors shall specify, where appropriate, the safety integrity levels in the application sector standards;

~~i~~j) provides general requirements for E/E/PE safety-related systems where no product or application sector international standards exist;

k) requires malevolent and unauthorised actions to be considered during hazard and risk analysis. The scope of the analysis includes all relevant safety lifecycle phases;(14)

NOTE 5 Other IEC/ISO standards address this subject in depth; see ISO/IEC/TR 19791 and IEC 62443 series.

~~j~~l) does not cover the precautions that may be necessary to prevent unauthorized persons damaging, and/or otherwise adversely affecting, the functional safety of E/E/PE safety-related systems (see k) above);

m) does not specify the requirements for the development, implementation, maintenance and/or operation of security policies or security services needed to meet a security policy that may be required by the E/E/PE safety-related system;(15)

n) does not apply for medical equipment in compliance with the IEC 60601 series.(16)

1.3 This part of ~~IEC 61508 specifies~~ the IEC 61508 series of standards includes general requirements that are applicable to all parts. Other parts of the IEC 61508 series concentrate on more specific topics:

– parts 2 and 3 provide additional and specific requirements for E/E/PE safety-related systems (for hardware and software);

– part 4 gives definitions and abbreviations that are used throughout this standard;

– part 5 provides guidelines on the application of part 1 in determining safety integrity levels, by showing example methods;

– part 6 provides guidelines on the application of parts 2 and 3;

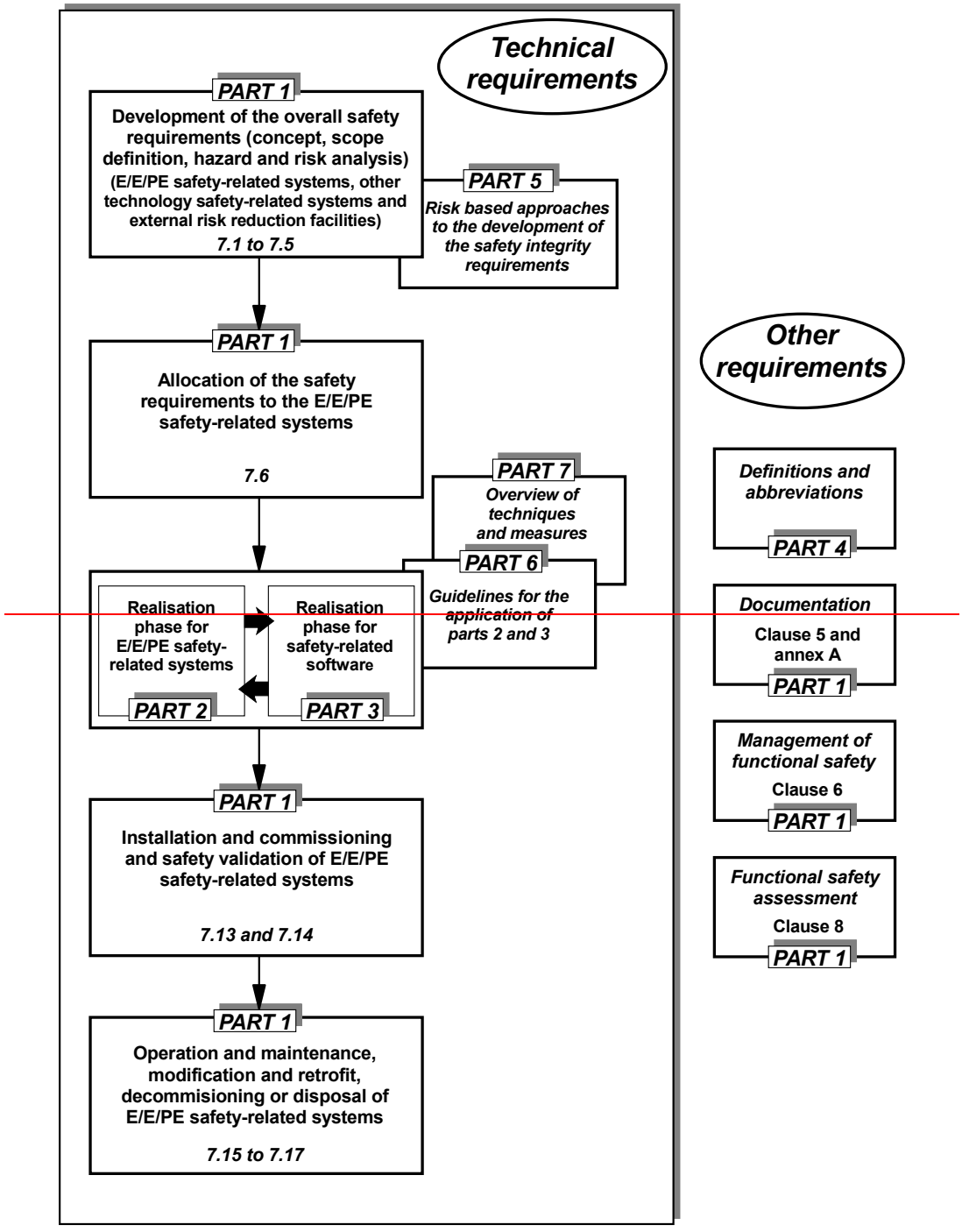
– part 7 contains an overview of techniques and measures.

1.4 IEC 61508-1, IEC 61508-2, IEC 61508-3 and IEC 61508-4 are basic safety publications, although this status does not apply in the context of low complexity E/E/PE safety-related systems (see ~~3.4.4~~ 3.4.3 of IEC 61508-4). As basic safety publications, they are intended for use by technical committees in the preparation of standards in accordance with the principles contained in IEC Guide 104 and ISO/IEC Guide 51. IEC 61508-1, IEC 61508-2, IEC 61508-3 and IEC 61508-4 are also intended for use as stand-alone publications. The horizontal safety function of this international standard does not apply to medical equipment in compliance with the IEC 60601 series.(16)

~~NOTE – In the USA and Canada, until the proposed process sector implementation of IEC 61508 is published as an international standard in the USA and Canada, existing national process safety standards based on IEC 61508 (i.e. ANSI/ISA S84.01-1996) (see reference [8] in annex C) can be applied to the process sector instead of IEC 61508.~~ (17)

NOTE One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications. In this context, the requirements, test methods or test conditions of this basic safety publication will not apply unless specifically referred to or included in the publications prepared by those technical committees.

1.5 Figure 1 shows the overall framework of the IEC 61508 series and indicates the role that IEC 61508-1 plays in the achievement of functional safety for E/E/PE safety-related systems.



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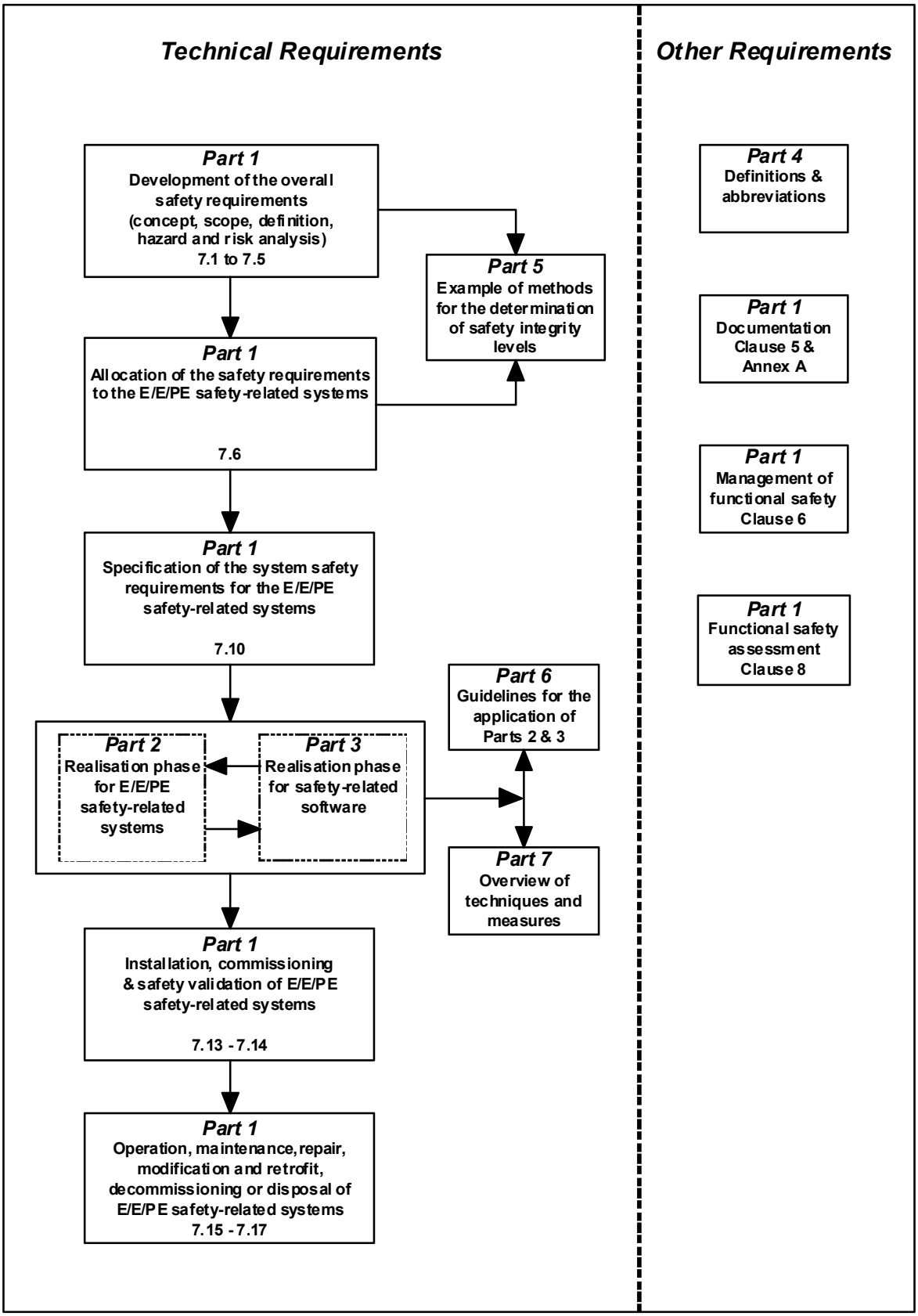


Figure 1 – Overall framework of the IEC 61508 series (1B)

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.

IEC 61508-2:2010, *Functional safety of electrical/electronic~~al~~/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronical/programmable electronic safety-related systems* ~~1)~~

IEC 61508-3:~~1998~~ 2010, *Functional safety of electrical/electronic~~al~~/programmable electronic safety-related systems – Part 3: Software requirements*

IEC 61508-4:~~1998~~ 2010, *Functional safety of electrical/electronic~~al~~/programmable electronic safety-related systems – Part 4: Definitions and abbreviations*

~~IEC 61508-5:1998, *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 5: Examples of methods for the determination of safety integrity levels*~~

~~IEC 61508-6, — *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 6: Guidelines on the application of parts 2 and 3* 1)~~

~~IEC 61508-7, — *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 7: Overview of techniques and measures* 2)~~

IEC Guide 104:1997, ~~*Guide to the drafting of safety standards, and the role of Committees with safety pilot functions and safety group functions*~~ *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51:~~1990~~ 1999, ~~*Guidelines for the inclusion of safety aspects in standards*~~ *Safety aspects – Guidelines for their inclusion in standards*

3 Definitions and abbreviations

For the purposes of this document, the definitions and abbreviations given in IEC 61508-4 apply.

4 Conformance to this standard

4.1 To conform to this standard it shall be demonstrated that all the relevant requirements have been satisfied to the required criteria specified (for example safety integrity level) and therefore, for each clause or subclause, all the objectives have been met.

~~NOTE – It is not generally possible to single out any one factor that determines the degree to which a requirement is to be satisfied (degree of rigour). It will be dependent upon a number of factors which, themselves, may depend upon the specific overall, E/E/PES or software safety lifecycle phase and activity. The factors will include:~~

~~– nature of the hazards;~~

~~– consequence and risk reduction;~~

~~– safety integrity level;~~

~~– type of implementation technology;~~

~~– size of systems;~~

~~2) To be published.~~

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems

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NOTE 2 The standard does not specify the safety integrity level requirements for any safety function, nor does it mandate how the safety integrity level is determined. Instead it provides a risk-based conceptual framework and example techniques.

– sets ~~numerical~~ (3) target failure measures for safety functions carried out by E/E/PE safety-related systems, which are linked to the safety integrity levels;

– sets a lower limit on the target failure measures~~, in a dangerous mode of failure, that can be claimed~~ for a safety function carried out by a single E/E/PE safety-related system (4). For E/E/PE safety-related systems operating in

  – a low demand mode of operation, the lower limit is set at an average probability of ~~failure~~ a dangerous failure on demand of 10^{-5} ~~to perform its design function on demand~~;(4)

  – a high demand or a continuous mode of operation, the lower limit is set at ~~a probability~~ an average frequency of a dangerous failure of 10^{-9} ~~per hour~~ [h^{-1}];(4)

NOTE 3 A single E/E/PE safety-related system does not necessarily mean a single-channel architecture.

NOTE 4 It may be possible to achieve designs of safety-related systems with lower values for the target safety integrity for non-complex systems, but these limits are considered to represent what can be achieved for relatively complex systems (for example programmable electronic safety-related systems) at the present time.(6)

– sets requirements for the avoidance and control of systematic faults, which are based on experience and judgement from practical experience gained in industry. Even though the probability of occurrence of systematic failures cannot in general be quantified the standard does, however, allow a claim to be made, for a specified safety function, that the target failure measure associated with the safety function can be considered to be achieved if all the requirements in the standard have been met;(7)

– introduces systematic capability which applies to an element (1) with respect to its confidence that the systematic safety integrity meets the requirements of the specified safety integrity level;(8)

– adopts a broad range of principles, techniques and measures to achieve functional safety for E/E/PE safety-related systems, but does not explicitly use the concept of fail safe ~~which may be of value when the failure modes are well defined and the level of complexity is relatively low. The concept of fail safe was considered inappropriate because of the full range of complexity of E/E/PE safety related systems that are within the scope of the standard.~~(5) However, the concepts of “fail safe” and “inherently safe” principles may be applicable and adoption of such concepts is acceptable providing the requirements of the relevant clauses in the standard are met.(9)

FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/ PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –

Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems

1 Scope

1.1 This part of the IEC 61508 series

a) is intended to be used only after a thorough understanding of IEC 61508-1, which provides the overall framework for the achievement of functional safety;

b) applies to any safety-related system, as defined by IEC 61508-1, that contains at least one electrical, electronic or programmable electronic ~~based component~~ element;(1)

c) applies to all ~~subsystems and their components~~ elements (1) within an E/E/PE safety-related system (including sensors, actuators and the operator interface);

d) ~~specifies how to refine the information developed in accordance with IEC 61508-1, concerning the overall safety requirements and their allocation to E/E/PE safety-related systems, and specifies how the overall safety requirements are refined into E/E/PES safety functions requirements and E/E/PES safety integrity requirements;~~ specifies how to refine the E/E/PE system safety requirements specification, developed in accordance with IEC 61508-1 (comprising the E/E/PE system safety functions requirements specification and the E/E/PE system safety integrity requirements specification), into the E/E/PE system design requirements specification;(60)

e) specifies the requirements for activities that are to be applied during the design and manufacture of the E/E/PE safety-related systems (i.e. establishes the E/E/PE~~S~~ system (2) safety lifecycle model) except software, which is dealt with in IEC 61508-3 (see Figures 2 ~~and 3~~ to 4). These requirements include the application of techniques and measures that are graded against the safety integrity level, for the avoidance of, and control of, faults and failures;

f) specifies the information necessary for carrying out the installation, commissioning and final safety validation of the E/E/PE safety-related systems;

g) does not apply to the operation and maintenance phase of the E/E/PE safety-related systems – this is dealt with in IEC 61508-1 – however, IEC 61508-2 does provide requirements for the preparation of information and procedures needed by the user for the operation and maintenance of the E/E/PE safety-related systems;

h) specifies requirements to be met by the organisation carrying out any modification of the E/E/PE safety-related systems;

NOTE 1 This part of IEC 61508 is mainly directed at suppliers and/or in-company engineering departments, hence the inclusion of requirements for modification.

NOTE 2 The relationship between IEC 61508-2 and IEC 61508-3 is illustrated in Figure ~~3~~ 4.

i) does not apply for medical equipment in compliance with the IEC 60601 series.(16)

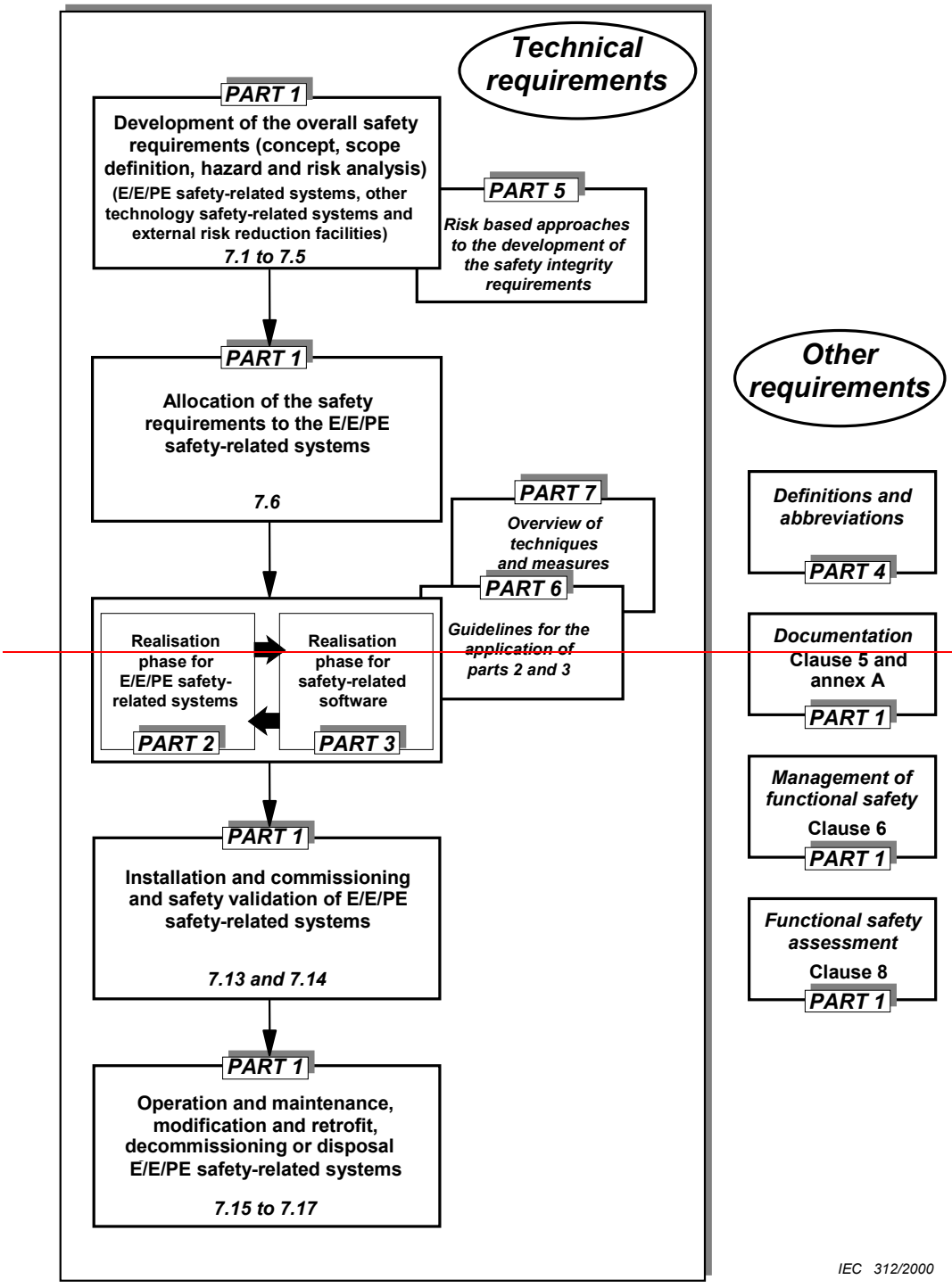
1.2 IEC 61508-1, IEC 61508-2, IEC 61508-3 and IEC 61508-4 are basic safety publications, although this status does not apply in the context of low complexity E/E/PE safety-related systems (see ~~3.4.4~~ 3.4.3 of IEC 61508-4). As basic safety publications, they are intended for use by technical committees in the preparation of standards in accordance with the principles contained in IEC Guide 104 and ISO/IEC Guide 51. IEC 61508-1, IEC 61508-2, IEC 61508-3 and IEC 61508-4 are also intended for use as stand-alone standards. The horizontal safety function of this international standard does not apply to medical equipment in compliance with the IEC 60601 series.(16)

1.3 One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications. In this context, the requirements, test methods or test conditions of this basic safety publication will not apply unless specifically referred to or included in the publications prepared by those technical committees.

NOTE ~~1~~ The functional safety of an E/E/PE safety-related system can only be achieved when all related requirements are met. Therefore, it is important that all related requirements are carefully considered and adequately referenced.

~~NOTE 2 In the USA and Canada, until the proposed sector implementation of IEC 61508 (i.e. IEC 61511) is published as an international standard in the USA and Canada, existing national process safety standards based on IEC 61508 (i.e. ANSI/ISA-S84.01) can be applied to process sector instead of IEC 61508.~~ (17)

~~**1.3**~~ **1.4** Figure 1 shows the overall framework of the IEC 61508 series and indicates the role that IEC 61508-2 plays in the achievement of functional safety for E/E/PE safety-related systems. Annex A of IEC 61508-6 describes the application of IEC 61508-2 and IEC 61508-3.


Technical requirements
PART 1
Development of the overall safety requirements (concept, scope definition, hazard and risk analysis)
(E/E/PE safety-related systems, other technology safety-related systems and external risk reduction facilities)
7.1 to 7.5
PART 5
Risk based approaches to the development of the safety integrity requirements
PART 1
Allocation of the safety requirements to the E/E/PE safety-related systems
7.6
PART 7
Overview of techniques and measures
PART 6
Guidelines for the application of parts 2 and 3
Realisation phase for E/E/PE safety-related systems
PART 2
Realisation phase for safety-related software
PART 3
PART 1
Installation and commissioning and safety validation of E/E/PE safety-related systems
7.13 and 7.14
PART 1
Operation and maintenance, modification and retrofit, decommissioning or disposal E/E/PE safety-related systems
7.15 to 7.17
Other requirements
Definitions and abbreviations
PART 4
Documentation
Clause 5 and annex A
PART 1
Management of functional safety
Clause 6
PART 1
Functional safety assessment
Clause 8
PART 1
IEC 312/2000

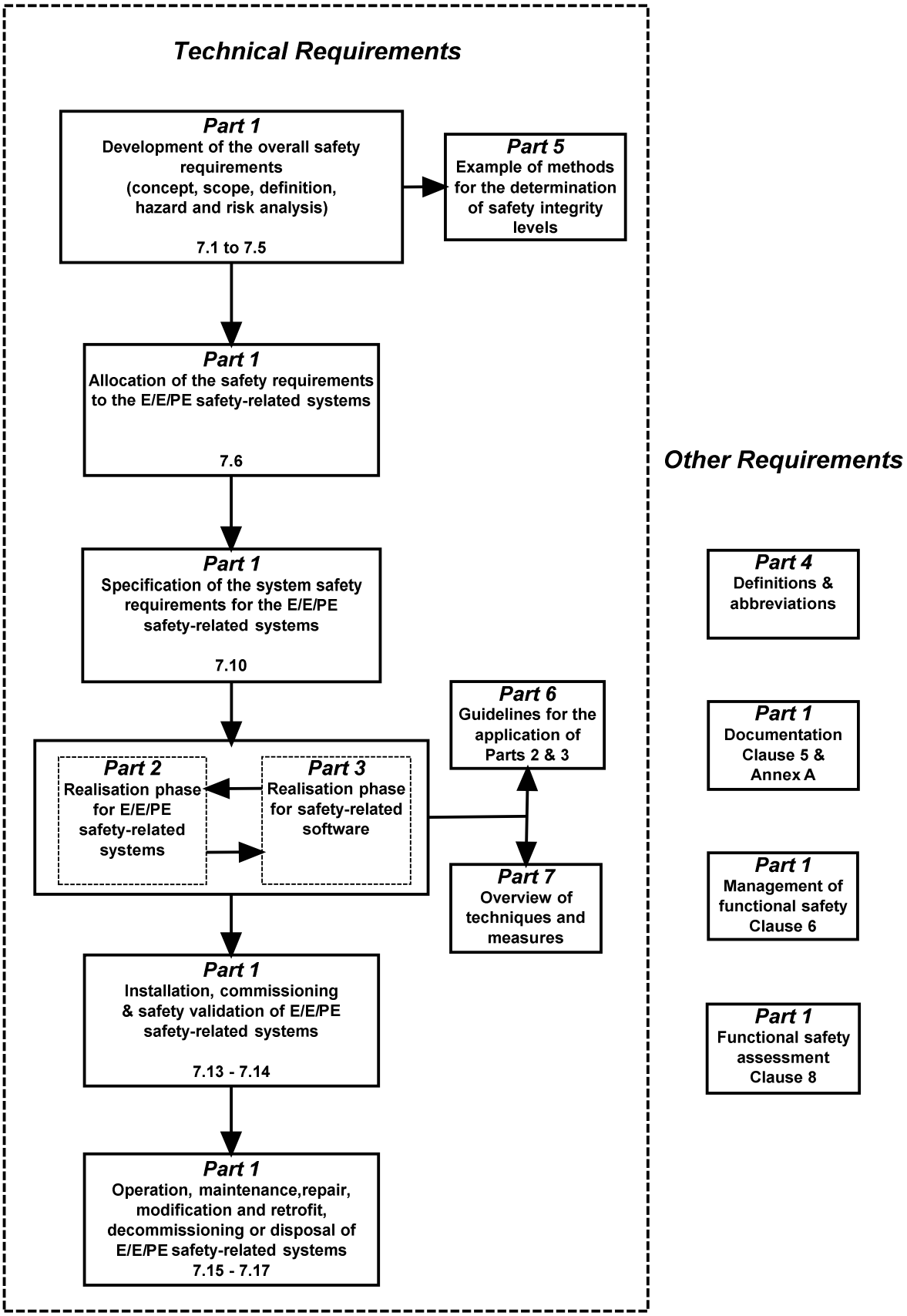


Figure 1 – Overall framework of the IEC 61508 series (1B)

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.

~~IEC 60050(371):1984, *International Electrotechnical Vocabulary – Chapter 371: Telecontrol*~~

~~IEC 60300-3-2:1993, *Dependability management – Part 3: Application guide – Section 2: Collection of dependability data from the field*~~

IEC 60947-5-1, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

~~IEC 61000-1-1:1992, *Electromagnetic compatibility (EMC) – Part 1: General – Section 1: Application and interpretation of fundamental definitions and terms*~~

IEC/TS 61000-1-2, *Electromagnetic compatibility (EMC) – Part 1-2: General – Methodology for the achievement of functional safety of electrical and electronic systems including equipment with regard to electromagnetic phenomena*

~~IEC 61000-2-5:1995, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 5: Classification of electromagnetic environments – Basic EMC publication*~~

IEC 61326-3-1, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications*

IEC 61508-1:~~1998~~ 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

IEC 61508-3:~~1998~~ 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements*

IEC 61508-4:~~1998~~ 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 4: Definitions and abbreviations*

~~IEC 61508-5:1998, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 5: Examples of methods for the determination of safety integrity levels*~~

~~IEC 61508-6, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 6: Guidelines on the application of parts 2 and 3* [1)]~~

IEC 61508-7:~~2000~~ 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 7: Overview of techniques and measures*

IEC 61784-3, *Industrial communication networks – Profiles – Part 3: Functional safety fieldbuses – General rules and profile definitions*

IEC 62280-1, *Railway applications – Communication, signalling and processing systems – Part 1: Safety-related communication in closed transmission systems*

~~1) To be published.~~

IEC 62280-2, *Railway applications – Communication, signalling and processing systems – Part 2: Safety-related communication in open transmission systems*

IEC Guide 104:1997, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51:~~1990~~ 1999, *Safety aspects – Guidelines for their inclusion in standards*

~~IEEE 352:1987, *IEEE guide for general principles of reliability analysis of nuclear power generating station safety systems*~~

EN 50205, *Relays with forcibly guided (mechanically linked) contacts*

3 Definitions and abbreviations

For the purposes of this document, the definitions and abbreviations given in IEC 61508-4 apply.

4 Conformance to this standard

The requirements for conformance to this standard are as detailed in Clause 4 of IEC 61508-1.

5 Documentation

The requirements for documentation are as detailed in Clause 5 of IEC 61508-1.

6 Management of functional safety

The requirements for management of functional safety are as detailed in Clause 6 of IEC 61508-1.

7 E/E/PE~~S~~ system (2) safety lifecycle requirements

7.1 General

7.1.1 Objectives and requirements – general

7.1.1.1 This subclause sets out the objectives and requirements for the E/E/PE~~S~~ system (2) safety lifecycle phases.

NOTE The objectives and requirements for the overall safety lifecycle, together with a general introduction to the structure of the standard, are given in IEC 61508-1.

7.1.1.2 For all phases of the E/E/PE~~S~~ system (2) safety lifecycle, Table 1 indicates

– the objectives to be achieved;

– the scope of the phase;

– a reference to the subclause containing the requirements;

– the required inputs to the phase;

– the outputs required to comply with the subclause.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/ PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –

Part 3: Software requirements

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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DISCLAIMER
This Redline version is not an official IEC Standard and is intended only to provide the user with an indication of what changes have been made to the previous version. Only the current version of the standard is to be considered the official document.

This Redline version provides you with a quick and easy way to compare all the changes between this standard and its previous edition. Additions and deletions are displayed in red, with deletions being struck through.

International Standard IEC 61508-3 has been prepared by subcommittee 65A: System aspects, of IEC technical committee 65: Industrial-process measurement, control and automation.

This second edition cancels and replaces the first edition published in 1998. This edition constitutes a technical revision.

This edition has been subject to a thorough review and incorporates many comments received at the various revision stages.

It has the status of a basic safety publication according to IEC Guide 104.

The text of this standard is based on the following documents:

FDIS	Report on voting
65A/550/FDIS	65A/574/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61508 series, published under the general title *Functional safety of electrical / electronic / programmable electronic safety-related systems*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

Systems comprised of electrical and/or electronic ~~components~~ elements (1) have been used for many years to perform safety functions in most application sectors. Computer-based systems (generically referred to as programmable electronic systems ~~(PESs)~~) are being used in all application sectors to perform non-safety functions and, increasingly, to perform safety functions. If computer system technology is to be effectively and safely exploited, it is essential that those responsible for making decisions have sufficient guidance on the safety aspects on which to make these decisions.

This International Standard sets out a generic approach for all safety lifecycle activities for systems comprised of electrical and/or electronic and/or programmable electronic ~~components (electrical/electronic/programmable electronic systems (E/E/PESs))~~ (E/E/PE) (2) elements (1) that are used to perform safety functions. This unified approach has been adopted in order that a rational and consistent technical policy be developed for all electrically-based safety-related systems. A major objective is to facilitate the development of product and application sector international standards based on the IEC 61508 series.

NOTE 1 Examples of product and application sector international standards based on the IEC 61508 series are given in the Bibliography (see references [1], [2] and [3]).

In most situations, safety is achieved by a number of ~~protective~~ systems which rely on many technologies (for example mechanical, hydraulic, pneumatic, electrical, electronic, programmable electronic). Any safety strategy must therefore consider not only all the elements (1) within an individual system (for example sensors, controlling devices and actuators) but also all the safety-related systems making up the total combination of safety-related systems. Therefore, while this International Standard is concerned with ~~electrical/electronic/programmable electronic~~ ~~(~~E/E/PE~~)~~ safety-related systems, it may also provide a framework within which safety-related systems based on other technologies may be considered.

It is recognized that there is a great variety of ~~E/E/PES~~ applications using E/E/PE safety-related systems in a variety of application sectors and covering a wide range of complexity, hazard and risk potentials. In any particular application, the required safety measures will be dependent on many factors specific to the application. This International Standard, by being generic, will enable such measures to be formulated in future product and (10) application sector international standards and in revisions of those that already exist.

This International Standard

– considers all relevant overall, E/E/PE~~S~~ system (2) and software safety lifecycle phases (for example, from initial concept, through design, implementation, operation and maintenance to decommissioning) when E/E/PE~~Ss~~ systems (2) are used to perform safety functions;

– has been conceived with a rapidly developing technology in mind; the framework is sufficiently robust and comprehensive to cater for future developments;

– enables product and application sector international standards, dealing with E/E/PE safety-related ~~E/E/PESs~~ systems (2), to be developed; the development of product and (10) application sector international standards, within the framework of this standard, should lead to a high level of consistency (for example, of underlying principles, terminology etc.) both within application sectors and across application sectors; this will have both safety and economic benefits;

– provides a method for the development of the safety requirements specification necessary to achieve the required functional safety for E/E/PE safety-related systems;

– adopts a risk-based approach ~~for the determination of~~ by which the safety integrity ~~level~~ requirements can be determined;

– ~~uses~~ introduces safety integrity levels for specifying the target level of safety integrity for the safety functions to be implemented by the E/E/PE safety-related systems;

NOTE 2 The standard does not specify the safety integrity level requirements for any safety function, nor does it mandate how the safety integrity level is determined. Instead it provides a risk-based conceptual framework and example techniques.

– sets ~~numerical~~ (3) target failure measures for safety functions carried out by E/E/PE safety-related systems, which are linked to the safety integrity levels;

– sets a lower limit on the target failure measures~~, in a dangerous mode of failure, that can be claimed~~ for a safety function carried out by a single E/E/PE safety-related system (4). For E/E/PE safety-related systems operating in

  – a low demand mode of operation, the lower limit is set at an average probability of ~~failure~~ a dangerous failure on demand of 10^{-5} ~~to perform its design function on demand~~;(4)

  – a high demand or a continuous mode of operation, the lower limit is set at ~~a probability~~ an average frequency of a dangerous failure of 10^{-9} ~~per hour~~ [h^{-1}];(4)

NOTE 3 A single E/E/PE safety-related system does not necessarily mean a single-channel architecture.

NOTE 4 It may be possible to achieve designs of safety-related systems with lower values for the target safety integrity for non-complex systems, but these limits are considered to represent what can be achieved for relatively complex systems (for example programmable electronic safety-related systems) at the present time.(6)

– sets requirements for the avoidance and control of systematic faults, which are based on experience and judgement from practical experience gained in industry. Even though the probability of occurrence of systematic failures cannot in general be quantified the standard does, however, allow a claim to be made, for a specified safety function, that the target failure measure associated with the safety function can be considered to be achieved if all the requirements in the standard have been met;(7)

– introduces systematic capability which applies to an element (1) with respect to its confidence that the systematic safety integrity meets the requirements of the specified safety integrity level;(8)

– adopts a broad range of principles, techniques and measures to achieve functional safety for E/E/PE safety-related systems, but does not explicitly use the concept of fail safe ~~which may be of value when the failure modes are well defined and the level of complexity is relatively low. The concept of fail safe was considered inappropriate because of the full range of complexity of E/E/PE safety related systems that are within the scope of the standard.~~(5) However, the concepts of “fail safe” and “inherently safe” principles may be applicable and adoption of such concepts is acceptable providing the requirements of the relevant clauses in the standard are met.(9)

FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/ PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –

Part 3: Software requirements

1 Scope

1.1 This part of the IEC 61508 series

a) is intended to be utilized only after a thorough understanding of IEC 61508-1 and IEC 61508-2;

b) applies to any software forming part of a safety-related system or used to develop a safety-related system within the scope of IEC 61508-1 and IEC 61508-2. Such software is termed safety-related software (including (4) operating systems, system software, software in communication networks, human-computer interface functions, ~~support tools~~ (300) and firmware as well as application ~~programs~~ software);

~~– Application programs include high level programs, low level programs and special purpose programs in limited variability languages (see 3.2.7 of IEC 61508-4).~~

c) provides specific requirements applicable to support tools used to develop and configure a safety-related system within the scope of IEC 61508-1 and IEC 61508-2;(300)

~~c)~~d) requires that the software safety functions and software ~~safety integrity levels~~ systematic capability (301) are specified;

NOTE 1 If this has already been done as part of the specification of the E/E/PE safety-related systems (see 7.2 of IEC 61508-2), then it does not have to be repeated in this part.

NOTE 2 Specifying the software safety functions and software ~~safety integrity levels~~ systematic capability is an iterative procedure; see Figures ~~2~~ 3 and 6.

NOTE 3 See Clause 5 and Annex A of IEC 61508-1 for documentation structure. The documentation structure may take account of company procedures, and of the working practices of specific application sectors.

NOTE 4 Note: See 3.5.9 of IEC 61508-4 for definition of the term "systematic capability".

~~d)~~e) establishes requirements for safety lifecycle phases and activities which shall be applied during the design and development of the safety-related software (the software safety lifecycle model). These requirements include the application of measures and techniques, which are graded against the ~~safety integrity level~~ required systematic capability (301), for the avoidance of and control of faults and failures in the software;

~~e)~~f) provides requirements for information relating to the software aspects of system (4) safety validation to be passed to the organisation carrying out the E/E/PE~~S~~ system (2) integration;

~~f)~~g) provides requirements for the preparation of information and procedures concerning software needed by the user for the operation and maintenance of the E/E/PE safety-related system;

~~g)~~h) provides requirements to be met by the organisation carrying out modifications to safety-related software;

~~h)~~i) provides, in conjunction with IEC 61508-1 and IEC 61508-2, requirements for support tools such as development and design tools, language translators, testing and debugging tools, configuration management tools;

NOTE ~~4~~ 5 Figure ~~4 and 6~~ 5 shows the relationship between IEC 61508-2 and IEC 61508-3.

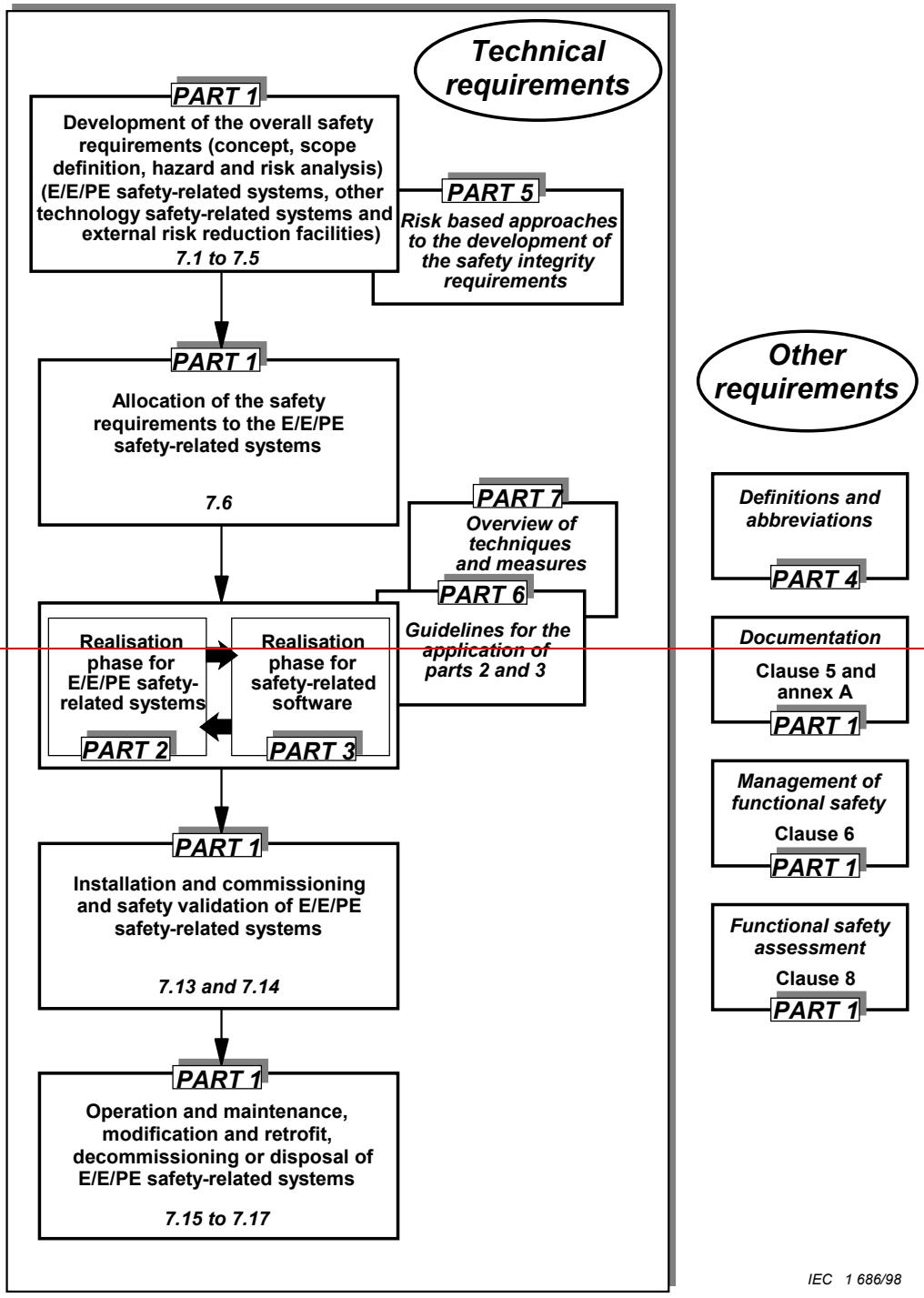
j) Does not apply for medical equipment in compliance with the IEC 60601 series.(16)

1.2 IEC 61508-1, IEC 61598-2, IEC 61508-3 and IEC 61508-4 are basic safety publications, although this status does not apply in the context of low complexity E/E/PE safety-related systems (see ~~3.4.4~~ 3.4.3 of IEC 61508-4). As basic safety publications, they are intended for use by technical committees in the preparation of standards in accordance with the principles contained in IEC Guide 104 and ISO/IEC Guide 51. IEC 61508-1, IEC 61508-2, IEC 61508-3 and IEC 61508-4 are also intended for use as stand-alone publications. The horizontal safety function of this international standard does not apply to medical equipment in compliance with the IEC 60601 series.(16)

~~NOTE – In the USA and Canada, until the proposed process sector implementation of IEC 61508 (i.e. IEC 61511) is published as an international standard in the USA and Canada, existing national process safety standards based on IEC 61508 (i.e. ANSI/ISA S84.01-1996) can be applied to the process sector instead of IEC 61508.~~(17)

1.3 One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications. In this context, the requirements, test methods or test conditions of this basic safety publication will not apply unless specifically referred to or included in the publications prepared by those technical committees.

~~**1.3**~~ **1.4** Figure 1 shows the overall framework of the IEC 61508 series and indicates the role that IEC 61508-3 plays in the achievement of functional safety for E/E/PE safety-related systems. ~~Annex A of IEC 61508-6 describes the application of IEC 61508-2 and IEC 61508-3.~~


Technical requirements
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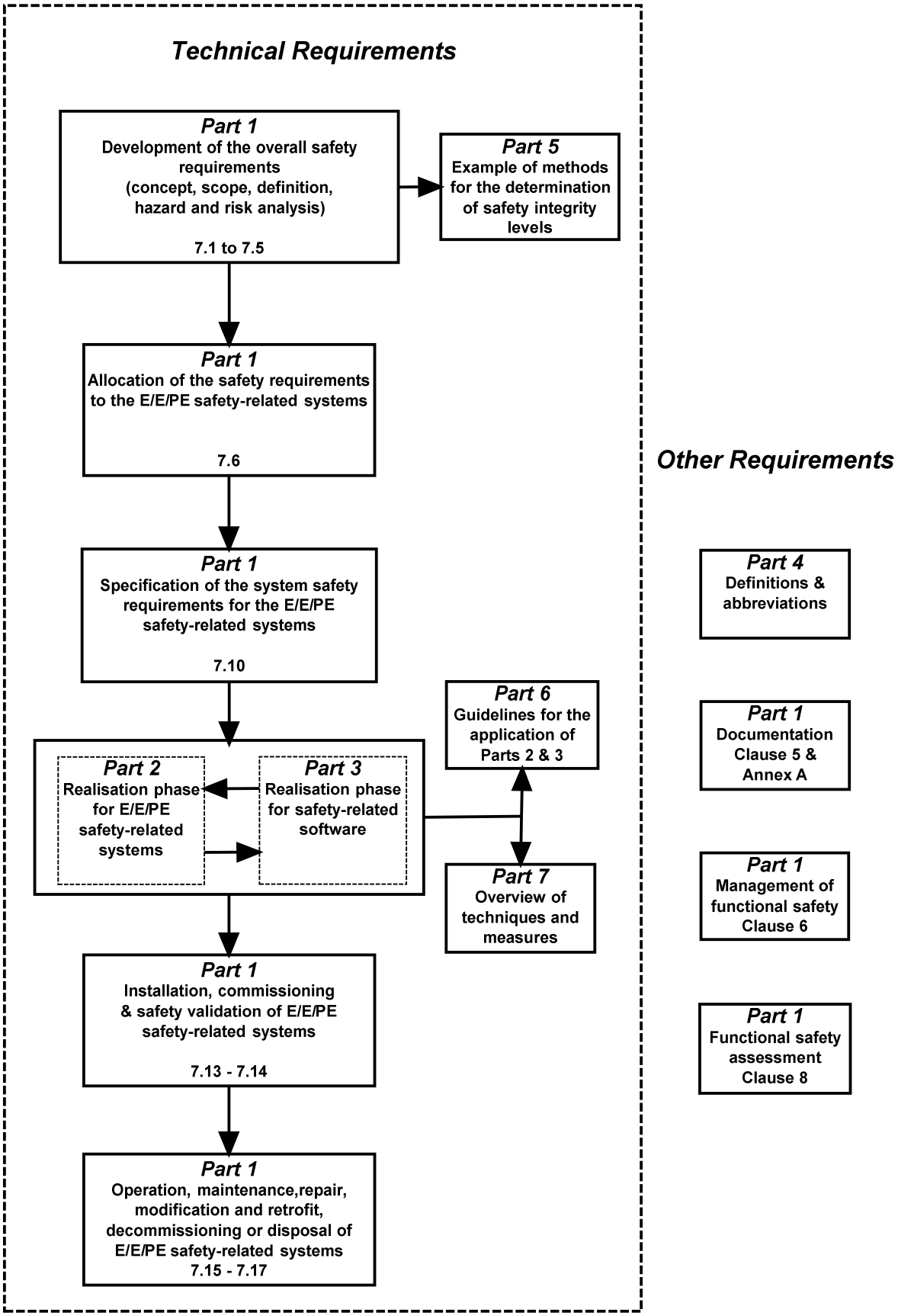


Figure 1 – Overall framework of the IEC 61508 series (1B)

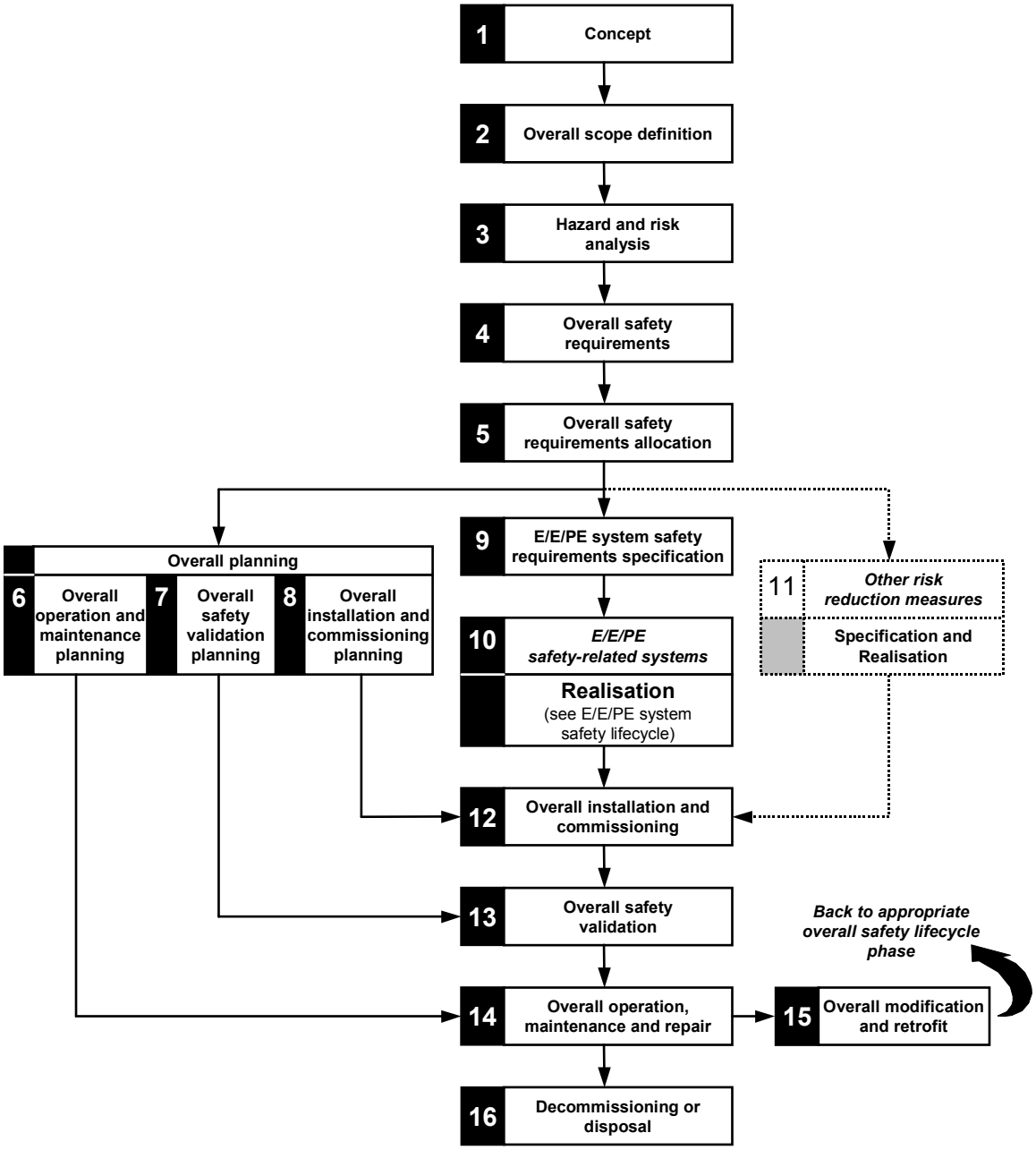


Figure 2 – Overall safety lifecycle

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.

IEC 61508-1:~~1998~~ 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

IEC 61508-2:— 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems*

IEC 61508-4:~~1998~~ 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 4: Definitions and abbreviations*

~~IEC 61508-5:1998, *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 5: Examples of methods for the determination of safety integrity levels*~~

~~IEC 61508-6: —, *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 6: Guidelines on the application of parts 2 and 3*~~ [1)]

~~IEC 61508-7: —, *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 7: Overview of techniques and measures*~~ [1)]

IEC Guide 104:1997, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51:~~1990~~ 1999, *Safety aspects – Guidelines for their inclusion in standards*

3 Definitions and abbreviations

For the purposes of this document, the definitions and abbreviations given in IEC 61508-4 apply.

4 Conformance to this standard

The requirements for conformance to this standard are given in Clause 4 of IEC 61508-1.

5 Documentation

The objectives and requirements for documentation are given in Clause 5 of IEC 61508-1.

~~6 Software quality management system~~

6 Additional requirements for management of safety-related software (4)

6.1 Objectives

The objectives are as detailed in 6.1 of IEC 61508-1.

6.2 Requirements

6.2.1 The requirements are as detailed in 6.2 of IEC 61508-1, with the following additional requirements.

6.2.2 The functional safety planning shall define the strategy for software procurement, development, integration, verification, validation and modification to the extent required by the safety integrity level of the safety functions implemented by the (4) E/E/PE safety-related system.

NOTE The philosophy of this approach is to use the functional safety planning as an opportunity to customize this standard to take account of the ~~varying safety integrity which is required in~~ required safety integrity for each safety function implemented by the E/E/PE safety-related system ~~components~~. ~~7.4.2.8 of part 3 should be taken into account when E/E/PE safety-related system components of differing safety integrity levels are to be used together.~~

6.2.3 Software configuration management ~~should~~ shall:

a) apply administrative and technical controls throughout the software safety lifecycle, in order to manage software changes and thus ensure that the specified requirements for safety-related software ~~safety~~ (4) continue to be satisfied;

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/ PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –

Part 4: Definitions and abbreviations

FOREWORD

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International Standard IEC 61508-4 has been prepared by subcommittee 65A: System aspects, of IEC technical committee 65: Industrial-process measurement, control and automation.

This second edition cancels and replaces the first edition published in 1998. This edition constitutes a technical revision.

This edition has been subject to a thorough review and incorporates many comments received at the various revision stages.

It has the status of a basic safety publication according to IEC Guide 104.

The text of this standard is based on the following documents:

FDIS	Report on voting
65A/551/FDIS	65A/575/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2

A list of all parts of the IEC 61508 series, published under the general title *Functional safety of electrical / electronic / programmable electronic safety-related systems*, can be found on the IEC website.

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- reconfirmed,
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INTRODUCTION

Systems comprised of electrical and/or electronic ~~components~~ elements (1) have been used for many years to perform safety functions in most application sectors. Computer-based systems (generically referred to as programmable electronic systems ~~(PESs)~~) are being used in all application sectors to perform non-safety functions and, increasingly, to perform safety functions. If computer system technology is to be effectively and safely exploited, it is essential that those responsible for making decisions have sufficient guidance on the safety aspects on which to make these decisions.

This International Standard sets out a generic approach for all safety lifecycle activities for systems comprised of electrical and/or electronic and/or programmable electronic ~~components (electrical/electronic/programmable electronic systems (E/E/PESs))~~ (E/E/PE) (2) elements (1) that are used to perform safety functions. This unified approach has been adopted in order that a rational and consistent technical policy be developed for all electrically-based safety-related systems. A major objective is to facilitate the development of product and application sector international standards based on the IEC 61508 series.

NOTE 1 Examples of product and application sector international standards based on the IEC 61508 series are given in the Bibliography (see references [1], [2] and [3]).

In most situations, safety is achieved by a number of ~~protective~~ systems which rely on many technologies (for example mechanical, hydraulic, pneumatic, electrical, electronic, programmable electronic). Any safety strategy must therefore consider not only all the elements (1) within an individual system (for example sensors, controlling devices and actuators) but also all the safety-related systems making up the total combination of safety-related systems. Therefore, while this International Standard is concerned with ~~electrical/electronic/programmable electronic (~~E/E/PE~~)~~ safety-related systems, it may also provide a framework within which safety-related systems based on other technologies may be considered.

It is recognized that there is a great variety of ~~E/E/PES~~ applications using E/E/PE safety-related systems in a variety of application sectors and covering a wide range of complexity, hazard and risk potentials. In any particular application, the required safety measures will be dependent on many factors specific to the application. This International Standard, by being generic, will enable such measures to be formulated in future product and (10) application sector international standards and in revisions of those that already exist.

This International Standard

– considers all relevant overall, E/E/PE~~S~~ system (2) and software safety lifecycle phases (for example, from initial concept, through design, implementation, operation and maintenance to decommissioning) when E/E/PE~~Ss~~ systems (2) are used to perform safety functions;

– has been conceived with a rapidly developing technology in mind; the framework is sufficiently robust and comprehensive to cater for future developments;

– enables product and application sector international standards, dealing with E/E/PE safety-related ~~E/E/PESs~~ systems (2), to be developed; the development of product and (10) application sector international standards, within the framework of this standard, should lead to a high level of consistency (for example, of underlying principles, terminology etc.) both within application sectors and across application sectors; this will have both safety and economic benefits;

– provides a method for the development of the safety requirements specification necessary to achieve the required functional safety for E/E/PE safety-related systems;

– adopts a risk-based approach ~~for the determination of~~ by which the safety integrity ~~level~~ requirements can be determined;

– ~~uses~~ introduces safety integrity levels for specifying the target level of safety integrity for the safety functions to be implemented by the E/E/PE safety-related systems;

NOTE 2 The standard does not specify the safety integrity level requirements for any safety function, nor does it mandate how the safety integrity level is determined. Instead it provides a risk-based conceptual framework and example techniques.

– sets ~~numerical~~ (3) target failure measures for safety functions carried out by E/E/PE safety-related systems, which are linked to the safety integrity levels;

– sets a lower limit on the target failure measures~~, in a dangerous mode of failure, that can be claimed~~ for a safety function carried out by a single E/E/PE safety-related system (4). For E/E/PE safety-related systems operating in

  – a low demand mode of operation, the lower limit is set at an average probability of ~~failure~~ a dangerous failure on demand of 10^{-5} ~~to perform its design function on demand~~;(4)

  – a high demand or a continuous mode of operation, the lower limit is set at ~~a probability~~ an average frequency of a dangerous failure of 10^{-9} ~~per hour~~ [h^{-1}];(4)

NOTE 3 A single E/E/PE safety-related system does not necessarily mean a single-channel architecture.

NOTE 4 It may be possible to achieve designs of safety-related systems with lower values for the target safety integrity for non-complex systems, but these limits are considered to represent what can be achieved for relatively complex systems (for example programmable electronic safety-related systems) at the present time.(6)

– sets requirements for the avoidance and control of systematic faults, which are based on experience and judgement from practical experience gained in industry. Even though the probability of occurrence of systematic failures cannot in general be quantified the standard does, however, allow a claim to be made, for a specified safety function, that the target failure measure associated with the safety function can be considered to be achieved if all the requirements in the standard have been met;(7)

– introduces systematic capability which applies to an element (1) with respect to its confidence that the systematic safety integrity meets the requirements of the specified safety integrity level;(8)

– adopts a broad range of principles, techniques and measures to achieve functional safety for E/E/PE safety-related systems, but does not explicitly use the concept of fail safe ~~which may be of value when the failure modes are well defined and the level of complexity is relatively low. The concept of fail safe was considered inappropriate because of the full range of complexity of E/E/PE safety-related systems that are within the scope of the standard.~~(5) However, the concepts of “fail safe” and “inherently safe” principles may be applicable and adoption of such concepts is acceptable providing the requirements of the relevant clauses in the standard are met.(9)

FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/ PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –

Part 4: Definitions and abbreviations

1 Scope

1.1 This part of IEC 61508 contains the definitions and explanation of terms that are used in parts 1 to 7 of the IEC 61508 series of standards.

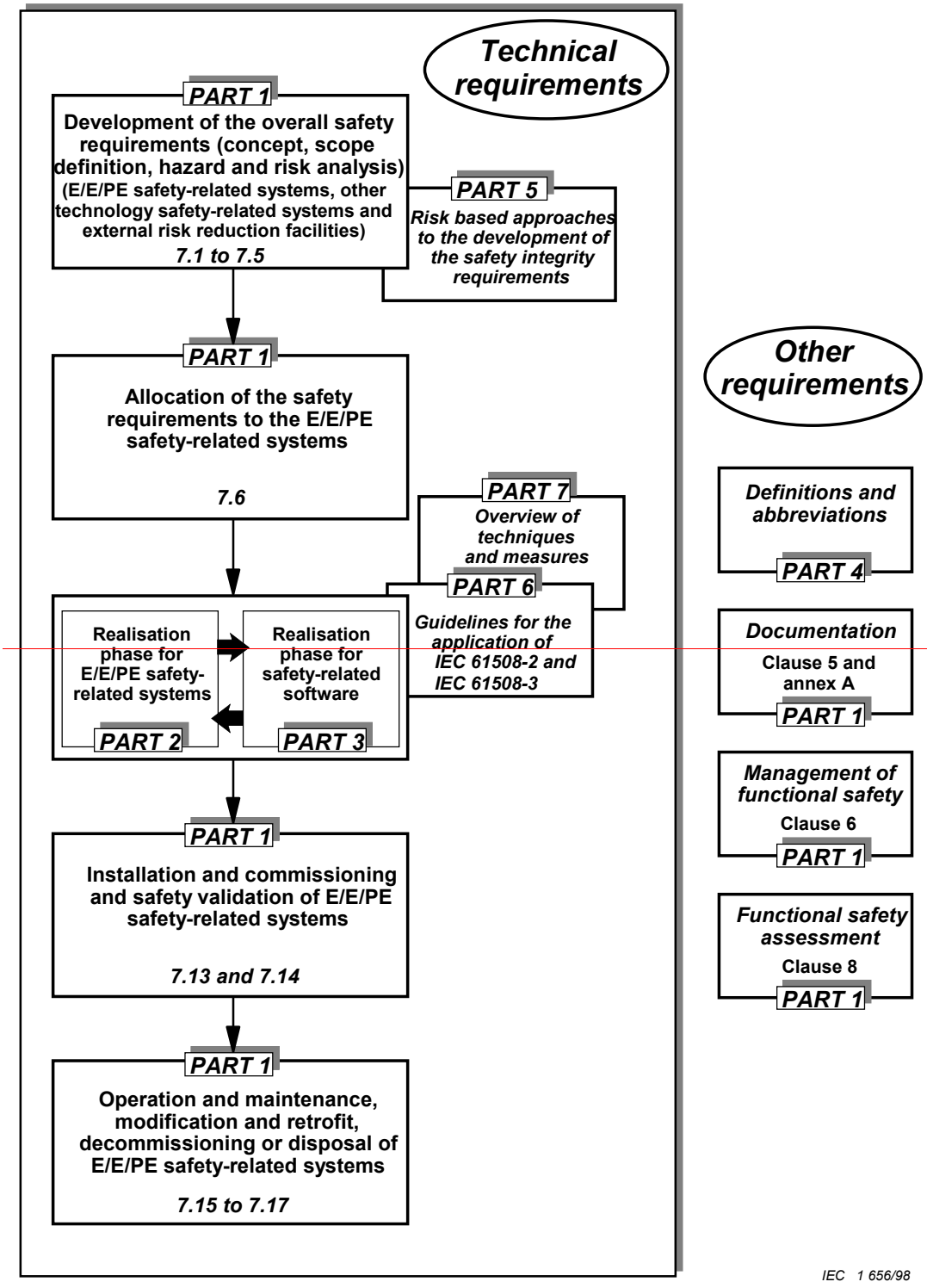
1.2 The definitions are grouped under general headings so that related terms can be understood within the context of each other. However, it should be noted that these headings are not intended to add meaning to the definitions ~~and in this sense the headings should be disregarded~~.

1.3 IEC 61508-1, IEC 61508-2, IEC 61508-3 and IEC 61508-4 are basic safety publications, although this status does not apply in the context of low complexity E/E/PE safety-related systems (see ~~3.4.4~~ 3.4.3 of IEC 61508-4). As basic safety publications, they are intended for use by technical committees in the preparation of standards in accordance with the principles contained in IEC Guide 104 and ISO/IEC Guide 51. IEC 61508-1, IEC 61508-2, IEC 61508-3 and IEC 61508-4 are also intended for use as stand-alone publications. The horizontal safety function of this international standard does not apply to medical equipment in compliance with the IEC 60601 series.(16)

1.4 One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications. In this context, the requirements, test methods or test conditions of this basic safety publication will not apply unless specifically referred to or included in the publications prepared by those technical committees.

~~NOTE – In the USA and Canada, until the proposed process sector implementation of IEC 61508 (i.e. IEC 61511) is published as an international standard in the USA and Canada, existing national process safety standards based on IEC 61508 (i.e. ANSI/ISA S84.01-1996) can be applied to the process sector instead of IEC 61508.~~(17)

~~**1.4**~~ **1.5** Figure 1 shows the overall framework of the IEC 61508 series and indicates the role that IEC 61508-4 plays in the achievement of functional safety for E/E/PE safety-related systems.(1B)


Technical requirements
PART 1
Development of the overall safety requirements (concept, scope definition, hazard and risk analysis)
(E/E/PE safety-related systems, other technology safety-related systems and external risk reduction facilities)
7.1 to 7.5
PART 5
Risk based approaches to the development of the safety integrity requirements
PART 1
Allocation of the safety requirements to the E/E/PE safety-related systems
7.6
PART 7
Overview of techniques and measures
PART 6
Guidelines for the application of IEC 61508-2 and IEC 61508-3
Realisation phase for E/E/PE safety-related systems
PART 2
Realisation phase for safety-related software
PART 3
PART 1
Installation and commissioning and safety validation of E/E/PE safety-related systems
7.13 and 7.14
PART 1
Operation and maintenance, modification and retrofit, decommissioning or disposal of E/E/PE safety-related systems
7.15 to 7.17
Other requirements
Definitions and abbreviations
PART 4
Documentation
Clause 5 and annex A
PART 1
Management of functional safety
Clause 6
PART 1
Functional safety assessment
Clause 8
PART 1
IEC 1 656/98

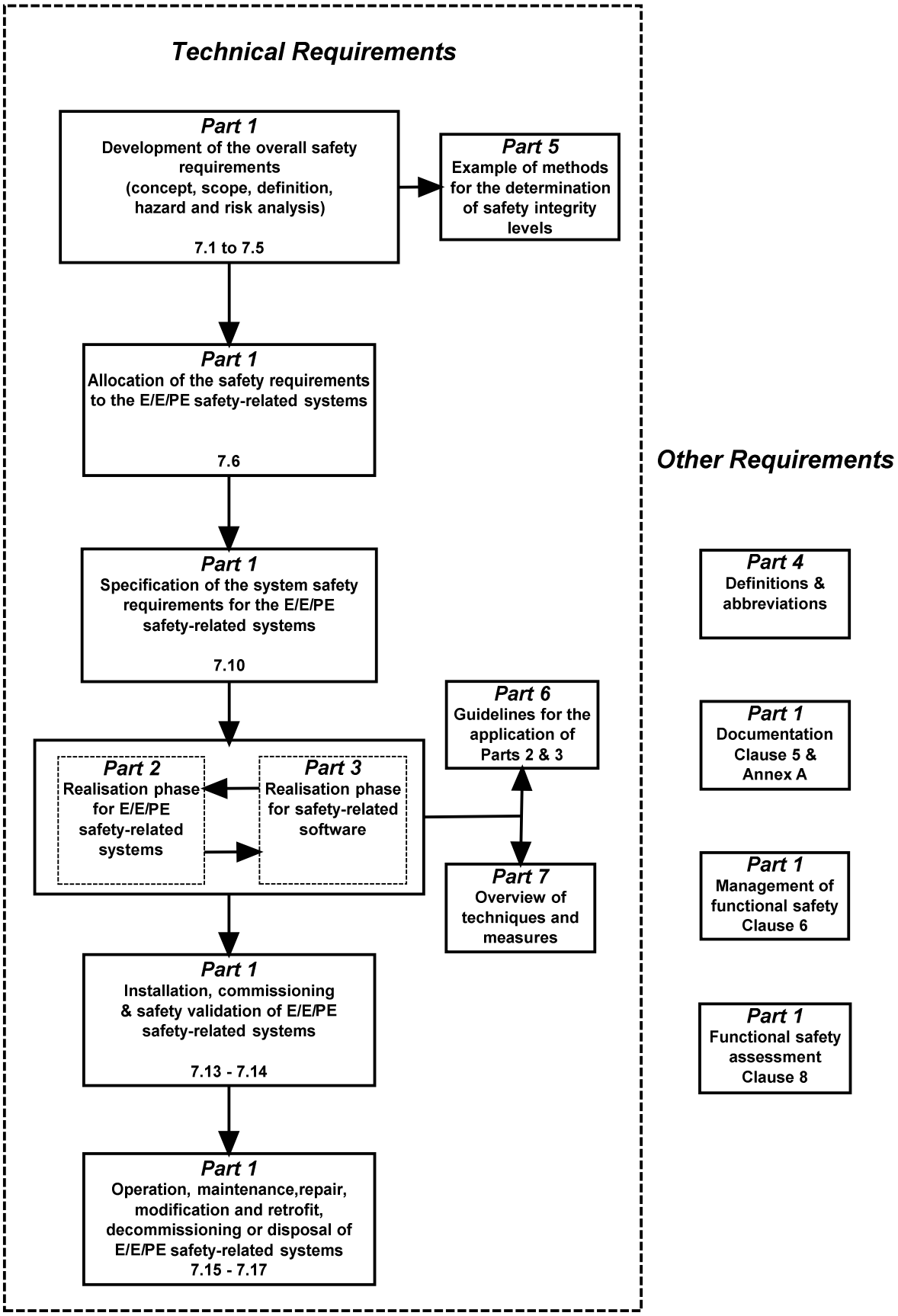


Figure 1 – Overall framework of the IEC 61508 series (1B)

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.

~~IEC 60050(191):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 191: Dependability and quality of service*~~

~~IEC 60050(351):1975, *International Electrotechnical Vocabulary (IEV) – Chapter 351: Automatic control*~~

~~IEC 61508-1:1998, *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 1: General requirements*~~

~~IEC 61508-2:–, *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronical/programmable electronic safety-related* _)~~

~~IEC 61508-3:1998, *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 3: Software requirements*~~

~~IEC 61508-5:1998, *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 5: Examples of methods for the determination of safety integrity levels*~~

~~IEC 61508-6:–, *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3*~~[1)]

~~IEC 61508-7:–, *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 7: Overview of techniques and measures*~~[1)]

IEC Guide 104:1997, *The preparation of safety publications and the use of basic safety publications and group safety publications*

~~ISO/IEC 2382-14:1998, *Data processing – Vocabulary – Part 14: Reliability, maintainability and availability*~~

ISO/IEC Guide 51:~~1990~~1999, *Safety aspects – Guidelines for their inclusion in standards*

~~ISO 8402:1994, *Quality management and quality assurance – Vocabulary*~~

3 Definitions and abbreviations

For the purposes of this document, the definitions and the abbreviations given in Table 1 below, as well as the following apply.

~~1) To be published.~~

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/ PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –

Part 5: Examples of methods for the determination of safety integrity levels

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This International Standard

– considers all relevant overall, E/E/PE~~S~~ system (2) and software safety lifecycle phases (for example, from initial concept, through design, implementation, operation and maintenance to decommissioning) when E/E/PE~~Ss~~ systems (2) are used to perform safety functions;

– has been conceived with a rapidly developing technology in mind; the framework is sufficiently robust and comprehensive to cater for future developments;

– enables product and application sector international standards, dealing with E/E/PE safety-related ~~E/E/PESs~~ systems (2), to be developed; the development of product and (10) application sector international standards, within the framework of this standard, should lead to a high level of consistency (for example, of underlying principles, terminology etc.) both within application sectors and across application sectors; this will have both safety and economic benefits;

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– sets a lower limit on the target failure measures~~, in a dangerous mode of failure, that can be claimed~~ for a safety function carried out by a single E/E/PE safety-related system (4). For E/E/PE safety-related systems operating in

  – a low demand mode of operation, the lower limit is set at an average probability of ~~failure~~ a dangerous failure on demand of 10^{-5} ~~to perform its design function on demand~~;(4)

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NOTE 3 A single E/E/PE safety-related system does not necessarily mean a single-channel architecture.

NOTE 4 It may be possible to achieve designs of safety-related systems with lower values for the target safety integrity for non-complex systems, but these limits are considered to represent what can be achieved for relatively complex systems (for example programmable electronic safety-related systems) at the present time.(6)

– sets requirements for the avoidance and control of systematic faults, which are based on experience and judgement from practical experience gained in industry. Even though the probability of occurrence of systematic failures cannot in general be quantified the standard does, however, allow a claim to be made, for a specified safety function, that the target failure measure associated with the safety function can be considered to be achieved if all the requirements in the standard have been met;(7)

– introduces systematic capability which applies to an element (1) with respect to its confidence that the systematic safety integrity meets the requirements of the specified safety integrity level;(8)

– adopts a broad range of principles, techniques and measures to achieve functional safety for E/E/PE safety-related systems, but does not explicitly use the concept of fail safe ~~which may be of value when the failure modes are well defined and the level of complexity is relatively low. The concept of fail safe was considered inappropriate because of the full range of complexity of E/E/PE safety related systems that are within the scope of the standard.~~(5) However, the concepts of “fail safe” and “inherently safe” principles may be applicable and adoption of such concepts is acceptable providing the requirements of the relevant clauses in the standard are met.(9)

FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/ PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –

Part 5: Examples of methods for the determination of safety integrity levels

1 Scope

1.1 This part of IEC 61508 provides information on

– the underlying concepts of risk and the relationship of risk to safety integrity (see Annex A);

– a number of methods that will enable the safety integrity levels for the E/E/PE safety-related systems ~~other technology safety-related systems and external risk reduction facilities~~ to be determined (see Annexes ~~B,~~ C, D, E, F and G).

~~**1.2**~~ The method selected will depend upon the application sector and the specific circumstances under consideration. Annexes ~~B,~~ C, D, E, F and G illustrate quantitative and qualitative approaches and have been simplified in order to illustrate the underlying principles. These annexes have been included to illustrate the general principles of a number of methods but do not provide a definitive account. Those intending to apply the methods indicated in these annexes should consult the source material referenced.

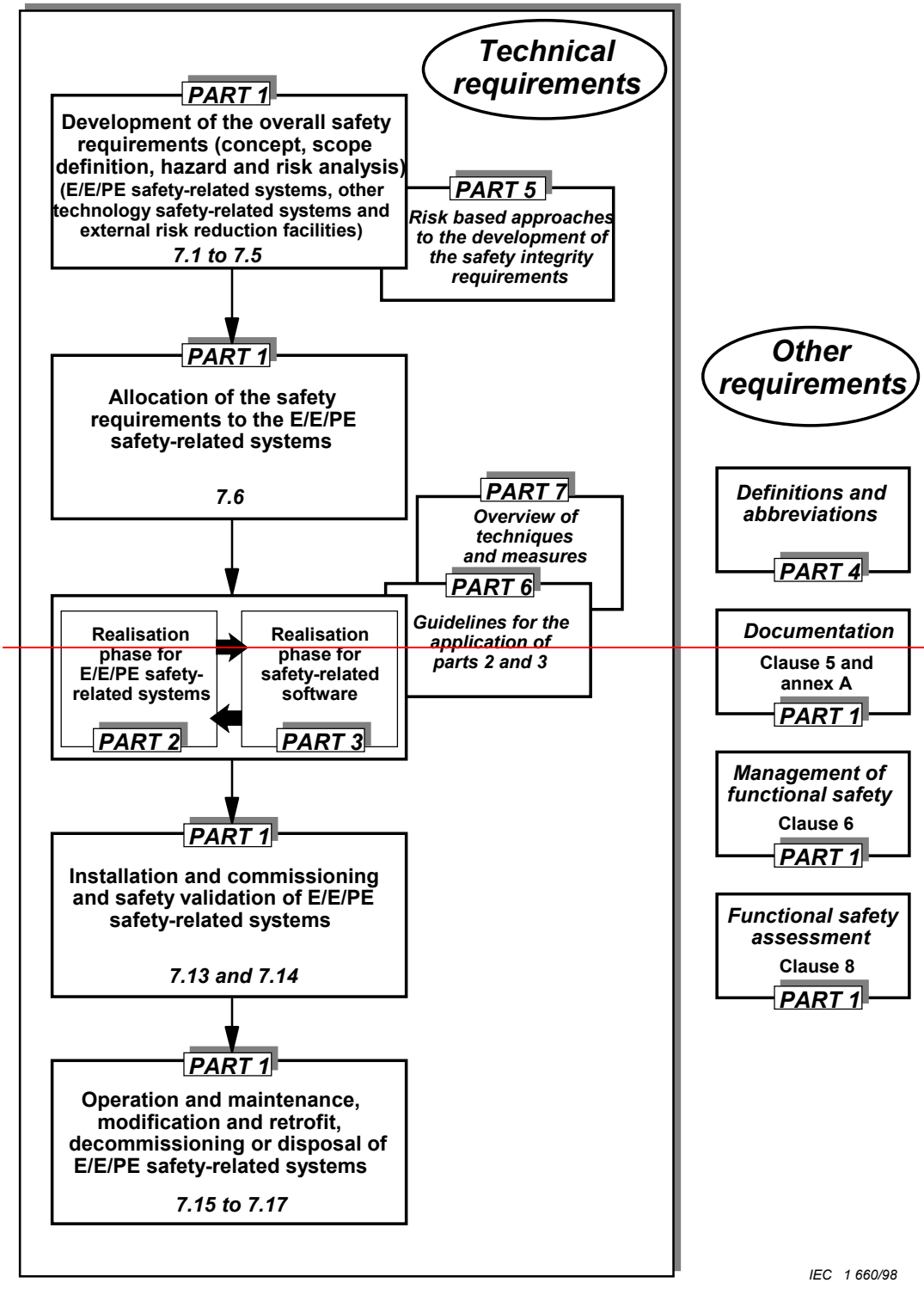
NOTE For more information on the approaches illustrated in Annexes B, ~~D~~ and E, see references ~~[4], [2] and [3]~~ [5] and [8] in the Bibliography. See also reference ~~[5]~~ [6] in the Bibliography for a description of an additional approach.

~~**1.3**~~ **1.2** IEC 61508-1, IEC 61508-2, IEC 61508-3 and IEC 61508-4 are basic safety publications, although this status does not apply in the context of low complexity E/E/PE safety-related systems (see ~~3.4.4~~ 3.4.3 of IEC 61508-4). As basic safety publications, they are intended for use by technical committees in the preparation of standards in accordance with the principles contained in IEC Guide 104 and ISO/IEC Guide 51. IEC 61508-1, IEC 61508-2, IEC 61508-3 and IEC 61508-4 are also intended for use as stand-alone publications. The horizontal safety function of this international standard does not apply to medical equipment in compliance with the IEC 60601 series.

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1.4 Figure 1 shows the overall framework of the IEC 61508 series and indicates the role that IEC 61508-5 plays in the achievement of functional safety for E/E/PE safety-related systems.


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PART 6
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PART 2
Realisation phase for safety-related software
PART 3
PART 1
Installation and commissioning and safety validation of E/E/PE safety-related systems
7.13 and 7.14
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Operation and maintenance, modification and retrofit, decommissioning or disposal of E/E/PE safety-related systems
7.15 to 7.17
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Documentation
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Management of functional safety
Clause 6
PART 1
Functional safety assessment
Clause 8
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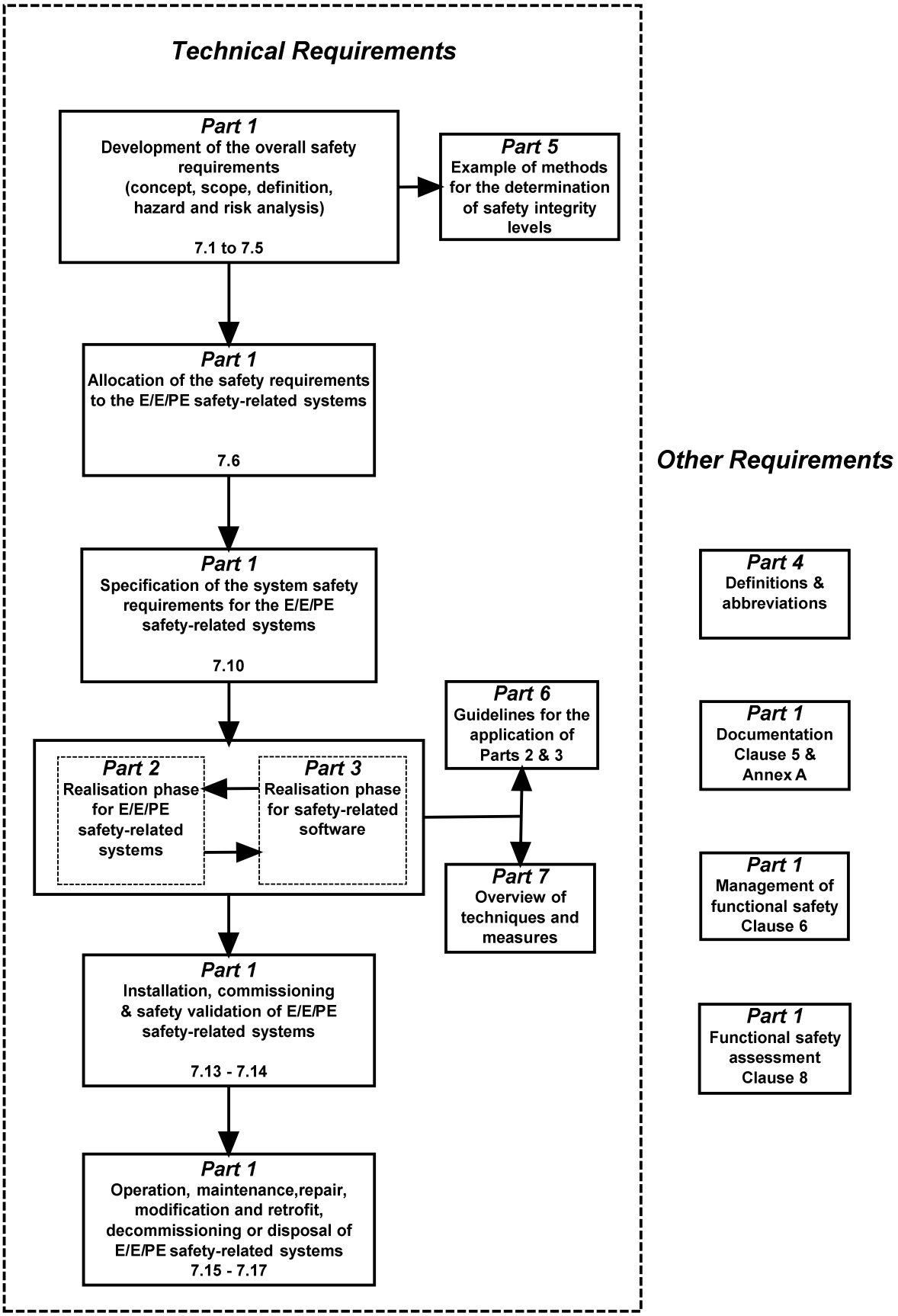


Figure 1 – Overall framework of the IEC 61508 series (1B)

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.

IEC 61508-1:~~1998~~ 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

~~IEC 61508-2, *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronical/programmable electronic safety-related systems*~~ [1)]

~~IEC 61508-3:1998, *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 3: Software requirements*~~

IEC 61508-4:~~1998~~ 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 4: Definitions and abbreviations*

~~IEC 61508-6, *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 6: Guidelines on the application of parts 2 and 3*~~ [1)]

~~IEC 61508-7, *Functional safety of electrical/electronical/programmable electronic safety-related systems – Part 7: Overview of techniques and measures*~~ [1)]

~~ISO/IEC Guide 51:1990, *Guidelines for the inclusion of safety aspects in standards*~~

~~IEC Guide 104:1997, *Guide to the drafting of safety standards, and the role of Committees with safety pilot functions and safety group functions*~~

3 Definitions and abbreviations

For the purposes of this document, the definitions and abbreviations given in IEC 61508-4 apply.

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1) To be published.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/ PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –

Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
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6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

DISCLAIMER
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This Redline version provides you with a quick and easy way to compare all the changes between this standard and its previous edition. Additions and deletions are displayed in red, with deletions being struck through.

International Standard IEC 61508-6 has been prepared by subcommittee 65A: System aspects, of IEC technical committee 65: Industrial-process measurement, control and automation.

This second edition cancels and replaces the first edition published in 2000. This edition constitutes a technical revision.

This edition has been subject to a thorough review and incorporates many comments received at the various revision stages.

The text of this standard is based on the following documents:

FDIS	Report on voting
65A/553/FDIS	65A/577/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61508 series, published under the general title *Functional safety of electrical / electronic / programmable electronic safety-related systems*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

Systems comprised of electrical and/or electronic ~~components~~ elements (1) have been used for many years to perform safety functions in most application sectors. Computer-based systems (generically referred to as programmable electronic systems ~~(PESs)~~) are being used in all application sectors to perform non-safety functions and, increasingly, to perform safety functions. If computer system technology is to be effectively and safely exploited, it is essential that those responsible for making decisions have sufficient guidance on the safety aspects on which to make these decisions.

This International Standard sets out a generic approach for all safety lifecycle activities for systems comprised of electrical and/or electronic and/or programmable electronic ~~components (electrical/electronic/programmable electronic systems (E/E/PESs))~~ (E/E/PE) (2) elements (1) that are used to perform safety functions. This unified approach has been adopted in order that a rational and consistent technical policy be developed for all electrically-based safety-related systems. A major objective is to facilitate the development of product and application sector international standards based on the IEC 61508 series.

NOTE 1 Examples of product and application sector international standards based on the IEC 61508 series are given in the Bibliography (see references [1], [2] and [3]).

In most situations, safety is achieved by a number of ~~protective~~ systems which rely on many technologies (for example mechanical, hydraulic, pneumatic, electrical, electronic, programmable electronic). Any safety strategy must therefore consider not only all the elements (1) within an individual system (for example sensors, controlling devices and actuators) but also all the safety-related systems making up the total combination of safety-related systems. Therefore, while this International Standard is concerned with ~~electrical/electronic/programmable electronic (~~E/E/PE~~)~~ safety-related systems, it may also provide a framework within which safety-related systems based on other technologies may be considered.

It is recognized that there is a great variety of ~~E/E/PES~~ applications using E/E/PE safety-related systems in a variety of application sectors and covering a wide range of complexity, hazard and risk potentials. In any particular application, the required safety measures will be dependent on many factors specific to the application. This International Standard, by being generic, will enable such measures to be formulated in future product and (10) application sector international standards and in revisions of those that already exist.

This International Standard

– considers all relevant overall, E/E/PE~~S~~ system (2) and software safety lifecycle phases (for example, from initial concept, through design, implementation, operation and maintenance to decommissioning) when E/E/PE~~Ss~~ systems (2) are used to perform safety functions;

– has been conceived with a rapidly developing technology in mind; the framework is sufficiently robust and comprehensive to cater for future developments;

– enables product and application sector international standards, dealing with E/E/PE safety-related ~~E/E/PESs~~ systems (2), to be developed; the development of product and (10) application sector international standards, within the framework of this standard, should lead to a high level of consistency (for example, of underlying principles, terminology etc.) both within application sectors and across application sectors; this will have both safety and economic benefits;

– provides a method for the development of the safety requirements specification necessary to achieve the required functional safety for E/E/PE safety-related systems;

– adopts a risk-based approach ~~for the determination of~~ by which the safety integrity ~~level~~ requirements can be determined;

– ~~uses~~ introduces safety integrity levels for specifying the target level of safety integrity for the safety functions to be implemented by the E/E/PE safety-related systems;

NOTE 2 The standard does not specify the safety integrity level requirements for any safety function, nor does it mandate how the safety integrity level is determined. Instead it provides a risk-based conceptual framework and example techniques.

– sets ~~numerical~~ (3) target failure measures for safety functions carried out by E/E/PE safety-related systems, which are linked to the safety integrity levels;

– sets a lower limit on the target failure measures~~, in a dangerous mode of failure, that can be claimed~~ for a safety function carried out by a single E/E/PE safety-related system (4). For E/E/PE safety-related systems operating in

  – a low demand mode of operation, the lower limit is set at an average probability of ~~failure~~ a dangerous failure on demand of 10^{-5} ~~to perform its design function on demand~~;(4)

  – a high demand or a continuous mode of operation, the lower limit is set at ~~a probability~~ an average frequency of a dangerous failure of 10^{-9} ~~per hour~~ [h^{-1}];(4)

NOTE 3 A single E/E/PE safety-related system does not necessarily mean a single-channel architecture.

NOTE 4 It may be possible to achieve designs of safety-related systems with lower values for the target safety integrity for non-complex systems, but these limits are considered to represent what can be achieved for relatively complex systems (for example programmable electronic safety-related systems) at the present time.(6)

– sets requirements for the avoidance and control of systematic faults, which are based on experience and judgement from practical experience gained in industry. Even though the probability of occurrence of systematic failures cannot in general be quantified the standard does, however, allow a claim to be made, for a specified safety function, that the target failure measure associated with the safety function can be considered to be achieved if all the requirements in the standard have been met;(7)

– introduces systematic capability which applies to an element (1) with respect to its confidence that the systematic safety integrity meets the requirements of the specified safety integrity level;(8)

– adopts a broad range of principles, techniques and measures to achieve functional safety for E/E/PE safety-related systems, but does not explicitly use the concept of fail safe ~~which may be of value when the failure modes are well defined and the level of complexity is relatively low. The concept of fail safe was considered inappropriate because of the full range of complexity of E/E/PE safety related systems that are within the scope of the standard.~~(5) However, the concepts of “fail safe” and “inherently safe” principles may be applicable and adoption of such concepts is acceptable providing the requirements of the relevant clauses in the standard are met.(9)

FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/ PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –

Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3

1 Scope

1.1 This part of IEC 61508 contains information and guidelines on IEC 61508-2 and IEC 61508-3.

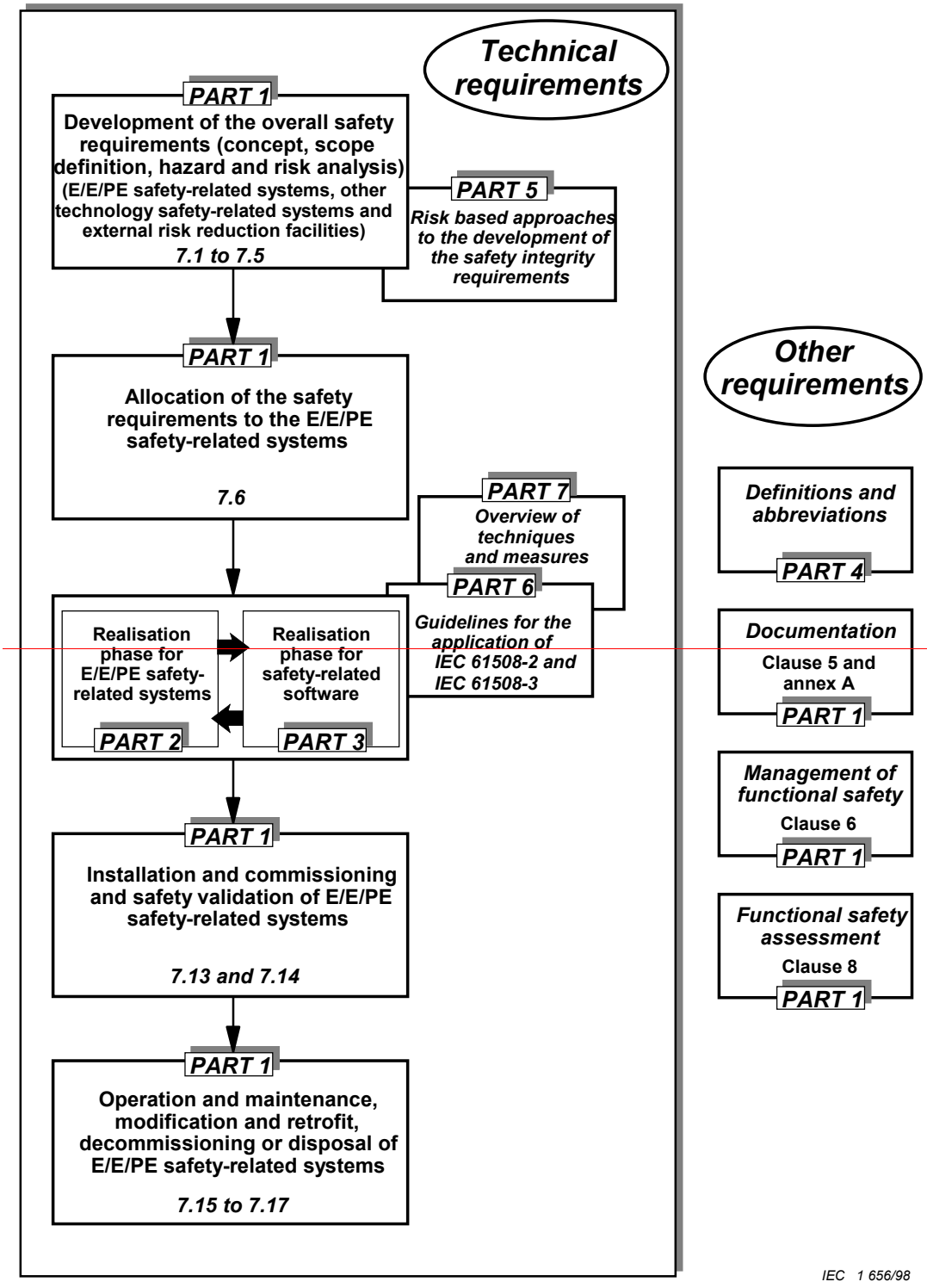
- Annex A gives a brief overview of the requirements of IEC 61508-2 and IEC 61508-3 and sets out the functional steps in their application.
- Annex B gives an example technique for calculating the probabilities of hardware failure and should be read in conjunction with 7.4.3 and Annex C of IEC 61508-2 and Annex D.
- Annex C gives a worked example of calculating diagnostic coverage and should be read in conjunction with Annex C of IEC 61508-2.
- Annex D gives a methodology for quantifying the effect of hardware-related common cause failures on the probability of failure.
- Annex E gives worked examples of the application of the software safety integrity tables specified in Annex A of IEC 61508-3 for safety integrity levels 2 and 3.

1.2 IEC 61508-1, IEC 61508-2, IEC 61508-3 and IEC 61508-4 are basic safety publications, although this status does not apply in the context of low complexity E/E/PE safety-related systems (see ~~3.4.4~~ 3.4.3 of IEC 61508-4). As basic safety publications, they are intended for use by technical committees in the preparation of standards in accordance with the principles contained in IEC Guide 104 and ISO/IEC Guide 51. ~~IEC 61508~~ IEC 61508-1, IEC 61508-2, IEC 61508-3 and IEC 61508-4 are also intended for use as stand-alone publications. The horizontal safety function of this international standard does not apply to medical equipment in compliance with the IEC 60601 series.(16)

1.3 One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications. In this context, the requirements, test methods or test conditions of this basic safety publication will not apply unless specifically referred to or included in the publications prepared by those technical committees.

~~NOTE In the USA and Canada, until the proposed process sector implementation of IEC 61508 (i.e. IEC 61511) is published as an international standard, existing national process safety standards based on IEC 61508 (i.e. ANSI/ISA S84.01-1996) can be applied to the process sector instead of IEC 61508.~~(17)

1.4 Figure 1 shows the overall framework of the IEC 61508 series and indicates the role that IEC 61508-6 plays in the achievement of functional safety for E/E/PE safety-related systems.


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Development of the overall safety requirements (concept, scope definition, hazard and risk analysis)
(E/E/PE safety-related systems, other technology safety-related systems and external risk reduction facilities)
7.1 to 7.5
PART 5
Risk based approaches to the development of the safety integrity requirements
PART 1
Allocation of the safety requirements to the E/E/PE safety-related systems
7.6
PART 7
Overview of techniques and measures
PART 6
Guidelines for the application of IEC 61508-2 and IEC 61508-3
Realisation phase for E/E/PE safety-related systems
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Realisation phase for safety-related software
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Clause 6
PART 1
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Clause 8
PART 1
IEC 1 656/98

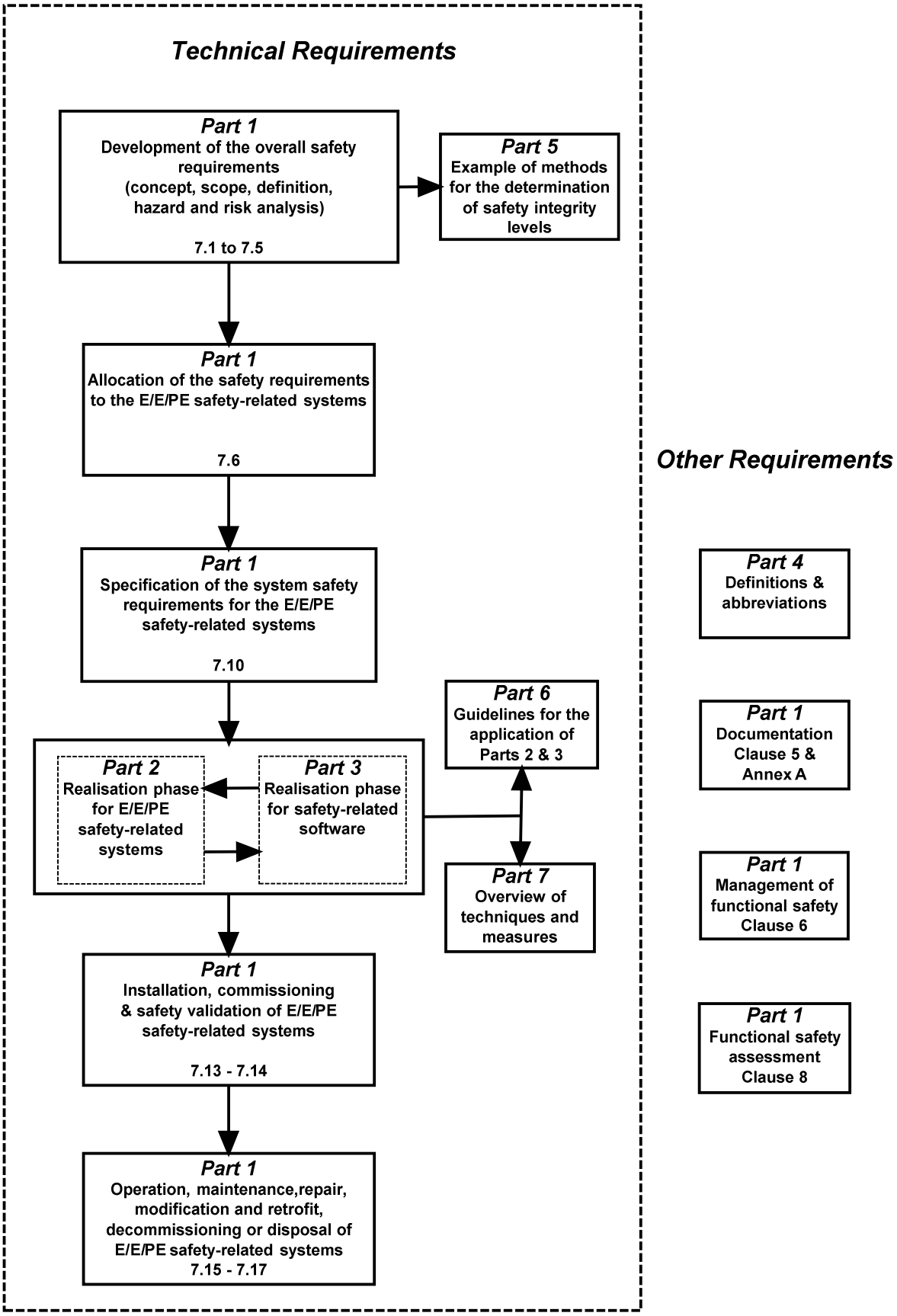


Figure 1 – Overall framework of the IEC 61508 series (1B)

2 Normative references

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~~IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*~~

IEC 61508-2:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems*

IEC 61508-3:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements*

IEC 61508-4:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 4: Definitions and abbreviations*

~~IEC Guide 104:1997, *Guide to the drafting of safety standards and the rôle of committees with safety pilot functions and safety group functions*~~

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/ PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –

Part 7: Overview of techniques and measures

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This second edition cancels and replaces the first edition published in 2000. This edition constitutes a technical revision.

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This International Standard sets out a generic approach for all safety lifecycle activities for systems comprised of electrical and/or electronic and/or programmable electronic ~~components (electrical/electronic/programmable electronic systems (E/E/PESs))~~ (E/E/PE) (2) elements (1) that are used to perform safety functions. This unified approach has been adopted in order that a rational and consistent technical policy be developed for all electrically-based safety-related systems. A major objective is to facilitate the development of product and application sector international standards based on the IEC 61508 series.

NOTE 1 Examples of product and application sector international standards based on the IEC 61508 series are given in the Bibliography (see references [21], [22] and [37]).

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– considers all relevant overall, E/E/PE~~S~~ system (2) and software safety lifecycle phases (for example, from initial concept, through design, implementation, operation and maintenance to decommissioning) when E/E/PE~~Ss~~ systems (2) are used to perform safety functions;

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– enables product and application sector international standards, dealing with E/E/PE safety-related ~~E/E/PESs~~ systems (2), to be developed; the development of product and (10) application sector international standards, within the framework of this standard, should lead to a high level of consistency (for example, of underlying principles, terminology etc.) both within application sectors and across application sectors; this will have both safety and economic benefits;

– provides a method for the development of the safety requirements specification necessary to achieve the required functional safety for E/E/PE safety-related systems;

– adopts a risk-based approach ~~for the determination of~~ by which the safety integrity ~~level~~ requirements can be determined;

– ~~uses~~ introduces safety integrity levels for specifying the target level of safety integrity for the safety functions to be implemented by the E/E/PE safety-related systems;

NOTE 2 The standard does not specify the safety integrity level requirements for any safety function, nor does it mandate how the safety integrity level is determined. Instead it provides a risk-based conceptual framework and example techniques.

– sets ~~numerical~~ (3) target failure measures for safety functions carried out by E/E/PE safety-related systems, which are linked to the safety integrity levels;

– sets a lower limit on the target failure measures~~, in a dangerous mode of failure, that can be claimed~~ for a safety function carried out by a single E/E/PE safety-related system (4). For E/E/PE safety-related systems operating in

  – a low demand mode of operation, the lower limit is set at an average probability of ~~failure~~ a dangerous failure on demand of 10^{-5} ~~to perform its design function on demand~~;(4)

  – a high demand or a continuous mode of operation, the lower limit is set at ~~a probability~~ an average frequency of a dangerous failure of 10^{-9} ~~per hour~~ [h^{-1}];(4)

NOTE 3 A single E/E/PE safety-related system does not necessarily mean a single-channel architecture.

NOTE 4 It may be possible to achieve designs of safety-related systems with lower values for the target safety integrity for non-complex systems, but these limits are considered to represent what can be achieved for relatively complex systems (for example programmable electronic safety-related systems) at the present time.(6)

– sets requirements for the avoidance and control of systematic faults, which are based on experience and judgement from practical experience gained in industry. Even though the probability of occurrence of systematic failures cannot in general be quantified the standard does, however, allow a claim to be made, for a specified safety function, that the target failure measure associated with the safety function can be considered to be achieved if all the requirements in the standard have been met;(7)

– introduces systematic capability which applies to an element (1) with respect to its confidence that the systematic safety integrity meets the requirements of the specified safety integrity level;(8)

– adopts a broad range of principles, techniques and measures to achieve functional safety for E/E/PE safety-related systems, but does not explicitly use the concept of fail safe ~~which may be of value when the failure modes are well defined and the level of complexity is relatively low. The concept of fail safe was considered inappropriate because of the full range of complexity of E/E/PE safety related systems that are within the scope of the standard.~~(5) However, the concepts of “fail safe” and “inherently safe” principles may be applicable and adoption of such concepts is acceptable providing the requirements of the relevant clauses in the standard are met.(9)

FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/ PROGRAMMABLE ELECTRONIC SAFETY-RELATED SYSTEMS –

Part 7: Overview of techniques and measures

1 Scope (700)

1.1 This part of IEC 61508 contains an overview of various safety techniques and measures relevant to IEC 61508-2 and IEC 61508-3.

The references should be considered as basic references to methods and tools or as examples, and may not represent the state of the art.

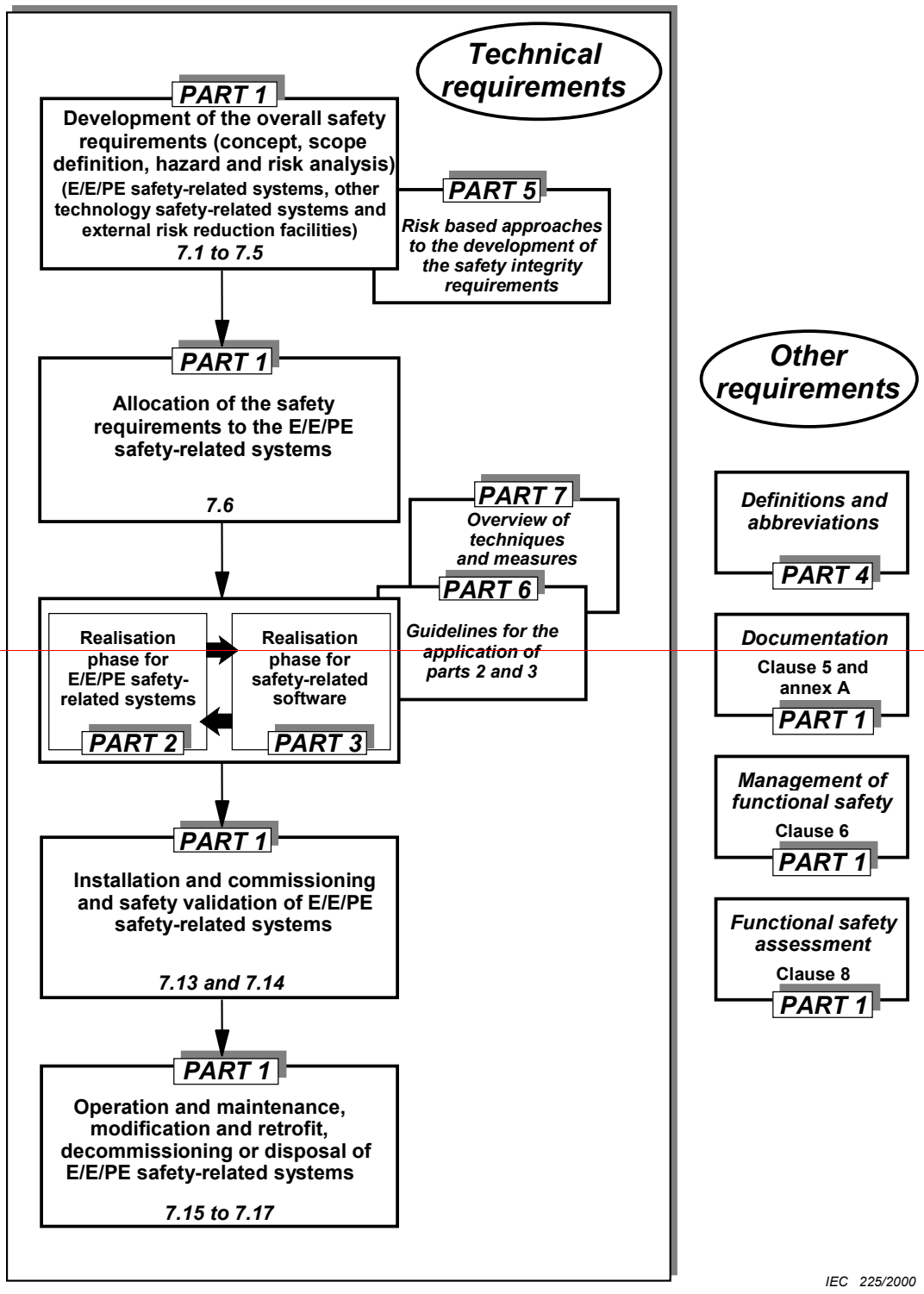
1.2 IEC 61508-1, IEC 61598-2, IEC 61508-3 and IEC 61508-4 are basic safety publications, although this status does not apply in the context of low complexity E/E/PE safety-related systems (see ~~3.4.4~~ 3.4.3 of IEC 61508-4). As basic safety publications, they are intended for use by technical committees in the preparation of standards in accordance with the principles contained in IEC Guide 104 and ISO/IEC Guide 51. ~~IEC 61508~~ IEC 61508-1, IEC 61508-2, IEC 61508-3 and IEC 61508-4 are also intended for use as stand-alone publications. The horizontal safety function of this international standard does not apply to medical equipment in compliance with the IEC 60601 series.(16)

1.3 One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications. In this context, the requirements, test methods or test conditions of this basic safety publication will not apply unless specifically referred to or included in the publications prepared by those technical committees.

~~NOTE 1 The functional safety of an E/E/PE safety-related system can only be achieved when all related requirements are met. Therefore it is important that all related requirements are carefully considered and adequately referenced.~~

~~NOTE 2 In the USA and Canada, until the proposed process sector implementation of IEC 61508~~**1.4** Figure 1 shows the overall framework for parts 1 to 7 of IEC 61508 ~~(i.e. IEC 61511) is published as an international standard in the USA and Canada, existing national process safety standards based on IEC 61508 (i.e. ANSI/ISA S84.01-1996) can be applied to the process sector instead of IEC 61508.~~(17)

~~**1.3**~ **1.4** Figure 1 shows the overall framework for parts 1 to 7 of IEC 61508 and indicates the role that IEC 61508-7 plays in the achievement of functional safety for E/E/PE safety-related systems.


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PART 1
Management of functional safety
Clause 6
PART 1
Functional safety assessment
Clause 8
PART 1
IEC 225/2000

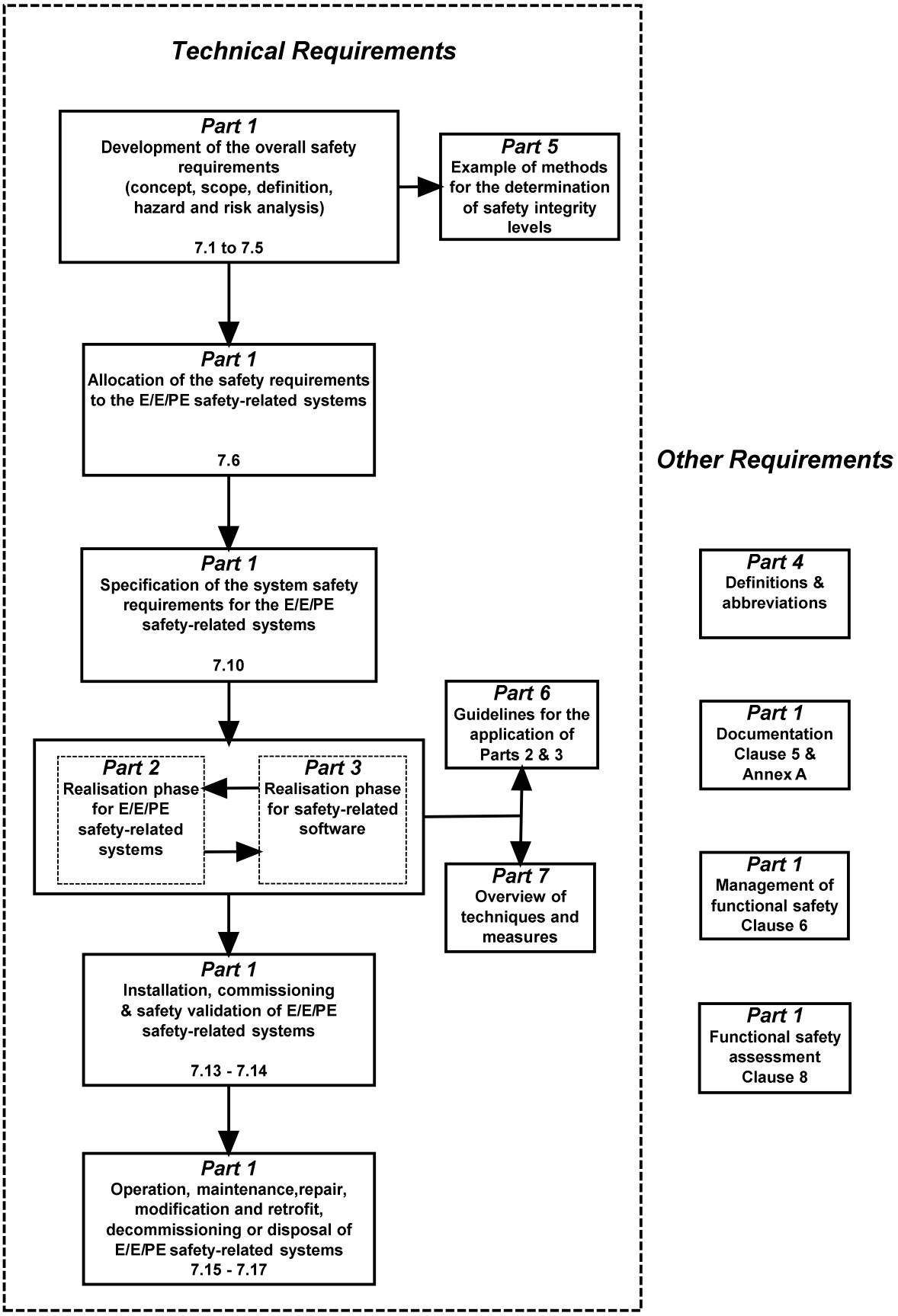


Figure 1 – Overall framework of IEC 61508 (1B)

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.

~~IEC 61508-1:1998, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*~~

~~IEC 61508-2, *Functional safety of electrical/electronic/programmable electronic safety related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems* [1)]~~

~~IEC 61508-3:1998, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements*~~

IEC 61508-4:~~1998~~ 2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 4: Definitions and abbreviations*

~~IEC 61508-5:1998, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 5 Examples of methods for the determination of safety integrity levels*~~

~~IEC 61508-6, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3* [1)]~~

~~IEC Guide 104:1997, *The preparation of safety publications and the use of basic safety publications and group safety publications*~~

~~IEC/ISO Guide 51:1990, *Guidelines for the inclusion of safety aspects in standards*~~

3 Definitions and abbreviations

For the purposes of this document, the definitions and abbreviations given in IEC 61508-4 apply.

~~1) To be published.~~