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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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 199, *Safety of machinery*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This third edition cancels and replaces the second edition (ISO 19353:2015), which has been technically revised. It also incorporates the Amendment ISO 19353:2015/DAM 1:2017. The main changes compared to the previous edition are as follows:

— old Annexes A and B have become Annexes D and A, respectively;

— an example of methodology for selecting and qualifying a fire detection and fire suppression system has been added as new Annex B;

— old Annex D has been improved editorially and it has become Annex E;

— old Annex E on fire risk reduction measures has been deleted as well as references to it.

Introduction

The safety of machinery against fire involves fire prevention and fire protection and fire-fighting. In general, 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.

This document deals with the measures shown in Figure 1.

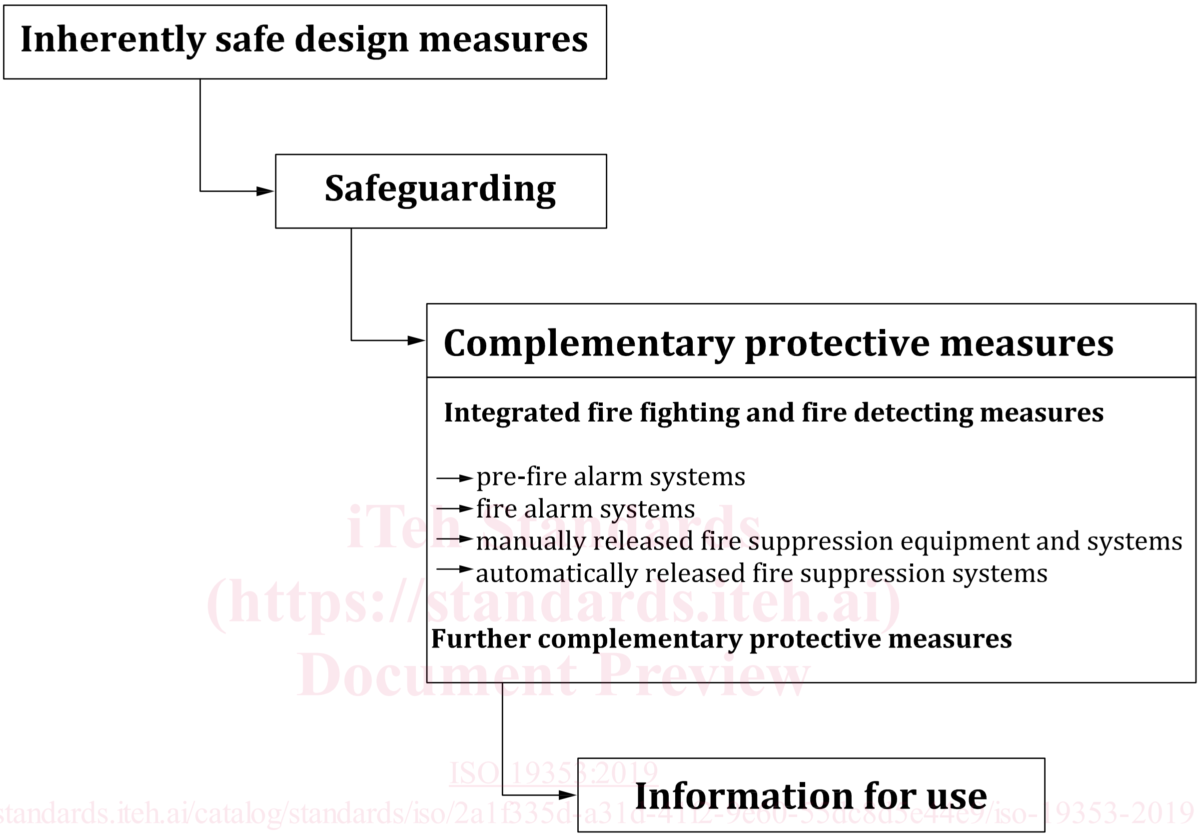


Figure 1 — Protective measures dealt with in ISO 19353

This document is a type-B 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 organizations, market surveillance etc.).

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

— 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 which are covered by the scope of a type-C standard and which 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 document 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 document 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 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.

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*

ISO 13943, *Fire safety — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100, ISO 13943 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
combustibility
property of a material capable of burning

Note 1 to entry: Accurate assessment of the combustibility characteristics of a material depends 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
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.

3.3
fire
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.

3.4
fire-extinguishing agent
agent which is appropriate to extinguish *fire* (3.3) 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.

3.5
fire prevention
set of measures to prevent the outbreak of a *fire* (3.3) and/or to limit its effects

[SOURCE: ISO 8421-1:1987, 1.21, modified — The words “set of” has been added to the definition.]

3.6
fire protection
set of measures such as design features, systems, equipment, buildings or other structures to reduce danger to persons and property by detecting, extinguishing or containing *fires* (3.3)

[SOURCE: ISO 8421-1:1987, 1.23, modified — The words “set of measures such as” have been added to the definition.]

3.7
fire suppression system
technical system to fight a *fire* (3.3) and to reduce the damaging effects of flames and heat

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

3.8
ignition energy
energy necessary to initiate combustion

3.9
low evaporation metalworking fluid
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.

3.10
overheating
uncontrolled temperature increase

3.11
pre-fire alarm system
pre-fire detection
system that detects conditions that can lead to the potential onset of *fire* (3.3) 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.

Note 3 to entry: A fire alarm system is understood to be a system that, by the use of sensors, detects the onset of fire and initiates a response. Sensors can be designed to detect smoke, combustion gases, heat or flames.

3.12
required performance level
PL_r
performance level (PL) applied in order to achieve the required risk reduction for each safety function

[SOURCE: ISO 13849-1:2015, 3.1.24, modified — Note 1 to entry has been deleted.]

3.13
self-ignition
spontaneous ignition resulting from self-heating

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).

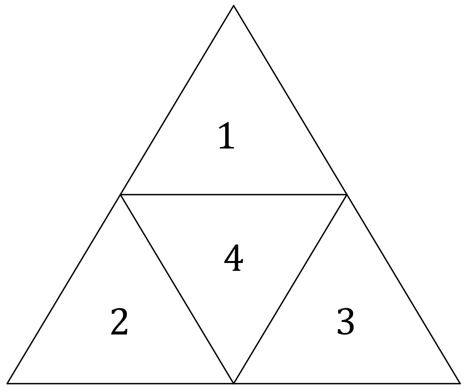
A fire can be prevented or suppressed by controlling or removing one or more of the components of the fire tetrahedron.

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 machines and their typical fire related hazards and Annex D for examples of ignition sources.

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);

 3) risk estimation (see 5.4);

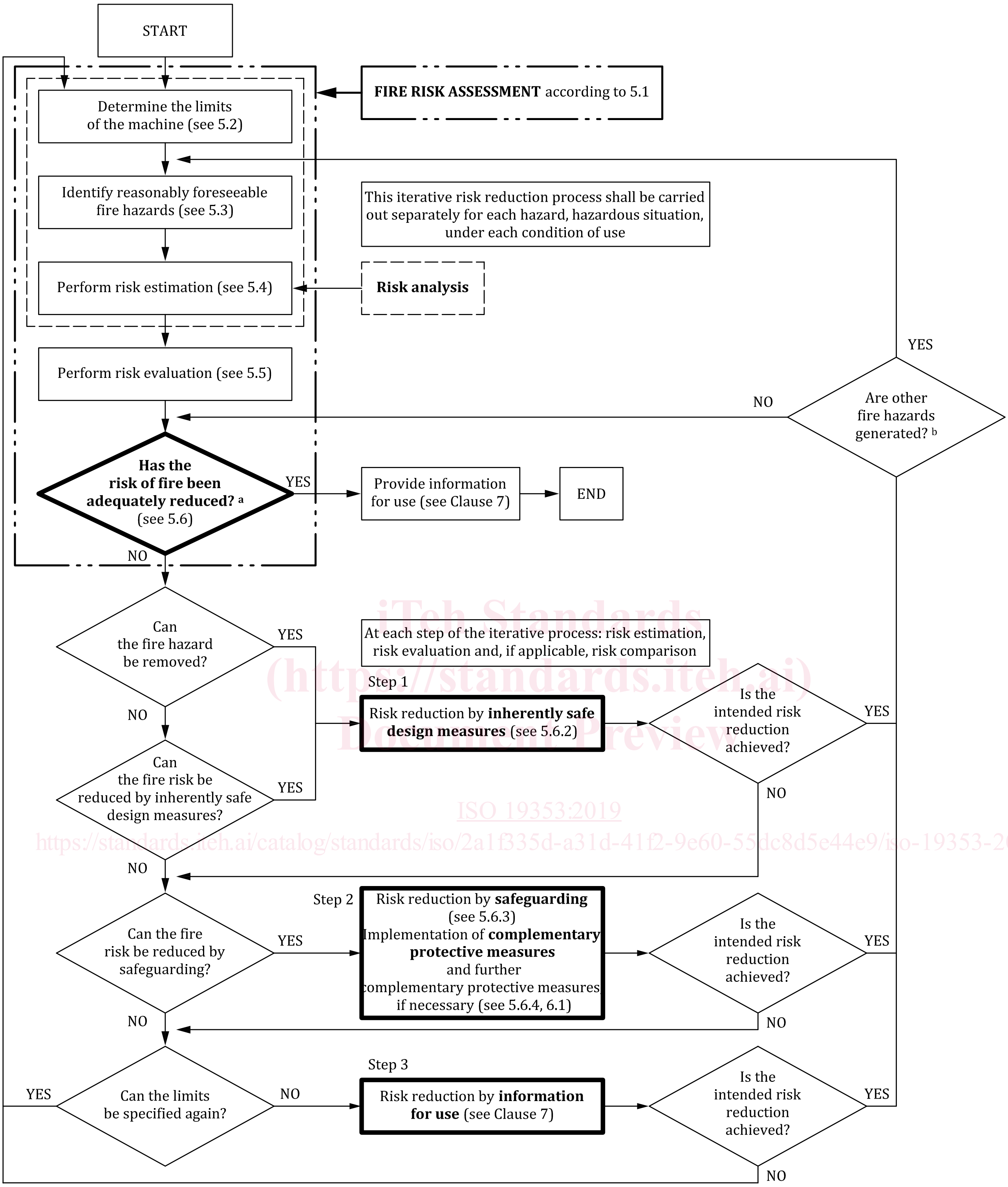
b) risk evaluation.

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.

NOTE See Annex E for an example for the risk assessment and risk reduction of a machining centre for the machining of metallic materials.



Key

a The first time the question is asked, it is answered by the result of the initial risk assessment.

b If the applied risk reduction generates other hazards than fire hazards, risk reduction methods according to ISO 12100 shall be applied.

Figure 3 — Schematic representation of fire risk reduction process including iterative three-step method (adopted from ISO 12100)

5.2 Determination of the limits of the machinery

Risk assessment shall include determination of the limits of the machinery, taking into account the phases of the machinery life that can involve fire hazards.

Examples of machine limits that are useful in fire risk assessment are as follows:

- intended use and reasonably foreseeable misuse of the machine;
- properties of materials processed by the machine;
- machine operating modes;
- anticipated levels of training, experience or ability of the machine operators, maintenance personnel, and where appropriate the general public;
- the level of awareness of fire hazards by those persons likely to be exposed to the fire hazards;
- the anticipated life of the machine and its components and the impact of ageing with respect to creation of fire hazards;
- recommended service intervals;
- housekeeping and level of cleanliness as potential contributors to a fire hazard;
- the environment in which the machine is expected to be operated (e.g. dry, dusty, humid, hot, cold conditions).

5.3 Identification of fire hazards

Following the determination of the limits of the machinery, reasonably foreseeable fire hazards shall be identified, taking into consideration the phases of machinery life in which a fire hazard can be present.

NOTE See Clause 4 for a general discussion on the nature of fire hazards.

All reasonably foreseeable fire hazards associated with the various uses of the machine shall be identified. The hazard can be identified according to the fire loads and ignition sources (see Figure 4).

For the determination of fire scenarios according to fire loads and ignition sources and for an estimation of the fire risk, the procedures outlined in ISO 12100 shall be followed. The procedure provides a sequence of logical steps allowing systematic examination of the fire hazards arising from the machinery and/or the work process (see Figure 3).

Identification of fire hazards shall include the following steps:

- identification of intended and reasonably foreseeable operating conditions;
- identification of combustible and/or flammable materials that are related to the fire hazard (all materials involved in the machine and process, including raw and process materials);
- evaluation of their ignitability, flammability, combustibility, fire supporting effect and toxic issues;
- estimation of the fire load based on the main combustible materials (fuel);
- identification of all possible ignition sources (e.g. heat) that can contribute to an ignition event;
- identification of fire scenarios according to fire loads and ignition sources: all reasonably foreseeable scenarios that can lead to an ignition of the combustible and flammable materials, including scenarios brought about by human errors such as exchange of substances, improper operation of the machine, or improper maintenance.

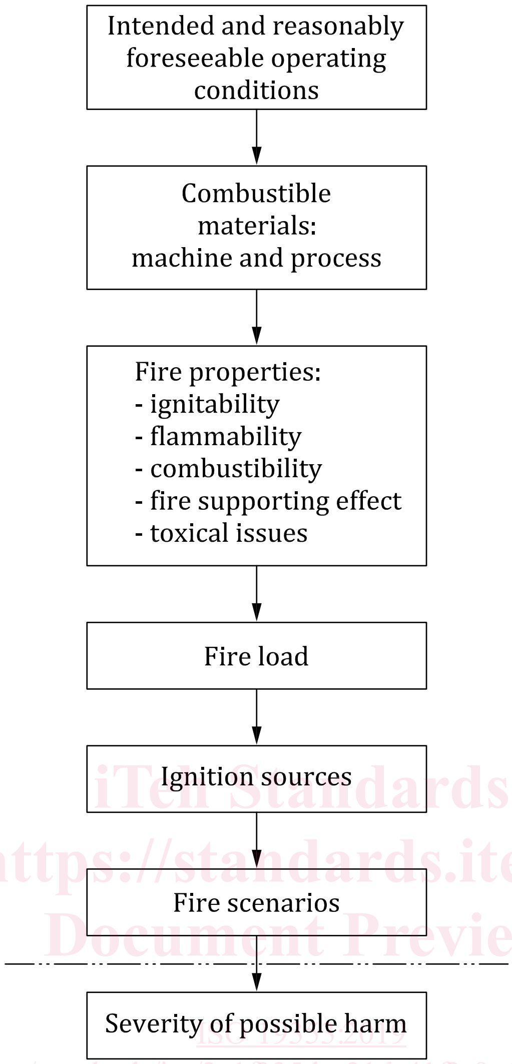


Figure 4 — Identification of significant fire hazards

5.4 Risk estimation

Once the fire hazards (fire scenarios) have been identified, the risk of occurrence of a fire shall be determined by estimation. Risk estimation provides information required for the risk evaluation, which in turn allows judgements to be made about whether or not risk reduction is required. Risk estimation depends on the existence of a fire hazard, the frequency at which the machine is exposed to the fire hazard, the probability of a fire occurring once exposure to hazard is present and the degree of possible harm.

The risk related to the fire hazard is a function of the severity of harm that can result from the fire hazard and the probability of occurrence of that harm. The risk graph given in Figure 5 provides guidance for risk estimation.

NOTE Methodology equivalent to Figure 5 can be used (see ISO/TR 14121-2).

