INTERNATIONAL STANDARD

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Safety of machinery — Fire prevention and fire protection

Sécurité des machines — Prévention et protection contre l'incendie

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 199, *Safety of machinery*.

This second edition cancels and replaces the first edition (ISO 19353:2005), which has been technically revised.

Introduction

The safety of machinery against fire involves fire prevention and fire protection and fire-fighting. In general, as shown in Annex E, these include technical, structural, organizational and fire suppression measures. Effective fire safety of machinery can require the implementation of a single measure or a combination of measures.

Annex E provides an overview on fire risk reduction measures. This International Standard deals with the measures shown in Figure 1.

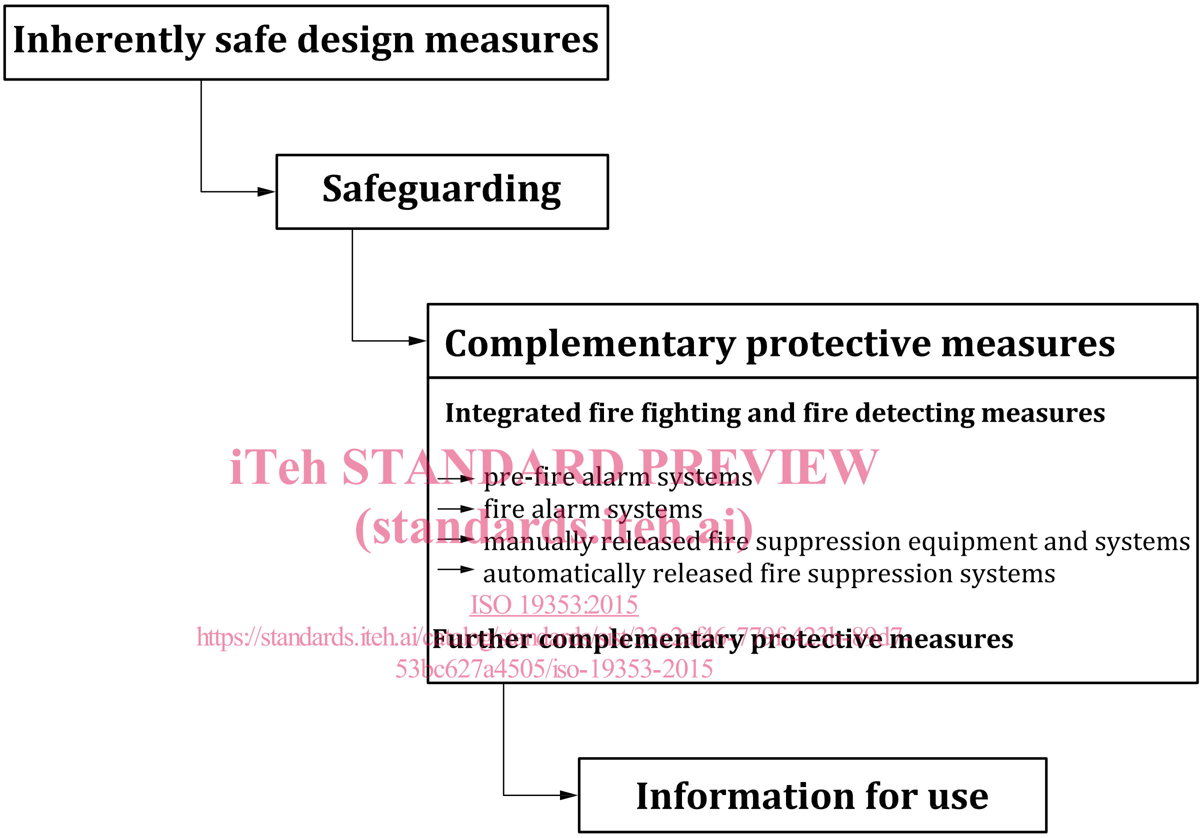


Figure 1 — Protective measures dealt with in ISO 19353

The structure of safety standards in the field of machinery is as follows.

a) **type-A standards** (basis standards) giving basic concepts, principle for design, and general aspects that can be applied to machinery;

b) **type-B standards** (generic safety standards) dealing with one or more safety aspect(s), or one or more type(s) of safeguards 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-hands controls, interlocking devices, pressure sensitive devices, guards);

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

ISO 19353 is a type-B1 standard as stated in ISO 12100.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

— machine manufacturers (small, medium and large enterprises);

— health and safety bodies (regulators, accident prevention organisations, market surveillance, etc.);

— machine users/employers (small, medium and large enterprises);

— machine users/employees (e.g. trade unions, organizations for people with special needs);

— service providers, e.g. for maintenance (small, medium and large enterprises);

— consumers (in case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

In addition, this document is intended for standardization bodies elaborating type-C standards.

The requirements of this document can be supplemented or modified by a type-C standard.

For machines that are covered by the scope of a type-C standard and that have been designed and built according to the requirements of that standard, the requirements of that type-C standard take precedence.

Safety of machinery — Fire prevention and fire protection

1 Scope

This International Standard specifies methods for identifying fire hazards resulting from machinery and for performing a risk assessment.

It gives the basic concepts and methodology of protective measures for fire prevention and protection to be taken during the design and construction of machinery. The measures consider the intended use and reasonably foreseeable misuse of the machine.

It provides guidelines for consideration in reducing the risk of machinery fires to acceptable levels through machine design, risk assessment and operator instructions.

This International Standard is not applicable to

— mobile machinery,

— machinery designed to contain controlled combustion processes (e.g. internal combustion engines, furnaces), unless these processes can constitute the ignition source of a fire in other parts of the machinery or outside of this,

— machinery used in potentially explosive atmospheres and explosion prevention and protection, and

— fire detection and suppression systems that are integrated in building fire safety systems.

It is also not applicable to machinery or machinery components manufactured before the date of its publication.

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.

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100 and the following apply.

3.1
combustibility
property of a material capable of burning

Note 1 to entry: Accurate assessment of the combustibility characteristics of a material will depend on the operating conditions of the machinery and the form and physical state of the material (e.g. gaseous, liquid or solid; solids chopped to form shavings or dust, or not).

Note 2 to entry: On the basis of their combustibility, materials can be classified into non-combustible, hardly combustible, combustible and easily combustible materials. It is important not to mix up combustibility on the one hand, and flammability or ignitability on the other. Consequently, flash points and ignition points do not represent quantitative measures of combustibility.

3.2
combustible
capable of being ignited or burned

[SOURCE: ISO 13943:2008, 4.43]

3.3
combustion
exothermic reaction of a substance with an oxidizing agent

Note 1 to entry: Combustion generally emits fire effluent accompanied by flames and/or glowing.

[SOURCE: ISO 13943:2008, 4.46]

3.4
damaging fire
fire that causes harm to people, buildings, machinery and/or environment

3.5
extinguishing opening
port in the machine housing, closed with a plug or flap that can be safely accessed with an extinguishing device

Note 1 to entry: An extinguishing device, e.g. a hose or lance, can be used.

3.6
fire
<general> self-supporting combustion that can occur as controlled combustion or uncontrolled combustion

Note 1 to entry: Controlled combustion is deliberately arranged to provide an intended effect.

Note 2 to entry: Uncontrolled combustion is spreading uncontrolled in time and space.

Note 3 to entry: In the case of a combustion control failure, controlled combustion can lead to uncontrolled combustion.

[SOURCE: ISO 13943:2008, 4.96 to 4.98, modified.]

3.7
fire alarm system
system that, by the use of sensors, detects the onset of fire and initiates a response

Note 1 to entry: Sensors can be designed to detect smoke, combustion gases, heat or flames.

3.8
fire-extinguishing agent
agent which is appropriate to extinguish fire by cooling below ignition temperature and/or by reducing the oxidizer level

Note 1 to entry: The extinguishing agent can be gaseous, liquid or solid. Common extinguishing agents include water, carbon dioxide, nitrogen, argon, chemical powder or foam.

3.9
fire hazard
physical object or condition with a potential for an undesirable consequence from fire

[SOURCE: ISO 13943:2008, 4.112]

3.10
fire load
quantity of heat that can be released by the complete combustion of all the combustible materials in a volume, including the facings of all bounding surfaces

Note 1 to entry: Fire load can be based on effective heat of combustion, gross heat combustion or net heat combustion as required by the specifier.

Note 2 to entry: The word "load" can be used to denote force or power or energy. In this context, it is used to denote energy.

Note 3 to entry: The typical units are kilojoules (kJ) and megajoules (MJ).

[SOURCE: ISO 13943:2008, 4.114]

3.11
fire prevention
measures to prevent the outbreak of a fire and/or to limit its effects

[SOURCE: ISO 8421-1:1987, 1.21]

3.12
fire protection
measures such as design features, systems, equipment, buildings or other structures to reduce danger to persons and property by detecting, extinguishing or containing fires

[SOURCE: ISO 8421-1:1987, 1.23, modified — "measures such as" has been added to the original definition.]

3.13
fire risk
probability of a fire combined with a quantified measure of its consequence

[SOURCE: ISO 13943:2008, 4.124]

3.14
fire suppression system
technical system to fight a fire and to reduce the damaging effects of flames and heat

Note 1 to entry: Additional devices might be required to extinguish the fire.

3.15
flame
rapid, self-sustaining, sub-sonic propagation of combustion in a gaseous medium, usually with emission of light

[SOURCE: ISO 13943:2008, 4.133]

3.16
flame retardant
substance added, or treatment applied, to a material in order to suppress or delay the appearance of a flame and/or reduce its propagation rate

[SOURCE: ISO 13943:2008, 4.139, modified — The note has been deleted and "the flame-spread rate" replaced with "its propagation rate".]

3.17
flammability
ability of a material or product to burn with a flame under specified conditions

Note 1 to entry: Accurate assessment of the ignition characteristics of material will depend on the operating conditions of the machinery.

[SOURCE: ISO 13943:2008, 4.151, modified — Note 1 to entry has been added.]

3.18
glow
glowing combustion
combustion of a material in the solid phase without flame but with emission of light from the combustion zone

[SOURCE: ISO 13943:2008, 4.169, modified — "glow" has been introduced as the preferred term.]

3.19
ignitability
ease of ignition
measure of the ease with which a test specimen can be ignited, under specified conditions

[SOURCE: ISO 13943:2008, 4.182, modified —Cross reference has been deleted.]

3.20
ignition
<general> initiation of combustion

[SOURCE: ISO 13943:2008, 4.187, modified — Deprecated synonymous term "sustained ignition" has been deleted.]

3.21
ignition energy
energy necessary to initiate combustion

3.22
ignition source
source of energy that initiates combustion

[SOURCE: ISO 13943:2008, 4.189]

3.23
low-emission metalworking fluid
metalworking fluid composed of low-evaporation base media and anti-mist additives

Note 1 to entry: Low-evaporation base media are base oils consisting of low-evaporation mineral oils, synthetic esters and/or special liquids.

3.24
overheating
uncontrolled temperature increase

3.25
pre-fire alarm system
system that detects conditions that can lead to the potential onset of fire and initiates a response

Note 1 to entry: A response can be a trigger of an alarm signal or can initiate an automatic reaction.

Note 2 to entry: Sensors for these systems can detect heat due to friction, hot surfaces, loss of inerting, abnormal changes of gas concentrations, failure of lubrication or cooling supply, etc.

3.26
required performance level
PLr
performance level (PL) applied in order to achieve the required risk reduction for each safety function

[SOURCE: ISO 13849-1:2006, 3.1.24, modified — Cross references have been deleted.]

3.27
self-heating
<chemical> rise in temperature in a material resulting from an exothermic reaction within the material

[SOURCE: ISO 13943:2008, 4.287]

3.28
self-ignition
spontaneous ignition resulting from self-heating

3.29
smoke
visible part of fire effluent

Note 1 to entry: For definition of fire effluent see ISO 13943:2008, 4.105.

[SOURCE: ISO 13943:2008, 4.2693, modified — Note 1 to entry has been added.]

4 Fire hazards

4.1 General

A fire hazard occurs if combustible materials (fuel), oxidizer (oxygen) and ignition energy (heat) are available in sufficient quantities at the same place and at the same time. A fire is an interaction of these three components in the form of an uninhibited chemical reaction (see Figure 2).

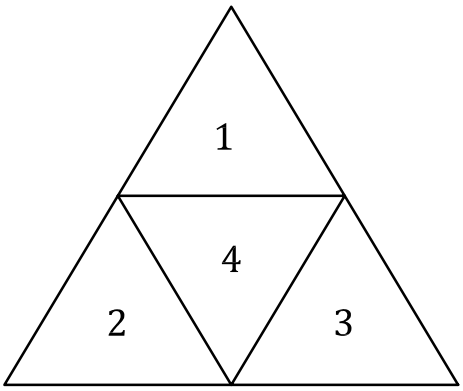
A fire can be prevented or suppressed by controlling or removing one or more of the components of the fire tetrahedron.

Certain materials are inherently unstable, extraordinary oxidizers or capable of self-heating. This affects the fire hazard.

Variation in oxygen concentration (e.g. oxygen enrichment) can also affect the fire hazard.

The fire hazard can arise from the material processed, used or released by the machinery, from materials in the vicinity of the machinery, or from materials used in the construction of the machinery.

NOTE An explosion hazard can exist in addition to the fire hazard.



Key

1 heat
2 oxygen
3 fuel
4 uninhibited chemical chain reaction

Figure 2 — Fire tetrahedron

4.2 Combustible materials

It shall be determined whether combustible materials exist or can exist and in what quantity and distribution. Combustible materials can occur as solids, liquids or gases.

The ease of combustion of materials is affected by the size, shape and deposition of the materials. For example, small pieces of a material loosely collected together can be more easily ignited than a large piece of that material. Also, the combination of materials can have an influence on the ignitability and the burning behaviour.

Consideration shall be given as to whether the properties of the materials can change over time or with use. Such changes can include the possibility of decomposition of the material releasing combustible gases and vapours. This can lead to an increased fire hazard.

4.3 Oxidizers

In assessing the fire hazard, the existence and quantity of fire-supporting substances, e.g. oxygen-producing substances, and the probability of their occurrence shall be determined. The most common oxidizer is air. But there are other oxidizers that support combustion, e.g. potassium nitrate (KNO_3), potassium permanganate ($KMnO_4$), perchloric acid ($HClO_4$), hydrogen peroxide (H_2O_2) and nitrous oxide (N_2O).

4.4 Ignition sources

It shall be determined which ignition sources exist or can occur.

Possible ignition sources can arise due to the influence of

a) heat energy,

b) electrical energy,

c) mechanical energy, and/or

d) chemical energy.

NOTE See Annex A for examples of ignition sources and Annex B for examples of machines and their typical fire related hazards.

5 Strategy for fire risk assessment and risk reduction

5.1 General

Fire risk assessment comprises a series of logical steps that allow systematic examination of fire hazards according to the procedures outlined in ISO 12100. Fire risk assessment includes the following sequential phases:

a) fire risk analysis, comprising

   1) determination of the limits of the machinery (see 5.2),

   2) identification of fire hazards (see 5.3), and

   3) risk estimation (see 5.4), and

b) risk evaluation.

When deemed necessary risk evaluation is followed by risk reduction.

In planning fire prevention and protection measures, normal operating conditions – including start-up and standstill procedures, possible technical failures and reasonably foreseeable misuse – shall be taken into account.

The fire risk assessment and risk reduction shall be repeated as an iterative process until the risk of a fire occurrence has been adequately reduced. Risk analysis judgements shall be supported by a qualitative or, where appropriate, quantitative estimate of the risk associated with the hazards present on the machinery. See Figure 3.