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Guidelines for assessing the adverse environmental impact of fire effluents —

Part 1: General

Lignes directrices pour déterminer l'impact environnemental des effluents du feu —
Partie 1: Généralités

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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 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 92, *Fire safety*, Subcommittee SC 3, *Fire threat to people and environment*.

This second edition cancels and replaces the first edition (ISO 26367:2011), which has been technically revised.

The main changes compared to the previous edition are as follows:

— Additional terms have been added to Clause 3.

— Revision of Clause 4.3.2.

— Additional examples of recent significant fire incidents were added to Table A.1 in Annex A.

A list of all parts in the ISO 26367 series can be found on the ISO website.

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.

Introduction

In view of the fact that relevant quantitative data on environmentally hazardous components of fire effluents cannot routinely be obtained from accidental fires, appropriate data may also have to be obtained from real scale fire tests and simulations involving physical fire models.

General awareness of the fact that large fires present dramatic and persistent adverse effects on the environment has been accentuated by a number of high-impact incidents over the past half-century. Annex A contains a list of significant fire incidents in recent years.

The serious consequences of such events have confirmed that the environmental impact of fires is an important issue that needs to be dealt with internationally and systematically. This document provides a framework for a common treatment of the environmental impact of fires in answer to this pressing need.

Guidelines for assessing the adverse environmental impact of fire effluents —

Part 1: General

1 Scope

This document gives guidelines whose primary focus is the assessment of the adverse environmental impact of fire effluents, including those from fires occurring in commercial and domestic premises, unenclosed commercial sites, industrial and agricultural sites, as well as those involving road, rail and maritime transport systems. It is not applicable to direct acute toxicity issues or wildland fires, which are covered by other existing ISO standards.

It is intended to serve as a tool for the development of standard protocols for

a) the assessment of local and remote adverse environmental impacts of fires, and the definition of appropriate preventive measures,

b) post-fire analyses to identify the nature and extent of the adverse environmental impacts of fires, and

c) the collection of relevant data for use in environmental fire hazard assessments.

This document is intended as an umbrella document to set the scene concerning *what* should be considered when determining the environmental impact of fires. It is not a comprehensive catalogue of methods and models defining *how* to determine the environmental impact of fires, intended to be addressed by other parts of ISO 26367.

This document is principally intended for use by firefighters and investigators, building owners and managers, storage facility operators, materials and product manufacturers, insurance providers, environmental regulatory authorities, civil defence organizations and public health authorities.

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 13943, *Fire safety — Vocabulary*

ISO 26367-2, *Guidelines for assessing the adverse environmental impact of fire effluents — Part 2: Methodology for compiling data on environmentally significant emissions from fires*

ISO/TR 26368, *Environmental damage limitation from fire-fighting water run-off*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943, ISO 26367-2 and ISO/TR 26368 and the following apply.

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

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

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

3.1
ecotoxic
harmful to the environment or a specific ecosystem

3.2
ecotoxicity
potential for biological, chemical or physical stressors to affect ecosystems

3.3
enclosed fires
fires which have been ignited and which take place inside an enclosure

Note 1 to entry: This term is particularly important when defining the ventilation conditions in the fire.

3.4
environment
surroundings within which a fire occurs, including air, water, land, natural resources, flora, fauna and humans, and their interrelation

Note 1 to entry: "environment", for the purposes of this document, includes the following:

— *local*: within the perimeter of a burning enclosure (this document is not applicable to burning enclosures during a fire);

— *immediate*: vicinity within a short distance of, e.g. 1 km from the fire and excluding the local area of an enclosure fire;

— *external*: area outside the immediate vicinity of a fire; the extent of this depends on weather conditions and types of emission, i.e. to air, water or land, with short-term or long-term consequences.

Note 2 to entry: Adapted from ISO 14001[1].

3.5
environmental impact
any change to the environment, whether adverse or beneficial, wholly or partially resulting from an accidental fire

Note 1 to entry: Adapted from ISO 14001[1].

Note 2 to entry: In this document it is used to signify an *adverse* change to the environment.

3.6
fire effluent
all gases and aerosols, including suspended particles, created by combustion or pyrolysis and emitted to the environment

Note 1 to entry: Adapted from ISO 13943.

Note 2 to entry: It also refers to run-off water generated during firefighting activities.

3.7
fires in ruptured enclosures
fires in enclosures that have been breached and that allow unrestricted emission of the fire smoke plume for environmental distribution

Note 1 to entry: Firefighting tactics in this type of fire are, in some cases, similar to those for an enclosure fire, even though emissions and environmental effects are similar to those for a fire in the open.

3.8
pollutant
chemical species or particulate that is harmful to the environment

Note 1 to entry: This term includes components of fire effluents that cause short-term or long-term impacts on the environment.

Note 2 to entry: Adapted from ISO 26367-2.

3.9
primary fire effluent
effluent released directly from the fire

3.10
receptors
segments of the environment on which accidental fire can have an impact, including air, water, and soil environments, plus flora and fauna associated with these environments, including humans

3.11
run-off
fluid effluent created through the interaction between a fire and a liquid extinguishing agent and hazardous materials stored or generated on site

3.12
secondary fire effluent
effluent created through interaction between a primary fire effluent and the environment

3.13
significant incident
emission, fire or explosion resulting from uncontrolled developments leading to delayed hazardous exposure to humans and/or immediate and delayed hazard to the environment

3.14
unenclosed fires
fires which initiate and propagate in the open air and those which initiate and propagate within an enclosure that subsequently ruptures and transforms the fire in terms of ventilation conditions and effluent transport mechanisms

4 Fire effluents

4.1 Overview

The interaction between a fire and its surroundings or environment is illustrated in Figure 1, which shows how fires cause harm to the environment through

— direct gaseous and particulate emissions to the atmosphere,

— spread of atmospheric emissions,

— deposition of atmospheric emissions,

— soil contamination, and

— ground and surface water contamination.

NOTE 1 The contamination can be due to emissions from the fire itself or those associated with the firefighting activities, which was the cause of the greatest environmental impact on the fire in the chemical facility in Basel, Switzerland in 1986 (see Annex A).

Interaction through thermal radiation is not included in Figure 1. In the case of sensitive environments, this effect should also be taken into account.

The effect of these various emissions depends in part on the transfer mechanism, e.g. the emission of gaseous species and the effect of weather or the emission of contaminated firefighting water and its interaction with the drainage system, and on the specific species, i.e. small gaseous compounds, large particles and the range of species in between. It should also be noted that emissions can undergo chemical changes after emission, e.g. chemical modification of nitrogen oxides (NO_x) in the atmosphere due to ultraviolet (UV) light.

A wide variety of toxic effluents (both primary and secondary) are emitted in fires. These effluents can follow a number of pathways to impact on human, animal or plant receptors. Even for industrial sites, risk assessments cannot take into account all potential impacts.

NOTE 2 Annex B gives an overview of relevant regulations and guidance documents, for information.

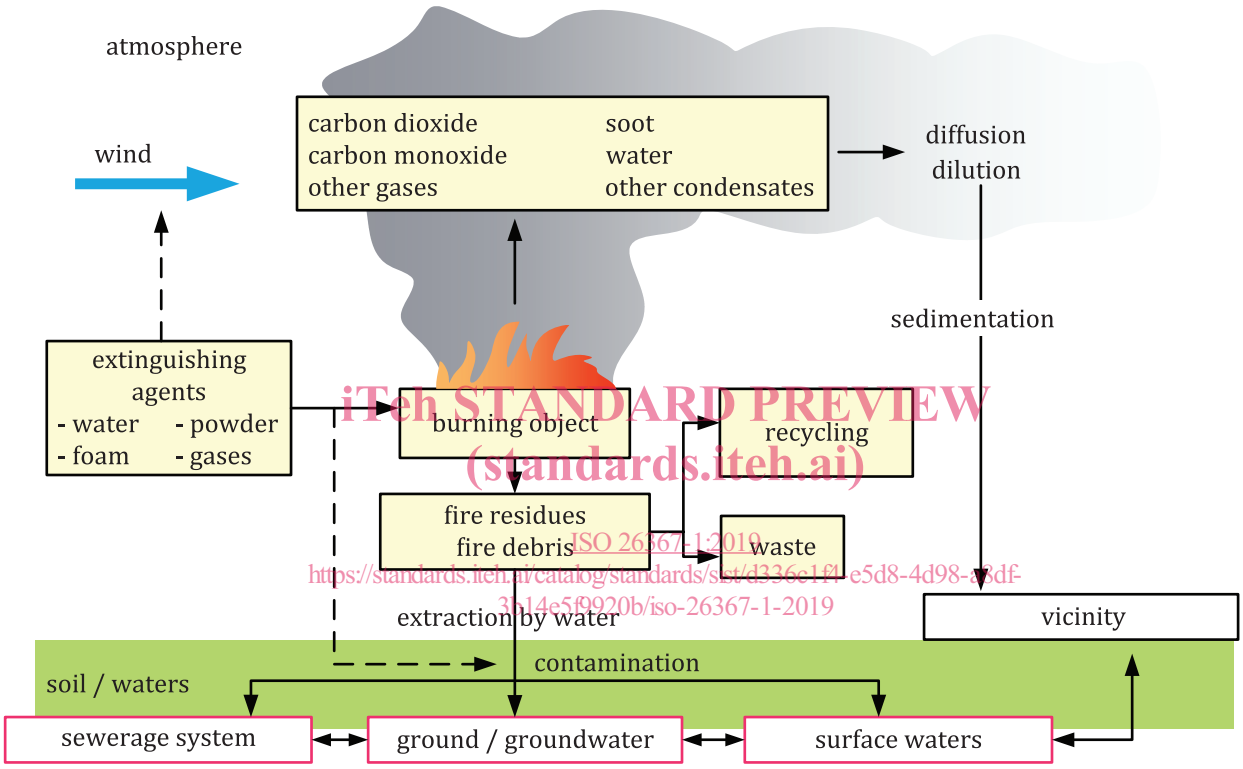

Figure 1 — Emission pathways from fires

4.2 Effluent generation

Initial decomposition is generally through pyrolysis, by which materials are broken down by heat to yield a range of organic by-products that provide the volatile fuel for combustion.

The elemental composition of materials provides guidance when predicting the combustion or decomposition products that can be generated during a fire. The molecular composition or structure of materials can affect combustion efficiency and the mix of organic and inorganic combustion products generated in a fire.

NOTE 1 BS 7982[2] gives guidance on the environmental impact of large fires involving plastics materials.

The relative yields of combustion and pyrolysis compounds depend mainly upon the combustion conditions. Smouldering fires involve slow thermal decomposition under oxidative non-flaming conditions. These conditions can give rise to fire emissions that are rich in organic compounds. Well-ventilated flaming fires, having a high air/fuel ratio, provide more efficient combustion conditions than vitiated fires. In the context of potential impacts to the environment, large, ventilation-controlled flaming fires are potentially the most environmentally harmful. In an event it is important to consider what is being produced at any given stage in the fire and how this can be emitted to the environment.

For example, species produced under low-temperature conditions in the later stages of a fire combined with a reduced plume height can represent a greater local hazard than those produced under high temperature conditions during the early stages, despite the fact that the yield of species could be higher during those early stages. A possible response to this could therefore be to allow a fire to initially burn and commence firefighting once the fire begins to die down. The advantage of such an approach is that it would allow less firefighting water to be used, thereby making containment easier.

Investigations of emissions from fires indicate that, whereas gases such as carbon monoxide (CO), carbon dioxide (CO_2), hydrogen cyanide (HCN), nitrogen oxides (NO_x) and other irritants are most important from an acute toxicological point of view, organic species of high molecular weight and aerosols, e.g. particulate matter, polycyclic aromatic hydrocarbons (PAHs) and dioxins, are most significant from an environmental point of view[3].

NOTE 2 The absolute and relative concentrations of species depend on the ventilation conditions and chemical make-up of the fuel.

NOTE 3 Molecules adsorbed on particles can be environmentally significant even when distant from the fire. Examples include HCl or dioxins adsorbed on particles.

NOTE 4 Water containment issues are addressed in ISO/TR 26368.

The products of combustion interact with the environment through direct emission to the air or through contamination of surface or groundwater and soil. These three emission pathways are discussed in more detail in 4.4 to 4.6.

The contamination of the surface or groundwater and soil is potentially compounded by the presence of physical fire debris, unburned products, and firefighting agents.

4.3 Fire stages

4.3.1 Background

Large-scale fires are complex events whose behaviour depends on many parameters, including the level of ventilation, fire load, the presence or absence of an enclosure and the burning properties of the combustible materials.

Emissions to the environment are generally more restricted in an enclosure fire than in the case of a fire in the open, owing to the potential for natural containment of fire effluents and firefighting agent within the structure.

4.3.2 Enclosed fire

In agreement with ISO 16733-1[4], four main stages of fire development within an enclosure are considered, as shown in Figure 2. It is assumed that no intervention by firefighters occurs or active fire protection systems such as sprinklers are activated. Depending on the relative availability of oxygen versus fuel the fire will follow either the “a” path (solid line, well-ventilated flaming, fuel controlled) or it will follow the “b” path (dashed line, under-ventilated, ventilation controlled). Most flaming enclosure fires begin in well-ventilated conditions; however, as the fire grows in relation to the enclosure size, the conditions frequently become ventilation controlled.