INTERNATIONAL STANDARD

ISO 12100-1

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Safety of machinery — Basic concepts, general principles for design —

Part 1: Basic terminology, methodology

Sécurité des machines — Notions fondamentales, principes généraux de conception —

Partie 1: Terminologie de base, méthodologie

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 12100-1 was prepared by Technical Committee ISO/TC 199, *Safety of machinery.*

This edition cancels and replaces ISO/TR 12100-1:1992, which has been technically revised.

This standard results from the revision of EN 292:1991 / ISO/TR 12100:1992, carried out by a Special Working Group composed of experts from ISO, CEN, IEC and CENELEC.

ISO 12100 consists of the following parts, under the general title *Safety of machinery — Basic concepts, general principles for design*:

— *Part 1: Basic terminology, methodology*, expressing the basic overall methodology to be followed when designing machinery and when producing safety standards for machinery, together with the basic terminology related to the philosophy underlying this work;

— *Part 2: Technical principles*, giving advice on how this philosophy can be applied using available techniques.

Introduction

The primary purpose of ISO 12100 is to provide designers with an overall framework and guidance to enable them to produce machines that are safe for their intended use. It also provides a strategy for standard makers.

The concept of safety of machinery considers the ability of a machine to perform its intended function(s) during its lifecycle where risk has been adequately reduced.

This standard is the basis for a set of standards which has the following structure:

— **type-A standards** (basic safety standards) giving basic concepts, principles for design, and general aspects that can be applied to all machinery;

— **type-B standards** (generic safety standards) dealing with one safety aspect or one type of safeguard that can be used across a wide range of machinery:

  — type-B1 standards on particular safety aspects (e.g. safety distances, surface temperature, noise);

  — type-B2 standards on safeguards (e.g. two-hand controls, interlocking devices, pressure sensitive devices, guards);

— **type-C standards** (machine safety standards) dealing with detailed safety requirements for a particular machine or group of machines.

This standard is a type-A standard.

When a type-C standard deviates from one or more provisions dealt with by Part 2 of this standard or by a type-B standard, the type-C standard takes precedence.

It is recommended that this standard be incorporated in training courses and manuals to convey basic terminology and general design methods to designers.

ISO/IEC Guide 51 has been taken into account as far as practicable at the time of drafting of this standard.

Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology

1 Scope

This standard defines basic terminology and methodology used in achieving safety of machinery.

The provisions stated in this standard are intended for the designer.

This standard does not deal with damage to domestic animals, property or the environment.

2 Normative references

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

ISO 12100-2:2003, *Safety of machinery – Basic concepts, general principles for design – Part 2 : Technical principles.*

3 Terms and definitions

For the purposes of ISO 12100-1 and -2, the following terms and definitions apply.

3.1
machinery
machine
assembly of linked parts or components, at least one of which moves, with the appropriate machine actuators, control and power circuits, joined together for a specific application, in particular for the processing, treatment, moving or packaging of a material.

The terms "machinery" and "machine" also cover an assembly of machines which, in order to achieve the same end, are arranged and controlled so that they function as an integral whole.

NOTE Annex A provides a general schematic representation of a machine.

3.2
reliability (of a machine)
ability of a machine or its components or equipment, to perform a required function under specified conditions and for a given period of time without failing

3.3
maintainability (of a machine)
ability of a machine to be maintained in a state which enables it to fulfil its function under conditions of intended use, or restored into such a state, the necessary actions (maintenance) being carried out according to specified practices and using specified means

3.4
usability (of a machine)
ability of a machine to be easily used thanks to, among others, properties or characteristics that enable its function(s) to be easily understood.

3.5
harm
physical injury or damage to health

3.6
hazard
potential source of harm

NOTE 1 The term "hazard" can be qualified in order to define its origin (e.g. mechanical hazard, electrical hazard) or the nature of the potential harm (e.g. electric shock hazard, cutting hazard, toxic hazard, fire hazard).

NOTE 2 The hazard envisaged in this definition:

— either is permanently present during the intended use of the machine (e.g. motion of hazardous moving elements, electric arc during a welding phase, unhealthy posture, noise emission, high temperature);

— or may appear unexpectedly (e.g. explosion, crushing hazard as a consequence of an unintended / unexpected start-up, ejection as a consequence of a breakage, fall as a consequence of acceleration / deceleration).

3.7
relevant hazard

hazard which is identified as being present at or associated with the machine

NOTE A relevant hazard is identified as the result of one step of the process described in ISO 14121.

3.8
significant hazard
hazard which has been identified as relevant and which requires specific action by the designer to eliminate or to reduce the risk according to the risk assessment

3.9
hazardous situation
circumstance in which a person is exposed to at least one hazard. The exposure can immediately or over a period of time result in harm

3.10
hazard zone
danger zone
any space within and/or around machinery in which a person can be exposed to a hazard

3.11
risk
combination of the probability of occurrence of harm and the severity of that harm

3.12
residual risk
risk remaining after protective measures have been taken (see also figure 1)

NOTE This standard distinguishes:

— the residual risk after protective measures have been taken by the designer;

— the residual risk after all protective measures have been implemented.

3.13
risk assessment
overall process comprising a risk analysis and a risk evaluation

3.14
risk analysis
combination of the specification of the limits of the machine, hazard identification and risk estimation

3.15
risk estimation
defining likely severity of harm and probability of its occurrence

3.16
risk evaluation
judgement, on the basis of risk analysis, of whether the risk reduction objectives have been achieved

3.17
adequate risk reduction
risk reduction at least in accordance with the legal requirements under consideration of the current state of the art

NOTE Criteria for determining when adequate risk reduction is achieved are given in 5.5.

3.18
protective measure
measure intended to achieve risk reduction, implemented:

— by the designer (inherently safe design, safeguarding and complementary protective measures, information for use) and

— by the user (organization: safe working procedures, supervision, permit-to-work systems; provision and use of additional safeguards; use of personal protective equipment; training).

See figure 1.

3.19
inherently safe design measure
protective measure which either eliminates hazards or reduces the risks associated with hazards by changing the design or operating characteristics of the machine without the use of guards or protective devices

NOTE ISO 12100-2:2003, clause 4, deals with risk reduction by inherently safe design measures.

3.20
safeguarding
protective measure using safeguards to protect persons from the hazards which cannot reasonably be eliminated or from the risks which cannot be sufficiently reduced by inherently safe design measures

NOTE ISO 12100-2:2003, clause 5, deals with safeguarding.

3.21
information for use
protective measure consisting of communication links (e.g. texts, words, signs, signals, symbols, diagrams) used separately or in combination, to convey information to the user

NOTE ISO 12100-2:2003, clause 6, deals with information for use.

3.22
intended use of a machine
use of a machine in accordance with the information provided in the instructions for use

3.23
reasonably foreseeable misuse
use of a machine in a way not intended by the designer, but which may result from readily predictable human behaviour

3.24
safeguard
guard or protective device

3.25
guard
physical barrier, designed as part of the machine, to provide protection

NOTE 1 A guard may act:

— alone; it is then only effective when it is "closed" for a movable guard or "securely held in place" for a fixed guard;

— in conjunction with an interlocking device with or without guard locking; in this case, protection is ensured whatever the position of the guard.

NOTE 2 Depending on its design, a guard may be called e.g. casing, shield, cover, screen, door, enclosing guard.

NOTE 3 See ISO 12100-2:2003, 5.3.2, and ISO 14120 for types of guards and their requirements.

3.25.1
fixed guard
guard affixed in such a manner (e.g. by screws, nuts, welding) that it can only be opened or removed by the use of tools or destruction of the affixing means

3.25.2
movable guard
guard which can be opened without the use of tools

3.25.3
adjustable guard
fixed or movable guard which is adjustable as a whole or which incorporates adjustable part(s). The adjustment remains fixed during a particular operation

3.25.4
interlocking guard
guard associated with an interlocking device so that, together with the control system of the machine, the following functions are performed:

— the hazardous machine functions "covered" by the guard cannot operate until the guard is closed;

— if the guard is opened while hazardous machine functions are operating, a stop command is given;

— when the guard is closed, the hazardous machine functions "covered" by the guard can operate. The closure of the guard does not by itself start the hazardous machine functions

NOTE ISO 14119 gives detailed provisions.

3.25.5
interlocking guard with guard locking
guard associated with an interlocking device and a guard locking device so that, together with the control system of the machine, the following functions are performed:

— the hazardous machine functions "covered" by the guard cannot operate until the guard is closed and locked;

— the guard remains closed and locked until the risk due to the hazardous machine functions "covered" by the guard has disappeared;

— when the guard is closed and locked, the hazardous machine functions "covered" by the guard can operate. The closure and locking of the guard do not by themselves start the hazardous machine functions

NOTE ISO 14119 gives detailed provisions.

3.25.6
interlocking guard with a start function
control guard
special form of an interlocking guard which, once it has reached its closed position, gives a command to initiate the hazardous machine function(s) without the use of a separate start control

NOTE ISO 12100-2:2003, 5.3.2.5, gives detailed provisions regarding the conditions of use.

3.26
protective device
safeguard other than a guard

NOTE Examples of protective devices are given in 3.26.1 to 3.26.9.

3.26.1
interlocking device
interlock
mechanical, electrical or other type of device, the purpose of which is to prevent the operation of hazardous machine functions under specified conditions (generally as long as a guard is not closed)

3.26.2
enabling device
additional manually operated device used in conjunction with a start control and which, when continuously actuated, allows a machine to function

NOTE IEC 60204–1:1997, 9.2.5.8 gives provisions on enabling devices.

3.26.3
hold-to-run control device
control device which initiates and maintains hazardous machine functions only as long as the manual control (actuator) is actuated

3.26.4
two-hand control device
control device which requires at least simultaneous actuation by both hands in order to initiate and to maintain hazardous machine functions, thus providing a protective measure only for the person who actuates it

NOTE ISO 13851 gives detailed provisions.

3.26.5
sensitive protective equipment (SPE)
equipment for detecting persons or parts of persons which generates an appropriate signal to the control system to reduce risk to the persons detected. The signal may be generated when a person or part of a person goes beyond a predetermined limit – e.g. enters a hazard zone – (tripping) or while a person is detected in a predetermined zone (presence sensing), or in both cases

3.26.6
active opto-electronic protective device (AOPD)
device whose sensing function is performed by opto-electronic emitting and receiving elements detecting the interruption of optical radiation, generated within the device, by an opaque object present in the specified detection zone

NOTE IEC 61496-2 gives detailed provisions.

3.26.7
mechanical restraint device
device which introduces into a mechanism a mechanical obstacle (e.g. wedge, spindle, strut, scotch) which, by virtue of its own strength, can prevent any hazardous movement

3.26.8
limiting device
device which prevents a machine or hazardous machine condition(s) from exceeding a designed limit (e.g.space limit, pressure limit, load moment limit)

3.26.9
limited movement control device
control device, a single actuation of which, together with the control system of the machine, permits only a limited amount of travel of a machine element

3.27
impeding device
any physical obstacle – e. g. low barrier, rail – which, without totally preventing access to a hazard zone, reduces the probability of access to this zone by offering an obstruction to free access

3.28
safety function

function of a machine whose failure can result in an immediate increase of the risk(s)

3.29
unexpected start-up
unintended start-up

any start-up which, because of its unexpected nature, generates a hazard. This can be caused by, e. g.:

— a start command which is the result of a failure in, or an external influence on, the control system;

— a start command generated by inopportune action on a start control or other parts of the machine as, e. g., a sensor or a power control element;

— restoration of the power supply after an interruption;

— external / internal influences (e.g. gravity, wind, self-ignition in internal combustion engines) on parts of the machine

NOTE Machine start-up during normal sequence of an automatic cycle is not unintended, but can be considered to be unexpected from the point of view of the operator. Prevention of accidents in this case involves the use of safeguarding measures (see ISO 12100-2:2003, clause 5).

[from ISO 14118:2000, 3.2]

3.30
failure to danger
any malfunction in the machinery, or in its power supply, that increases the risk

3.31
fault
the state of an item characterized by inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources

NOTE 1 A fault is often the result of a failure of the item itself, but may exist without prior failure.

[IEV 191-05-01]

NOTE 2 In the field of machinery, the English term 'fault' is commonly used in accordance with the definition in IEV 191-05-01, whereas the French term "défaut" and the German term "Fehler" are used rather than the terms "panne" and "Fehlzustand" that appear in the IEV with this definition.

NOTE 3 In practice, the terms "fault" and "failure" are often used synonymously.

3.32
failure
the termination of the ability of an item to perform a required function

NOTE 1 After failure, the item has a fault.

NOTE 2 "Failure" is an event, as distinguished from "fault", which is a state.

NOTE 3 The concept as defined does not apply to items consisting of software only.

[IEV 191-04-01]

3.33
common cause failures
failures of different items, resulting from a single event, where these failures are not consequences of each other

NOTE Common cause failures should not be confused with common mode failures.

[IEV 191-04-23]

3.34
common mode failures
failures of items characterized by the same fault mode

NOTE Common mode failures should not be confused with common cause failures, as the common mode failures may result from different causes.

[IEV 191-04-24]

3.35
emergency situation
hazardous situation needing to be urgently ended or averted

NOTE An emergency situation may arise :

— during normal operation of the machine (e.g. due to human interaction, or as a result from external influences);

— as a consequence of a malfunction or a failure of any part of the machine.

3.36
emergency operation
all actions and functions intended to end or avert an emergency situation

3.37
emergency stop
function which is intended:

— to avert arising or to reduce existing hazards to persons, damage to machinery or to work in progress;

— to be initiated by a single human action