IEC 61511-1

Edition 2.0 2016-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Functional safety – Safety instrumented systems for the process industry sector –
Part 1: Framework, definitions, system, hardware and application programming requirements

Sécurite fonctionnelle – Systèmes instrumentes de sécurité pour le secteur des industries de transformation –
Partie 1: Cadre, définitions, exigences pour le système, le matériel et la programmation d'application

IEC 61511-1:2016-02(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FUNCTIONAL SAFETY – SAFETY INSTRUMENTED SYSTEMS FOR THE PROCESS INDUSTRY SECTOR –

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FOREWORD

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International Standard IEC 61511-1 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 2003. This edition constitutes a technical revision. This edition includes the following significant technical changes with respect to the previous edition:

- references and requirements to software replaced with references and requirements to application programming;
- functional safety assessment requirements provided with more detail to improve management of functional safety.
- management of change requirement added;

- security risk assessment requirements added;.
- requirements expanded on the basic process control system as a protection layer;
- requirements for hardware fault tolerance modified and should be reviewed carefully to understand user/integrator options.

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

FDIS	Report on voting
65A/777/FDIS	65A/784/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 in the IEC 61511 series, published under the general title *Functional safety – safety instrumented systems for the process industry sector*, 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 website 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.

The contents of the corrigendum of September 2016 have been included in this copy.

INTRODUCTION

Safety instrumented systems (SISs) have been used for many years to perform safety instrumented functions (SIFs) in the process industries. If instrumentation is to be effectively used for SIFs, it is essential that this instrumentation achieves certain minimum standards and performance levels.

The IEC 61511 series addresses the application of SISs for the process industries. The IEC 61511 series also addresses a process Hazard and Risk Assessment (H&RA) to be carried out to enable the specification for SISs to be derived. Other safety systems' contributions are only considered with respect to the performance requirements for the SIS. The SIS includes all devices necessary to carry out each SIF from sensor(s) to final element(s).

The IEC 61511 series has two concepts which are fundamental to its application: SIS safety life-cycle and safety integrity levels (SILs).

The IEC 61511 series addresses SISs which are based on the use of electrical/electronic/programmable electronic technology. Where other technologies are used for logic solvers, the basic principles of the IEC 61511 series should be applied to ensure the functional safety requirements are met. The IEC 61511 series also addresses the SIS sensors and final elements regardless of the technology used. The IEC 61511 series is process industry specific within the framework of the IEC 61508 series.

The IEC 61511 series sets out an approach for SIS safety life-cycle activities to achieve these minimum principles. This approach has been adopted in order that a rational and consistent technical policy is used.

In most situations, safety is best achieved by an inherently safe process design. However in some instances this is not possible or not practical. If necessary, this may be combined with a protective system or systems to address any residual identified risk. Protective systems can rely on different technologies (chemical, mechanical, hydraulic, pneumatic, electrical, electronic, and programmable electronic). To facilitate this approach, the IEC 61511 series:

- addresses that a H&RA is carried out to identify the overall safety requirements;
- addresses that an allocation of the safety requirements to the SIS is carried out;
- works within a framework which is applicable to all instrumented means of achieving functional safety;
- details the use of certain activities, such as safety management, which may be applicable to all methods of achieving functional safety.

The IEC 61511 series on SIS for the process industry:

- addresses all SIS safety life-cycle phases from initial concept, design, implementation, operation and maintenance through to decommissioning;
- enables existing or new country specific process industry standards to be harmonized with the IEC 61511 series.

The IEC 61511 series is intended to lead to a high level of consistency (e.g., of underlying principles, terminology, and information) within the process industries. This should have both safety and economic benefits. Figure 1 below shows an overall framework of the IEC 61511 series.

In jurisdictions where the governing authorities (e.g., national, federal, state, province, county, city) have established process safety design, process safety management, or other regulations, these take precedence over the requirements defined in the IEC 61511 series.

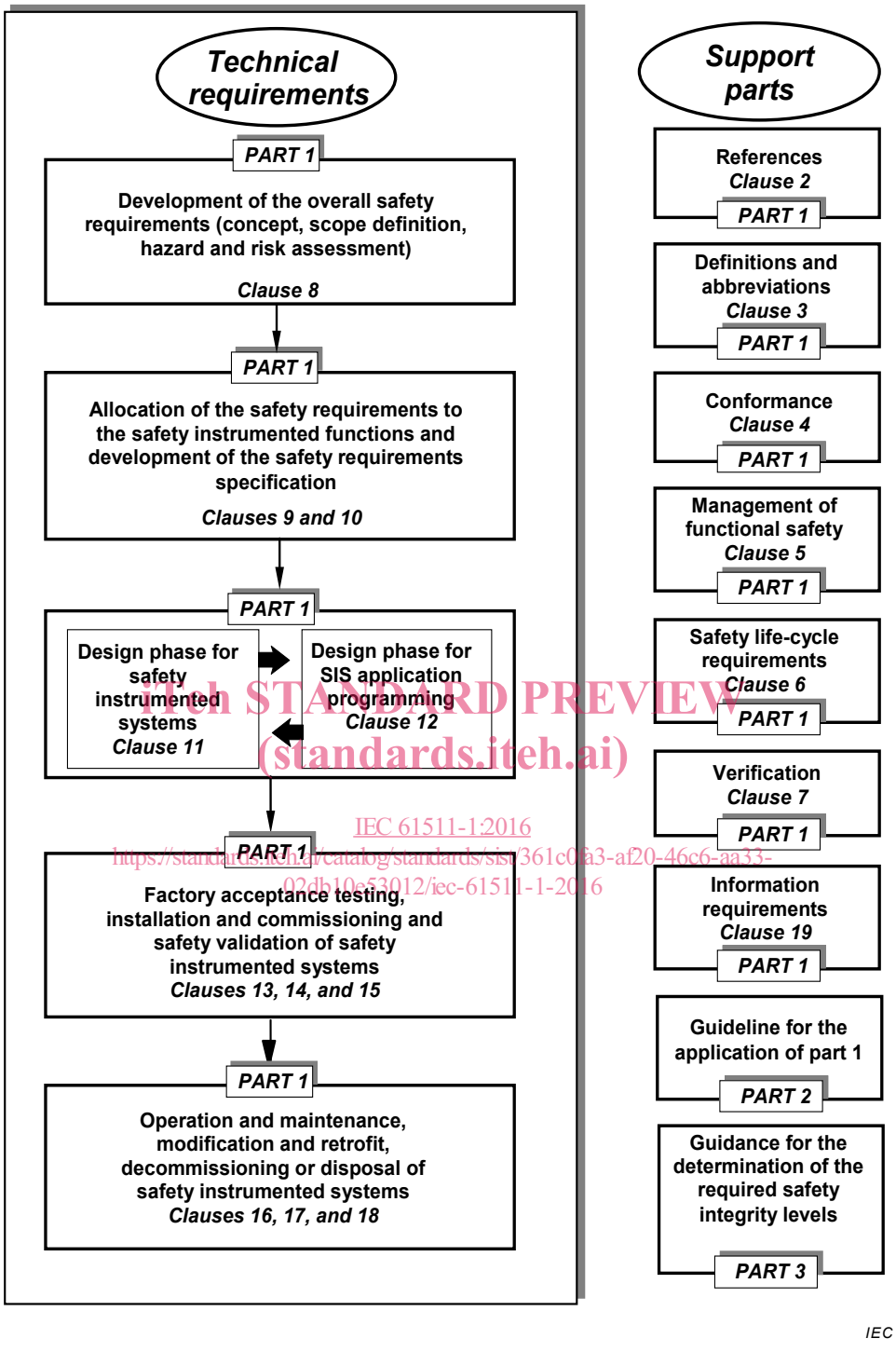

Figure 1 – Overall framework of the IEC 61511 series

FUNCTIONAL SAFETY – SAFETY INSTRUMENTED SYSTEMS FOR THE PROCESS INDUSTRY SECTOR –

Part 1: Framework, definitions, system, hardware and application programming requirements

1 Scope

This part of IEC 61511 gives requirements for the specification, design, installation, operation and maintenance of a safety instrumented system (SIS), so that it can be confidently entrusted to achieve or maintain a safe state of the process. IEC 61511-1 has been developed as a process sector implementation of IEC 61508:2010.

In particular, IEC 61511-1:

a) specifies the requirements for achieving functional safety but does not specify who is responsible for implementing the requirements (e.g., designers, suppliers, owner/operating company, contractor). This responsibility will be assigned to different parties according to safety planning, project planning and management, and national regulations;

b) applies when devices that meets the requirements of the IEC 61508 series published in 2010, or IEC 61511-1:2016 [11.5], is integrated into an overall system that is to be used for a process sector application. It does not apply to manufacturers wishing to claim that devices are suitable for use in SISs for the process sector (see IEC 61508-2:2010 and IEC 61508-3:2010);

c) defines the relationship between IEC 61511 and IEC 61508 (see Figures 2 and 3);

d) applies when application programs are developed for systems having limited variability language or when using fixed programming language devices, but does not apply to manufacturers, SIS designers, integrators and users that develop embedded software (system software) or use full variability languages (see IEC 61508-3:2010);

e) applies to a wide variety of industries within the process sector for example, chemicals, oil and gas, pulp and paper, pharmaceuticals, food and beverage, and non-nuclear power generation;

NOTE 1 Within the process sector some applications may have additional requirements that have to be satisfied.

f) outlines the relationship between SIFs and other instrumented functions (see Figure 4);

g) results in the identification of the functional requirements and safety integrity requirements for the SIF taking into account the risk reduction achieved by other methods;

h) specifies life-cycle requirements for system architecture and hardware configuration, application programming, and system integration;

i) specifies requirements for application programming for users and integrators of SISs.

j) applies when functional safety is achieved using one or more SIFs for the protection of personnel, protection of the general public or protection of the environment;

k) may be applied in non-safety applications for example asset protection;

l) defines requirements for implementing SIFs as a part of the overall arrangements for achieving functional safety;

m) uses a SIS safety life-cycle (see Figure 7) and defines a list of activities which are necessary to determine the functional requirements and the safety integrity requirements for the SIS;

n) specifies that a H&RA is to be carried out to define the safety functional requirements and safety integrity levels (SIL) of each SIF;

NOTE 2 Figure 9 presents an overview of risk reduction means.

o) establishes numerical targets for average probability of failure on demand (in demand mode) and average frequency of dangerous failures (in demand mode or continuous mode) for each SIL;

p) specifies minimum requirements for hardware fault tolerance (HFT);

q) specifies measures and techniques required for achieving the specified SIL;

r) defines a maximum level of functional safety performance (SIL 4) which can be achieved for a SIF implemented according to IEC 61511-1;

s) defines a minimum level of functional safety performance (SIL 1) below which IEC 61511-1 does not apply;

t) provides a framework for establishing the SIL but does not specify the SIL required for specific applications (which should be established based on knowledge of the particular application and on the overall targeted risk reduction);

u) specifies requirements for all parts of the SIS from sensor to final element(s);

v) defines the information that is needed during the SIS safety life-cycle;

w) specifies that the design of the SIS takes into account human factors;

x) does not place any direct requirements on the individual operator or maintenance person:

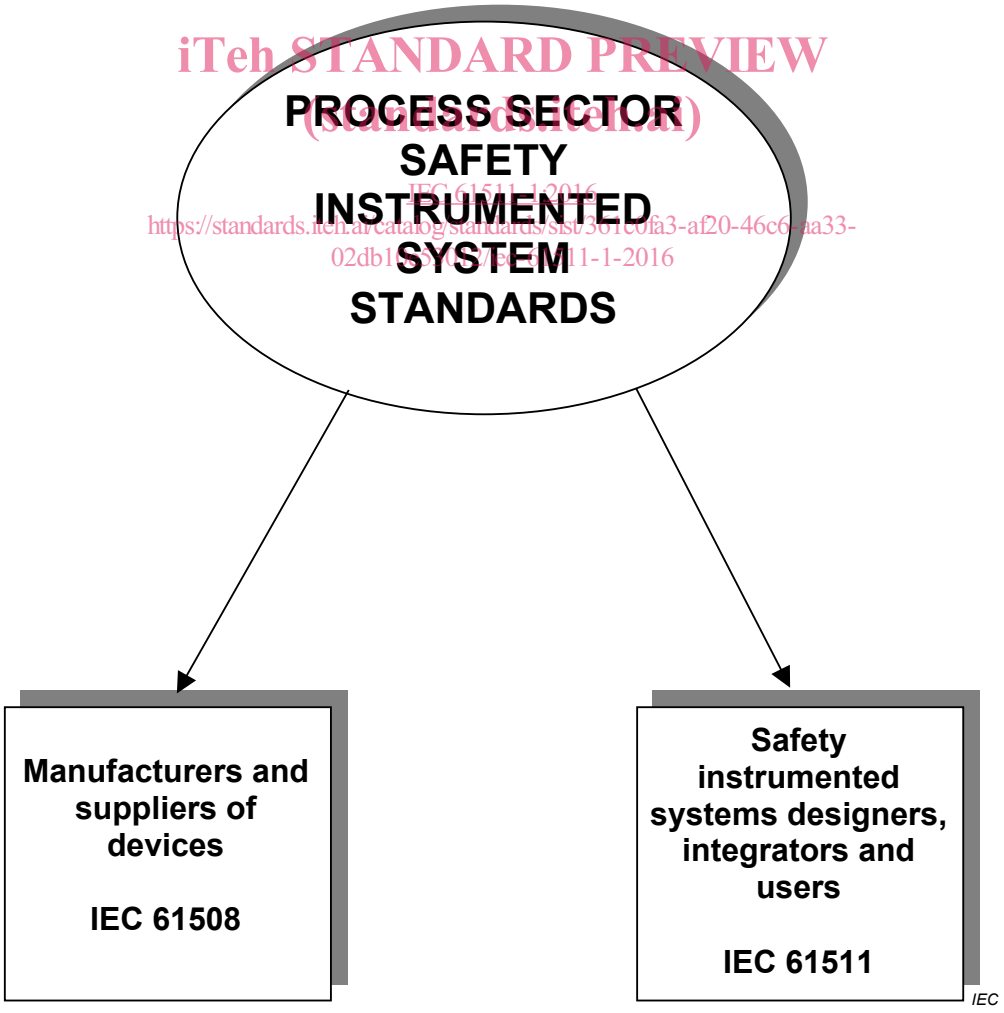

Figure 2 – Relationship between IEC 61511 and IEC 61508

NOTE 3 IEC 61508 is also used by safety instrumented designers, integrators and users where directed in IEC 61511.

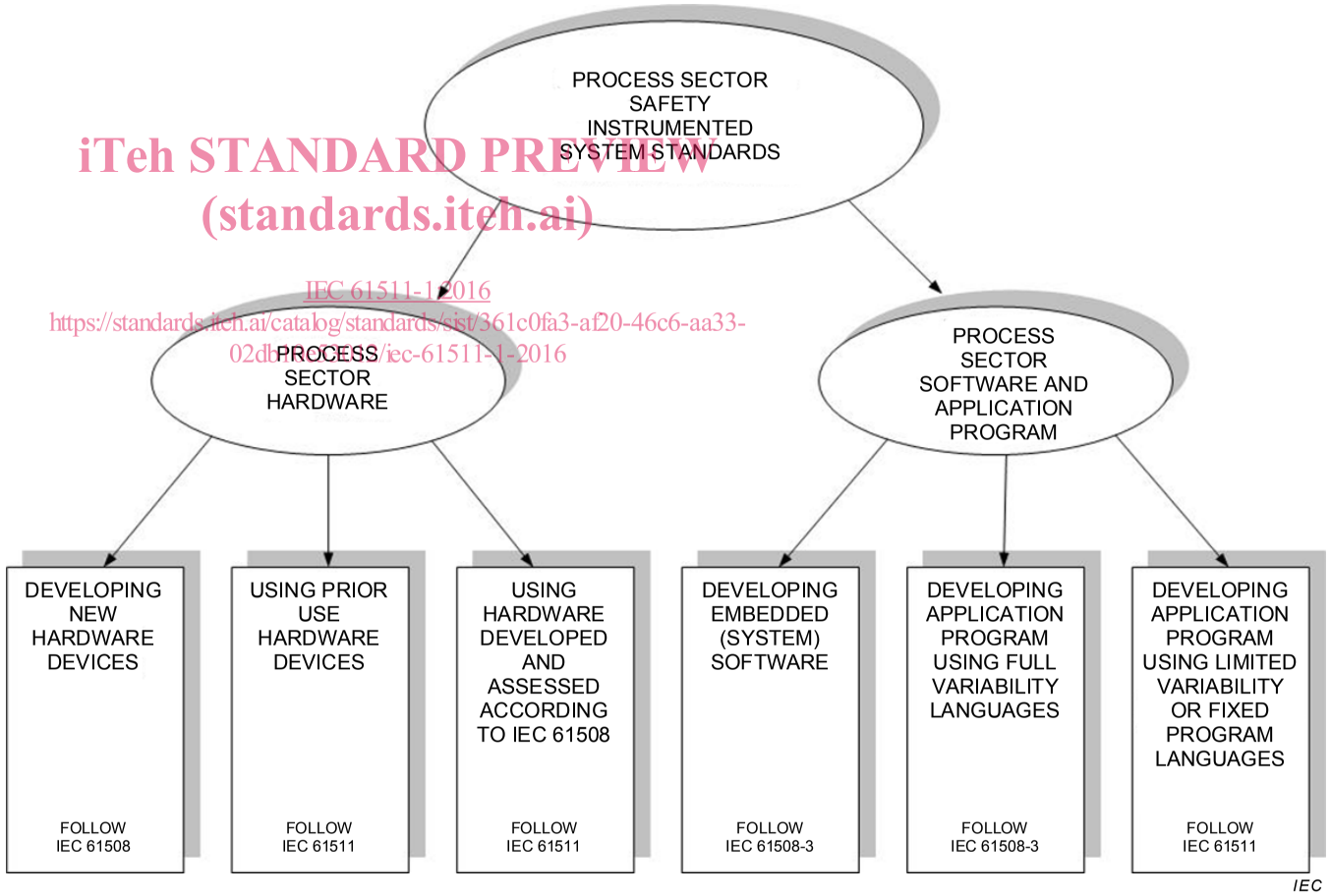

Figure 3 – Detailed relationship between IEC 61511 and IEC 61508

NOTE 4 Subclause 7.2.2 in IEC 61511-1:2016 and IEC 61511-2:2016 contain guidance on handling integration of sub-systems that comply with other standards (such as machinery , burner, etc.).

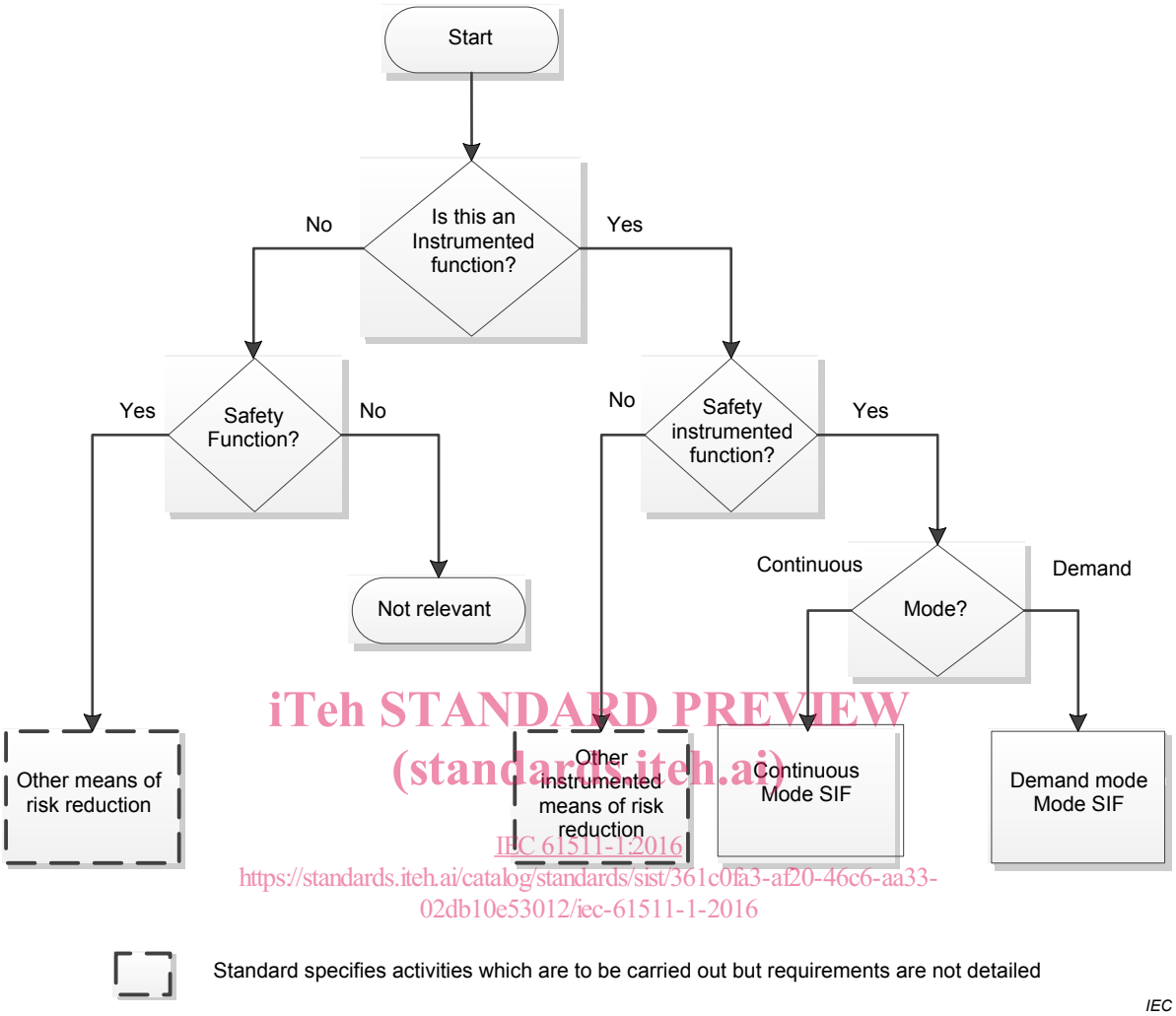

Figure 4 – Relationship between safety instrumented functions and other functions

2 Normative references

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

IEC 61508-1:2010, *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 61508-3:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements*

3 Terms, definitions and abbreviations

3.1 Terms

Terms are listed alphabetically in 3.2.

3.2 Terms and definitions

For the purposes of this document, the following definitions apply.

In some cases these definitions differ from the definitions of the same terms in IEC 61508-4:2010. In some cases this is due to the terminology used in the process sector. In other cases these definitions have been aligned with other relevant definitive references (e.g., IEC 60050 the International Electrotechnical Vocabulary, ISO/IEC Guide 51:2013). However, unless otherwise stated, there is no difference in the technical meaning between these definitions and the definitions of the same terms in IEC 61508-4:2010.

3.2.1
architecture
configuration
specific configuration of hardware and software components in a system

Note 1 to entry: In the IEC 61511 series this can mean, for example, arrangement of SIS subsystems, the internal structure of a SIS subsystem or the internal structure of SIS application programs.

3.2.2
asset protection
function allocated to a system and designed for the purpose of preventing loss or damage to assets

3.2.3
basic process control system
BPCS
system which responds to input signals from the process, its associated equipment, other programmable systems and/or operators and generates output signals causing the process and its associated equipment to operate in the desired manner but which does not perform any SIF

Note 1 to entry: A BPCS includes all of the devices necessary to ensure that the process operates in the desired manner.

Note 2 to entry: A BPCS typically may implement various functions such as process control functions, monitoring, and alarms.

3.2.4
bypass
action or facility to prevent all or parts of the SIS functionality from being executed

Note 1 to entry: Examples of bypassing include:

– the input signal is blocked from the trip logic while still presenting the input parameters and alarm to the operator;
– the output signal from the trip logic to a final element is held in the normal state preventing final element operation;
– a physical bypass line is provided around the final element;
– preselected input state (e.g., on/off input) or set is forced by means of an engineering tool (e.g., in the application program).

Note 2 to entry: Other terms are also used to refer to bypassing, such as override, defeat, disable, force, or inhibit or muting.

3.2.5
channel
device or group of devices that independently perform(s) a specified function