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Guidelines for assessing the adverse environmental impact of fire effluents —

Part 3:
Sampling and analysis

Lignes directrices pour déterminer l'impact environnemental des effluents du feu —
Partie 3: Échantillonnage et analyse

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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

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

Pollution of indoor and outdoor environments by complex mixtures of physical and chemical combustion products is a causative agent of human health and environmental problems on a global scale. Uncontrolled and incomplete combustion processes are responsible for the emission of chemical and physical pollutants in quantities that affect humans and the environment.

General awareness of the fact that fires can present dramatic and persistent adverse effects on the environment has been accentuated by a number of high-impact incidents over the past half century as exemplified in ISO 26367-1. 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. The ISO 26367 series of documents provides a framework for a common treatment of the environmental impact of fires in answer to this pressing need.

This document provides references to methods for sampling and analysis of fire effluents from environmentally significant fires. It is important to understand the chemical and physical nature of the components of the fire effluents, including their concentration within the fire plume and within different recipients. It is also necessary to determine the natural levels of the same pollutants in the affected area(s) in order to establish a baseline for measurement of the environmental impact of the fire.

With fires that primarily have the potential to harm the environment it is likely that there will be fewer logistical restraints for obtaining samples from the fire effluent than those from life-threatening fires. For example, these fires can be relatively large and less confined, compared to their mainly life-threatening counterparts. The fire plume can extend for many kilometres and can deposit particles and associated chemical species over a wide area. The fire residues can contaminate the soil and as run-off, contaminate surface and groundwater courses. Sampling, although unlikely to be straightforward, is therefore feasible with standard techniques and trained personnel.

In many cases, the sampling and analysis of compounds having the potential to harm the environment have been well-documented. This document therefore provides a guide to the “best practice” methodologies for sampling and analysing specific compounds that could be present in fire effluents. The compounds and the concentration levels of interest are dependent on the goals of the user and could be outside of the limits of the recommended sampling and analysis methods referenced in this document.

A methodology for compiling the information needed to assess the environmental damage caused by a fire incident and the establishment of data quality objectives and the design of sampling programmes is included in ISO 26367-2. It also provides a standardized method for reporting the results of the compilation and findings of the analyses for use in contingency planning or for the assessment of the potential adverse environmental impact of a specific fire incident.

Guidelines for assessing the adverse environmental impact of fire effluents —

Part 3: Sampling and analysis

1 Scope

This document is applicable to the sampling and analysis of effluents produced during fires that have the potential to cause harm through environmental contamination. It provides additional requirements to those standards already published by ISO TC 92/SC3 for the sampling and analysis of fire effluents from experimental fires and standard tests, specifically as best practice from previously published methodologies. This document does not include pollutant screening of exposed humans or animals.

The principle aims for the sampling and analysis of effluents from fires that can result in environmental contamination is therefore to provide information on:

— the nature and concentrations of airborne effluents over time and distance;

— the nature and concentrations of solid and liquid ground contaminants and "run-off" compounds from firefighting operations over time and distance.

This document is principally of interest for the following parties:

— environmental regulatory authorities;

— public health authorities;

— fire investigators;

— property owners.

This document is intended to be used together with ISO 26367-1 and ISO 26367-2 in assessments of the environmental impact of fire effluents.

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 3941, *Classification of fires*

ISO 13943, *Fire safety — Vocabulary*

ISO 14050, *Environmental management — Vocabulary*

ISO 19258, *Soil quality — Guidance on the determination of background values*

ISO 26367-1, *Guidelines for assessing the adverse environmental impact of fire effluents — Part 1: General*

ISO 26367-2:2017, *Guidelines for assessing the adverse environmental impact of fire effluents — Part 2: Methodology for compiling data on environmentally significant emissions from fires*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3941, ISO 13943, ISO 14050, ISO 26367-1 and ISO 26367-2 and the following apply.

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

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

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

3.1
background concentration
concentration of a substance characteristic of an environmental phase in an area or region arising from both natural sources and non-natural diffuse sources, such as atmospheric deposition

Note 1 to entry: Commonly expressed in terms of average, typical median, a range of values or a background value.

[SOURCE: ISO 11074:2015, 3.5.1[1], modified — "soil type" has been replaced with "environmental phase".]

3.2
continuous measurement
measurement obtained by taking a sample continuously with simultaneous or slightly delayed analysis

[SOURCE: ISO 11665-1:2019, 3.1.8[2], modified — the phrase "(or at integration intervals typically in the range of 1 min to 120 min)" has been removed. Notes to entry 1 and 2 have been removed.]

3.3
extractive sampling
extraction of the sample, removal of interfering materials and maintenance of gas concentration throughout the sampling system for subsequent analysis by appropriate instrumentation

[SOURCE: ISO 11042-2:1996, 3.4.1[3], modified — figure removed.]

3.4
in situ measurement
direct measurement of the measurand in its original place

Note 1 to entry: Measurand means substance of interest.

[SOURCE: ISO/TS 19159-1:2014, 4.11[4], modified — Note 1 to entry added.]

3.5
open-path measurement
measurement where the light beam of an optical method is directed across the effluent in its original place

Note 1 to entry: An example of an optical method is FTIR.

4 Abbreviated terms

BOD	biological oxygen demand
COD	chemical oxygen demand
DQO	data quality objective
FTIR	fourier transform infrared (spectroscopy)

GC-ECD	gas chromatography-electron capture detector
GC-MS	gas chromatography-mass spectroscopy
HX	halogenated acids
ICP-OES	inductively coupled plasma-optical emission spectroscopy
LC/MS/MS	liquid chromatography/mass spectroscopy/mass spectroscopy
LIDAR	laser induced differential absorption radar
NOX	nitrogen oxides
OP-FTIR	open path-FTIR
PAH	polycyclic aromatic hydrocarbons
PBDD	polybrominated dibenzodioxins
PBDF	polybrominated dibenzofurans
PBB	polybrominated biphenyls
PCB	polychlorinated biphenyls
PCDF	polychlorinated dibenzofurans
PCDD	polychlorinated dibenzodioxins
PFC	perfluorinated compounds
PFAS	per- and polyfluorinated alkylated substances
POP	persistent organic pollutant
SVOC	semi-volatile organic compounds
VOC	volatile organic compounds
XRF	X-ray fluorescence (spectroscopy)

5 Indicators and pollutants

Pollutants that either typically occur as a result of fire or are particularly harmful to the environment are listed in ISO 26367-2 and are also given here in Tables 1 to 3 for convenience. In some cases, other species should be considered, depending on the suspected substances in the fuel. ISO 26367-2:2017, Clause 6 shall be followed for the selection of indicators and pollutants to analyse.

Fire effluents can produce adverse environmental impacts that are not directly associated with specific pollutants but are indicated by the effects they produce. The properties listed in Table 1 represent general indicators of environmental pollution and the relevant environmental phase in each case.

Specific pollutants can be associated with short-term adverse effects or long-term adverse effects on the environment, or both. The pollutants listed in Table 2 are associated with short-term effects and the pollutants listed in Table 3 are associated with long-term effects. The relevant environmental phase is also given in these tables.

Table 1 — Indicators of environmental pollution

Indicator	Environmental phase
Alkalinity	Surface water, groundwater, sediment, soil
Biological oxygen demand (BOD)	Surface water, groundwater, sediment
Chemical oxygen demand (COD)	Surface water, groundwater, sediment
Electrical conductivity	Surface water, groundwater, sediment, soil
Hydrocarbon (oil) screening	Surface water, groundwater, sediment, soil
pH	Surface water, groundwater, sediment, soil
Turbidity	Surface water, groundwater
Water quality (e.g. luminescent bacteria)	Surface water
NOTE Oil is often used as a screening parameter for contaminated areas. There are different screening methods that include different ranges of hydrocarbons.	

Table 2 — Pollutants associated with short-term adverse effects on the environment

Pollutant	Environmental phase
Halogenated acids (HX)	Air
Metals	Air, surface water, groundwater, sediment, soil
Nitrogen oxides (NOx)	Air
Particulates	Air, deposition on surface water and soil
Sulfur oxides	Air
Volatile Organic Compounds (VOC)	Air
NOTE Additional background information is provided in ISO 26367-2 on pollutants having short-term effects.	

Table 3 — Pollutants associated with long-term adverse effects on the environment

Pollutant	Environmental phase
Metals	Air, surface water, groundwater, sediment, soil
Particulates	Air, deposition on surface water and soil
Perfluorinated compounds (PFC)[a]	Surface water, groundwater, sediment, soil
Polychlorinated biphenyls (PCB)	Air, deposition on surface water and soil, sediment
Polychlorinated dibenzodioxins (PCDD)[b]	Air, deposition on surface water and soil, sediment
Polychlorinated dibenzofurans (PCDF)[b]	Air, deposition on surface water and soil, sediment
Polycyclic aromatic hydrocarbons (PAH)	Air, deposition on surface water and soil
Volatile organic compounds (VOC)[c]	Air, surface water, groundwater, sediment, soil

[a] Analysis of a broader spectrum of PFAS compounds (perfluorinated and polyfluorinated substances) might be relevant in a detailed investigation.

[b] Polybrominated dibenzodioxins (PBDD), polybrominated dibenzofurans (PBDF) and mixed chlorine/bromine dioxin-furan congeners shall be analysed if the fuel load has a significant bromine content, for example in the case of materials containing brominated flame retardants.

[c] Semi-volatile organic compounds (SVOC) might be relevant to analyse in a detailed investigation. This class of compounds include plasticisers (phthalates) and some fire retardants (e.g. polybrominated biphenyls, PBB).

NOTE Additional background information is provided in ISO 26367-2 on pollutants having long-term effects.

6 Sampling requirements

6.1 General

The process for determining the overall sampling design begins with identifying data quality objectives (DQOs), which are used throughout the sampling and analysis process to ensure that the results are of

sufficient quality to satisfy the needs of the project. The steps involved in establishing DQOs described in ISO 26367-2:2017, Clause 5 shall be followed.

NOTE The framework for recording the steps taken to collect and treat data are provided in ISO 26367-2:2017, Clauses 6 and 7, including compiling the contaminants of interest, recording all relevant information and analysing the usability of the data. This document also includes a flow diagram showing the steps and indicating a structure for the sampling process.

Representative background concentrations shall be analysed in all cases to be used as a basis for the assessment of pollution levels.

The requirements in the following clauses assume that the procedures given in ISO 26367-2 have been implemented.

6.2 Personnel requirements

Individuals performing the sampling work should be environmental professionals or should work under the responsible supervision of an environmental professional.

NOTE An environmental professional is defined as a person having relevant competencies recognized by authorities having jurisdiction in the region of the work.

6.3 Sampling techniques

6.3.1 General

The equipment and techniques required to analyse pollutant samples are dependent on the environmental phase (air, surface water, groundwater, sediment or soil) and on whether the analysis takes place by in situ measurement or in a laboratory. They are also dependent on the nature of the chemical compound or species of interest.

In the following subclauses the sampling apparatus and techniques are grouped primarily by phase (gas, liquid, solid) and secondarily by groups of compounds typically found in these phases. Many compounds and species are emitted into multiple phases as fire effluent or are transported across phase boundaries over time.

NOTE Information on specific sampling requirements for individual pollutants is given in the respective subclause on sample analysis.

6.3.2 Fire plume sampling

Direct sampling of emissions to the air can only be made when the fire is ongoing. Airborne sampling from a variety of aircraft has been reported[5, 6]; however, it is unclear how such point samples can be related to ground deposition.

General standards for air sampling include ISO 9359[7] (stratified sampling method), ISO 7168-1[8] and ISO 7168-2[9] (both on exchange of air quality data).

Fire plume sampling or sample collection procedures shall be conducted in accordance with standardized methods; such methods are included in ISO 19701[10], ISO 19702[11] and ISO 29904[12]. The techniques described in ISO 19701 and ISO 19702 were developed to analyse higher concentrations in smoke. When they are used for environmental purposes, users should consider specific requirements for short-lived species and also limits of quantification and range of concentrations.

6.3.3 Liquid phase sampling

Emissions to the aquatic environment can affect both surface and ground water. Transport of fire effluent to the aquatic environment can occur through deposition of airborne contaminants onto soil or water surfaces or from fire water run-off that carries extinguishing media and/or residue from the fire ground. The location and nature of sampling shall be based on the knowledge of the pathway by