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Guidelines for assessing the adverse environmental impact of fire effluents —

Part 2: Methodology for compiling data on environmentally significant emissions from fires

Lignes directrices pour déterminer l'impact environnemental des effluents du feu —

Partie 2: Méthodologie pour compiler les données relatives aux émissions des feux ayant un impact significatif sur l'environnement

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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.

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 on 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 the following URL: 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.

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. This problem is severe, not only in industrialized regions, but also in less developed, predominantly agricultural areas where people depend on biomass as fuel for cooking, heating and lighting.

General awareness of the fact that fires can present acute 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 limited number of examples of emissions associated with various types of fires which could be expected to affect the environment adversely. These examples should not be considered as describing typical observations as fires and fire impacts are generally not comparable.

The serious consequences of such events have confirmed that the environmental impact of fires is an international issue that urgently needs to be dealt with globally and systematically. The ISO 26367 series of International Standards provides a framework for a common treatment of the environmental impact of fires in answer to this pressing need.

This document provides methods for the compilation of relevant data for assessing damage after a fire and for use in environmental fire hazard and risk assessments.

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 be obtained from real-scale fire tests and simulations involving physical fire models.

The Sixth EC Environmental Action Programme, Environment 2010: Our Future, Our Choice spells out the objective of controlling levels of man-made chemicals so that they do not give rise to significant adverse impacts on human health or the environment[1]. In the case of eco-toxicity indicators, toxicity impact potential (TIP) characterization factors are used and are often developed using a multimedia environmental fate model to predict the movement and distribution of a given substance in environmental regions of interest[2].

In the case of organohalogen compounds that are known to have natural as well as man-made sources, TIP characterization can be difficult, a fact acknowledged by the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) in quality status report, QSR 2000, as follows: “Many substances occur naturally in soils, plants and animals. It is therefore important to distinguish between the natural concentrations and fluxes of these substances and the extent to which they are augmented by human activities. Such distinctions are essential if informed decisions are to be made regarding the management of contaminants”[3].

This document is principally intended for use by the following parties: environmental regulatory authorities, fire fighters and investigators, storage facility operators, materials and product manufacturers, property owners, and public health authorities.

Guidelines for assessing the adverse environmental impact of fire effluents —

Part 2: Methodology for compiling data on environmentally significant emissions from fires

1 Scope

This document specifies a methodology for compiling the information needed to assess the environmental damage caused by a fire incident. This includes conducting a site reconnaissance, establishing data quality objectives and designing sampling programmes. This document 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. This document does not include specific instruction on sampling and analysis of fire effluents. Sampling and analysis are the focus of a future document in the ISO 26367 series.

This document is applicable to uncontrolled fires, including fires in commercial and domestic premises, unenclosed commercial sites, agricultural storage sites, wildland and forest fires, as well as fires involving road, rail and maritime transport systems.

This document focuses on the fire effluents that are environmentally significant, including pollutants causing short-term effects (e.g. pollutants causing biotope damage and components of smog) and long-term effects (e.g. persistent organic pollutants, POP). Since it is not possible to treat all potential pollutants that could be found in fire effluents in a single document, a list of those pollutants specifically addressed in this document is given below:

a) pollutants with short-term effects: halogenated acids (HX), metals, nitrogen oxides (NOx), particulates, and sulfur oxides (SOx);

b) pollutants with long-term effects: metals, particulates, perfluorinated compounds (PFC), polyaromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and polyhalogenated dioxins and furans (PXDD/PXDF).

The reporting template provided in Annex D proposes additional potential pollutants and indicators for inclusion in the compilation. Not all of the pollutants and indicators listed in Table D.1 are relevant to every fire site, and others not mentioned in the table can apply.

This document does not include direct acute toxicity issues on humans, which are covered by other standards, such as ISO 13344 and ISO 13571.

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 5667-1, *Water quality — Sampling — Part 1: Guidance on the design of sampling programmes and sampling techniques*

ISO 5667-20, *Water quality — Sampling — Part 20: Guidance on the use of sampling data for decision making — Compliance with thresholds and classification systems*

ISO 10381-1, *Soil quality — Sampling — Part 1: Guidance on the design of sampling programmes*

ISO 11771, *Air quality — Determination of time-averaged mass emissions and emission factors — General approach*

ISO 13943, *Fire safety — Vocabulary*

ISO 14050, *Environmental management — Vocabulary*

ISO 26367-1:2011, *Guidelines for assessing the adverse environmental impact of fire effluents — Part 1: General*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943, ISO 14050, and ISO 26367-1 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 http://www.iso.org/obp

3.1
acute
sharp or severe in effect, generally used in reference to human health effects

3.2
chronic
continuing over a long time period or recurring at low levels frequently, generally used in reference to human health effects

3.3
congener
<chemistry> related chemicals

EXAMPLE A derivative or an element in the same group of the periodic table.

3.4
dioxin
family of halogenated organic compounds, the most common consisting of polychlorinated dibenzofurans (PCDF) and polychlorinated dibenzodioxins (PCDD), although brominated dioxins and furans are also important

Note 1 to entry: The term polyhalogenated dioxin and furan (PXDD/PXDF) includes any halogen.

Note 2 to entry: Dioxins are among the most toxic substances known to man[6].

3.5
halogenated acid
HX
molecule consisting of a positively charged hydrogen atom ionically bonded to a negatively charged halogen atom

Note 1 to entry: Includes hydrogen fluoride (HF), hydrogen chloride (HCl), and hydrogen bromide (HBr).

3.6
long-term effect
impacts occurring after a fire, over a period of years

3.7
perfluorinated compound
PFC
organofluorine compound containing only carbon-fluorine bonds, carbon-carbon bonds, and other heteroatom bonds, but not carbon-hydrogen bonds

Note 1 to entry: Perfluorooctane sulfonate (also known as Perfluorooctane sulfonic acid, PFOS) and Perfluorooctanoic acid (PFOA) belong to this group of compounds. PFOS and PFOA were recently included in certain fire-fighting foams, but are now replaced in many cases with other organofluoride compounds.

Note 2 to entry: PFOS and PFOA are both perfluorinated alkyl acids (PFAA) compounds, which is a sub-group to the PFC group. The replacement substances for PFOS and PFOA are included in the broader group of poly and perfluorinated alkylic substances (PFAS).

3.8
persistent organic pollutant
POP
chemical substance that persists in the environment, bio-accumulates through the food web, poses a risk of causing adverse effects to human health and the environment, and can be subject to long range transport away from its original source

Note 1 to entry: Substances are classified as POPs according to either The Protocol to the regional UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP) on POPs, opened for signatures in June 1998 and entered into force on 23 October 2003 or the global Stockholm Convention on POPs, opened for signatures in May 2001 and entered into force on 17 May 2004.

3.9
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.

3.10
polycyclic aromatic hydrocarbon
PAH
hydrocarbon containing two or more aromatic rings

Note 1 to entry: PAHs constitute a complex group. They can be divided into two subclasses, the carcinogenic and the non-carcinogenic. See C.1.

3.11
short-term effect
impacts occurring after a fire, over the period of a few minutes to a few days

3.12
toxic equivalent
TEQ
weight of the toxicity of the less toxic compounds in a group expressed as fractions of the toxicity of the most toxic compound

Note 1 to entry: Each compound in a TEQ scheme is attributed a specific toxic equivalency factor (TEF). This factor indicates the degree of toxicity compared to the most toxic compound, which is given a reference value of 1. More information is found in Reference [7].

4 Use of this document and prerequisites

4.1 Use of this document

This document is intended to assist individuals and organizations in compiling information about a fire incident and the affected area, which can later be used to assess the adverse environmental impact of emissions from fires. This is best done when comparing data with information collected prior to the fire (baseline data) that includes reference pollutant concentrations. This document is flexible in its application due to the wide range of conditions that can be encountered. The extent of the compilation depends on the intended use of the compilation.

4.2 Prerequisites

In cases where objective, validated information is not available, the user of this methodology should exercise professional judgement in evaluating the fire, establishing data quality objectives, designing sampling programmes, and interpreting the results. For this reason, individuals performing the work should be environmental professionals or should work under the responsible supervision of an environmental professional.

5 Identification of data needs

5.1 Data quality objectives

Prior to initiating a sampling programme, the objectives of the sampling work shall be clearly stated and shall include the following components.

— A concise statement of the problem, including the identification and roles of key decision makers and technical specialists involved in the work.

— The identification of the status of the affected area. Examples include such areas as farm land, drinking water supplies, endangered habitat, and other sensitive biotopes.

— The identification and prioritization of possible decisions that should be made in order to carry out the work. A list of questions that require decisions provides a basis for identifying the decisions. Example questions are: Which environmental phases are affected by fire effluents? What are the remediation requirements? What are the pollutant concentrations? Does the sampling and analysis process have time constraints? Will monitoring be necessary?

— The data requirements that will resolve each of the decisions identified above.

— A definition of boundaries. The boundaries can be spatial, temporal, demographic, regulatory, political, or economic in nature.

— Statements that describe the logical basis for choosing how the sample data will be compared to reference contamination concentrations or other values, which decisions will be made regarding the results of this comparison, and what subsequent actions will be taken based on the decisions.

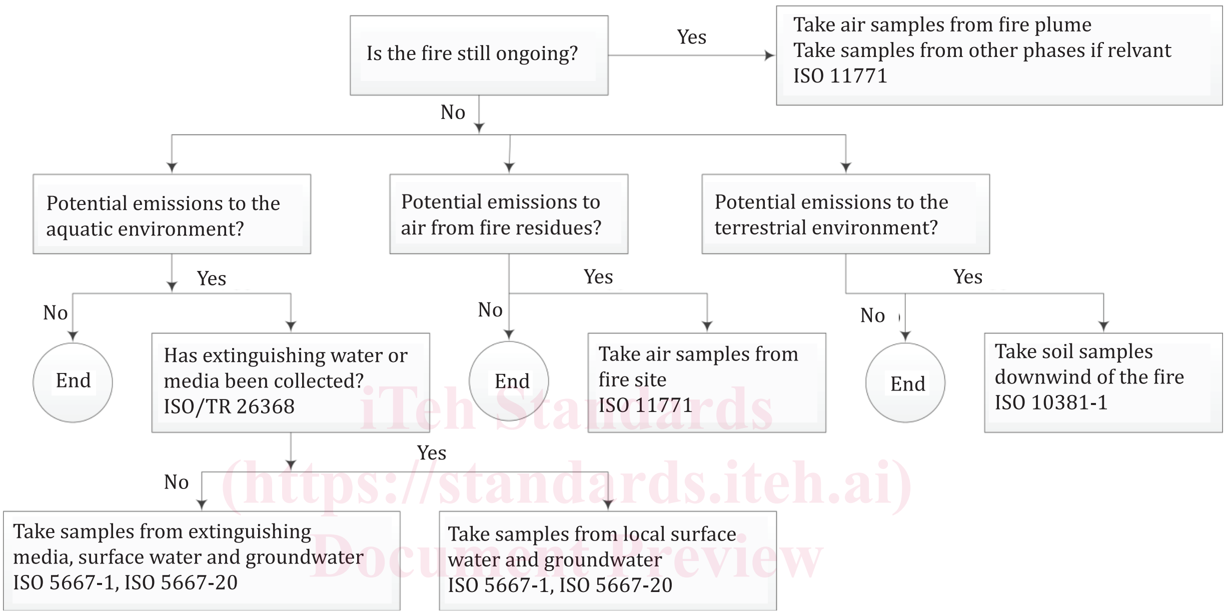
— Specifications that establish the acceptable degree of uncertainty for each decision.

— An optimized sampling design based on the results of the previous steps.

NOTE See the Bibliography for documents that provide further information about developing effective data quality objectives.

5.2 Sampling programme design

5.2.1 The extent of the fire plume zone, the plume deposition zone, and the transport of pollutants into the environment determine the need for and location of sampling and analysis in the assessment of the environmental impact. The flow chart shown in Figure 1 shall be used, together with the steps listed in 5.1 and Clause 6, to determine the type of samples to be collected.



NOTE The International Standards referenced in the boxes in Figure 1 provide useful information about the development of sampling programmes. See Clause 2 or the Bibliography for the full document title.

Figure 1 — Decision flow chart for environmental sampling with reference to the relevant International Standards

5.2.2 The selection and optimization of the sampling programme design is an iterative process that can begin with several sampling programmes that are evaluated against practical, statistical, and cost considerations. The final sampling programme shall be capable of satisfying each of the data quality objectives established in 5.1.

NOTE See the Bibliography for documents that provide further information and practical guidance on the selection and optimization of sample designs.

5.2.3 ISO 5667-1 and ISO 5667-20 shall be consulted for further information about the design of sampling programmes for water, including surface water, groundwater, waste waters, sludges, effluents and bottom deposits.

5.2.4 ISO 11771 shall be consulted for further information about the design of sampling programmes for air and fire plumes.

5.2.5 ISO 10381-1 shall be consulted for further information about the design of sampling programmes for soil and related material.

NOTE Emissions to air from residues can be significant after the fire has been extinguished.

5.2.6 Measurement of the natural level of the pollutants of interest in the vicinity of the fire shall be included in the sampling programme.

5.2.7 Measurement of natural levels of airborne pollutants shall be conducted upwind of the fire plume zone.

5.2.8 Measurement of natural levels of soil, standing water, and groundwater pollutants shall be conducted upwind of the plume deposition zone.

5.2.9 Measurement of natural levels of flowing water pollutants shall be conducted upstream of the plume deposition zone.

NOTE 1 The fire plume zone and fire deposition zone are described in ISO 26367-1:2011, Clause 4.

NOTE 2 Detailed guidance on sampling and analysis techniques is outside the scope of this document and will be the focus of a future document in the ISO 26367 series.

6 Selection of pollutants

6.1 General

6.1.1 The environmental professional conducting the work shall select the pollutants to be included in the compilation.

6.1.2 Pollutants that either typically occur as a result of fire or are particularly harmful to the environment are listed in 6.2. The environmental professional conducting the work shall consider whether to include these pollutants in the compilation and shall provide justification for excluding them.

NOTE Certain pollutants/indicators can be judged irrelevant by the environmental professional conducting the compilation, depending on the firefighting tactics used or the specific materials known to be involved in the fire.

6.1.3 If the environmental professional conducting the work has reason to believe that pollutants having a potentially significant impact on the environment are present at the incident site, other than those listed in Table 1 to Table 3, these pollutants shall be included in the compilation.

NOTE 1 Examples of fire incidents where pollutants other than those listed in Table 1 to Table 3 can be significant include warehouse fires, industrial fires, and vehicle fires, among others.

NOTE 2 Due to the inherent differences between fire incidents, it is not possible to anticipate the presence of every potential pollutant. An extensive list is provided in Table D.1 and can be used as a basis for selection of relevant pollutants. Additional space at the bottom of each category in Table D.1 is provided if a pollutant of interest is not on the list; alternatively, the tables can be expanded.

6.2 Indicators and pollutants

6.2.1 Fire effluent 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 shall be included in the compilation or justification for their exclusion shall be given.

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 (luminescent bacteria)	Surface water

NOTE Oil is often used as a screening parameter for contaminated areas. There are different methods that include different ranges of hydrocarbons.

6.2.2 The pollutants listed in Table 2 are associated with short-term adverse effects on the environment and shall be included in the compilation or justification for their exclusion shall be given.

Table 2 — Pollutants associated with short-term effects

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 B.1 on pollutants having short-term effects.

6.2.3 The pollutants listed in Table 3 are associated with long-term adverse effects on the environment and shall be included in the compilation or justification for their exclusion shall be given.

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)	Surface water, groundwater, sediment, soil
Polychlorinated biphenyls (PCB)	Surface water, groundwater, sediment, soil
Polychlorinated dibenzodioxins (PCDD)	Air, deposition on surface water and soil, sediment
Polychlorinated dibenzofurans (PCDF)	Air, deposition on surface water and soil, sediment
Polycyclic aromatic hydrocarbons (PAH)	Air, deposition on surface water and soil
Volatile organic compounds (VOC)	Air, surface water, groundwater, sediment, soil

In some cases, other species should be considered, depending on the suspected substances in the fuel. See B2.

6.3 Documentation of procedures

6.3.1 Each testing procedure used to physically measure concentrations of pollutants in fire effluents shall be identified, including a reference to the relevant standard and the version or year it was updated.

6.3.2 The natural level of pollutants in the fire incident area shall be established.

6.3.3 An indication shall be made as to whether the testing procedures are used to measure concentrations from samples or *in situ*.

6.3.4 The uncertainty of each pollutant concentration shall be indicated, including the natural concentration level, as well as the method by which the uncertainty was determined.

NOTE 1 For information about uncertainty calculations, see ISO 10576-1[45], ISO 21748[47], ISO/IEC Guide 98-1[48], and ISO/IEC Guide 98-3[49].

NOTE 2 Predictive methods can be employed, either as standalone models or based on empirical physical measurements of key pollutants, in cases where it is not feasible to make physical measurements of each pollutant of interest.

NOTE 3 Additional background information is provided in B.3 on comparison models for pollutants.

6.3.5 If modelling is performed, the modelling method used for each pollutant shall be clearly identified, including a reference to its source and the version or year it was updated.

6.3.6 The pollutants shall be assembled into a compilation that includes at least the following data for each sample collected or *in situ* measurement location:

— the species or compound of interest;

— the environmental phase (air, surface water, groundwater, sediment, soil) in which the sample is collected or measured;

— the units of measurement or prediction;

— the measured or predicted value;

— the measurement or prediction uncertainty;

— the sampling method used, including reference;

— the physical measurement technique and/or testing procedure used, including reference and indication of sample or *in situ* measurement;

— the predictive model used, including reference;

— the natural concentration of the pollutant;

— the uncertainty of the natural concentration level;

— the reference level or range;

— the reference level uncertainty;

— the reference level source citation.

7 Reporting

7.1 Intent of the report

The compilation of environmentally significant emissions from fires shall include all components required by Clause 6. The general reporting scheme described in 7.2 to 7.6 shall be employed to the

