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Functional safety – Safety instrumented systems for the process industry sector –

Part 2: Guidelines for the application of IEC 61511-1:2016

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ELECTROTECHNICAL
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CONTENTS

FOREWORD.....	9
INTRODUCTION.....	11
1 Scope.....	13
2 Normative references	13
3 Terms, definitions, and abbreviations	13
Annex A (informative) Guidance for IEC 61511-1.....	14
A.1 Scope	14
A.2 Normative references.....	14
A.3 Terms, definitions and abbreviations.....	14
A.4 Conformance to this International Standard the IEC 61511-1:-	14
A.5 Management of functional safety.....	14
A.5.1 Objective	14
A.5.2 Guidance to "Requirements"	15
A.6 Safety life-cycle requirements	23
A.6.1 Objectives	23
A.6.2 Guidance to "Requirements".....	23
A.6.3 Guidance to "Application program SIS safety life-cycle requirements"	24
A.7 Verification	25
A.7.1 Objective	25
A.7.2 Guidance to "Requirements".....	25
A.8 Process hazard and risk assessment (H&RA)	27
A.8.1 Objectives	27
A.8.2 Guidance to "Requirements".....	27
A.9 Allocation of safety functions to protection layers.....	30
A.9.1 Objective	30
A.9.2 Guidance to "Requirements of the allocation process"	31
A.9.3 Guidance to "Requirements on the basic process control system as a protection layer"	33
A.9.4 Guidance to "Requirements for preventing common cause, common mode and dependent failures"	36
A.10 SIS safety requirements specification	37
A.10.1 Objective	37
A.10.2 Guidance to "General requirements"	37
A.10.3 Guidance to "SIS safety requirements"	37
A.11 SIS design and engineering	42
A.11.1 Objective	42
A.11.2 Guidance to "General requirements".....	42
A.11.3 Guidance to "Requirements for system behaviour on detection of a fault".....	50
A.11.4 Requirements Guidance to "Hardware fault tolerance".....	50
A.11.5 Guidance to "Requirements for selection of components and subsystems devices"	53
A.11.6 Field devices	57
A.11.7 Interfaces	57
A.11.8 Guidance to "Maintenance or testing design requirements".....	59
A.11.9 SIF probability of failure Guidance to "Quantification of random failure".....	60

This is a preview of "S+ IEC 61511-2 Ed. 2...". Click here to purchase the full version from the ANSI store.

12	Requirements for application software, including selection criteria for utility software	81
12.1	Application software safety lifecycle requirements	81
12.2	Application software safety requirements specification	81
12.3	Application software safety validation planning	81
12.4	Application software design and development	81
12.5	Integration of the application software with the SIS subsystem	81
12.6	FPL and LVL software modification procedures	81
12.7	Application software verification	81
A.12	SIS application program development	81
A.12.1	Objective	81
A.12.2	Guidance to "General requirements"	81
A.12.4	Guidance to "Application program implementation"	84
A.12.3	Guidance to "Application program design"	82
A.12.5	Guidance to "Requirements for application program verification (review and testing)"	85
A.12.6	Guidance to "Requirements for application program methodology and tools"	89
A.13	Factory acceptance testing (FAT)	91
A.13.1	Objectives	91
A.13.2	Guidance to "Recommendations"	91
A.14	SIS installation and commissioning	91
A.14.1	Objectives	91
A.14.2	Guidance to "Requirements"	92
A.15	SIS safety validation	92
A.15.1	Objective	92
A.15.2	Guidance to "Requirements"	92
A.16	SIS operation and maintenance	93
A.16.1	Objectives	93
A.16.2	Guidance to "Requirements"	93
A.16.3	Proof testing and inspection	94
A.17	SIS modification	97
A.17.1	Objective	97
A.17.2	Guidance to "Requirements"	97
A.18	SIS decommissioning	98
A.18.1	Objectives	98
A.18.2	Guidance to "Requirements"	98
A.19	Information and documentation requirements	98
A.19.1	Objectives	98
A.19.2	Guidance to "Requirements"	98
	Annex A (informative) Example of techniques for calculating the probability of failure on demand for a safety instrumented function	98
	Annex B (informative) Typical SIS architecture development	98
	Annex B (informative) Example of SIS logic solver application program development using function block diagram	106
B.1	General	106
B.2	Application program development and validation philosophy	106
B.3	Application description	107
B.3.1	General	107

B.3.2	Process description.....	107
B.3.3	Safety instrumented functions	108
B.3.4	Risk reduction and domino effects	109
B.4	Application program safety life-cycle execution	109
B.4.1	General	109
B.4.2	Inputs to application program SRS development	109
B.4.3	Application program design and development	112
B.4.4	Application program production	126
B.4.5	Application program verification and testing	126
B.4.6	Validation	126
Annex C (informative) Application features of a safety PLC		
Annex C (informative)	Considerations when converting from NP technologies to PE technologies	129
Annex D (informative) Example of SIS logic solver application software development methodology		
Annex D (informative)	Example of how to get from a piping and instrumentation diagram (P&ID) to application program	135
Annex E (informative) Example of development of externally configured diagnostics for a safety-configured PE logic solver		
Annex E (informative)	Methods and tools for application programming	141
E.1	Typical toolset for application programming	141
E.2	Rules and constraints for application program design.....	142
E.3	Rules and constraints for application programming	142
Annex F (informative)	Example SIS project illustrating each phase of the safety life cycle with application program development using relay ladder language	144
F.1	Overview	144
F.2	Project definition	144
F.2.1	General	144
F.2.2	Conceptual planning	145
F.2.3	Process hazards analysis	145
F.3	Simplified process description	145
F.4	Preliminary design	147
F.5	IEC 61511 application	147
F.5.1	General	147
F.5.2	Step F.1: Hazard & risk assessment	151
F.5.3	Hazard identification	151
F.5.4	Preliminary hazard evaluation	151
F.5.5	Accident history	151
F.6	Preliminary process design safety considerations	154
F.7	Recognized process hazards.....	154
F.8	Process design definitions strategy.....	155
F.9	Preliminary hazard assessment	158
F.9.1	General	158
F.9.2	Step F.2: Allocation of safety functions	162
F.10	SIF safety integrity level determination	163
F.11	Layer of protection analysis (LOPA) applied to example.....	163
F.12	Tolerable risk criteria.....	164
F.13	Step F.3: SIS safety requirements specifications.....	167
F.13.1	Overview	167

F.13.2	Input requirements	167
F.13.3	Safety functional requirements	168
F.13.4	Safety integrity requirements.....	169
F.14	Functional description and conceptual design	170
F.14.1	Narrative for example reactor system logic	170
F.15	SIL verification calculations	171
F.16	Application program requirements	178
F.17	Step F.4: SIS safety life-cycle.....	185
F.18	Technology and device selection	185
F.18.1	General	185
F.18.2	Logic solver	185
F.18.3	Sensors	186
F.18.4	Final elements	186
F.18.5	Solenoid valves.....	186
F.18.6	Emergency vent valves	187
F.18.7	Modulating valves	187
F.18.8	Bypass valves.....	187
F.18.9	Human-machine interfaces (HMIs).....	187
F.18.10	Separation	188
F.19	Common cause and systematic failures	189
F.19.1	General	189
F.19.2	Diversity	189
F.19.3	Specification errors	189
F.19.4	Hardware design errors	189
F.19.5	Software design errors	190
F.19.6	Environmental overstress	190
F.19.7	Temperature	190
F.19.8	Humidity	190
F.19.9	Contaminants.....	191
F.19.10	Vibration	191
F.19.11	Grounding.....	191
F.19.12	Power line conditioning	191
F.19.13	Electro-magnetic compatibility (EMC)	191
F.19.14	Utility sources	192
F.19.15	Sensors	193
F.19.16	Process corrosion or fouling	193
F.19.17	Maintenance	193
F.19.18	Susceptibility to mis-operation	193
F.19.19	SIS architecture	193
F.20	SIS application program design features	194
F.21	Wiring practices	195
F.22	Security	195
F.23	Step F.5: SIS installation, commissioning, validation	196
F.24	Installation	196
F.25	Commissioning	197
F.26	Documentation	198
F.27	Validation.....	198
F.28	Testing	199
F.29	Step F.6: SIS operation and maintenance	212

F.30	Step F.7: SIS Modification	215
F.31	Step F.8: SIS decommissioning	215
F.32	Step F.9: SIS verification.....	215
F.33	Step F.10: Management of functional safety and SIS FSA	217
F.34	Management of functional safety	217
F.34.1	General	217
F.34.2	Competence of personnel.....	217
F.35	Functional safety assessment.....	217
Annex G (informative)	Guidance on developing application programming practices	218
G.1	Purpose of this guidance	218
G.2	Generic safe application programming attributes	218
G.3	Reliability.....	218
G.3.1	General	218
G.3.2	Predictability of memory utilisation	219
G.3.3	Predictability of control flow.....	220
G.3.4	Accounting for precision and accuracy.....	222
G.3.5	Predictability of timing.....	224
G.4	Predictability of mathematical or logical result.....	224
G.5	Robustness.....	225
G.5.1	General	225
G.5.2	Controlling use of diversity	225
G.5.3	Controlling use of exception handling	226
G.5.4	Checking input and output.....	227
G.6	Traceability	228
G.6.1	General	228
G.6.2	Controlling use of built-in functions.....	228
G.6.3	Controlling use of compiled libraries	228
G.7	Maintainability.....	228
G.7.1	General	228
G.7.2	Readability.....	229
G.7.3	Data abstraction.....	232
G.7.4	Functional cohesiveness	233
G.7.5	Malleability	233
G.7.6	Portability	233
Bibliography	235

Figure 1 – Overall framework of IEC 61511 series	12
--	----

Figure 2 – BPCS function and initiating cause independence illustration
--	------------------

Figure 3 – Software development lifecycle (the V-model).....
---	------------------

Figure A.1 – Application program V-Model.....	25
---	----

Figure A.2 – Independence of a BPCS protection layer and an initiating source in the BPCS	35
---	----

Figure A.3 – Independence of two protection layers allocated to the BPCS	36
--	----

Figure A.4 – Relationship of system, SIS hardware, and SIS application program.....	41
---	----

Figure A.5 – Illustration of uncertainties on a reliability parameter.....	64
--	----

Figure A.6 – Illustration of the 70 % confidence upper bound	65
--	----

Figure A.7 – Typical probabilistic distribution of target results from Monte Carlo simulation.....	66
--	----

This is a preview of "S+ IEC 61511-2 Ed. 2...". Click here to purchase the full version from the ANSI store.

Figure B.1 – Process flow diagram for SIF 02.01	108
Figure B.2 – Process flow diagram for SIF 06.02	109
Figure B.3 – Functional specification of SIF02.01 and SIF 06.02	110
Figure B.4 – SIF 02.01 hardware functional architecture	110
Figure B.5 – SIF 06.02 hardware functional architecture	111
Figure B.6 – Hardware specification for SOV extracted from piping and instrumentation diagram.....	111
Figure B.7 – SIF 02.01 hardware physical architecture	112
Figure B.8 – SIF 06.02 hardware physical architecture	112
Figure B.9 – Hierarchical structure of model integration	116
Figure B.10 – Hierarchical structure of model integration including models of safety properties and of BPCS logic	118
Figure B.11 – State transition diagram	119
Figure B.12 – SOV typical block diagram.....	120
Figure B.14 – Typical model block diagram implementation – BPCS part.....	123
Figure B.13 – SOV typical model block diagram	121
Figure B.15 – SOV application program typical model implementation – SIS part	124
Figure B.16 – Complete model for final implementation model checking	126
Figure C.1 – Logic solver
Figure D.1 – Example of P&ID for an oil and gas separator.....	135
Figure D.2 – Example of (part of) an ESD cause & effect diagram (C&E).....	136
Figure D.3 – Example of (part of) an application program in a safety PLC function block programming	137
Figure E.1 – EWDT timing diagram
Figure F.1 – Simplified flow diagram: the PVC process	146
Figure F.2 – SIS safety life-cycle phases and FSA stages.....	148
Figure F.3 – Example of the preliminary P&ID for PVC reactor unit	157
Figure F.4 – SIF S-1 Bubble diagram showing the PFD_{avg} of each SIS device.....	173
Figure F.5 – S-1 Fault tree	174
Figure F.6 – SIF S-2 Bubble diagram showing the PFD_{avg} of each SIS device.....	175
Figure F.7 – SIF S-2 fault tree	176
Figure F.8 – SIF S-3 Bubble diagram showing the PFD_{avg} of each SIS device.....	177
Figure F.9 – SIF S-3 fault tree.....	178
Figure F.10 – P&ID for PVC reactor unit SIF.....	179
Figure F.11 – Legend (1 of 5).....	180
Figure F.12 – SIS for the VCM reactor.....	194
Table 1 – Typical Safety Manual organisation and contents
Table B.1 – Modes of operation specification.....	113
Table B.2 – State transition table	119
Table F.1 – SIS safety life-cycle overview	149
Table F.2 – SIS safety life-cycle – Box 1	151
Table F.3 – Some physical properties of vinyl chloride.....	153
Table F.4 – What-If/Checklist	159

This is a preview of "S+ IEC 61511-2 Ed. 2...". [Click here to purchase the full version from the ANSI store.](#)

Table F.5 – HAZOP	160
Table F.6 – Partial summary of hazard assessment for SIF strategy development	161
Table F.7 – SIS safety life-cycle – Box 2	163
Table F.8 – Tolerable risk ranking	165
Table F.9 – VCM reactor example: LOPA based integrity level.....	166
Table F.10 – SIS safety life-cycle – Box 3	167
Table F.11 – Safety instrumented functions and SILs.....	167
Table F.12 – Functional relationship of I/O for the SIF(s)	168
Table F.13 – SIS sensors, normal operating range & trip points	168
Table F.14 – Cause and effect diagram	171
Table F.15 – MTTFd figures of SIS F.1 devices	172
Table F.16 – SIS safety life-cycle – Box 4	185
Table F.17 – SIS safety life-cycle – Box 5	196
Table F.18 – List of instrument types and testing procedures used.....	200
Table F.19 – Interlock check procedure bypass/simulation check sheet.....	212
Table F.20 – SIS safety life-cycle – Box 6	212
Table F.21 – SIS trip log	213
Table F.22 – SIS device failure log.....	213
Table F.23 – SIS safety life-cycle – Box 7	215
Table F.24 – SIS safety life-cycle – Box 8	215
Table F.25 – SIS safety life-cycle – Box 9	216

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 2: Guidelines for the application of IEC 61511-1:2016

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. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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International Standard IEC 61511-2 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:

- guidance examples based on all phases of the safety life cycle provided based on usage experience with IEC61511 1st edition;
- annexes replaced to address transition from software to application programming.

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

FDIS	Report on voting
65A/783/FDIS	65A/787/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.

This International Standard is to be read in conjunction with IEC 61511-1. It is based on the second edition of that standard.

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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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.

The IEC 61511 series addresses the application of SISs for the process industries. It also deals with the interface between SISs and other safety systems in requiring that a process ~~hazard and risk assessment~~ H&RA be carried out. The SIS includes sensors, logic solvers and final elements.

The IEC 61511 series has two concepts, which are fundamental to its application; SIS safety life-cycle and the safety integrity level (SIL). The SIS safety life-cycle forms the central framework which links together most of the concepts in this International Standard.

The SIS logic solvers addressed include Electrical (E)/Electronic (E)/ and Programmable Electronic (PE) technology. Where other technologies are used for logic solvers, the basic principles of this standard ~~may also~~ can be applied to ensure the functional safety requirements were met. The IEC 61511 series also addresses the SIS sensors and final elements regardless of the technology used. The IEC 61511 series has been developed as a process sector implementation of the IEC 61508 series. 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 standards. This approach has been adopted in order that a rational and consistent technical policy is used. The objective of this part of IEC 61511 is to provide guidance on how to comply with IEC 61511-1:2016.

To facilitate use of IEC 61511-1:2016, the clause ~~and subclause~~ numbers provided in Annex A (informative) are identical to the corresponding normative text in IEC 61511-1:2016 (excluding the annexes) except for the "A" notation.

In most situations, safety is best achieved by an inherently safe process design whenever practicable, combined, if necessary, with a number of protective systems which rely on different technologies (e.g., chemical, mechanical, hydraulic, pneumatic, electrical, electronic, thermodynamic (e.g., flame arrestors), programmable electronic) which manage any residual identified risk. Any safety strategy considers each individual SIS in the context of the other protective systems. To facilitate this approach, IEC 61511-1:2016:

- requires that a H&RA is carried out to identify the overall safety requirements;
- requires that an allocation of the safety requirements to the safety functions and related safety systems, such as the SIS(s), is carried out;
- works within a framework which is applicable to all instrumented methods 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.

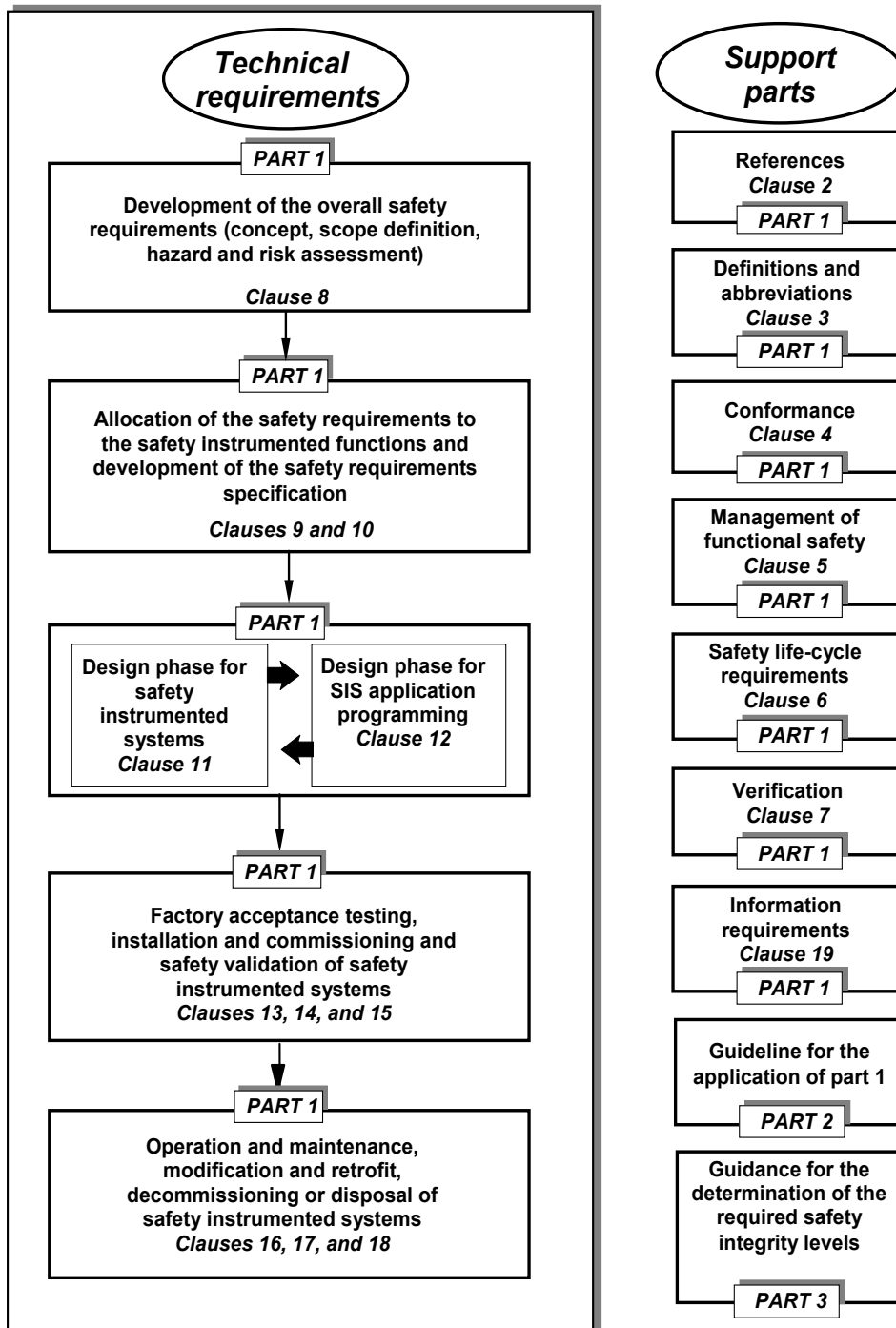
~~This International Standard on safety instrumented systems for the process industry:~~

- addresses relevant SIS safety life-cycle stages from initial concept, through design, implementation, operation and maintenance and decommissioning;
- enables existing or new country specific process industry standards to be harmonized with this standard.

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

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Figure 1 below shows the overall framework of the IEC 61511 series.



IEC

Figure 1 – Overall framework of IEC 61511 series

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

Part 2: Guidelines for the application of IEC 61511-1:2016

1 Scope

This part of IEC 61511 provides guidance on the specification, design, installation, operation and maintenance of SIFs and related SIS as defined in IEC 61511-1:2016. ~~This standard has been organized so that each clause and subclause number herein addresses the same clause number in IEC 61511-1 (with the exception of the annexes).~~

NOTE 1 Annex A (informative) has been organized so that each clause and subclause number therein addresses the corresponding clause and subclause number in IEC 61511-1:2016 except for being preceded by "A".

NOTE 2 Annex A now contains material previously in the body of the first edition. These changes are required for compliance with IEC rules which prohibit a standard being wholly informative.

NOTE 3 To achieve maximum use of this guideline;

- review the section guidance as well as the specific clause guidance. (e.g., when looking for guidance on 5.2.6.1.3, consider guidance in 5.2.6);
- when specific clause guidance is not provided (e.g.; no further guidance provided), consider reviewing the section guidance as well, as it can be applicable).

NOTE 4 Examples given in the Annexes of this Standard are intended only as case specific examples of implementing IEC 61511 requirements in a specific instance, and the user should satisfy themselves that the chosen methods and techniques are appropriate to their situation.

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 61511-1:2016, *Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements*



INTERNATIONAL STANDARD

NORME INTERNATIONALE



Functional safety – Safety instrumented systems for the process industry sector –

Part 2: Guidelines for the application of IEC 61511-1: 2016

Sécurité fonctionnelle – Systèmes instrumentés de sécurité pour le secteur des industries de transformation –

Partie 2: Lignes directrices pour l'application de l'IEC 61511-1:2016

CONTENTS

FOREWORD.....	9
INTRODUCTION.....	11
1 Scope.....	13
2 Normative references	13
3 Terms, definitions, and abbreviations	13
Annex A (informative) Guidance for IEC 61511-1.....	14
A.1 Scope	14
A.2 Normative references	14
A.3 Terms, definitions and abbreviations.....	14
A.4 Conformance to the IEC 61511-1:–.....	14
A.5 Management of functional safety	14
A.5.1 Objective	14
A.5.2 Guidance to "Requirements".....	14
A.6 Safety life-cycle requirements.....	23
A.6.1 Objectives.....	23
A.6.2 Guidance to "Requirements".....	23
A.6.3 Guidance to "Application program SIS safety life-cycle requirements"	24
A.7 Verification.....	25
A.7.1 Objective	25
A.7.2 Guidance to "Requirements".....	25
A.8 Process hazard and risk assessment (H&RA)	27
A.8.1 Objectives.....	27
A.8.2 Guidance to "Requirements".....	27
A.9 Allocation of safety functions to protection layers	30
A.9.1 Objective	30
A.9.2 Guidance to "Requirements of the allocation process".....	30
A.9.3 Guidance to "Requirements on the basic process control system as a protection layer".....	32
A.9.4 Guidance to "Requirements for preventing common cause, common mode and dependent failures"	35
A.10 SIS safety requirements specification	36
A.10.1 Objective	36
A.10.2 Guidance to "General requirements".....	36
A.10.3 Guidance to "SIS safety requirements"	36
A.11 SIS design and engineering.....	40
A.11.1 Objective	40
A.11.2 Guidance to "General requirements".....	40
A.11.3 Guidance to "Requirements for system behaviour on detection of a fault".....	47
A.11.4 Guidance to "Hardware fault tolerance"	47
A.11.5 Guidance to "Requirements for selection of devices".....	50
A.11.6 Field devices	53
A.11.7 Interfaces	53
A.11.8 Guidance to "Maintenance or testing design requirements"	55
A.11.9 Guidance to "Quantification of random failure".....	56
A.12 SIS application program development.....	62

A.12.1	Objective	62
A.12.2	Guidance to "General requirements".....	62
A.12.3	Guidance to "Application program design"	64
A.12.4	Guidance to "Application program implementation"	66
A.12.5	Guidance to "Requirements for application program verification (review and testing)"	67
A.12.6	Guidance to "Requirements for application program methodology and tools"	70
A.13	Factory acceptance testing (FAT)	73
A.13.1	Objectives.....	73
A.13.2	Guidance to "Recommendations".....	73
A.14	SIS installation and commissioning.....	73
A.14.1	Objectives.....	73
A.14.2	Guidance to "Requirements".....	73
A.15	SIS safety validation	74
A.15.1	Objective	74
A.15.2	Guidance to "Requirements".....	74
A.16	SIS operation and maintenance	74
A.16.1	Objectives.....	74
A.16.2	Guidance to "Requirements".....	75
A.16.3	Proof testing and inspection	76
A.17	SIS modification	78
A.17.1	Objective	78
A.17.2	Guidance to "Requirements".....	79
A.18	SIS decommissioning	79
A.18.1	Objectives.....	79
A.18.2	Guidance to "Requirements".....	79
A.19	Information and documentation requirements.....	80
A.19.1	Objectives.....	80
A.19.2	Guidance to "Requirements".....	80
Annex B (informative)	Example of SIS logic solver application program development using function block diagram	81
B.1	General.....	81
B.2	Application program development and validation philosophy	81
B.3	Application description	82
B.3.1	General	82
B.3.2	Process description.....	82
B.3.3	Safety instrumented functions	83
B.3.4	Risk reduction and domino effects	84
B.4	Application program safety life-cycle execution	84
B.4.1	General	84
B.4.2	Inputs to application program SRS development	84
B.4.3	Application program design and development	87
B.4.4	Application program production	101
B.4.5	Application program verification and testing.....	101
B.4.6	Validation	101
Annex C (informative)	Considerations when converting from NP technologies to PE technologies	102

Annex D (informative) Example of how to get from a piping and instrumentation diagram (P&ID) to application program	104
Annex E (informative) Methods and tools for application programming	107
E.1 Typical toolset for application programming	107
E.2 Rules and constraints for application program design.....	108
E.3 Rules and constraints for application programming	108
Annex F (informative) Example SIS project illustrating each phase of the safety life cycle with application program development using relay ladder language	110
F.1 Overview	110
F.2 Project definition	110
F.2.1 General	110
F.2.2 Conceptual planning	111
F.2.3 Process hazards analysis	111
F.3 Simplified process description	111
F.4 Preliminary design	113
F.5 IEC 61511 application	113
F.5.1 General	113
F.5.2 Step F.1: Hazard & risk assessment	117
F.5.3 Hazard identification	117
F.5.4 Preliminary hazard evaluation	117
F.5.5 Accident history	117
F.6 Preliminary process design safety considerations	120
F.7 Recognized process hazards.....	120
F.8 Process design definitions strategy.....	121
F.9 Preliminary hazard assessment	124
F.9.1 General	124
F.9.2 Step F.2: Allocation of safety functions	128
F.10 SIF safety integrity level determination	129
F.11 Layer of protection analysis (LOPA) applied to example	129
F.12 Tolerable risk criteria.....	130
F.13 Step F.3: SIS safety requirements specifications.....	133
F.13.1 Overview	133
F.13.2 Input requirements	133
F.13.3 Safety functional requirements	134
F.13.4 Safety integrity requirements.....	135
F.14 Functional description and conceptual design	136
F.14.1 Narrative for example reactor system logic	136
F.15 SIL verification calculations	137
F.16 Application program requirements	144
F.17 Step F.4: SIS safety life-cycle.....	151
F.18 Technology and device selection	151
F.18.1 General	151
F.18.2 Logic solver	151
F.18.3 Sensors	152
F.18.4 Final elements	152
F.18.5 Solenoid valves.....	152
F.18.6 Emergency vent valves	153
F.18.7 Modulating valves	153
F.18.8 Bypass valves.....	153

F.18.9	Human-machine interfaces (HMIs)	153
F.18.10	Separation	154
F.19	Common cause and systematic failures	155
F.19.1	General	155
F.19.2	Diversity	155
F.19.3	Specification errors	155
F.19.4	Hardware design errors	155
F.19.5	Software design errors	156
F.19.6	Environmental overstress	156
F.19.7	Temperature	156
F.19.8	Humidity	156
F.19.9	Contaminants	157
F.19.10	Vibration	157
F.19.11	Grounding	157
F.19.12	Power line conditioning	157
F.19.13	Electro-magnetic compatibility (EMC)	157
F.19.14	Utility sources	158
F.19.15	Sensors	159
F.19.16	Process corrosion or fouling	159
F.19.17	Maintenance	159
F.19.18	Susceptibility to mis-operation	159
F.19.19	SIS architecture	159
F.20	SIS application program design features	160
F.21	Wiring practices	161
F.22	Security	161
F.23	Step F.5: SIS installation, commissioning, validation	162
F.24	Installation	162
F.25	Commissioning	163
F.26	Documentation	164
F.27	Validation	164
F.28	Testing	165
F.29	Step F.6: SIS operation and maintenance	178
F.30	Step F.7: SIS Modification	181
F.31	Step F.8: SIS decommissioning	181
F.32	Step F.9: SIS verification	181
F.33	Step F.10: Management of functional safety and SIS FSA	182
F.34	Management of functional safety	183
F.34.1	General	183
F.34.2	Competence of personnel	183
F.35	Functional safety assessment	183
Annex G (informative)	Guidance on developing application programming practices	184
G.1	Purpose of this guidance	184
G.2	Generic safe application programming attributes	184
G.3	Reliability	184
G.3.1	General	184
G.3.2	Predictability of memory utilisation	185
G.3.3	Predictability of control flow	186
G.3.4	Accounting for precision and accuracy	188
G.3.5	Predictability of timing	190

G.4	Predictability of mathematical or logical result.....	190
G.5	Robustness.....	191
G.5.1	General	191
G.5.2	Controlling use of diversity	191
G.5.3	Controlling use of exception handling	192
G.5.4	Checking input and output.....	193
G.6	Traceability	194
G.6.1	General	194
G.6.2	Controlling use of built-in functions.....	194
G.6.3	Controlling use of compiled libraries	194
G.7	Maintainability.....	194
G.7.1	General	194
G.7.2	Readability.....	195
G.7.3	Data abstraction.....	198
G.7.4	Functional cohesiveness	199
G.7.5	Malleability	199
G.7.6	Portability	199
	Bibliography	201
	Figure 1 – Overall framework of IEC 61511 series	12
	Figure A.1 – Application program V-Model.....	25
	Figure A.2 – Independence of a BPCS protection layer and an initiating source in the BPCS	34
	Figure A.3 – Independence of two protection layers allocated to the BPCS	35
	Figure A.4 – Relationship of system, SIS hardware, and SIS application program.....	39
	Figure A.5 – Illustration of uncertainties on a reliability parameter.....	60
	Figure A.6 – Illustration of the 70 % confidence upper bound	61
	Figure A.7 – Typical probabilistic distribution of target results from Monte Carlo simulation.....	62
	Figure B.1 – Process flow diagram for SIF 02.01	83
	Figure B.2 – Process flow diagram for SIF 06.02	84
	Figure B.3 – Functional specification of SIF02.01 and SIF 06.02.....	85
	Figure B.4 – SIF 02.01 hardware functional architecture	85
	Figure B.5 – SIF 06.02 hardware functional architecture	86
	Figure B.6 – Hardware specification for SOV extracted from piping and instrumentation diagram.....	86
	Figure B.7 – SIF 02.01 hardware physical architecture	87
	Figure B.8 – SIF 06.02 hardware physical architecture	87
	Figure B.9 – Hierarchical structure of model integration	91
	Figure B.10 – Hierarchical structure of model integration including models of safety properties and of BPCS logic	93
	Figure B.11 – State transition diagram	94
	Figure B.12 – SOV typical block diagram.....	95
	Figure B.13 – SOV typical model block diagram	96
	Figure B.14 – Typical model block diagram implementation – BPCS part.....	98
	Figure B.15 – SOV application program typical model implementation – SIS part	99

Figure B.16 – Complete model for final implementation model checking	101
Figure D.1 – Example of P&ID for an oil and gas separator	104
Figure D.2 – Example of (part of) an ESD cause & effect diagram (C&E).....	105
Figure D.3 – Example of (part of) an application program in a safety PLC function block programming	106
Figure F.1 – Simplified flow diagram: the PVC process	112
Figure F.2 – SIS safety life-cycle phases and FSA stages.....	114
Figure F.3 – Example of the preliminary P&ID for PVC reactor unit	123
Figure F.4 – SIF S-1 Bubble diagram showing the $PF_{D_{avg}}$ of each SIS device.....	139
Figure F.5 – S-1 Fault tree	140
Figure F.6 – SIF S-2 Bubble diagram showing the $PF_{D_{avg}}$ of each SIS device.....	141
Figure F.7 – SIF S-2 fault tree.....	142
Figure F.8 – SIF S-3 Bubble diagram showing the $PF_{D_{avg}}$ of each SIS device.....	143
Figure F.9 – SIF S-3 fault tree.....	144
Figure F.10 – P&ID for PVC reactor unit SIF.....	145
Figure F.11 – Legend (1 of 5).....	146
Figure F.12 – SIS for the VCM reactor.....	160
Table B.1 – Modes of operation specification.....	88
Table B.2 – State transition table	93
Table F.1 – SIS safety life-cycle overview	115
Table F.2 – SIS safety life-cycle – Box 1	117
Table F.3 – Some physical properties of vinyl chloride.....	119
Table F.4 – What-If/Checklist	125
Table F.5 – HAZOP	126
Table F.6 – Partial summary of hazard assessment for SIF strategy development	127
Table F.7 – SIS safety life-cycle – Box 2	129
Table F.8 – Tolerable risk ranking	131
Table F.9 – VCM reactor example: LOPA based integrity level.....	132
Table F.10 – SIS safety life-cycle – Box 3	133
Table F.11 – Safety instrumented functions and SILs.....	133
Table F.12 – Functional relationship of I/O for the SIF(s)	134
Table F.13 – SIS sensors, normal operating range & trip points	134
Table F.14 – Cause and effect diagram	137
Table F.15 – MTTFD figures of SIS F.1 devices	138
Table F.16 – SIS safety life-cycle – Box 4	151
Table F.17 – SIS safety life-cycle – Box 5	162
Table F.18 – List of instrument types and testing procedures used.....	166
Table F.19 – Interlock check procedure bypass/simulation check sheet.....	178
Table F.20 – SIS safety life-cycle – Box 6	178
Table F.21 – SIS trip log	179
Table F.22 – SIS device failure log.....	179
Table F.23 – SIS safety life-cycle – Box 7	181

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Table F.24 – SIS safety life-cycle – Box 8	181
Table F.25 – SIS safety life-cycle – Box 9	182
Table F.26 – SIS safety life-cycle – Box 10.....	182

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 2: Guidelines for the application of IEC 61511-1:2016

FOREWORD

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International Standard IEC 61511-2 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:

- guidance examples based on all phases of the safety life cycle provided based on usage experience with IEC61511 1st edition;
- annexes replaced to address transition from software to application programming.

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

FDIS	Report on voting
65A/783/FDIS	65A/787/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.

This International Standard is to be read in conjunction with IEC 61511-1. It is based on the second edition of that standard.

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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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.

The IEC 61511 series addresses the application of SISs for the process industries. It also deals with the interface between SISs and other safety systems in requiring that a process H&RA be carried out. The SIS includes sensors, logic solvers and final elements.

The IEC 61511 series has two concepts, which are fundamental to its application; SIS safety life-cycle and the safety integrity level (SIL). The SIS safety life-cycle forms the central framework which links together most of the concepts in this International Standard.

The SIS logic solvers addressed include Electrical (E)/Electronic (E)/ and Programmable Electronic (PE) technology. Where other technologies are used for logic solvers, the basic principles of this standard can be applied to ensure the functional safety requirements were met. The IEC 61511 series also addresses the SIS sensors and final elements regardless of the technology used. The IEC 61511 series has been developed as a process sector implementation of the IEC 61508 series. 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 standards. This approach has been adopted in order that a rational and consistent technical policy is used. The objective of this part of IEC 61511 is to provide guidance on how to comply with IEC 61511-1:2016.

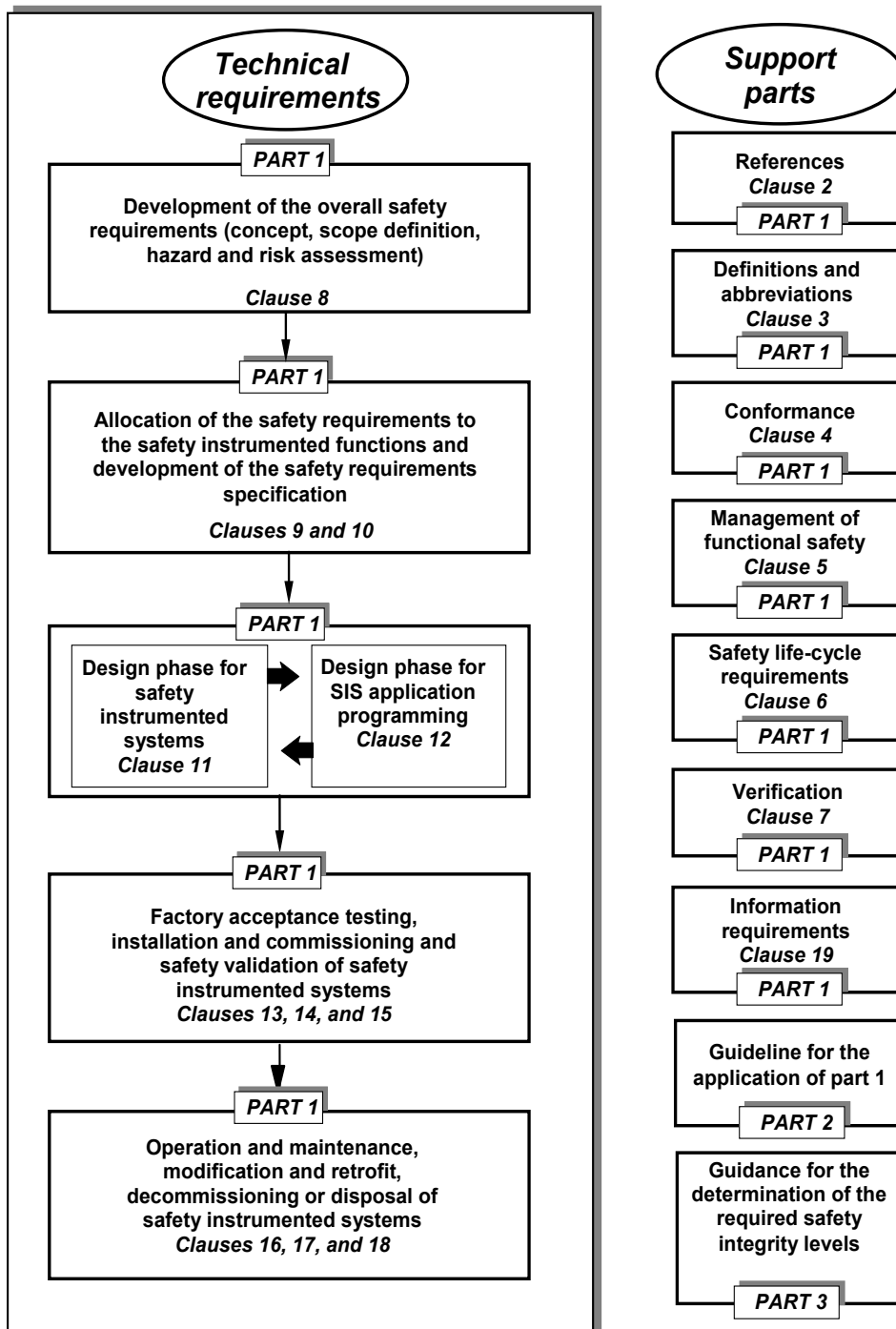
To facilitate use of IEC 61511-1:2016, the clause numbers provided in Annex A (informative) are identical to the corresponding normative text in IEC 61511-1:2016 except for the "A" notation.

In most situations, safety is best achieved by an inherently safe process design whenever practicable, combined, if necessary, with a number of protective systems which rely on different technologies (e.g., chemical, mechanical, hydraulic, pneumatic, electrical, electronic, thermodynamic (e.g., flame arrestors), programmable electronic) which manage any residual identified risk. Any safety strategy considers each individual SIS in the context of the other protective systems. To facilitate this approach, IEC 61511-1:2016:

- requires that a H&RA is carried out to identify the overall safety requirements;
- requires that an allocation of the safety requirements to the safety functions and related safety systems, such as the SIS(s), is carried out;
- works within a framework which is applicable to all instrumented methods 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.
- addresses relevant SIS safety life-cycle stages from initial concept, through design, implementation, operation and maintenance and decommissioning;
- enables existing or new country specific process industry standards to be harmonized with this standard.

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

Figure 1 below shows the overall framework of the IEC 61511 series.



IEC

Figure 1 – Overall framework of IEC 61511 series

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

Part 2: Guidelines for the application of IEC 61511-1:2016

1 Scope

This part of IEC 61511 provides guidance on the specification, design, installation, operation and maintenance of SIFs and related SIS as defined in IEC 61511-1:2016.

NOTE 1 Annex A (informative) has been organized so that each clause and subclause number therein addresses the corresponding clause and subclause number in IEC 61511-1:2016 except for being preceded by "A".

NOTE 2 Annex A now contains material previously in the body of the first edition. These changes are required for compliance with IEC rules which prohibit a standard being wholly informative.

NOTE 3 To achieve maximum use of this guideline;

- review the section guidance as well as the specific clause guidance. (e.g., when looking for guidance on 5.2.6.1.3, consider guidance in 5.2.6);
- when specific clause guidance is not provided (e.g.; no further guidance provided), consider reviewing the section guidance as well, as it can be applicable).

NOTE 4 Examples given in the Annexes of this Standard are intended only as case specific examples of implementing IEC 61511 requirements in a specific instance, and the user should satisfy themselves that the chosen methods and techniques are appropriate to their situation.

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 61511-1:2016, *Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements*

SOMMAIRE

AVANT-PROPOS.....	211
INTRODUCTION.....	213
1 Domaine d'application.....	217
2 Références normatives	217
3 Termes, définitions et abréviations.....	217
Annexe A (informative) Lignes directrices pour l'IEC 61511-1	218
A.1 Domaine d'application	218
A.2 Références normatives.....	218
A.3 Termes, définitions et abréviations	218
A.4 Conformité à l'IEC 61511-1:2016	218
A.5 Gestion de la sécurité fonctionnelle	218
A.5.1 Objectif.....	218
A.5.2 Lignes directrices relatives aux "Exigences"	219
A.6 Exigences relatives au cycle de vie de sécurité.....	228
A.6.1 Objectifs	228
A.6.2 Lignes directrices relatives aux "Exigences"	228
A.6.3 Lignes directrices des "exigences relatives aux cycles de vie de sécurité du SIS du programme d'application"	229
A.7 Vérification.....	230
A.7.1 Objectif.....	230
A.7.2 Lignes directrices relatives aux "Exigences"	230
A.8 Analyse de danger et de risque (H&RA).....	232
A.8.1 Objectifs	232
A.8.2 Lignes directrices relatives aux "Exigences"	232
A.9 Affectation des fonctions de sécurité aux couches de protection.....	236
A.9.1 Objectif.....	236
A.9.2 Lignes directrices relatives aux "Exigences relatives au processus d'allocation"	236
A.9.3 Lignes directrices relatives aux "Exigences relatives au système de commande de processus de base en tant que couche de protection".....	238
A.9.4 Lignes directrices relatives aux "Exigences pour prévenir les défaillances de cause commune, les défaillances de mode commun et les défaillances dépendantes"	241
A.10 Spécification des exigences concernant la sécurité du SIS.....	242
A.10.1 Objectif.....	242
A.10.2 Lignes directrices relatives aux "Exigences générales"	242
A.10.3 Lignes directrices relatives aux "Exigences de sécurité du SIS"	243
A.11 Conception et ingénierie du SIS	248
A.11.1 Objectif.....	248
A.11.2 Lignes directrices relatives aux "Exigences générales"	248
A.11.3 Lignes directrices pour les "Exigences relatives au comportement du système lors de la détection d'une anomalie".....	255
A.11.4 Lignes directrices pour la "Tolérance aux défauts du matériel"	255
A.11.5 Lignes directrices relatives aux "Exigences relatives au choix des appareils"	259
A.11.6 Appareils de terrain.....	262
A.11.7 Interfaces	262

A.11.8	Lignes directrices relatives aux "Exigences relatives à la maintenance ou à la conception des essais"	265
A.11.9	Lignes directrices relatives à la "Quantification de défaillance aléatoire".....	266
A.12	Développement du programme d'application du SIS	273
A.12.1	Objectif.....	273
A.12.2	Lignes directrices relatives aux "Exigences générales"	273
A.12.3	Lignes directrices relatives à la "Conception du programme d'application"	274
A.12.4	Lignes directrices relatives à la "Mise en œuvre du programme d'application"	277
A.12.5	Lignes directrices relatives aux "Exigences relatives à la vérification du programme d'application (revue et essai)"	278
A.12.6	Lignes directrices relatives aux "Exigences relatives à la méthodologie et aux outils du programme d'application"	283
A.13	Essai de réception en usine (ERU)	285
A.13.1	Objectifs	285
A.13.2	Lignes directrices relatives aux "Recommandations".....	285
A.14	Installation et mise en service du SIS	286
A.14.1	Objectifs	286
A.14.2	Lignes directrices relatives aux "Exigences"	286
A.15	Validation de sécurité du SIS.....	286
A.15.1	Objectif.....	286
A.15.2	Lignes directrices relatives aux "Exigences"	286
A.16	Fonctionnement et maintenance du SIS	287
A.16.1	Objectifs	287
A.16.2	Lignes directrices relatives aux "Exigences"	287
A.16.3	Essais périodiques et inspection.....	289
A.17	Modification du SIS	292
A.17.1	Objectif.....	292
A.17.2	Lignes directrices relatives aux "Exigences"	292
A.18	Déclassement du SIS	292
A.18.1	Objectifs	292
A.18.2	Lignes directrices relatives aux "Exigences"	292
A.19	Exigences relatives aux informations et à la documentation	293
A.19.1	Objectifs	293
A.19.2	Lignes directrices relatives aux "Exigences"	293
Annexe B (informative)	Exemple de développement de programme d'application de solveur logique de SIS à l'aide d'un diagramme de bloc fonctionnel	294
B.1	Généralités	294
B.2	Développement du programme d'application et philosophie de validation.....	294
B.3	Description de l'application.....	296
B.3.1	Généralités	296
B.3.2	Description du processus	296
B.3.3	Fonctions instrumentées de sécurité.....	296
B.3.4	Réduction de risque et réaction en chaîne	298
B.4	Exécution du cycle de vie de sécurité du programme d'application	298
B.4.1	Généralités	298
B.4.2	Entrées pour le développement de la SRS du programme d'application.....	298
B.4.3	Conception et développement du programme d'application	303
B.4.4	Production du programme d'application	321

B.4.5	Vérification et essai du programme d'application.....	321
B.4.6	Validation	321
Annexe C (informative)	Considérations lors de la conversion des technologies NP en technologies PE.....	322
Annexe D (informative)	Exemple présentant le passage d'un schéma de tuyauterie et d'instrumentation (P&ID) à un programme d'application	324
Annexe E (informative)	Méthodes et outils de programmation d'application	328
E.1	Jeu d'outils type pour la programmation d'application.....	328
E.2	Règles et contraintes pour la conception du programme d'application.....	329
E.3	Règles et contraintes pour la programmation d'application	330
Annexe F (informative)	Exemple de projet de SIS présentant chaque phase du cycle de vie de sécurité avec le développement du programme d'application en utilisant le langage à relais.....	332
F.1	Présentation	332
F.2	Définition du projet.....	333
F.2.1	Généralités	333
F.2.2	Planification conceptuelle.....	333
F.2.3	Analyse des dangers du processus	333
F.3	Description simplifiée du processus.....	334
F.4	Conception préliminaire.....	335
F.5	Application de l'IEC 61511.....	335
F.5.1	Généralités	335
F.5.2	Etape F.1: Analyse de danger et de risque	340
F.5.3	Identification de danger.....	340
F.5.4	Evaluation de danger préliminaire	340
F.5.5	Historique de l'accident	341
F.6	Considérations de sécurité de conception du processus préliminaire	343
F.7	Dangers de processus reconnus.....	343
F.8	Stratégie des définitions de conception du processus	345
F.9	Evaluation du danger préliminaire.....	347
F.9.1	Généralités	347
F.9.2	Etape F.2: Affectation des fonctions de sécurité.....	353
F.10	Détermination du niveau d'intégrité de sécurité de la SIF	353
F.11	Analyse de la couche de protection (LOPA) appliquée à un exemple	353
F.12	Critères de risque tolérables.....	355
F.13	Etape F.3: Spécifications des exigences concernant la sécurité du SIS	357
F.13.1	Présentation	357
F.13.2	Exigences d'entrée.....	357
F.13.3	Exigences fonctionnelles de sécurité	358
F.13.4	Exigences d'intégrité de sécurité	359
F.14	Description fonctionnelle et modèle conceptuel.....	360
F.14.1	Texte rédactionnel pour l'exemple de logique du système du réacteur.....	361
F.15	Calculs de vérification du SIL	362
F.16	Exigences du programme d'application	372
F.17	Etape F.4: Cycle de vie de sécurité du SIS	386
F.18	Choix de la technologie et de l'appareil.....	386
F.18.1	Généralités	386
F.18.2	Solveur logique	386
F.18.3	Capteurs.....	387

F.18.4	Eléments terminaux	387
F.18.5	Electrovannes	387
F.18.6	Vannes de ventilation d'urgence	388
F.18.7	Vannes de modulation.....	388
F.18.8	Vannes de dérivation	388
F.18.9	Interfaces homme-machine (IHM).....	389
F.18.10	Séparation	390
F.19	Défaillances de cause commune et défaillances systématiques.....	391
F.19.1	Généralités	391
F.19.2	Diversité	391
F.19.3	Erreurs de spécification.....	391
F.19.4	Erreurs de conception du matériel	391
F.19.5	Erreurs de conception du logiciel.....	391
F.19.6	Contraintes environnementales	392
F.19.7	Température	392
F.19.8	Humidité	392
F.19.9	Contaminants.....	392
F.19.10	Vibration	393
F.19.11	Mise à la terre.....	393
F.19.12	Conditionnement de la ligne d'alimentation	393
F.19.13	Compatibilité électromagnétique (CEM).....	393
F.19.14	Sources utilitaires	394
F.19.15	Capteurs.....	395
F.19.16	Traitement de la corrosion ou de l'encrassement	395
F.19.17	Maintenance	395
F.19.18	Susceptibilité à la mauvaise manipulation.....	395
F.19.19	Architecture du SIS.....	395
F.20	Fonctionnalités de conception du programme d'application du SIS	397
F.21	Pratiques de câblage.....	397
F.22	Sécurité	398
F.23	Etape F.5: Installation, mise en service et validation du SIS	399
F.24	Installation	399
F.25	Mise en service.....	400
F.26	Documentation.....	401
F.27	Validation.....	401
F.28	Essais.....	402
F.29	Etape F.6: Fonctionnement et maintenance du SIS	417
F.30	Etape F.7: Modification du SIS	420
F.31	Etape F.8: Déclassement du SIS	420
F.32	Etape F.9: Vérification du SIS.....	421
F.33	Etape F.10: Gestion de la sécurité fonctionnelle et de la FSA du SIS.....	422
F.34	Gestion de la sécurité fonctionnelle	422
F.34.1	Généralités	422
F.34.2	Compétences du personnel	422
F.35	Evaluation de la sécurité fonctionnelle	422
Annexe G (informative) Lignes directrices relatives au développement de pratiques de programmation d'application		424
G.1	Objectif de ces lignes directrices	424
G.2	Attributs génériques de programmation sûre d'applications	424

G.3	Fiabilité.....	425
G.3.1	Généralités	425
G.3.2	Prévisibilité de l'utilisation de la mémoire.....	425
G.3.3	Prévisibilité du flux de contrôle.....	426
G.3.4	Comptabilité de la précision	429
G.3.5	Prévisibilité du planning	430
G.4	Prévisibilité du résultat mathématique ou logique	431
G.5	Robustesse.....	431
G.5.1	Généralités	431
G.5.2	Contrôle de l'utilisation de la diversité	432
G.5.3	Contrôle de l'utilisation de la gestion des exceptions.....	434
G.5.4	Vérification de l'entrée et de la sortie.....	434
G.6	Traçabilité.....	435
G.6.1	Généralités	435
G.6.2	Contrôle de l'utilisation des fonctions intégrées.....	435
G.6.3	Contrôle de l'utilisation des bibliothèques compilées.....	436
G.7	Maintenabilité	436
G.7.1	Généralités	436
G.7.2	Lisibilité	436
G.7.3	Abstraction des données	440
G.7.4	Cohérence fonctionnelle.....	441
G.7.5	Malléabilité	441
G.7.6	Portabilité	442
	Bibliographie	443
	Figure 1 – Cadre général de la série IEC 61511	216
	Figure A.1 – Modèle en V du programme d'application.....	230
	Figure A.2 – Indépendance d'une couche de protection BPCS et d'une source initiatrice dans le BPCS	240
	Figure A.3 – Indépendance de deux couches de protection affectées au BPCS	241
	Figure A.4 – Relations du système, du matériel du SIS et du programme d'application du SIS	247
	Figure A.5 – Représentation des incertitudes d'un paramètre de fiabilité	270
	Figure A.6 – Représentation de la limite supérieure de confiance à 70 %.....	271
	Figure A.7 – Distribution probabiliste type des résultats cibles de la simulation de Monte-Carlo.....	272
	Figure B.1 – Schéma de procédé de la SIF 02.01	297
	Figure B.2 – Schéma de procédé de la SIF 06.02	298
	Figure B.3 – Spécification fonctionnelle de la SIF 02.01 et de la SIF 06.02.....	299
	Figure B.4 – Architecture fonctionnelle matérielle de la SIF 02.01	300
	Figure B.5 – Architecture fonctionnelle matérielle de la SIF 06.02.....	300
	Figure B.6 – Spécification matérielle pour une SOV extraite du schéma de tuyauterie et d'instrumentation	301
	Figure B.7 – Architecture physique matérielle de la SIF 02.01.....	302
	Figure B.8 – Architecture physique matérielle de la SIF 06.02.....	303
	Figure B.9 – Structure hiérarchique d'intégration de modèle	307

Figure B.10 – Structure hiérarchique d'intégration de modèle comprenant des modèles de propriétés de sécurité et de la logique du BPCS	309
Figure B.11 – Diagramme de transition d'état	311
Figure B.12 – Diagramme de blocs type de la SOV.....	313
Figure B.13 – Diagramme de blocs de modèle type d'une SOV	315
Figure B.14 – Mise en œuvre du diagramme de blocs de modèle type – partie du BPCS	317
Figure B.15 – Mise en œuvre du modèle type de programme d'application de la SOV – partie du SIS	318
Figure B.16 – Modèle complet pour la vérification du modèle de mise en œuvre finale	320
Figure D.1 – Exemple de schéma de tuyauterie et d'instrumentation d'un séparateur d'huile et de gaz	324
Figure D.2 – Exemple de schéma de cause à effet d'une ESD (en partie).....	326
Figure D.3 – Exemple de programme d'application (en partie) dans une programmation de blocs fonctionnels d'automate de sécurité.....	327
Figure F.1 – Schéma de procédé simplifié: processus pour le PVC	335
Figure F.2 – Phases de cycle de vie de sécurité du SIS et étapes de la FSA.....	337
Figure F.3 – Exemple de schéma de tuyauterie et d'instrumentation préliminaire pour unité de réacteur PVC.....	347
Figure F.4 – Schéma architectural de la SIF S-1 présentant la PFD_{avg} de chaque appareil du SIS.....	364
Figure F.5 – Arbre des défaillances S-1.....	366
Figure F.6 – Schéma architectural de la SIF S-2 présentant la PFD_{avg} de chaque appareil du SIS.....	367
Figure F.7 – Arbre des défaillances de la SIF S-2.....	369
Figure F.8 – Schéma architectural de la SIF S-3 présentant la PFD_{avg} de chaque appareil du SIS.....	370
Figure F.9 – Arbre des défaillances de la SIF S-3.....	372
Figure F.10 – Schéma de tuyauterie et d'instrumentation pour SIF d'unité de réacteur PVC	374
Figure F.11 – Légende (1 de 5).....	377
Figure F.12 – SIS pour le réacteur VCM	397
Tableau B.1 – Modes de spécification de fonctionnement	304
Tableau B.2 – Tableau de transition d'état.....	310
Tableau F.1 – Vue d'ensemble du cycle de vie de sécurité du SIS	338
Tableau F.2 – Cycle de vie de sécurité du SIS – Zone 1	340
Tableau F.3 – Propriétés physiques du chlorure de vinyle.....	342
Tableau F.4 – Simulation/Liste de contrôle	349
Tableau F.5 – HAZOP	350
Tableau F.6 – Récapitulatif partiel de l'évaluation du danger pour le développement de stratégie SIF.....	351
Tableau F.7 – Cycle de vie de sécurité du SIS – Zone 2	353
Tableau F.8 – Classement du risque tolérable	355
Tableau F.9 – Exemple de réacteur VCM: Niveau d'intégrité LOPA	356
Tableau F.10 – Cycle de vie de sécurité du SIS – Zone 3	357

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Tableau F.11 – Fonctions instrumentées de sécurité et SIL	357
Tableau F.12 – Relation fonctionnelle d'E/S pour la/les SIF	358
Tableau F.13 – Capteurs du SIS, plages de fonctionnement normal et points de déclenchement	358
Tableau F.14 – Schéma de cause à effet.....	361
Tableau F.15 – Chiffres MTTFd des appareils F.1 du SIS	362
Tableau F.16 – Cycle de vie de sécurité du SIS – Zone 4	386
Tableau F.17 – Cycle de vie de sécurité du SIS – Zone 5	399
Tableau F.18 – Liste des types d'instruments et des procédures d'essais utilisées	404
Tableau F.19 – Feuille de contrôle de dérivation/simulation de la procédure de vérification de verrouillage	417
Tableau F.20 – Cycle de vie de sécurité du SIS – Zone 6	417
Tableau F.21 – Journal de déclenchement du SIS	418
Tableau F.22 – Journal des défaillances de l'appareil du SIS	418
Tableau F.23 – Cycle de vie de sécurité du SIS – Zone 7	420
Tableau F.24 – Cycle de vie de sécurité d'un SIS – Zone 8.....	420
Tableau F.25 – Cycle de vie de sécurité du SIS – Zone 9	421
Tableau F.26 – Cycle de vie de sécurité du SIS – Zone 10	422

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

SÉCURITÉ FONCTIONNELLE – SYSTÈMES INSTRUMENTÉS DE SÉCURITÉ POUR LE SECTEUR DES INDUSTRIES DE TRANSFORMATION –

Partie 2: Lignes directrices pour l'application de l'IEC 61511-1:2016

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La Norme internationale IEC 61511-2 a été établie par le sous-comité 65A: Aspects systèmes, du comité d'études 65 de l'IEC: Mesure, commande et automation dans les processus industriels.

Cette deuxième édition annule et remplace la première édition parue en 2003. Cette édition constitue une révision technique. Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- description des exemples d'orientation, basés sur toutes les phases du cycle de vie de sécurité, réalisée avec des exemples basés sur l'expérience de l'utilisation de la norme IEC 61511 première édition;

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- remplacement des annexes pour répondre à la transition de logiciel à programmation d'application.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
65A/783/FDIS	65A/787/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2.

La présente Norme internationale doit être lue conjointement avec l'IEC 61511-1. Elle est basée sur la deuxième édition de cette norme.

Une liste de toutes les parties de la série IEC 61511, publiées sous le titre général *Sécurité fonctionnelle – Systèmes instrumentés de sécurité pour le secteur des industries de transformation*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives à la publication recherchée. A cette date, la publication sera

- reconduite,
- supprimée,
- remplacée par une édition révisée, ou
- amendée.

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INTRODUCTION

Les systèmes instrumentés de sécurité (SIS, *Safety Instrumented System*) sont utilisés dans les industries de transformation depuis de nombreuses années pour remplir des fonctions instrumentées de sécurité (SIF, *Safety Instrumented Function*). Si l'instrumentation doit être effectivement utilisée pour réaliser des SIF, il est essentiel que cette instrumentation satisfasse à certaines normes minimales.

La série IEC 61511 concerne l'application des SIS aux industries de transformation. Elle traite également de l'interface entre les SIS et les autres systèmes de sécurité, et exige de procéder à une analyse de danger et de risque du processus. Le SIS comprend les capteurs, les solveurs logiques et les éléments terminaux.

La série IEC 61511 aborde deux concepts, qui sont fondamentaux vis-à-vis de son application: le cycle de vie de sécurité SIS et le niveau d'intégrité de sécurité (SIL, *Safety Integrity Level*). Le cycle de vie de sécurité SIS constitue le cadre central qui lie la plupart des concepts de cette Norme internationale.

Les solveurs logiques du SIS mentionnés dans cette norme incluent les technologies électriques (E)/électroniques (E)/et électroniques programmables (PE). Si d'autres technologies sont utilisées pour les solveurs logiques, les principes de base de la présente norme peuvent être appliqués afin de garantir que les exigences de sécurité fonctionnelle sont satisfaites. La série IEC 61511 concerne également les capteurs et les éléments terminaux des SIS, quelle que soit la technologie utilisée. La série IEC 61511 a été conçue pour être une mise en œuvre de la série IEC 61508 dans le secteur des industries de transformation. La série IEC 61511 est propre aux industries de transformation, dans le cadre de la série IEC 61508.

La série IEC 61511 définit une approche concernant les activités relatives au cycle de vie de sécurité des SIS dans le but de satisfaire à ces normes minimales. Cette approche a été adoptée afin de mettre en œuvre une politique technique cohérente et rationnelle. La présente partie de l'IEC 61511 a pour objet de fournir des lignes directrices sur la façon de satisfaire à l'IEC 61511-1:2016 .

Pour faciliter l'utilisation de l'IEC 61511-2:—, les numéros d'articles indiqués à l'Annexe A (informative) sont identiques à ceux du texte normatif correspondant de l'IEC 61511-1:2016 à l'exception de la notation "A".

Dans la plupart des cas, la meilleure sécurité est obtenue, chaque fois que cela est possible, par des processus à conception à sécurité intrinsèque combinée, au besoin, avec un certain nombre de systèmes de protection, fondés sur différentes technologies (par exemple, chimique, mécanique, hydraulique, pneumatique, électrique, électronique, thermodynamique (par exemple, pare-feu), électronique programmable) couvrant tous les risques résiduels identifiés. Toute stratégie de sécurité prend en compte chacun des SIS individuellement, dans le contexte des autres systèmes de protection. Pour faciliter cette approche, l'IEC 61511-1:2016 :

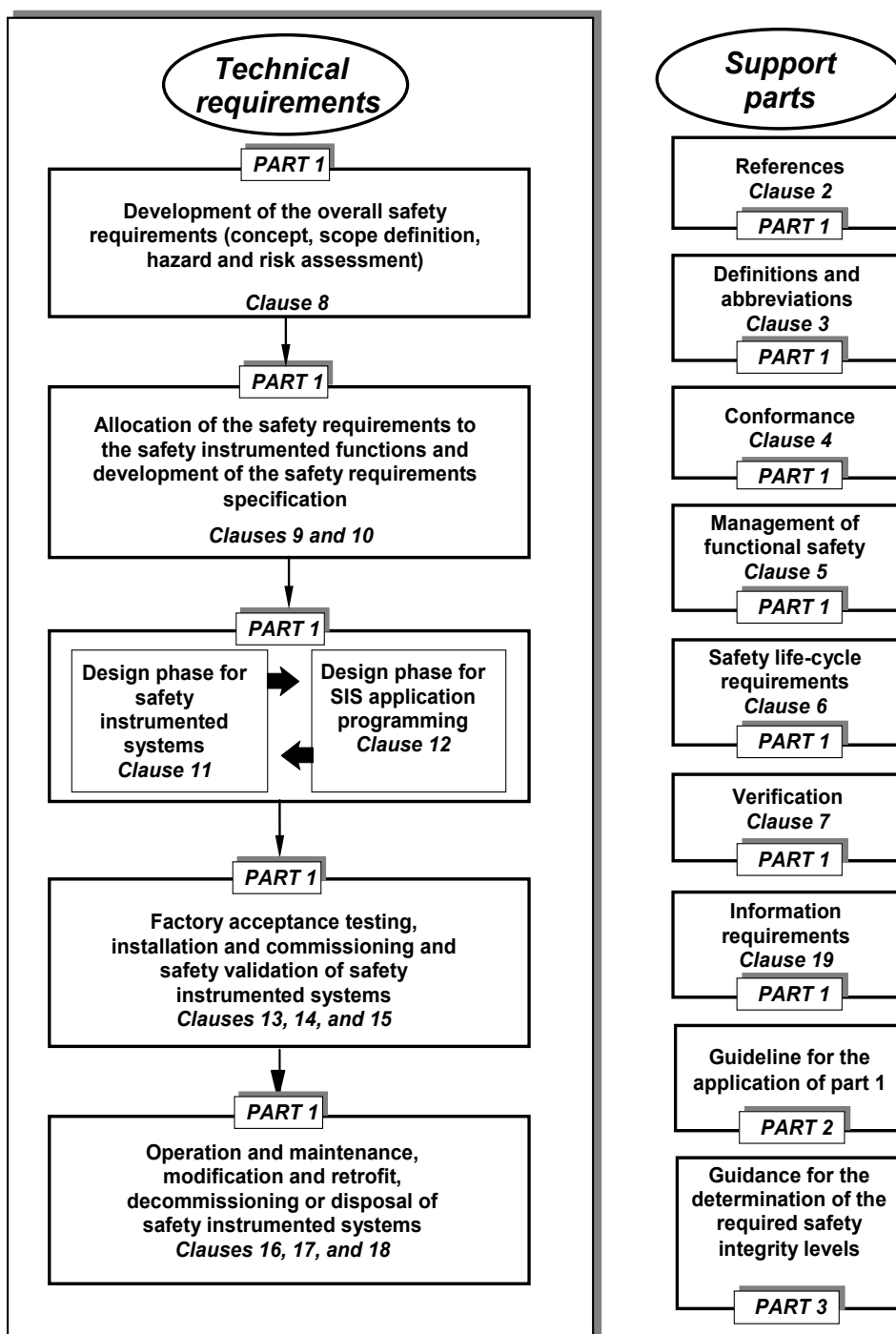
- exige de procéder à une analyse de danger et de risque pour identifier les exigences de sécurité globales;
- exige l'allocation des exigences de sécurité aux fonctions de sécurité et aux systèmes de sécurité relatifs, par exemple aux SIS;
- s'inscrit dans un cadre applicable à toutes les méthodes instrumentées qui permettent d'obtenir la sécurité fonctionnelle;
- détaille l'utilisation de certaines activités, telles que la gestion de la sécurité, qui peuvent être applicables à toute méthode permettant d'obtenir la sécurité fonctionnelle;

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- prend en compte les étapes pertinentes du cycle de vie de sécurité SIS, depuis la conceptualisation initiale, en passant par la conception, la mise en œuvre, le fonctionnement et la maintenance, jusqu'au déclassement;
- permet l'harmonisation des normes de l'industrie de transformation nationales existantes ou nouvelles par rapport à cette norme.

La série IEC 61511 vise à obtenir un haut niveau de cohérence (des principes sous-jacents, de la terminologie, de l'information, par exemple) dans le secteur des industries de transformation. Cela présenterait des avantages tant du point de vue de la sécurité que du point de vue économique.

La Figure 1 ci-dessous présente le cadre général de la série IEC 61511.



IEC

Anglais	Français
Technical requirements	Exigences techniques
PART 1	PARTIE 1
Development of the overall safety requirements (concept, scope definition, hazard and risk assessment) Clause 8	Développement des exigences de sécurité globales (concept, définition du domaine d'application, analyse de danger et de risque) Article 8

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Anglais	Français
Allocation of the safety requirements to the safety instrumented functions and development of the safety requirements specification Clauses 9 and 10	Affectation des exigences de sécurité aux fonctions instrumentées de sécurité et développement de la spécification des exigences de sécurité Articles 9 et 10
Design phase for safety instrumented systems Clause 11	Phase de conception pour les systèmes instrumentés de sécurité Article 11
Design phase for SIS application programming Clause 12	Phase de conception pour la programmation d'application du SIS Article 12
Factory acceptance testing, installation and commissioning and safety validation of safety instrumented systems Clauses 13, 14, and 15	Essais de réception en usine, installation et mise en service, et validation de la sécurité des systèmes instrumentés de sécurité Articles 13, 14, et 15
Operation and maintenance, modification and retrofit, decommissioning or disposal of safety instrumented systems Clauses 16,17, and 18	Fonctionnement et maintenance, modification et remise à niveau, déclassement ou mise au rebut des systèmes instrumentés de sécurité Articles 16, 17, et 18
Support parts	Parties de prise en charge
References Clause 2	Références Article 2
Definitions and abbreviations Clause 3	Définitions et abréviations Article 3
Conformance Clause 4	Conformité Article 4
Management of functional safety Clause 5	Gestion de la sécurité fonctionnelle Article 5
Safety life-cycle requirements Clause 6	Exigences relatives au cycle de vie de sécurité Article 6
Verification Clause 7	Vérification Article 7
Information requirements Clause 19	Exigences relatives aux informations Article 19
Guideline for the application of part 1 PART 2	Ligne directrice pour l'application de la partie 1 PARTIE 2
Guidance for the determination of the required safety integrity levels PART 3	Conseils pour la détermination des niveaux exigés d'intégrité de sécurité PARTIE 3

Figure 1 – Cadre général de la série IEC 61511

ÉCURITÉ FONCTIONNELLE – SYSTÈMES INSTRUMENTÉS DE SÉCURITÉ POUR LE SECTEUR DES INDUSTRIES DE TRANSFORMATION –

Partie 2: Lignes directrices pour l'application de l'IEC 61511-1:2016

1 Domaine d'application

La présente partie de l'IEC 61511 donne les lignes directrices relatives à la spécification, la conception, l'installation, au fonctionnement et à la maintenance des SIF et des SIS associés, telles que définies dans l'IEC 61511-1:2016 .

NOTE 1 L'Annexe A (informative) a été organisée de sorte que tous les numéros d'articles et de paragraphes qu'elle contient correspondent à ceux de l'IEC 61511-1:2016 , sauf s'ils sont précédés de la lettre "A".

NOTE 2 L'Annexe A contient désormais les éléments précédemment présents dans le texte de la première édition. Ces changements sont exigés pour la conformité aux règles de l'IEC, lesquelles interdisent l'existence d'une norme intégralement informative.

NOTE 3 Pour assurer l'utilisation maximale de ces lignes directrices:

- passer en revue les lignes directrices de la section et celles de l'article spécifique (lors de la consultation des lignes directrices de 5.2.6.1.3, tenir compte de celles de 5.2.6, par exemple);
- lorsque les lignes directrices de l'article spécifique ne sont pas fournies (plus de lignes directrices fournies, par exemple), passer également en revue les lignes directrices de la section, tant que cela peut être applicable.

2 Références normatives

Les documents suivants sont cités en référence de manière normative, en intégralité ou en partie, dans le présent document et sont indispensables pour son application. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 61511-1:2016 , *Sécurité fonctionnelle – Systèmes instrumentés de sécurité pour le secteur des industries de transformation – Partie 1: Cadre, définitions, exigences pour le système, le matériel et la programmation d'application*