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Health and safety in welding and allied processes — Sampling of airborne particles and gases in the operator's breathing zone —

Part 2: Sampling of gases

Hygiène et sécurité en soudage et techniques connexes — Échantillonnage des particules en suspension et des gaz dans la zone respiratoire des opérateurs —

Partie 2: Échantillonnage des gaz

Reference number
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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 document 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 44, *Welding and allied processes*, Subcommittee SC 9, *Health and safety*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding and allied processes*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 10882-2:2000), which has been technically revised.

The main changes are as follows:

— references to other documents have been updated;

— position of the personal sampler has been changed.

A list of all parts in the ISO 10882 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. Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: https://committee.iso.org/sites/tc44/home/interpretation.html.

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Introduction

Gases encountered during welding and allied processes are so numerous that it would be impracticable to cover them all in this document. Depending on the process, they can include:

a) fuel gases which are used in gas welding and cutting, which on combustion produce carbon dioxide and, in some instances, carbon monoxide;

b) shielding gases, such as argon, helium, carbon dioxide or mixtures of these gases, which can be toxic or asphyxiant;

c) gases produced by the action of heat upon the welding flux or slag, e.g. carbon dioxide and carbon monoxide;

d) gases produced by the action of heat or ultraviolet radiation upon the atmosphere surrounding the welding arc, e.g. nitric oxide, nitrogen dioxide and ozone;

e) vapours produced as a result of thermal degradation of surface coatings in the welding or cutting of metals treated with paint, primer, sealer or other substances. Vapours can also be produced as a result of degradation of solvent vapour from degreasing operations, but their measurement is not dealt with in this document because good working practices will avoid their production.

The scope of this document has been limited to those gases which are produced by welding operations. In particular, fuel, oxidant and shielding gases used in welding and allied processes are not covered, since the hazards associated with their use (e.g. asphyxiation, explosion) are different from those arising from the gases dealt with in this document.

This document gives a generalised description of measurement methods suitable for the assessment of personal exposure to gases produced by welding and allied processes; gives details of relevant European Standards which specify required characteristics, performance requirements and test methods; augments guidance provided in EN 689 on assessment strategy and measurement strategy; lists basic sampling requirements; and provides specific information about the availability of direct reading electrical apparatus, detector tubes and indirect methods involving laboratory analysis for individual gases.

It has been assumed in the drafting of this document that the execution of its provisions, and the interpretation of the results obtained, is entrusted to appropriately qualified and experienced people.

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Health and safety in welding and allied processes — Sampling of airborne particles and gases in the operator's breathing zone —

Part 2: Sampling of gases

1 Scope

This document provides guidance and specifications for the determination of personal exposure to gases and vapours in welding and allied processes. It applies to the following thermal processes used to join, cut, surface or remove metals:

(111) Manual metal arc welding (metal arc welding with covered electrode); shielded metal arc welding /USA/

(114) Self-shielded tubular-cored arc welding

(131) Metal inert gas welding; MIG welding; gas metal arc welding /USA/

(135) Metal active gas welding; MAG welding; gas metal arc welding /USA/

(136) Tubular-cored metal arc welding with active gas shield; flux cored arc welding /USA/

(137) Tubular-cored metal arc welding with inert gas shield; flux cored arc welding /USA/

(141) Tungsten inert gas arc welding; TIG welding; gas tungsten arc welding /USA/

(15) Plasma arc welding;

(31) Oxy-fuel gas welding; oxy-fuel gas welding /USA/

(52) Laser beam welding;

(912) Flame brazing; torch brazing /USA/

(97) Braze welding;

— arc and flame gouging;

— arc and laser cutting processes;

— flame and plasma cutting processes;

— metal-spraying (see ISO 4063).

The following gases and vapours which can be produced or be present during welding and allied processes are covered:

— ozone (O_3);

— carbon monoxide (CO);

— carbon dioxide (CO_2);

— nitric oxide (NO) and nitrogen dioxide (NO_2);

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— vapours produced in the welding or cutting of metals having paint or other surface coatings.

Fuel, oxidant and shielding gases used in welding and allied processes are not covered.

The general background level of gases and vapours in the workplace atmosphere influences personal exposure, and therefore the role of fixed-point measurements is also considered.

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 10882-1:2024, *Health and safety in welding and allied processes — Sampling of airborne particles and gases in the operator's breathing zone — Part 1: Sampling of airborne particles*

EN 482, *Workplace exposure — Procedures for the determination of the concentration of chemical agents — Basic performance requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10882-1 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 General terms

3.1.1
work pattern
sequence of activities carried out by the worker during the period under consideration

3.1.2
workplace
designated area or areas in which the work activities are carried out

[SOURCE: ISO 18158:2016, 2.1.6.2]

3.2 Measurement terms

3.2.1
diffusive detector tube
diffusion tube, similar in construction to a pumped detector tube

Note 1 to entry: The length of the stain produced provides a measure of the exposure dose of a specified chemical agent in air, stated in ppm hours.

3.2.2
pumped detector tube
glass tube containing chemical reagents in which a colour change can be produced when a sample of the atmosphere is drawn through it

Note 1 to entry: The length of the stain produced provides a measure of the concentration of a specified chemical agent in air.

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3.2.3
diffusion tube
diffusive tube
tube type diffusive sampler
diffusive sampler with a cross-sectional area which is small in relation to the internal air gap, across which the gas or vapour passes by diffusion to the sorbent

3.2.4
diffusive badge
badge type diffusive sampler
passive badge
diffusive sampler in which the gas or vapour passes to the sorbent by permeation through a thin solid membrane or diffusion across a porous membrane

Note 1 to entry: The cross-sectional area is large in relation to the internal air gap.

3.2.5
diffusive sampler
passive sampler
device which is capable of taking samples of gases or vapours from the atmosphere at a rate controlled by a physical process such as gaseous diffusion through a static air layer or permeation through a membrane, but which does not involve the active movement of air through the sampler

[SOURCE: EN 838]

3.2.6
direct reading electrical apparatus
direct reading instrument
apparatus in which the presence of a gas or vapour causes a change that is manifest as an automatically generated electrical signal

Note 1 to entry: When applied to a calibrated indicating or recording meter, this gives a direct measure of the concentration of the relevant gas or vapour.

3.2.7
fixed apparatus
apparatus which is intended to have all parts permanently installed

[SOURCE: EN 45544-1]

3.2.8
interferent
constituent of the (air) sample or other aspect of the sampling or analytical procedure having an adverse effect on the accuracy of the measurement

Note 1 to entry: Interferents can include components of sampling or analysis equipment or reagents.

[SOURCE: ISO 18158:2016, 2.3.6]

3.2.9
long-term detector tube
detector tube that provides a means of obtaining a measurement of the time-weighted average concentration of a specified chemical agent in air

3.2.10
portable apparatus
spot reading or continuously sensing apparatus that has been designed to be readily carried from place to place and to be used while being carried

Note 1 to entry: Portable apparatus is battery powered.

[SOURCE: EN 45544-1]

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3.2.11
screening measurements of variation of concentration in time
measurements performed to provide information on the likely pattern of concentration of chemical agents

Note 1 to entry: They can be used to identify locations and periods of elevated exposure and to set the duration and frequency of sampling for measurements for comparison with occupational exposure limit values.

Note 2 to entry: Emission sources can be located and the effectiveness of ventilation or other technical measures can be estimated.

3.2.12
short-term detector tube
detector tube that provides a means of obtaining a rapid measurement (typically up to 15 min) of the concentration of a specified chemical agent in air

[SOURCE: ISO 17621:2015, 3.2, modified — Definition revised and note to entry removed.]

3.2.13
sorbent tube
sampling device, usually made of metal or glass, containing a collection substrate such as a sorbent or a support impregnated with reagent, through which sampled air passes

Note 1 to entry: Some sorbent tubes are intended for use as active samplers and some as passive samplers.

[SOURCE: ISO 18158:2016, 2.2.2.5]

3.2.14
transportable apparatus
apparatus not intended to be portable, but which can be readily moved from one place to another

[SOURCE: EN 45544-1]

3.2.15
worst-case measurements
screening measurements of time-weighted average concentration made to identify work activity during which highest exposure occurs

3.3 Welding terms

3.3.1
welding episode
period during which the operator carries out welding and allied processes, including welding-related operations, except when these generate a significant quantity of airborne particles, for example during lengthy periods of grinding

3.3.2
welding protector
device which provides protection to the wearer from harmful optical radiation and other specific hazards generated by welding and allied processes

EXAMPLE Welder's shield, welder's goggles or welder's spectacles.

3.4 Analytical terms

3.4.1
bias
estimate of systematic measurement error

[SOURCE: ISO 18158:2016, 2.4.3.1, modified — Note 1 to entry removed.]

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3.4.2
selectivity
degree of independence from interferents

[SOURCE: EN 482]

3.4.3
true value
value which characterizes a quantity or quantitative characteristic perfectly defined in the conditions which exist when that quantity or quantitative characteristic is considered

Note 1 to entry: The true value of a quantity or quantitative characteristic is a theoretical concept and, in general, cannot be known exactly. In practice, a reference value is commonly accepted as the true value.

[SOURCE: ISO 18158:2016, 2.4.3.10]

3.4.4
overall uncertainty
<of a measuring procedure or instrument> quantity used to characterize as a whole the uncertainty of the result given by an apparatus or a measuring procedure

Note 1 to entry: It is expressed, as a percentage, by a combination of bias and precision, usually according to the formula:

$$\frac{\left|\overline{x} - x_{\text{ref}}\right| + 2s}{x_{\text{ref}}} \times 100$$

where

$\overline{x}$ is the mean value of results of a number (n) of repeated measurements;

x_{ref} is the true or accepted reference value of concentration;

s is the standard deviation of measurements.

4 Description of measurement methods

4.1 General

Personal exposure to gases and vapours in welding and allied processes is generally determined using:

— direct reading electrical apparatus;

— detector tubes (short term or long term); or

— indirect methods involving laboratory analysis.

Direct reading electrical apparatus or detector tubes are generally most applicable for measurement of gases. Indirect methods, which involve laboratory analysis of samples collected using a suitable solid or liquid sorbent, are most applicable for the determination of vapours which can be produced in the welding or cutting of metals having paint or other coatings.

A complex mixture of particulates and gases is produced in welding and allied processes and, whatever method of analysis is selected, it is necessary to confirm that techniques which have possibly been used successfully in other applications are suitable for the welding situation.

In selecting any of the methods described, due regard should be paid to the possibility of interference with the determinations of one gas or vapour by the presence of another, which could result in either enhancement or reduction of the result.

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