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

Part 3:
Guidance for the determination of the required
safety integrity levels

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International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11  Telefax: +41 22 919 03 00  E-mail: inmail@iec.ch  Web: www.iec.ch

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CONTENTS

FOREWORD ....................................................................................................................... ... 4
INTRODUCTION ................................................................................................................... .6
1 Scope .............................................................................................................................. 9
2 Terms, definitions and abbreviations...............................................................................10
3 Risk and safety integrity – general guidance .................................................................10
  3.1 General .................................................................................................................10
  3.2 Necessary risk reduction........................................................................................11
  3.3 Role of safety instrumented systems .....................................................................11
  3.4 Safety integrity ......................................................................................................11
  3.5 Risk and safety integrity ........................................................................................13
  3.6 Allocation of safety requirements ...........................................................................14
  3.7 Safety integrity levels ............................................................................................14
  3.8 Selection of the method for determining the required safety integrity level .............15

Annex A (informative)  As Low As Reasonably Practicable (ALARP) and tolerable risk concepts ................................. 16
Annex B (informative)  Semi-quantitative method ............................................................ 19
Annex C (informative)  The safety layer matrix method ................................................... 27
Annex D (informative)  Determination of the required safety integrity levels – a semi- qualitative method: calibrated risk graph ................................................................. 33
Annex E (informative)  Determination of the required safety integrity levels – a qualitative method: risk graph ................................................................. 41
Annex F (informative)  Layer of protection analysis (LOPA) ............................................. 46

Figure 1 – Overall framework of this standard ........................................................................ 8
Figure 2 – Typical risk reduction methods found in process plants ........................................ 10
Figure 3 – Risk reduction: general concepts ..........................................................................13
Figure 4 – Risk and safety integrity concepts ........................................................................13
Figure 5 – Allocation of safety requirements to the Safety Instrumented Systems, non-SIS prevention/mitigation protection layers and other protection layers ................................................................. 14
Figure A.1 – Tolerable risk and ALARP .................................................................................17
Figure B.1 – Pressurized Vessel with Existing Safety Systems .............................................. 20
Figure B.2 – Fault Tree for Overpressure of the Vessel ......................................................... 23
Figure B.3 – Hazardous Events with Existing Safety Systems .............................................. 24
Figure B.4 – Hazardous Events with Redundant Protection Layer ....................................... 25
Figure B.5 – Hazardous Events with SIL 2 SIS Safety Function .......................................... 26
Figure C.1 – Protection Layers .............................................................................................27
Figure C.2 – Example Safety Layer Matrix ............................................................................31
Figure D.1 – Risk graph: general scheme ............................................................................37
Figure D.2 – Risk Graph: Environmental Loss .....................................................................39
Figure E.1 – DIN V 19250 Risk graph – personnel protection (see Table E.1) ....................... 44
Figure E.2 – Relationship IEC 61511, DIN 19250 and VDI/VDE 2180 ................................... 45
Figure F.1 – Layer of Protection Analysis (LOPA) Report .................................................... 47
Table A.1 – Example of risk classification of incidents...........................................................18
Table A.2 – Interpretation of risk classes...............................................................................18
Table B.1 – HAZOP analysis results........................................................................................21
Table C.1 – Frequency of hazardous event likelihood (without considering PLs) ...............30
Table C.2 – Criteria for rating the severity of impact of hazardous events .........................30
Table D.1 – Descriptions of process industry risk graph parameters.................................34
Table D.2 – Example calibration of the general purpose risk graph ....................................37
Table D.3 – General environmental consequences...............................................................39
Table E.1 – Data relating to risk graph (see Figure E.1)........................................................44
Table F.1 – HAZOP developed data for LOPA.......................................................................47
Table F.2 – Impact event severity levels................................................................................48
Table F.3 – Typical protection layer (prevention and mitigation) PFDs.................................49
Table F.4 – Initiation Likelihood.............................................................................................48
FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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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International Standard IEC 61511-3 has been prepared by subcommittee 65A: System aspects, of IEC technical committee 65: Industrial-process measurement and control.

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

<table>
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<tr>
<th>FDIS</th>
<th>Report on voting</th>
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<tr>
<td>65A/367/FDIS</td>
<td>65A/370/RVD</td>
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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.

IEC 61511 series has been developed as a process sector implementation of IEC 61508 series.
IEC 61511 consists of the following parts, under the general title *Functional safety – Safety Instrumented Systems for the process industry sector* (see Figure 1):

Part 1: Framework, definitions, system, hardware and software requirements
Part 2: Guidelines for the application of IEC 61511-1
Part 3: Guidance for the determination of the required safety integrity levels

The committee has decided that the contents of this publication will remain unchanged until 2007. At this date, the publication will be

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

The contents of the corrigendum of October 2004 have been included in this copy.
INTRODUCTION

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

This International Standard addresses the application of safety instrumented systems for the Process Industries. It also requires a process hazard and risk assessment to be carried out to enable the specification for safety instrumented systems to be derived. Other safety systems are only considered so that their contribution can be taken into account when considering the performance requirements for the safety instrumented systems. The safety instrumented system includes all components and subsystems necessary to carry out the safety instrumented function from sensor(s) to final element(s).

This International Standard has two concepts which are fundamental to its application: safety lifecycle and safety integrity levels.

This International Standard addresses safety instrumented systems which are based on the use of Electrical (E)/Electronic (E)/Programmable Electronic (PE) technology. Where other technologies are used for logic solvers, the basic principles of this standard should be applied. This standard also addresses the safety instrumented system sensors and final elements regardless of the technology used. This International Standard is process industry specific within the framework of IEC 61508 (see Annex A of IEC 61511-1).

This International Standard sets out an approach for safety lifecycle activities to achieve these minimum standards. This approach has been adopted in order that a rational and consistent technical policy be used.

In most situations, safety is best achieved by an inherently safe process design. 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, programmable electronic). Any safety strategy should consider each individual safety instrumented system in the context of the other protective systems. To facilitate this approach, this standard

- requires that a hazard and risk assessment is carried out to identify the overall safety requirements;
- requires that an allocation of the safety requirements to the safety instrumented system(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 all 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 this standard.

This standard is intended to lead to a high level of consistency (for example, of underlying principles, terminology, information) within the process industries. This should have both safety and economic benefits.
In jurisdictions where the governing authorities (for example national, federal, state, province, county, city) have established process safety design, process safety management, or other requirements, these take precedence over the requirements defined in this standard.

This standard deals with guidance in the area of determining the required SIL in hazards and risk analysis (H & RA). The information herein is intended to provide a broad overview of the wide range of global methods used to implement H & RA. The information provided is not of sufficient detail to implement any of these approaches.

Before proceeding, the concept and determination of safety integrity level(s) (SIL) provided in IEC 61511-1 should be reviewed. The annexes in this standard address the following:

- **Annex A** provides an overview of the concepts of tolerable risk and ALARP.
- **Annex B** provides an overview of a semi-quantitative method used to determine the required SIL.
- **Annex C** provides an overview of a safety matrix method to determine the required SIL.
- **Annex D** provides an overview of a method using a semi-qualitative risk graph approach to determine the required SIL.
- **Annex E** provides an overview of a method using a qualitative risk graph approach to determine the required SIL.
- **Annex F** provides an overview of a method using a layer of protection analysis (LOPA) approach to select the required SIL.
Figure 1 – Overall framework of this standard
1 Scope

1.1 This part provides information on

- the underlying concepts of risk, the relationship of risk to safety integrity, see Clause 3;
- the determination of tolerable risk, see Annex A;
- a number of different methods that enable the safety integrity levels for the safety instrumented functions to be determined, see Annexes B, C, D, E, and F.

In particular, this part

a) applies when functional safety is achieved using one or more safety instrumented functions for the protection of either personnel, the general public, or the environment;
b) may be applied in non-safety applications such as asset protection;
c) illustrates typical hazard and risk assessment methods that may be carried out to define the safety functional requirements and safety integrity levels of each safety instrumented function;
d) illustrates techniques/measures available for determining the required safety integrity levels;
e) provides a framework for establishing safety integrity levels but does not specify the safety integrity levels required for specific applications;
f) does not give examples of determining the requirements for other methods of risk reduction.

1.2 Annexes B, C, D, E, and F 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.

NOTE Those intending to apply the methods indicated in these annexes should consult the source material referenced in each annex.

1.3 Figure 1 shows the overall framework for IEC 61511-1, IEC 61511-2 and IEC 61511-3 and indicates the role that this standard plays in the achievement of functional safety for safety instrumented systems.

Figure 2 gives an overview of risk reduction methods.
Figure 2 – Typical risk reduction methods found in process plants (for example, protection layer model)