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Safety of machinery – Guidelines on functional safety of safety-related control system

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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SAFETY OF MACHINERY – GUIDELINES ON FUNCTIONAL SAFETY OF SAFETY-RELATED CONTROL SYSTEMS

FOREWORD

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IEC TS 63394 has been prepared by IEC technical committee 44: Safety of machinery – Electrotechnical aspects. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
44/980/DTS	44/989/RVDTS

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

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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

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- withdrawn,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

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INTRODUCTION

In the context of the safety of machinery, the sector standard IEC 62061, along with ISO 13849-1, provides requirements and guidance to the manufacturers of machines to design, develop and integrate a safety-related control system (SCS) or safety-related parts of control systems (SRP/CS), respectively, including input devices and final elements whatever the technology (mechanical, pneumatic, hydraulic and electrical technologies).

The following aspects are relevant:

– the classification of safety functions,

– the architecture of the realization of safety functions,

– the modes of operation of safety functions,

– the calculation based on the used technology.

Therefore, safety functions can be classified as follows:

– Safety functions that stop the dangerous movement(s) of the machine and that are mainly performed by SCS or SRP/CS of machines for the protection of persons. Typical examples are interlocking guards, sensitive protective equipment, two-hand control devices and emergency stop.

– Safety functions that protect the integrity of the machine against its destruction and that in a second step can have an impact on the protection of persons. Typical examples are protective devices, devices for limiting pressure or temperature (also defined as "safety-related parameters", e.g. position, speed, temperature or pressure, deviate from limits defined in the control system).

– Other safety functions that are not covered by the two previous cases.

NOTE 1 The different kinds of safety functions are defined and in line with the classifications and definitions of ISO 12100 and ISO 13849-1.

The subsystem architectures to perform safety function(s) are considered.

NOTE 2 In IEC 62061:2021, information is introduced to map SIL (Safety Integrity Level) classification of IEC 62061/IEC 61508 and classification of ISO 13849-1 in terms of categories, architectures, designated architectures and PL (Performance Level). In order to allow backward compatibility, these different criteria are considered in this document.

Depending on the mode of operation of the safety function, criteria and calculations will be considered in order to fulfil the requirements of this document and in order to be in line with existing regulations (e.g. such as recommendations for use in Europe) and other requirements already defined in existing standards, for example on test periodicity.

In order to consider mechanical, pneumatic, hydraulic and electrical technologies, applications for the safety functions, architectures and mode of operation, the associated calculations are evaluated.

NOTE 3 For example, most calculations inside standards are based on the exponential law that is typically applicable to electronic technology. For mechanic or other technologies, Weibull distribution is applied and exponential distribution is not used, except under restrictions.

SAFETY OF MACHINERY – GUIDELINES ON FUNCTIONAL SAFETY OF SAFETY-RELATED CONTROL SYSTEMS

1 Scope

In the context of the safety of machinery, the sector standard IEC 62061, along with ISO 13849-1, provides requirements to manufacturers of machines for the design, development and integration of safety-related control systems (SCS) or safety-related parts of control systems (SRP/CS), depending on technology used (mechanical, pneumatic, hydraulic or electrical technologies) to perform safety function(s). This document does not replace ISO 13849-1 and IEC 62061. This document gives additional guidance to the application of IEC 62061 or ISO 13849-1. This document:

– gives guidelines and specifies additional requirements for specific safety functions based on the methodology of ISO 12100, which are relevant in machinery and respecting typical boundary conditions of machinery;

– considers safety functions which are designed for high demand mode of operation yet are rarely operated, called rarely activated safety functions;

NOTE 1 IEC 62061:2021 completely covers high demand. However, other safety functions related to the protection of the machine itself and indirectly of persons are considered more in detail in this document.

– gives additional information for the calculation of failure rates using other (non-electronic) technologies based e.g. on Weibull distribution, because all the formula defined in IEC 62061 and ISO 13849-1 are based on exponential distribution.

Therefore, the basis for these guidelines and additional requirements is

– a typical classification of safety functions;

– a consideration of typical architectures used for designing safety functions;

– a consideration of modes of operation of safety functions;

– the derivation and evaluation of PFH formulas for subsystems considering the used technology.

NOTE 2 These guidelines can also be used for application of ISO 13849-1 for the design process of SRP/CS.

This document does not address low demand mode of operation according to IEC 61508.

This document does not take into account either layer of protection analysis (LOPA) or basic process control system (BPCS), according to IEC 61511 as a risk reduction measure.

This document considers all lifecycle phases of the machine regarding functional safety, and SCS or SRP/CS.

NOTE 3 The user of the machine needs information from the machine manufacturer for the safe operation of the machine, e.g. useful lifetime of components, maintenance information, testing of safety functions if necessary.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62061:2021, *Safety of machinery – Functional safety of safety-related control systems*

IEC TR 63074:2019, *Safety of machinery – Security aspects related to functional safety of safety-related control systems*

ISO 12100:2010, *Safety of machinery – General principles for design – Risk assessment and risk reduction*

ISO 13849-1:2015, *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design*

ISO 13850:2015, *Safety of machinery – Emergency stop function – Principles for design*

ISO 13851:2019, *Safety of machinery – Two-hand control devices – Principles for design and selection*

ISO 14118:2017, *Safety of machinery – Prevention of unexpected start-up*

ISO 14119:2013, *Safety of machinery – Interlocking devices associated with guards – Principles for design and selection*